REPORT OF THE SUPERINTENDENT

OF THE

COAST AND GEODETIC SURVEY

SHOWING

THE PROGRESS OF THE WORK

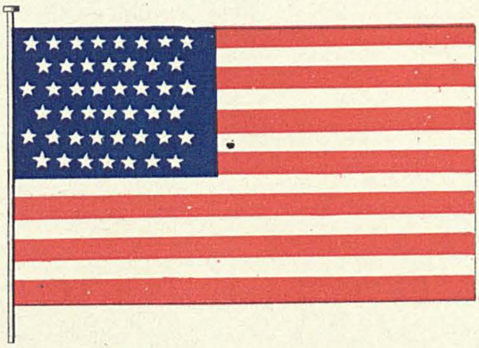
FROM

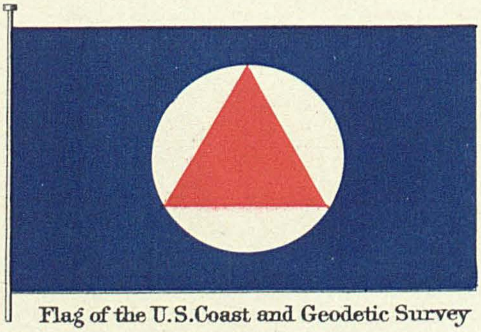
JULY 1, 1898, TO JUNE 30, 1899.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

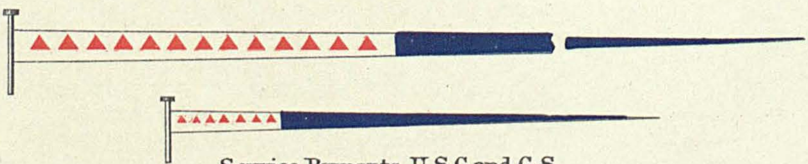
National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

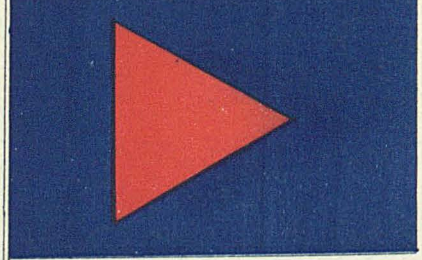




Flag of the U. S. Coast and Geodetic Survey



Service Pennants, U. S. C. and G. S.



Flag of the Superintendent, U.S.C. and G.S.

Flag of the Secretary of the Treasury.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

LETTER

FROM

THE SECRETARY OF THE TREASURY

TRANSMITTING

The report of the Superintendent of the United States Coast and Geodetic Survey.

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., December 22, 1899.

SIR: In compliance with the requirements of section 4690, Revised Statutes, I have the honor to transmit herewith, for the information of Congress, a report addressed to this Department by Dr. Henry S. Pritchett, Superintendent of the Coast and Geodetic Survey, showing the progress made in that work during the fiscal year ended June 30, 1899, and accompanied by maps illustrating the general advance in the operations of the Survey up to that date.

Respectfully, yours,

L. J. GAGE, *Secretary.*

The PRESIDENT OF THE SENATE.

LETTER

FROM THE

SUPERINTENDENT OF THE UNITED STATES COAST AND GEODETIC SURVEY

SUBMITTING HIS

Annual Report for the fiscal year ended June 30, 1899.

UNITED STATES COAST AND GEODETIC SURVEY,
Washington, D. C., December 21, 1899.

SIR: In conformity with law and with the regulations of the Treasury Department, I have the honor to submit herewith, for transmission to Congress, the annual report of progress in the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899. It is accompanied by maps illustrating the general advance in the field work of the Survey up to that date.

Respectfully, yours,

HENRY S. PRITCHETT,
Superintendent.

The Honorable the SECRETARY OF THE TREASURY.

CONGRESSIONAL ACTION IN REGARD TO THE COAST AND GEODETIC SURVEY.

ACT OF CONGRESS AUTHORIZING THE SURVEY OF THE COAST.

ACT OF FEBRUARY 10, 1807.

AN ACT to provide for surveying the coast of the United States.

SECTION 1. *Be it enacted, etc.*, That the President of the United States shall be, and he hereby is, authorized and requested to cause a survey to be taken of the coasts of the United States, in which shall be designated the islands and shoals, with the roads or places of anchorage, within twenty leagues of any part of the shores of the United States; and also the respective courses and distances between the principal capes or headlands, together with such other matters as he may deem proper for completing an accurate chart of every part of the coasts within the extent aforesaid.

SEC. 2. That it shall be lawful for the President of the United States to cause such examinations and observations to be made with respect to Saint Georges Bank, and any other bank or shoal, and the soundings and currents beyond the distance aforesaid to the Gulf Stream, as in his opinion may be especially subservient to the commercial interests of the United States.

SEC. 3. That the President of the United States shall be, and he is hereby, authorized and requested, for any of the purposes aforesaid, to cause proper and intelligent persons to be employed, and also such of the public vessels in actual service, as he may judge expedient, and to give such instructions for regulating their conduct as to him may appear proper, according to the tenor of this act.

THE COAST SURVEY REPORT AS DEFINED BY LAW.

REVISED STATUTES—1878.

TITLE LVI.

THE COAST SURVEY.

SECTION 4690. The Coast Survey report shall be submitted to Congress during the month of December in each year, and shall be accompanied by a general chart of the whole coasts of the United States, on as large a scale as convenient and practicable, showing, as near as practicable, the configuration of the coasts, and showing, by lines, the probable limits of the Gulf Stream, and showing, by lines, the probable limits to which the soundings off the coast will extend, and showing, by the use of colors and explanations, the exact portions of our coasts of which complete charts have been published by the Coast Survey; also, showing such other parts of the coasts of which the triangulation, the topography, and the soundings have been completed, but not published, and, also, such parts of the coasts of which the triangulation and topography, or the triangulation only, have been completed.

PREFACE.

The entire field of activity of the United States Coast and Geodetic Survey may be classified under the following synopsis, which outlines the scope of work down to matter of regular routine. In the general statement of progress made during the past fiscal year the subject is treated in the order stated. This analysis of the Survey's operations will enable the reader to understand the actual life of the organization in a short time and in a space as restricted as the importance of the matter will permit. Further detail, both in office and field work, may be found in the appendices, where, for the sake of continuity of narration, all the operations of individual parties in the several localities are better disposed of in a continuous statement.

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INTRODUCTION.

The present volume is the Sixty-Eighth Annual Report issued by this Bureau. The subject-matter is treated in two parts, the first pertaining to the office work, and the second describing the field operations. The office work is considered under four heads—Administration, Technical divisions, Publication, and Weights and Measures. The field work is described under Land operations and Sea operations.

During the latter part of the fiscal year 1899, by authority of the Honorable Secretary of the Treasury, a reorganization of the principal duties in the office and field was made. The position of Assistant Superintendent was created, to be filled by an officer charged with the executive details of the Survey, and who should act for the Superintendent in his absence.

Next in authority to the Assistant Superintendent is the Assistant in Charge of Office, who directs the general routine of the technical divisions of the Office.

All the operations in the field were classified into three grand divisions—(1) Hydrography and Topography, (2) Geodesy, and (3) Magnetism. Inspectors, charged with the supervision of these special lines of work, were appointed.

In order that the duties of the hydrographic force of the Survey might be more clearly defined, the Honorable Secretary of the Treasury promulgated certain orders as to the particular duties of vessel commanders, and in connection therewith authority was given to adopt special ensigns which should be used on proper occasions.

There are now in use on the Coast and Geodetic Survey vessels the following flags (see frontispiece):

The national ensign.

Flag of the Secretary of the Treasury.—A white ground, with seal of the Treasury Department, of blue, in the center.

Flag of the Superintendent of the Coast and Geodetic Survey.—A red triangle, apex forward, in a blue field.

United States Coast and Geodetic Survey flag (service flag).—A red triangle, base down, in a white circle, on a blue field.

United States Coast and Geodetic Survey pennants.—A union of red triangles, base down (13 for the larger and 7 for the smaller size), on a white field one-fourth the length of the pennant, the remaining three-fourths of its length to be blue.

GENERAL ADMINISTRATION.

This subject may be logically described under two heads—(1) that pertaining to duties, and (2) personnel.

Duties.—As before mentioned, the reorganization of the Survey involved the establishment of five distinct positions relating to the office and field work.

The Assistant Superintendent has charge of the details of instructions to field parties, prepares the allotments for approval by the Superintendent, and has general supervision of the field work in its larger details.

The Assistant in Charge of the Office has under his immediate direction the technical divisions. They are occupied with the computation and arrangement, for public use, of the results as they come from the field. This staff answers calls for information, whether they proceed from outside parties or from the officers of the Survey, requiring data for the prosecution of their immediate operations. The charge of the general property is also in the hands of the Assistant in Charge, as well as the inventories of the instruments belonging to the Survey.

The Inspector of Hydrography and Topography has general supervision of the field parties in this particular line. He inspects, from time to time, the actual operations, prepares detailed instructions for the further prosecution of the work, and has immediate direction of the maintenance and repairs of the vessels.

The Inspector of Geodesy supervises the details of field geodesy, and is at the same time Chief of the Computing Division, where the results of geodetic field measures are worked up and put in proper form for publication. He inspects, from time to time, the actual field work, visiting for this purpose the parties in different sections of the country in order to see and criticise, through actual contact, the methods that are employed in the routine of field work.

The Inspector of Magnetic Work has charge of the field operations in this branch of investigation, and directs the computations incident thereto. He inspects, from time to time, the different parties in the field, has charge of the magnetic observatories, and submits detailed plans for the prosecution of the work to the Superintendent for his approval.

Personnel.—The total number of persons employed in the Office, for which provision was made in the sundry civil bill approved July 1, 1898, was as follows:

Office force:		
Disbursing agent	1	
Chief librarian	1	
Clerical force	15	
Chart correctors, writers, etc	14	
Draftsmen	16	
Computers	13	
Engravers	17	
Electrotypers, photographers, instrument makers, etc	21	
Watchmen, messengers, etc	19	
		117
Field force:		
Assistants	40	
Aids	8	
		48
Total civilian office and field employees		165

To the above are to be added 2 petty officers and 316 sailors on duty June 30, 1899, giving a grand total of 483 persons permanently employed in the Coast and Geodetic Survey during the fiscal year 1898-99, or regularly engaged in the work at the close of the year.

APPROPRIATIONS.

The sundry civil bill approved July 1, 1898, appropriated for the expenses of the Coast and Geodetic Survey the following amounts:

Office expenses:		
Instruments, materials and supplies, books, copperplates, electrotyping and photographing, engraving, printing, etc.		$28 500
Discussion and publication of observations		1 000
Salaries:		
Office force	$136 090	
Field force	95 680	
		231 770
Repairs and maintenance of vessels		25 000
Completing and outfitting steamer *Pathfinder*		80 000
Field expenses:		
Atlantic coast, etc.	$44 400	
Pacific coast, etc.	54 400	
Tides	5 000	
Offshore work	10 100	
State surveys	22 000	
California-Nevada boundary	10 000	
Navy travel	3 400	
Objects not named	4 000	
		153 300
Total		519 570
Expended by Navy Department:		
Pay and subsistence of petty officers and sailors		113 415
Salaries of naval officers		5 109
Total		638 094

The above statement does not include $100 000, deficiency act of January 28, 1898, surveys of Yukon and Copper rivers, and $5 000, deficiency act of July 7, 1898, publishing charts, portions of which appropriations were expended during the fiscal year 1898–99.

THE WORK OF THE YEAR.

The general results of the work of the Coast and Geodetic Survey for the fiscal year may be summarized under three heads—Field operations, Office computations, and Publication of results.

Field operations.—Surveying was carried on throughout the year in widely distributed localities, including Alaska. Work was continued on the ninety-eighth meridian, in Texas, Indian Territory, and Nebraska. Part of this was reconnoissance, but much was finished triangulation. Some lines of levels were also run in connection with this work. As noted in previous reports, these operations will serve as a basis for all the surveys of the Mississippi Valley, and will, besides, contribute to our knowledge of the size and shape of the earth. The immediate and greatest use of the work will no doubt be found in the aid it furnishes in the establishment of land surveys of high precision in the Central United States, but the information given by an arc of the magnitude here proposed is most valuable on the general subject of geodesy, and its measurement will be appreciated both by the governmental surveys of Europe and those of our own country.

The international latitude work, the supervision of which, by authority of the Honorable Secretary of the Treasury, was undertaken by the Superintendent of the Coast and Geodetic Survey, has been carried on to the extent of acquiring land and making preliminary arrangements. This work, of great value both from an astronomical and a geodetic standpoint, will be carried out at six stations distributed around the earth near the thirty-ninth parallel of north latitude, under the general direction of the International Geodetic Association, with Central Bureau at Potsdam, Germany. The Coast and Geodetic Survey Report for the next fiscal year will contain a description of the instruments used in this work, the methods of observation, and the results expected from its prosecution.

The California-Nevada boundary, which has been in hand for a number of years, but which was interrupted several times on account of lack of appropriations, was completed during the fiscal year just closed. A line 400 miles long, running from Lake Tahoe, on the thirty-ninth parallel, in a southeasterly direction to the Colorado River, has been established and temporarily marked. Not enough funds were available to mark the stations permanently, but it is believed, in view of the great advantages derived by the States of California and Nevada from a permanent location of the line by a disinterested service, and by officers skilled in this special kind of work, that the funds will be forthcoming from the State treasuries to permanently fix the geodetic points established by the survey.

General operations were continued on the Atlantic coast, at Portsmouth, New Hampshire; Marthas Vineyard, Massachusetts; Chesapeake Bay, and in Florida. On the Gulf, at Aransas Pass and Lake Maurepas. On the Pacific, at Grays Harbor, San Diego, San Pedro, and San Francisco.

Topography has been executed along the Atlantic and Pacific coasts, and in Alaska; in the latter locality, notably at the mouth of the Yukon and the Copper rivers. Extensive hydrographic and topographic operations have been carried on to determine the best route for ocean steamers entering the delta of the Yukon. The other gateways to the Klondike region have also received attention, and the mouth of the Copper River has been fully explored. The passes at the head of Lynn Canal and the adjoining region have been carefully mapped. More than 30 000 people in one year used this route to the gold regions, thus demonstrating the necessity of an accurate map. The town of Skagway increased from three buildings in August, 1897, to 700 in January, 1898, at which time the population numbered 3 000.

The transcontinental line of precise leveling has been carried forward toward the summit of the Rocky Mountains, and will be pushed forward to the Pacific coast as fast as means are available. Magnetic elements have been determined in many localities, and a careful study of the secular variation, of extreme interest to land surveyors, has been made in a number of places. Meridian lines, by means of which compasses may be tested, and standards of length for the purpose of verifying surveyors, chains, have been laid out at many county court-houses. The determination of the force of gravity, although not prosecuted continuously during the year, has received some valuable additions through the execution of this work at individual stations.

In connection with the regular work of the Survey, special duty has been performed in connection with the Mississippi River Commission, the establishment of chart agencies, hydrography on the Brunswick Bar, and during the year the Coast and

Geodetic Survey steamer *Pathfinder*, began its voyage from Washington to San Francisco. A full and more detailed account of this voyage, which was eminently successful in all respects, will appear in the next annual report.

The hydrographic work during the year was carried on on both the Atlantic and Pacific coasts, and at the mouths of the two greatest rivers in Alaska, the Yukon and the Copper. In both these localities valuable information was acquired bearing on the best way of entering the country, and finally arriving at the gold fields of the Klondike.

The work on the Brunswick Outer Bar, Georgia, already cited, was done by an officer of the Coast and Geodetic Survey, under the personal supervision of the Secretary of War. This survey was made with extreme care, since large interests both to the Government and to the contractor were involved.

The establishment of compass ranges on the coast of California, for the use of vessels, was an important piece of hydrographic work. Tidal observations were carried on wherever the hydrographic operations demanded it, and permanent gauges established at different parts of the United States and in Hawaii have furnished valuable data for the prediction of tidal phenomena.

Field operations were begun during the year in Porto Rico, and work was taken up at Ponce, on the south coast, and at San Juan, on the north. The data secured will tend to materially improve the existing charts covering the region surveyed.

The Coast and Geodetic Survey has been represented during the year at a magnetic conference held in England, at the meeting of the International Geodetic Association, in Germany, and at the American Association for the Advancement of Science, in this country. At all these places the delegates accredited from our service presented papers and took part in the discussions. Matters of interest and value in our line of work came up for action, and the presence of officers who were specialists in the subjects under discussion was conducive to mutual benefit.

Office computations.—The office work has been carried on as rapidly as possible, and the material furnished by the field parties has been put in shape and prepared for the use of the Survey and for the public. Numerous additions and supplements to the Coast Pilot have been prepared, predictions for the Tide Tables have been made, many charts have been corrected, and geodetic computations made.

The complete determination of the distance across the United States by a chain of triangles on the thirty-ninth parallel, has been effected. This great work, in hand for a quarter of a century, is now done, the computations are made, and a volume descriptive of it in all its phases is at the present time running through the press. The combination of this arc with that of the ninety-eighth meridian, in the Mississippi Valley, will form the backbone of a network which will subsequently cover the country and give to each State in the Union accurate geographical positions.

Publication of results.—Matter has been prepared for publication in the Annual Report of the Superintendent, in the Bulletins, Coast Pilot, Notices to Mariners, Tide Tables, and Special Publications. Besides these, which may be classified as textual publications, numerous charts have been published.

The Annual Report, besides giving a general account of the work of the Survey, contains in the appendices certain details that more fully illustrate the character of the operations. Special technical papers also appear as appendices, and these are issued separately and distributed to the public on request.

The Bulletins, which are intended to give early announcement of results, are issued as occasion demands. During the year elapsed several important ones have appeared, containing hydrographic notes and sailing directions in Alaskan waters.

The Coast Pilot is revised and kept up to date. Five supplements to the Atlantic and Gulf Coast volumes have been issued during the year.

The Notices to Mariners appear monthly, and give new information affecting the accuracy of the charts.

The Tide Tables contain data from which predictions can be made for about 3 000 home and foreign ports. The publication is of great value to the maritime interests, and is highly appreciated by the public.

Special publications are issued from time to time, as material for them accumulates. They bear consecutive numbers, and contain collated or original information of value and interest to the public. It is proposed to publish in the near future an atlas of the Philippine Islands, embodying more than 30 colored charts of the different parts of the group.

Of the total number of charts (83 197) issued during the year, about one-fifth (16 240) were furnished to the Hydrographic Office of the Navy Department, 34 210 were delivered to the sales agents, and 15 386 found their way to the Executive Departments of the Government. There were 19 new charts published, mostly by photolithography.

HENRY S. PRITCHETT,
Superintendent.

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GENERAL STATEMENT OF PROGRESS.

OFFICE AND FIELD WORK.

OFFICE WORK:

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GENERAL STATEMENT OF PROGRESS.

OFFICE WORK.

I. ADMINISTRATION.

A. SUPERINTENDENT'S OFFICE.

1. PLAN OF OPERATIONS.

a. General statement.

The plan of operations proposed at the beginning of the fiscal year has been executed as faithfully as circumstances permitted. On account of the great changes taking place on some parts of the shore, and also the long time elapsed since some of the surveys were made, it has been necessary to devote a large portion of the resources of the Bureau to resurveys. Coast and interior work have been carried on simultaneously. The Alaskan operations were prosecuted energetically during the short season available, and the results of the work in that locality have been of great importance. The land area around the mouth of the Yukon extends at least 25 miles west of the point given by the best maps existing up to the time of the recent surveys; the mouth of the Copper River has been carefully surveyed, which operation, however, was entirely a new piece of work. Hydrographic surveys and Coast Pilot investigations were kept up to date as closely as the means at disposal would permit.

b. Resurveys.

Prominent among the resurveys made during the year are those at Chesapeake Bay; Hudson River; Portsmouth Harbor, New Hampshire; and San Francisco, Cal. No work had been done on the upper part of Chesapeake Bay for nearly fifty years, and the changes taking place fully warranted a resurvey, even though the commercial improvements had not called for it. Both the topography and hydrography of the Hudson River from Spuyten Duyvil to Ardsley were executed again, on account of great changes which had taken place. Especially does the topographic sheet show great developments in the line of wharves and buildings. Portsmouth Harbor has had both a topographical and hydrographical survey, which was badly needed on account of the length of time elapsed since the previous work was done. The rapid development of San Francisco in the last half century has made it necessary to go over the work there, some of which was done fifty years ago.

c. New work.

The principal operations under the head of new work are: first, the triangulation along the ninety-eighth meridian; second, the topographic and hydrographic survey of Lake Maurepas, Louisiana; third, the primary triangulation in southern California, and, fourth, the Alaska work at the mouth of the Yukon and Copper rivers. All these pieces of work seem to be equally important, and parties were engaged upon them to as great an extent as they were available. The ninety-eighth meridian work will furnish data for the foundation of the survey of the Mississippi River Valley, and will also aid materially in determining the earth's size and shape. The survey of Lake Maurepas was called for in order to complete the sheet containing the Lake Pontchartrain work, which had just been finished, and in view of the commercial importance of the place. It has always been desirable since the inception of the Coast and Geodetic Survey work on the Pacific coast to develop a scheme of triangulation from Puget Sound, on the north, to the Mexican boundary, on the south. The work from San Francisco southward was done many years ago, and after a number of interruptions it was determined to push this work on to the southern limit of our domain, and thus lay the foundation for correct topographic and hydrographic surveys along the coast. This work was completed during the last fiscal year by an extension of the triangulation from Santa Cruz Island to the monument marking the boundary between Mexico and the United States.

The work in Alaska has been carried on by large and well-equipped parties. Assistant Pratt, operating at the mouth of the Yukon River, has almost completed the work from St. Michael to the lower entrance of the Yukon, including a survey of the Kwikpak and Kwiklok, to the head of the passes, besides making hydrographic examinations for a considerable distance off shore. The work of Assistant Ritter at the mouth of the Copper River consisted in the establishment, astronomically, of the town of Orca and several points farther inland, and the execution of a triangulation covering the entire mouth of the river and determining the important mountain peaks as far as seen.

The importance of an exhaustive magnetic map of the United States has made it necessary to establish a new division of the Bureau for the purpose of carrying on this work. This was done at the close of the fiscal year just past, and the operations in this line will now be carried on systematically and rapidly.

One of the most important duties of the Survey, at this time, is to increase our knowledge of the island of Porto Rico. The Coast and Geodetic Survey steamer *Blake* proceeded thither in the month of January, 1899, and remained about five months on the southern shore, making both topographic and hydrographic surveys of important points, notably Ponce. San Juan, on the northern shore, was also visited, and a hydrographic survey of the harbor made.

2. ORGANIZATION OF PARTIES.

a. Land.

The organization of the land parties has been practically the same as during previous years, except that the greater number of parties placed in the field, and the fewer available officers, necessitated the assumption by younger men of greater responsibility. The withdrawal from shore to sea duty of a number of assistants has had no appreciable effect, either on the output or character of the work.

b. Sea.

During the previous fiscal year 44 naval officers had been attached to the Coast and Geodetic Survey service. At the beginning of hostilities with Spain, or shortly thereafter, all these were detached, which depleted the list of available hydrographic officers for the time being. The effect of this movement was to bring out the latent forces of the personnel, and to demonstrate the elasticity of our resources. No great discontinuity in the hydrographic operations of the Survey occurred on account of the detachment of the naval officers, and at the present time both topographic and hydrographic demands are fully met. The requirements of the situation are adequately discharged, notwithstanding the sudden change in the complexion of the hydrographic parties.

3. ISSUE OF INSTRUCTIONS.

a. Geographical distribution.

During the entire year instructions were issued for the execution of field work to 96 parties. These were distributed, geographically, as follows: 36 in the Eastern Division of the United States; 9 in the Middle Division; 19 in the Western; and 8 in Alaska. Twenty-four parties were assigned to special duty in all parts of the United States, including Porto Rico, and also including representative duty in England and on the Continent of Europe.

b. Character of work.

The instructions issued during the year may be classified, as regards the character of work proposed, into twelve heads. Twelve parties were engaged in the execution of hydrography; 12 in the establishment and maintenance of tide gauges; 7 on topography; 7 on magnetism; 5 on precise leveling; 4 on reconnoissance; 3 on triangulation; 3 on astronomical determinations; 2 on gravity; and 2 on base lines. Besides these, 15 parties were engaged in combined operations, the prominent part of the work being hydrography, topography, and triangulation; but in some of the parties additional work was carried on, such as reconnoissance, tidal and current observations, precise leveling, astronomical determinations, the measurement of bases, and magnetic observations. The special duty performed is comprised in the instructions to 24 parties, and calls for a great variety of work, prominent among which may be mentioned representative duty; the construction, trial trip, and command of the steamer *Pathfinder;* the operations in Porto Rico; on the California and Nevada boundary; on the Mississippi River Commission, and in the inspection of chart agencies.

4. ALLOTMENT OF FUNDS.

The allotment of funds has been in accordance with what seemed to be a just division between the different sections of the country and the actual necessities of the work, after a careful study of the situation. In many cases economy was better served by devoting, for the time being, a somewhat larger sum to a particular locality than was strictly proportionate, in order that greater relative progress might be made than would otherwise be possible.

The largest item in the field expenses for the year was that of the Pacific coast. Fifty-four thousand four hundred dollars was allotted to this work. The head of the Lynn Canal and passes adjacent thereto were included in this item, but not the Yukon and Copper rivers, for which a separate appropriation, afterwards to be alluded to, was made. Forty-four thousand four hundred dollars was allotted to the Atlantic and Gulf coasts. State surveys, including magnetic observations, the establishment of meridian lines, lines of exact levels between the Atlantic and Pacific, required $22 000. The California and Nevada State boundary, work on which had been in progress for several years, was finished during the past year at an expense of about $10 000. Offshore hydrographic work, including compilation of the Coast Pilot, required an equal amount, and $5 000 was devoted to the subject of physical hydrography, including the study of harbors and bars, and tidal and current observations. Four thousand dollars was allotted to objects not named above, but which were found urgent in the prosecution of the survey. Three thousand four hundred dollars was paid for the expenses of officers and men of the Navy, on duty and for special service.

B. ACCOUNTING DIVISION.

1. DISBURSING SECTION.

The great bulk of the expenditures of this Survey are made by small field parties, in widely separated and often remote localities, distant from mail facilities. Very many of these expenses are for comparatively small sums, requiring many vouchers, but in spite of these conditions, which are not conducive to careful and exact accounts, not a single dollar was suspended or disallowed by the auditing office of the Treasury Department during the year. This is a high tribute to the integrity of the various chiefs of parties who expended the money in the field, and to the painstaking work of the employees in this office, for the scrutiny of the auditing office of the Treasury is exact and rigid.

The disbursements during the year show that of the total appropriations for all purposes (about $625 000), slightly more than one-third was devoted to salaries, and one-fourth was consumed by party expenses or field work proper. This last amount is independent of the special appropriation of $100 000 (deficiency act of January 28, 1898) for the Yukon and Copper rivers operations, and which was also available for boat construction, pilotage, transportation, etc. One-sixth of the total amount was utilized in the construction and outfit of a new steamer and in repairs to all vessels. General office expenses, including publication of charts and discussion and publication of observations, required one-twentieth of the sum total.

The following table is made up from the Digest of Appropriations for 1899, and shows the actual amounts allotted to the items named:

Appropriations.

	Amount.	Per cent.
Salaries	$231 770	37
Party expenses	153 300	25
Yukon and Copper rivers	100 000	16
Vessels	105 000	17
Office expenses, etc.	34 500	5
Total	624 570	100

2. MISCELLANEOUS SECTION.

The miscellaneous section of the Accounting Division is charged with the custody and issuance of the annual reports, appendices, bulletins, notice to mariners, tide tables, coast pilots, and special publications. In round numbers, it may be stated that 1 000 copies of annual reports were distributed during the year, one-half of which were for the fiscal year 1896–97, the last published. There were also distributed 1 500 appendices; 3 000 tide tables; 1 000 coast pilots, of which 100 were for the Pacific coast and Alaska, and 300 miscellaneous publications.

Appendices to the report for 1896–97 were received from the Public Printer during the year in numbers varying from 100 to 700, according to the importance of the publications. Supplements to the coast pilot (about 2 000 copies); bulletins relating to the Alaska coast (6 000 copies), and monthly notices to mariners, containing corrections to charts (about 4 400 each month), have also been received.

All manuscript for the Public Printer is transmitted through this section. On January 1, 1899, the business connected with chart agencies throughout the country was transferred from the miscellaneous section, thereby avoiding some duplication of labor necessary under the old system.

C. OFFICE OF ASSISTANT IN CHARGE.

The office work of many of the technical divisions of the Coast and Geodetic Survey is under the immediate direction of the Assistant in Charge. Through his office pass all letters written by chiefs of divisions, which, after being read and initialed, are transmitted to the Superintendent for signature.

The original topographic and hydrographic sheets come to the Superintendent for approval after such action is recommended by the Assistant in Charge. The information furnished to Coast Survey officers in the field and to outside parties, whether secured in the Computing, Tidal, Drawing and Engraving, Chart, Instrument, or Library and Archives divisions, is first sent to the Assistant in Charge for scrutiny before being given out by the Superintendent.

The routine work of the Office, the conduct and efficiency of the personnel, and the general results attained are under the constant supervision of the Assistant in Charge, who is responsible to the Superintendent for the faithful discharge of duties by the employees and the economical expenditures of the resources of the Office.

II. TECHNICAL DIVISIONS.

A. HYDROGRAPHIC DIVISION.

1. ADMINISTRATIVE DUTIES.

The entire administration of the Hydrographic Division is in charge of the Inspector of Hydrography and Topograghy. In this Office are formulated the detailed instructions for field work, which, after approval by the Superintendent, are issued to the respective parties, and define the scope of their operations for the ensuing season.

The Coast Pilot party, both in its field and office work, the care of the vessels, their repairs, and the enlistment and discharge of the crews—all come under the supervision of the Inspector of Hydrography and Topography.

2. COAST PILOT PARTY.

a. Supplements.

The operations of the Coast Pilot party during the past fiscal year were confined exclusively to office work. Six supplements were prepared and published, embodying all changes affecting the Coast Pilot volumes since the date of last publication. These supplements affect the volumes of the Coast Pilot as follows: One for Parts I and II, 1 for Part III, 2 for Part IV, and 1 for Part VIII, and 1 containing the Rules of the Road at Sea.

b. Bulletins.

All the bulletins issued during the year refer to Alaskan waters. No. 37, Hydrographic Notes and Sailing Directions from Dixon Extrance to Yakutat Bay, was derived from information furnished by Lieut. Commander J. F. Moser, U. S. N., commanding the steamer *Albatross*, of the United States Fish Commission service. Bulletin No. 38, Hydrographic Notes and Sailing Directions, Prince William Sound, Cook Inlet, Kadiak Island, and route Unalaska to Chignik to Unamak Pass, inside the islands, is also from information furnished by Lieutenant-Commander Moser, under the same authority as the previous bulletin. Bulletin No. 39 gives the predicted times of slack water at Seymour Narrows, Discovery Passage, British Columbia, and Sergius Narrows, Peril Strait, Alaska, and was prepared from observations by the party of Commander E. K. Moore, U. S. N., while in command of the Coast and Geodetic Survey steamer *Patterson*. This bulletin, although largely compiled during the fiscal year, did not appear until after its close. Bulletin No. 40, Coast Pilot Notes on the Fox Island Passes, Unalaska Bay, Bering Sea, and Arctic Ocean, as far as Point Barrow, is essentially a compilation, and is made up from all available sources, including naval officers, officers of the Revenue-Cutter Service, and the work of Assistant J. F. Pratt, Coast and Geodetic Survey, in the vicinity of St. Michael and the mouth of the Yukon River. This bulletin was revised by Lieut. D. H. Jarvis, U. S. R. C. S., his detail for this purpose having been made by the Chief of the Revenue-Cutter Service. Lieutenant Jarvis has had large experience in Alaska and has made the trip to Point Barrow both by land and water. The thanks of this service are due to him for the interest he has evinced in the preparation of the work, and to the Chief of the Revenue-Cutter Service for his assignment to this duty.

B. COMPUTING.

1. GEODETIC.

a. Triangulation.

One of the principal, as well as the most laborious, duties of the Computing Division is the adjustment of triangulation. After the observations have been made it is necessary to subject the results to methods of computation which will give consistent results for all parts of the work. This is accomplished by applying the method of least squares to the conditions involved.

Some extended examples of intricate work in this line have been met with during the past year, and on one occasion, in order to adjust the system of network between the Salina Base and the El Paso Base, it was necessary to solve 99 normal equations.

This extraordinary number was solved in twenty-four working days. Besides the great adjustments, such as that just mentioned, work has been continued on the traverse line across the neck of Florida, and in the triangulation of that part of the oblique arc which extends from the vicinity of Montgomery, Ala., to the Gulf coast. The adjustment of the reconnoissance triangulation in southeastern Alaska was also carried on.

b. Leveling.

Differences of height are determined both by the spirit level and by the measurement of vertical angles. Both these methods have been carried on during the year, and the Computing Division has been occupied in reducing the observations and determining the final heights. The elevations of the primary stations in eastern Colorado, thence across the Rocky Mountains to California, were adjusted; and abstracts were prepared of the vertical measures in California for the past year. The spirit-level observations between Salina, Kans., and Hugo, Colo., were also computed.

2. ASTRONOMICAL.

a. Star places.

From the beginning of the fiscal year until August 17, Mr. John F. Hayford was engaged on the revision of star places, and abstracts were prepared of the resulting latitudes of stations on the transcontinental triangulation.

b. Latitude, longitude, and azimuth.

Abstracts of latitudes were prepared by Assistant John F. Hayford from October 5 to February 28, 1899. The telegraphic longitudes of stations Green River and Oasis, in Utah, and the azimuth at Bronson, Fla., were computed by Mr. D. L. Hazard. The chronometric longitudes of 3 stations in the delta of the Yukon, in Alaska, were also computed by him.

3. MAGNETIC.

The Magnetic Division of the Coast and Geodetic Survey was not distinctly organized until the 1st of June, 1899; so that in this Division during this fiscal year only work of a preliminary nature was undertaken. Requests for information were answered, the outfit for the steamer *Pathfinder* was prepared, and the observer accompanying the vessel was instructed in the work of magnetic observations.

Previous to June 1 the magnetic computations were made under the direction of Assistant Schott, and they were carried on regularly, as time was available, during the entire fiscal year. The observations in West Virginia in 1898 were taken up and completed.

4. SPECIAL INVESTIGATIONS.

a. Transcontinental arc.

The work of carrying on the computations on the great transcontinental arc, on the thirty-ninth parallel, has been pursued throughout the year whenever possible by Assistant C. A. Schott. This work, which is now being printed, will be contained in seven parts: The first treats of the units of length and base lines; the second, hypsometric measures; third, triangulation; fourth, astronomical latitude; fifth, astronomical azimuths; sixth, the astronomical longitudes, and seventh, results. Not only is this arc one of the longest possible in the United States, but it is the greatest arc ever measured by any nation. It furnishes material for the subsequent surveys across the continent, and also contributes to our knowledge of the size and shape of the earth.

b. Work in newly acquired territory.

Considerable scientific data has been gathered in the Computing Division from islands which have just come under the control of the United States. This material consists of both magnetic and astronomical data.

c. Board on spirit leveling.

On the 29th of November, 1898, a committee was appointed by the Superintendent to investigate, in its entirety, the question of precise leveling, as carried out in the service of the Coast and Geodetic Survey. This board consisted of Mr. John F. Hayford, chairman; Isaac Winston, J. J. Gilbert, and A. L. Baldwin. They held sessions daily for two months, and their report, submitted on February 9, 1899, contains the results of their deliberations and conclusions. This report is full of valuable suggestions, which have been recently put in practice in the field and have produced most excellent results. The questions treated were those touching economy and accuracy in the work. Comparisons were made with similar work done by other government organizations, and systematic errors which have, up to the present time, given considerable trouble were thoroughly examined. A number of changes in the program of observagestions were recommended, among which may be mentioned: (1) That direct reading rods, graduated to centimetres, be substituted for the present target rods; (2) that the readings on each sight shall be simply the readings against the rod, to the nearest millimetre, of the three horizontal lines of the telescope diaphragm; (3) that neither telescope nor striding level shall be reversed during the progress of the leveling operations; (4) that the alternate fore sights be taken before the corresponding back sights; (5) that the maximum length of sights shall be 150 metres, that no back sight and the corresponding fore sight shall differ by more than 10 metres, and that the continuous sum of the back sights shall not differ by more than 20 metres from the continuous sum of the fore sights between successive bench marks.

C. TIDAL.

1. TIDES.

a. Harmonic analysis.

As usual, the Tidal Division of the Office has been engaged regularly on the preparation of the Tide Tables, using the method of harmonic analysis. During this fiscal year those for the year 1900 were prepared. This volume is essentially similar to those of preceding years, with the exception that in the present one the predicted tides for St. Michael, Alaska, have been added. This is the first time such knowledge for this locality has been incorporated in the Tide Tables.

The great advantage of the application of harmonic analysis to tides, first made by Sir William Thomson, need not here be pointed out. By the use of the old method results were not sufficiently accurate, the data for an entire year, as then utilized, leading to predictions unreliable to the extent of a considerable fraction of a foot. This grew out of the fact, principally, that no account was taken of the longitude of the moon's node. By the introduction of harmonic analysis the effects are reduced to what they would be if the sun and moon moved in the equator and in circular orbits; while at the same time all the irregularities arising from the actual inequalities of the motions of these bodies are taken account of. A general agreement is now established between the predicted and observed tides at the many places published in the tables.

b. Chesapeake Bay.

A successful attempt to fix a permanent tidal plane for the Chesapeake Bay has also been made. During the past year nearly 40 stations were occupied, at 13 of which we are in possession of simultaneous tidal observations extending over one complete lunation. The application of harmonic analysis to this unique series along our seaboard will open the way for correct predictions from the Capes to Havre de Grace, and will also result in the establishment, for the whole bay, of a plane of reference of unequaled permanence and undoubted accuracy. The tide is usually small in Chesapeake Bay, being about 2½ feet at the entrance, diminishing to less than 1 foot in the middle, and increasing again to about 2 feet at the head of the bay. The surface is affected very much by winds, which often cause a variation of 3 feet in the level. This diminution in the height of the tides as we go northward from the entrance, and the subsequent increase as we continue on in the same direction, is one of the peculiar features of the tidal phenomena of the bay. The small range at Annapolis is due, partly to change in the width of the bay, and partly to the fact that there is an interference at this point between the incoming and outgoing tidal waves. When the crest of the southbound movement reaches the mouth of the Severn River, it meets the north-bound wave from the Capes, and a partial neutralization of the vertical motion of the water takes place.

c. Copper River delta.

The series of tides observed by the party of Assistant Homer P. Ritter in the delta of the Copper River, Alaska, were found to contain a most interesting type of tide, in which the upper portion of the wave is normal and the lower part is very nearly a straight line. In explanation of this peculiar form of tide it may be said that a barrier of some sort prevents the water from falling below a certain level. It therefore remains dammed up until the rising tide overflows the barrier and again produces the rise and subsequent fall.

d. Yukon River Delta.

No less interesting is the series of tides observed by the party under Assistant J. F. Pratt, on the Yukon River Delta, which shows a rapid transition from an almost strictly diurnal tide at St. Michael, to a well-marked semidiurnal at the Kusilvak entrance to the Yukon.

e. Manual of Tides.

Part IV of the Manual of Tides, now being prepared by Dr. R. A. Harris, has been continued during the year. This part relates to "Tidal Theory," and considerable progress has been made in the study of the tidal oscillations in the great oceanic basins. So far as this work has progressed it goes to show that the dominating tides of most localities owe their origin to one of two methods of generation. The first is that implied in the corrected equalibrium theory, and pertains to rather small and well-inclosed bodies of water; the second, and far more important method, is that implied in stationary oscillations whose free periods approximately coincide with the periods of the tidal forces.

As an example of these oscillating areas may be cited the region lying south of the Maine coast, from Nantucket to the southern end of Nova Scotia. Following a line, somewhat convex toward the south, joining these two points, there appears to be a small tidal disturbance, probably not more than 2 feet, whereas along the entire New England coast, north of Nantucket, the tides are in the neighborhood of from 8 to 10 feet. Moreover, on this nodal line just mentioned, running from Nantucket to Nova Scotia, the currents are well pronounced; so that it appears that we have here an area which oscillates about the nodal line as an axis, thus producing high water at practically the same time along the New England coast.

2. CURRENTS.

a. Alaska and British Columbia.

Besides the predicted tides for St. Michael, Alaska, spoken of above, there appear in the Tide Tables for 1900 the times of slack current for each day of the year at Seymour Narrows, in Discovery Passage, British Columbia, and at Sergius Narrows, in Peril Strait, Alaska. This is the first time that the Survey has issued full predictions of the times of slack currents. The observations were furnished by the party of Lieut. Commander E. K. Moore, U. S. N., commanding the Coast and Geodetic Survey steamer *Patterson*, and consisted of the times of the beginning and ending of slack waters for about six months.

b. Chesapeake Bay.

The series of current observations made by Lieut. E. H. Tillman, U. S. N., at two stations in Chesapeake Bay, Maryland, and one station occupied by Assistant R. L. Faris, United States Coast and Geodetic Survey, in the same vicinity, were subjected to harmonic analysis. These are the first examples of the application of this method of treatment to current observations that the Survey has accomplished. Only four components were obtained, because the velocity of the current at these stations was too slight to warrant a more exhaustive treatment.

D. DRAWING AND ENGRAVING DIVISION.

1. DRAWING SECTION.

The drawing section of this Division has been engaged, during the past year, in its regular routine work and other duties made incumbent upon it by the increased traffic toward the Yukon, and the war with Spain. Numerous maps were supplied for the war room at the White House, and these were kept up to date as occasion required. Charts were prepared for photolithographing, for the Hawaiian Islands and Porto Rico, in addition to the regular work along the Atlantic and Pacific coasts and Alaska. Considerable attention was given to the preparation of work at the Yukon Delta. A map of the Ladrone Islands was also finished, as well as one of the island of Guam. A chart of Alaska was traced, showing the wrecks and casualties in these waters; and a plan of the royal arsenal at San Juan, P. R., was also copied. A finished wall map of Alaska was prepared for the State Department, and plans and specifications for the reconstruction of the attic in the present Survey Office, for the use of the photographic section, were completed.

Space will not permit a detailed description of all the drawings completed for photolithographing and engraving. Twenty-two were completed on different scales ranging from 1:10 000 to 1:1 300 000. Two of these are on Mercator's projection, the others being on the polyconic. Besides the above mentioned completed drawings, 12 were in progress at the end of the fiscal year. These comprise work on the Atlantic and Pacific coasts, in the Pribilof Islands, Alaska, and the island of Guam. Other schemes for new charts have been approved for publication by the Office, but no work has been done upon them. The schemes comprise 26 charts, on scales ranging from 1:60 000 to 1:100 000, and distributed about equally over the coasts of the United States.

Besides the foregoing work, the usual projections for the use of field parties have been constructed, besides a number of projections on copper plates. Over 200 charts have been revised, corrected, and verified, for new editions or reprints, and, finally, an unusually large number of sketches and drawings have been made to illustrate the annual report of the Superintendent.

2. ENGRAVING SECTION.

The activity in the engraving section has been marked during the past fiscal year. Thirteen new charts and 28 new editions of charts were finished. A few miscellaneous ones were also taken up and disposed of. Besides this work, which was entirely completed, a great many new charts were commenced and are still under way. Eight section maps of the District of Columbia have been completed, each one consisting of 4 plates. These are to be printed in colors, which necessitated an increased number of plates. There were 36 unfinished plates on hand at the close of the fiscal year.

The work has been so arranged that those engravers having specialties have been given their particular kind of work, but aside from these a general effort has been made to familiarize each engraver with new kinds of work.

3. PRINTING SECTION.

The number of impressions actually drawn was slightly over 59 000. These came from 1 474 plates. They were distributed principally to the Chart Division, but the Office of the Assistant in Charge, the Engraving Section, and the lithographer each received a number of copies. There were published by lithography, during the year, more than 19 000 charts, making the total of charts issued by the Division, during the fiscal year, approximately 79 000.

4. PHOTOGRAPHING AND ELECTROTYPING SECTION.

The work of both these sections has been continued during the fiscal year on the same general lines as heretofore. Little material is available for an account of the work here, except tables of statistics, which will be found in another part of this report. The work consisted in making negatives, prints, lantern slides, etc. In the electrotyping rooms 2 000 pounds of copper were deposited on 76 000 square inches. Forty-two basso and 29 alto plates were finished.

The work accomplished in each section of this Division has been entirely satisfactory, and, considering the force employed, the output has been very large. The continued use of the engraved-plate notes, compasses, etc., has facilitated the work in the drawing section, and the adoption of the standard chart on prepared manila paper, on which all corrections are made, enables the engravers to make corrections and tracings direct from the proof without making adjustments for shrinkage and expansion.

E. CHART DIVISION.

1. PRELIMINARY STATEMENT.

Several changes have been made in the organization of the Chart Division during the past year which conduce to economy of service and the more rapid execution of routine duties. From the beginning of the year until November 1 Assistant Gershom Bradford was acting as Hydrographic Inspector, still retaining, however, the direction of the Chart Division, properly so called, in connection with his new duties. At the above-mentioned date he was reassigned to his former position, under the designation of Inspector of Charts, at the same time taking to this division what had been known as the Hydrographic Section under the Hydrographic Inspector.

On January 1, 1899, the entire business with the agencies for the sale of charts, Coast Pilots, and Tide Tables, which had previously been conducted in the Miscellaneous Section of the Accounting Division, was transferred to the Chart Division. The result of this has been, so far, very satisfactory; so that the Chart Division now comprises two subdivisions, in one of which, called the Hydrographic Section, the plotting and verification of charts is carried on, and the other, under the designation of Chart Section, has charge of the correction and distribution of charts.

When information is received making necessary a change on any chart, the correction is indicated on a standard sheet. This is kept for reference. The indicated correction, if of sufficient importance to justify its immediate publicity, is sent to the chart section, and all copies are corrected by hand before being sent out. If no reason exists why immediate publication should be made the information is sent to the Drawing and Engraving Division, and it is then engraved on the plate.

2. HYDROGRAPHIC SECTION.

a. Plotting.

The plotting and verification of sheets as they come from the field has been carried on throughout the year in the usual manner. Proofs, charts, and drawings have also been revised and verified. In this section is conducted the whole work of the preparation of the monthly notice to mariners, a publication which appears regularly for the improvement of charts. The drafting in this division has consisted in plotting the contents of nearly 150 volumes of field records, comprising over 200 000 soundings, and covering nearly 4 000 miles of distance. Over 200 drawings and proofs of charts were verified, and on nearly 4 000 separate charts corrections were indicated.

b. Data.

All the data employed in this division is not the result of our own work. Much is derived from outside sources, wherever available, notably from the Light-House Board (aids to navigation, etc.); the Corps of Engineers, U. S. A.; the Hydrographic Office of the Navy, and, finally, by miscellaneous means.

3. CHART SECTION.

a. Receipts.

The hand correction and the distribution of charts is carried on in this subdivision, and the work may be divided into two distinct parts: first, the receipts, and, second, the issue of material.

The receipts of new charts and maps during the past year comprised 17 different ones printed by lithography and 2 by copperplate, the total number of copies being over 72 000. These include 9 along the Atlantic and Pacific coasts; 3 for the vicinity of the Yukon River delta, Alaska; 3 for Porto Rico; and 1 for the Hawaiian Islands, and 1 for Cuba. Two of St. Paul Island, Alaska, have also been received and are ready for distribution. Thirty-five new copperplate editions of charts and 18 new lithograph editions have been delivered to this section for issue during the year.

b. Issue.

In the fiscal year 1899 the total issue was about 50 per cent larger than the average for the past nine years. This does not include the year 1898, which was omitted on account of the abnormal demand caused by the gold discoveries in Alaska and the war with Spain. The free distribution of charts was 75 per cent larger than the average. The net sales have increased 32 per cent in copies and 30 per cent in value as compared with the previous average. The Coast Pilots and Tide Tables issued during the year have been: For the Coast Pilots—Atlantic coast, 724; Pacific coast, 74, while the number of copies of Tide Tables issued, embracing the United States and foreign ports, has been 427, and the number of separate reprints issued for the Pacific coast, including Alaska, has been 2 458. These figures show the increased demand for Tide Tables on the Pacific coast on account of the Alaska commerce, and also that when the part of the volume desired is published separately it attains a very much greater distribution. Thirty-five new chart agencies have been added to our list on the Atlantic coast since the month of March. The total issue of charts during the year comprises something more than 83 000 copies, having a value of over $34 000.

F. INSTRUMENT DIVISION.

The work of the Instrument Division of the Office is properly the repair of old instruments and the design and construction of new ones. Other collateral duties naturally fall to this department, the details of which need not be specified in this place. Sometimes instruments are purchased in the open market, but when the peculiar work of the Survey requires special designs it is necessary to prepare them in our own Office.

More than 1 000 instruments were adjusted and sent to the field during the year, and about 800 were received. The total number of instruments owned by the Survey at this date is 8 089, of which 5 320 are actually in the field.

In order to avail ourselves of the recent experiments at the International Bureau of Weights and Measures, where an alloy of nickel and steel has been made with an extremely low temperature coefficient, correspondence was had with a view of obtaining certain specimens of this new metal for casting. By so doing many parts of our instruments could be made almost insensible to the effects of temperature. The alloy could not be furnished suitable for casting, and hence experiments were undertaken in our own Bureau which resulted in the production of an alloy which can be readily cast, and whose temperature coefficient is as much below that of steel as steel is less than that of brass. The application of this new metal to the construction of instruments will result in the perfection of many parts hitherto unsatisfactory on account of temperature variation. The new metal has already been applied to several geodetic levels, which are now in use in the field, and it is confidently believed that the results will show a practical elimination of discrepancies hitherto existing. In these new instruments provision was made for the observer to read the level and the rod at the same time, using an eye for each instrument, which reduces considerably the chance of error from vibrations on the ground.

Four new leveling rods were made and treated with paraffin, for protection against hygrometric influences. A new 12-inch position theodolite, for primary triangulation, was completed. But little progress could be made on the construction of the new tide-predicting machine on account of urgency of other work.

G. LIBRARY AND ARCHIVES DIVISION.

1. SUMMARY.

The Library and Archives Division is charged with the custody of original observations, and hydrographic and topographic sheets of the Survey, as well as tide rolls, negatives, log books, and all original matter embodying the results of labors of the Survey in the field.

2. SHELVING ARRANGEMENTS.

The fixed shelf system has been abandoned and the Dewey decimal system readopted. This enables all works to be classified in the same locality and adapts itself to the every day expansion of the Library. The maps and atlases have been classified according to the Cutter Local List, and the results have been found very satisfactory.

3. CLASSIFICATION.

During the year 15 000 volumes, comprising the entire Library, have been labeled and classified according to the Dewey system above mentioned. This includes the original volumes of computation and observation, original sheets, miscellaneous maps, and photographic negatives, prints, and lantern slides.

Sea-bottom specimens have been arranged according to geographical position, and numerous volumes have been prepared for the binder. These include both the periodicals received by the Survey and original volumes of observations. In the system now followed, all those books that are frequently used are brought to the lower floors, and are thus more easily accessible.

4. ACCESSIONS.

Every new piece received is entered in one of five books, according to its destination. The division adopted comprises the Library, archives, original sheets, maps and charts, and photographs and lantern slides. Each object is individually numbered. Over 800 volumes, 300 cahiers, and about 500 sheets, have been received. Miscellaneous articles, such as specimens of sea bottom, tidal rolls, photographs, and negatives, have come in and are stored in their appropriate places.

A. ANNUAL REPORT.

There has been published during the year the Annual Report of the Superintendent of the Survey for the year 1897, of which about 1 800 copies were received from the Public Printer. This report is a volume of 774 quarto pages, including 12 appendices. Fifteen progress sketches appear at the close of the report proper, and 188 diagrams and cuts illustrate the different appendices. Prominent among the subjects treated in these special papers are magnetism, longitude, leveling, gravity, tides, photo-topography, and base lines.

B. BULLETINS.

Three bulletins, all relating to Alaska, have been published. No. 37 contains hydrographic notes and sailing directions, from Dixon Entrance to Yakutat Bay; No. 38 gives similar information for Prince William Sound, Cook Inlet, Kadiak Island, and route from Unalaska to Chignik. These two bulletins are published through the courtesy of the United States Fish Commission, the information having been collected by Lieut. Commander J. F. Moser, U. S. N., commanding the steamer *Albatross*, belonging to the Commission. No. 40 contains Coast Pilot notes on the Fox Island Passes, Unalaska Bay, Bering Sea, and Arctic Ocean as far as Point Barrow. For fuller details regarding these publications, see under the heading "A. Hydrographic Division—2. Coast Pilot Party."

C. NOTICE TO MARINERS.

The usual number of Notices to Mariners, containing chart corrections, have been published monthly, about 4 400 copies being distributed at each time. This is one of the important publications of the service. In order that the charts may be of continual use to commerce they must be kept up to date. Changes are going on incessantly. New light-houses are being established; wreck buoys are being placed in position, and these are discontinued when the wrecks are removed; improvements are always in progress, as the dredging of channels, building of bridges, and the construction of jetties. Moreover, by the continual action of the sea, bars change at the entrance to harbors. This necessitates shifting the watermarks.

The Notice to Mariners gives, every month, the necessary chart corrections, and thus practically furnishes every possessor of a chart with a new edition containing the latest information available. As illustrating the character of information furnished, the following paragraph is extracted at random from the last edition (June, 1899):

NEW JERSEY.

12. *New York approach—Off Seabright—Lighted wreck buoy established.*—On June 20, 1899, a gas buoy, painted red and black in horizontal stripes, and showing a fixed white light during periods of thirteen seconds separated by eclipses of nine seconds' duration, was established in 54 feet of water, about 200 feet south-southeasterly from the wreck of the steamer *Macedonia*, sunk off Seabright. The wreck heads NW. by N., and both masts show above the water.

The buoy is on the bearings:

Scotland Light-vessel, N. by E. 3/8 E.
Sandy Hook Light-vessel, NE. 1/4 N.
Navesink Light, NW. 7/8 N., distant 3 8/10 miles.

(L. H. B., N. to M., No. 118 of 1899. Charts affected: 120, 121, 52, and 8; U. S. Coast Pilot, Atlantic Coast, Part V, p. 52.)

The publication also contains lists of new charts, new and canceled editions, publication agencies, and storm display stations.

The notices may be obtained, free of charge, in the principal seaboard cities of the country, and from United States consulates in foreign ports.

D. TIDE TABLES.

Tide Tables for the Pacific coast were received from the Public Printer during the year. These contain the predicted times and heights of every high and low water thoughtout the year, at seven principal ports. By means of auxiliary tables accompanying them this information can be extended to more than 400 subordinate stations. The times of slack water at Seymour Narrows, Discovery Passage, British Columbia, and Sergius Narrows, Peril Strait, Alaska, are also given. These are important points on the Alaskan route. The channels being all deep, information as to the height of the tide is of little concern to the mariner; whereas the state of the current, which is here very strong, is of vital importance. There are four slack waters each day; the times of which, singularly enough, do not coincide with the stand of the tide or the turning point of its vertical movement.

E. COAST PILOT.

Five supplements to the Coast Pilot for the Atlantic and Gulf coasts have been issued. One of these includes the Rules of the Road at Sea and in Harbors, Rivers, and Inland Waters.

The supplements are to the Coast Pilot what the Notice to Mariners is to the charts. They give information received and notes of the more important corrections and additions necessary since the publication of the volume affected.

F. SPECIAL PUBLICATIONS.

Special Publication No. 2, entitled Publications of the Coast and Geodetic Survey, 1807–1896, and Weights and Measures, 1790–1896, has also appeared.

Separate copies of the 12 appendices included in the Superintendent's Annual Report for 1897 have been received, in numbers varying from 100 to 300.

In addition to the above publications, circulars relating to office duties and routine matters have been printed.

IV. WEIGHTS AND MEASURES.

Important services have been rendered by the Office of Standard Weights and Measures to the various bureaus of the Government engaged in work requiring accurate standards of reference: The United States Mint, Department of Agriculture, United States Geological Survey, United States Coast and Geodetic Survey, the Nicaraguan Canal Commission, and especially to the United States Customs Service. All the apparatus used in the polariscopic analysis of imported sugars, for the imposition of duties, are tested, adjusted, and standardized by this Office.

As in previous years, a considerable portion of the time of this Office has been devoted to the comparison and adjustment of weights and measures for State and municipal purposes; for manufacturers, surveyors, engineers, and others aiming to secure the utmost accuracy in their work.

The preliminary arrangements have been almost completed for taking up the verification of electrical standards and measuring apparatus. Secondary standards of reference and electrical apparatus of various kinds have been acquired, standards of electro-motive force constructed, and methods of comparison developed.

The Office is now prepared to standardize direct current measuring apparatus, but the lack of time and of a sufficient appropriation have so far prevented any measures being taken for standardizing alternating current measuring apparatus. This will be a most important branch of work in the future, as alternating currents are almost exclusively used in the long distance transmission of power on a large scale.

Considerable time during the year was given to a redetermination of the temperature coefficients of sugar and quartz plates, and to the preparation of other testimony for use in the trial of importers of sugars versus the United States. Nearly all the work done in the Office has been, as usual, much hampered by lack of facilities. Most of the apparatus now on hand was designed many years ago and does not meet our present requirements, either for accuracy or facility in making comparisons. There is not in the Office at the present time a suitable instrument for the comparison of standards of length of 1 metre or less; nor are we prepared to make comparisons of thermometers at temperatures lower than zero or higher than 50 degrees Centigrade. Some study has been given to both these questions, but as we have no suitable rooms in which the apparatus could be installed, little could be done. The construction of a comparator and a constant temperature room is, therefore, one of the greatest necessities at present. Most of the verifications and comparisons, as well as the necessary computations, have been made by Mr. L. A. Fischer, Adjuster, who was in immediate charge of the Office, under the direction of Assistant Andrew Braid, in charge of the Office of Standard Weights and Measures. Dr. F. A. Wolff, jr., has given most of his time to the question of electrical standards. He purified the chemicals for and set up a number of Clark and Cadman cells, and inter compared the former with gratifying results. He also inter compared the resistances purchased from O. Wolff, of Berlin.

FIELD WORK.

1. LAND OPERATIONS.

A. GEODESY.

1. RECONNOISSANCE.

a. Middle Division.

Before an adequate scheme of triangulation can be adopted a reconnoissance is necessary. In the development of the work along the ninety-eighth meridian several parties have taken the field for the purpose of carrying out this preliminary work.

Nebraska.—Assistant Granger, who has been operating in Kansas and Nebraska for several years past, returned to the field and continued the work during both seasons of the present fiscal year. Only part of this time was devoted to reconnoissance, as it was considered desirable to carry along the triangulation as soon as sufficient points were available. A reconnoissance was made near Hastings, Nebr., in order to establish a station at a point called "Mason." The result of this work was that the old scheme of triangulation was somewhat modified and the work considerably strengthened. During the latter part of the fiscal year additional work in reconnoissance was executed in order to locate a base line. Considerable difficulty was experienced in this work, as the condition was imposed that one end of the line should be an interior station of a quadrilateral in the triangulation.

Kansas, Oklahoma, and Texas.—Assistant Stehman Forney, who has had charge of the work in this direction between the thirty-ninth parallel and the Mexican boundary, was in the field at the beginning of the fiscal year, and during the season, which includes the last part of the previous fiscal year and the first part of the present one, 480 miles along the ninety-eighth meridian were covered with a provisional scheme consisting of quadrilaterals. The average length of the sides was about 24 miles, and the area covered by the network is 17 000 square miles. Seventy-five triangulation stations are embraced in the scheme, and 108 points were examined and actually observed and occupied. This left $3° 30'$ between the termination of the work on the north and the transcontinental triangulation along the thirty-ninth parallel, and $3°$ between its southern terminus and the Rio Grande. The work was continued northward by Assistant Forney during the latter part of the fiscal year, and a junction was made in June, in the vicinity of Arlington, Kansas, 60 miles north of the State line with Assistant Eimbeck, working south from Ellsworth, Kans. During the first part of the fiscal year two base lines were selected in the Chickasaw Nation, Ind. T. During the latter part of the year two additional ones were established, one near Elreno and the other at Anthony. The conditions under which this reconnoissance was made were rather unfavorable, on account of the smoke from prairie fires. Nights, however, were exceptionally clear, and for this reason it has been recommended by Assistant Forney that observations during the daytime be limited to secondary points and the night reserved for the principal triangulation. Great differences of temperature were experienced, the thermometer standing at 110 in the shade on many days between June and October, while the nights were comparatively cool.

Kansas.—Assistant Eimbeck took the field early in May, and was charged with making a reconnoissance from the thirty-ninth parallel of latitude southward on the ninety-eighth meridian. This work was to be continued until a junction was made with Assistant Forney, after which the party was to return to Ellsworth, Kans., the point of departure, and take up the triangulation. The scheme proposed was executed, and four distinct trigonometrical figures were laid out, extending about 70 miles to the southward from the thirty-ninth parallel, here joining the reconnoissance of Assistant Forney, brought northward from Texas. At the end of the fiscal year the party had returned to Ellsworth, Kans., and was preparing to take up the triangulation.

b. Alaska.

Chilkat.—It is estimated that between thirty and forty thousand people entered the Yukon territory in 1897 via the Chilkoot and White Pass routes. Such activity made it incumbent on the Coast and Geodetic Survey to make a reconnoissance of the region, with a view of issuing, as soon as possible, maps covering the region between the head of Lynn Canal and the passes.

Assistant J. A. Flemer was given charge of this work, and two parties were organized, one under his personal supervision and the other in charge of Assistant John Nelson. The object of this work was to make a running survey of the Chilkat River Valley on the west and the Katsehin River Valley on the east, and later to continue the work from Dyea northward to the Chilkoot and White passes.

The parties, together, during the entire season, covered an area of about 500 square miles, including the valleys of the following rivers: Chilkat, Tsirku, Tlehini, Katsehin, Skagway, and Dyea. In the prosecution of this work the photo-topographic camera was called into requisition, and the sheets are based on observations from 18 camera stations on the Chilkat sheet and an equal number on the Dyea sheet. Triangulation was employed whenever practicable, and traverse lines were used when necessary. Much difficulty was experienced with the weather, only thirteen days without rain occurring between July 1 and September 9.

The necessity for new maps in such a region may be understood from the rapid transformation taking place. In August, 1897, but three wooden buildings were to be seen at Skagway. September found hundreds of tents on the ground, and in January, 1898, 700 buildings and over 3 000 inhabitants made up the town. Many of the conveniences of civilization are evident on all sides, including an electric-light plant, the power for which is derived from a mountain lake.

Skagway.—The work in the Skagway River Valley is executed on a scale of 1:80 000, and a map of the town of Skagway was drawn on a scale of 1:20 000. The valley map includes the White Pass and Yukon Railroad. From the summit of White

Pass to the head of Lake Bennett there is a pack trail, which joins at the latter point the old trail leading from the Chilkoot Pass. The Chilkoot route is shorter, but the one through White Pass offers better transportation facilities, and crosses the divide about 1 100 feet lower than the one through Chilkoot.

On the Dyea route the Chilkoot wagon road follows the old Indian trail very closely. The wagon road leads from Dyea to Canyon City, a distance of 9 miles, crossing the stream many times by fords and bridges. From Canyon City an aerial wire tramway conveys merchandise in wooden boxes or buckets over the Chilkoot Pass to Crater Lake. A pack trail also leads from Canyon City to The Scales, at the foot of Chilkoot Pass. From Sheep Camp to The Scales, about 2½ miles, the rise is 1 600 feet. From The Scales to the Summit, a distance of about 3 000 feet, the increase in height is at least 1 000 feet, the last 500 feet being very steep.

2. BASE LINES.

No primary bases were measured during the past fiscal year. Several tertiary ones were selected, and a few were measured in connection with triangulation of a secondary character, which was in hand at the time.

Three such bases were measured in the prosecution of the Yukon River work. One was situated at Camp Pritchett, on the tundra back of St. Michaels; another on the Kripniyuk, and another on the Kwiklok. The apparatus employed for these measurements were steel tapes, which furnished all the accuracy necessary for the triangulation based upon them.

3. TRIANGULATION.

The work in triangulation has been carried on extensively in many parts of the country. Most of it, however, has been done in connection with other work, forming a basis of hydrographic or topographic operations. Only two large schemes were carried on having for their object the development of the triangulation alone. These were in southern California and on the ninety-eighth meridian.

a. Eastern division.

The work in the Eastern Division comprises that around Portsmouth Harbor, New Hampshire, in connection with the hydrographic and topographic survey undertaken by Assistant P. A. Welker on the steamer *Bache*. Other triangulation of a secondary nature was executed by Assistant Hodgkins in Massachusetts and Maryland, and a number of parties carried out these operations on Chesapeake Bay. The work of Assistant Perkins in this last-named locality was comprehensive in its nature, and was intended to cover the whole bay, irrespective of the other operations then in progress. It was begun near Havre de Grace and completed to the Capes on the east side and nearly so on the western. The party operating on the Hudson River also executed triangulation, which was used in the topographic work there undertaken. In connection with the survey of the outer bar at Brunswick, Ga., by Assistant Marindin, Assistant Perkins was directed to develop the topography of the inside waters at this place. This necessitated a system of triangles, which were carried out as opportunity presented when the party was not engaged with Assistant Marindin on the bar work. Lake Maurepas, in Louisiana, was completed during the year, and this work was based on a triangulation running around the lake, with water signals some miles from shore.

b. Middle Division.

The triangulation in the Middle Division comprises work by Assistant Granger on the ninety-eighth meridian, in Kansas, and by Assistant Welker, at Aransas Pass, in Texas. The latter work was completed, but the former, forming part of the great arc of a meridian, is still in progress.

c. Western Division.

Assistant Sinclair was directed, during the year, to make geodetic connections of several longitude stations with the triangulation of the transcontinental arc. This was accomplished early in the year, after which work was resumed on the California and Nevada boundary. This work was also completed during the year, having been in hand for a number of years past. The work, however, was interrupted several times on account of a lack of appropriation. The triangulation, a more detailed account of which will be found in the field details published in Appendix No. 2 of this report, furnishes some fine examples of accurate work. Two points, one situated near Lake Tahoe and the other in the Colorado River, 400 miles distant, were connected by a range line which showed an error of only 150 metres at the terminal point. The work was controlled by triangulation and azimuth observations, but the line was ranged out from the initial point without correction until the southern extremity was reached.

The triangulation in southern California, by Assistant Mosman, was made in order to connect the work, discontinued some years ago, south of San Francisco, with the Mexican boundary. The sides are longer than those of any other triangulation executed during the year. In fact, this is really the most extended scheme of primary triangulation now in hand.

d. Alaska.

Yukon delta.—Triangulation was executed by the party of Assistant J. F. Pratt, operating in the region of the Yukon delta. A scheme of triangles was developed starting from a base line at St. Michael and carried southward to the Aproon entrance of the river. Minor triangulation was also made by cooperating parties at the mouth of the Kusilvak and other places in the delta.

Copper River delta.—An extensive system of triangles was observed by Assistant H. P. Ritter, at the mouth of the Copper River. This work was used in connection with hydrographic and topographic operations, and was carried as far inland as practicable, in order to determine the mountain peaks and other permanent landmarks necessary in a detailed survey of the country.

During the latter part of the fiscal year the steamer *Blake* was in Porto Rico engaged in combined operations. Among other duties a triangulation was begun, and it is intended to carry this entirely around the island and thus form a basis for its accurate delineation. The existing data have been found entirely inadequate, and it is hoped that before another year very material progress will be made toward the conclusion of this important operation.

4. ASTRONOMICAL DETERMINATIONS.

Astronomical observations have been carried on in connection with magnetic and gravity work, mention of which will be made under the proper headings. Besides these, the work executed in this line may be classified under the following subheads:

a. Latitude.

While occupying Green River, Utah, for the purpose of determining longitude, Assistant Sinclair made astronomical observations for geographical latitude. Similar observations were also made at Soledad, Cal., by Assistant Mosman, and at Orca and other poinis in the Copper River delta, by Assistant Ritter.

b. Longitude.

A number of important longitudes have been determined during the fiscal year, some of which were accomplished by the chronometric method, and others by means of the telegraphic. Under the head of the former may be mentioned the work in Alaska. Making a base station at St. Michael, Assistant Pratt determined three points, longitudinally, at the mouth of the Yukon, namely, the Aproon Pass, the Lower Kwiklok, and the Kripniyuk. At the mouth of the Copper River Assistant Ritter determined the longitude of Orca and several points farther in the interior.

The telegraphic determinations were made at Green River and Oasis, Utah, connecting them with Salt Lake City as a base station. Marlow, Ind. T., was determined similarly, using Austin, Tex., as the initial point.

c. Azimuth.

In order to complete the connection of the Gulf and Atlantic coast triangulations, a few remaining azimuths were measured on the Peninsula of Florida and one was observed at Cardona Island light-house, near Ponce, P. R., in connection with the triangulation at that point. Assistant Mosman observed an azimuth at Soledad, in southern California, in order to check his trigonometrical positions.

d. International latitude work.

At the Stuttgart meeting of the International Geodetic Association it was resolved to establish six stations on the parallel of latitude 39° 8′, evenly distributed around the world, as near as circumstances would permit, for an exhaustive study of the variation of latitude. Three of these stations will be in the United States—one at Cincinnati, in the observatory located there, and the other two at Gaithersburg, Md., and Ukiah, Cal. The work to be done in this country has been placed under the direct supervision of the Coast and Geodetic Survey, and the results obtained at the stations named will be reported from time to time in the publications of this Bureau.

The operations up to the close of this fiscal year were merely of a preliminary nature, such as acquiring land, building observatories, preparations of observers, etc. Some time was spent by Assistant Smith in establishing the station at Gaithersburg, Md. The observations there will begin soon after the close of the fiscal year 1899, and will continue for a number of years. A report of the progress made will be given in my next annual report. Similar preparations were made for a station at Ukiah, Cal., and reference to the work at that point will also appear later.

B. TOPOGRAPHY.

The topographical operations of the Survey have been widely distributed, and were carried on along the Atlantic and Pacific coasts and in Alaska and Porto Rico.

1. EASTERN DIVISION.

a. Marthas Vineyard.

A topographical survey of Marthas Vineyard and No Mans Land was finished soon after the beginning of the fiscal year, and the party engaged in that work was immediately transferred to Chesapeake Bay, in the vicinity of Havre de Grace, where work was continued until the end of the season.

b. Chesapeake Bay.

Other work on the upper part of Chesapeake Bay was that of Assistant French, in the vicinity of Baltimore, and of Extra Observer Donn, immediately in the suburbs of the city. Assistant Marindin carried on work on the Sassafras River, and Aid Bowie took up the west shore of the bay between Baltimore and Havre de Grace, including the shores of the Gunpowder River. The Annapolis Harbor shore line and the Magothy River were also surveyed, after which Assistant Boutelle's party proceeded to the Elk River and continued work there until the end of the season.

A chart covering the upper part of Chesapeake Bay is urgently needed at present, and a large part of the topographical force of the Survey has been assigned to this work. The topography in the vicinity of Baltimore is especially needed, and the hydrographic work throughout the entire upper part of the bay, from Annapolis northward, is a desideratum. This work will be pushed as rapidly as possible during the coming fiscal year.

c. Hudson River.

On the Hudson River, in connection with the hydrographic work, a topographic survey was made from Spuyten Duyvil to Piermont Pier, including the shore line and the commercial improvements along it.

d. Portsmouth and Arkansas Pass.

The harbor at Portsmouth, N. H., was also surveyed topographically by Assistant Welker, in command of the steamer *Bache*, at the conclusion of which work the party repaired to Aransas Pass, Tex., and completed the topography of the entrance and harbor at that place. On his way north a brief stop was made at Charleston Harbor, and in connection with other work some shore-line topography was done.

e. Lake Maurepas.

For some time past work has been continued on Lake Pontchartrain, and this having been recently completed it was desirable to complete the map of the region by making a survey of Lake Maurepas. This was successfully accomplished by Assistant French during the past year. The map shows the topography around the lake and is a valuable addition to the hydrographic map, which will soon be published, of the locality.

2. WESTERN DIVISION.

a. Grays Harbor. b. San Diego. c. San Pedro.

On the Pacific coast Assistant Westdahl, on the steamer *Gedney*, first proceeded to Grays Harbor, executing the topography of the entrance and the shore line for some distance northward; then went to San Diego, Cal., where the city front and the Government improvements were mapped, and finally touched at San Pedro, where the shore line and jetties were surveyed.

d. San Francisco.

On the north side of San Francisco Bay topography was executed by Assistant Fremont Morse, and on the conclusion of this work two additional sheets were taken up and finished on the ocean side of San Francisco Peninsula. This completed the topographical survey in the locality mentioned.

e. California and Nevada boundary.

In the operations on the California and Nevada boundary line it was necessary to do some topography, and Assistant Sinclair has made a map, on a scale of 1:40 000, of the Colorado River at the point where the boundary line terminates.

3. ALASKA.

a. Yukon River.

The topographical work in Alaska during this fiscal year consisted: first, in mapping the water front at St. Michael, at the request of the commanding officer of the military reservation; second, in surveying the Yukon Delta, especially at the mouth of the Kripniyuk; third, the operations on the Copper River, and fourth, those at the head of the Lynn Canal. In the last-mentioned work the photo-topographic method was largely employed and accelerated the work in the field very materially.

b. Copper River.

At the mouth of the Copper River, Assistant Ritter, also using the photo-topographic method, carried on a survey of the shore line, sloughs, etc., as well as a determination of the mountain peaks lying farther to the northward. The country in the vicinity of the mouth of the Copper River, as seen when approaching it from the sea, has the appearance of a vast, snow-capped mountain range whose tops are covered with perpetual snow. Innumerable glaciers move down the mountain sides and fill the deeply cut canyons. The distance from the head of the delta to the ocean reef is about 25 miles. The delta is 50 miles wide, and the mountain range from 1 000 to 8 000 feet in elevation. The flats at the mouth of the river are cut up into numerous islands by the many tidal sloughs and small streams flowing from the glaciers. Many interesting features may be noted in regard to this particular locality, among which may be mentioned the violent winds, which begin during the month of September and last with little interruption through the winter until early spring. They are of such violence that it is impossible for anyone to cross the delta while they prevail.

The body of water intervening between the flats and the ocean reefs is navigable to boats drawing from 3 to 4 feet of water, and is in places navigable to these only at high tide. With the receding of the tide an area of about 250 square miles is completely drained and presents nothing but one unbroken surface of mud. The currents during the rising tide are extremely swift, as the ocean reef forms a barrier until the water rises over it, when it flows in with great rapidity.

4. PORTO RICO.

During the visit of the United States steamer *Blake* to Porto Rico, for the execution of combined operations, topography was done in the harbor of Ponce during the months of January and February, 1899. This work was not extensive in character, being limited to a delineation of the shore line and the principal jetties of the harbor.

C. HYPSOMETRY.

1. SPIRIT LEVELING.

a. Eastern Division.

A line of precise levels has been proposed from the Great Lakes southward, crossing and checking our work on the thirty-ninth parallel, and continuing into Tennessee, there touching the lines from the seaboard by the Geological Survey; thence onward to the work of the United States Engineers, in Alabama; and finally to connect with our own levels, brought from the Gulf. This line will form a connecting link between the determinations of the three great Government organizations; and has been begun by Assistant O. W. Ferguson, starting from Gibraltar, Mich., and moving southward toward Cincinnati, Ohio. At the close of the fiscal year this line was completed to Toledo, Ohio, a distance of 39 miles.

b. Middle Division.

The measurement of an arc in North America, on the ninety-eighth meridian, involves the determination of heights as well. In order to carry out work in this direction, Assistant Baldwin was directed to take up precise leveling at Abilene, Kans., and continue northward through the country traversed by the triangulation just mentioned. The route to be followed was: First to Superior, Nebr., thence to Lester and Hastings; thence to Grand Island; and from that point by the Union Pacific Railway to Columbus and Norfolk. At the close of the fiscal year the line was completed to Lovewell, Kans.

While this work was in progress, Assistant Winston was continuing his line on the transcontinental route, and had begun operations at Denver, Colo. Early in the fiscal year this line had been extended by Assistant Winston from Colorado Springs, Colo., to Denver, and a check line run back to Limon, Colo., a point on the direct line to Colorado Springs.

At Colorado Springs connection was made with bench marks established previously by Assistant Eimbeck and connected by him with Pikes Peak triangulation point by vertical angle measures.

Bench marks established by Assistant Eimbeck on top of Pikes Peak were also connected by Assistant Winston with a bench mark of the cogwheel railroad on the summit.

Triangulation points Divide and West Base, when vertical angles on Pikes Peak had been observed, were brought into the line of levels during the last fiscal year, and thus four independent connections were made between the levels and the Pikes Peak station, giving connection with tide water on the Pacific Coast through the vertical angle measures already made between Pikes Peak and the coast.

On this connection depends the elevation of the Salt Lake Base Line, near Ogden, Utah.

Assistant Winston extended the line northward from Denver in the latter part of the fiscal year, and at its close had reached the vicinity of Eaton, Colo.

c. Western Division.

The lines of leveling carried out on the Pacific Coast were only such as were required to connect the station Mount Lola with Truckee, on the Central Pacific Railroad, and at Sacramento to determine the height of the State capitol dome above the bench mark in that place. This gave a close connection between the vertical angles which Assistant Gilbert had carried out during the last fiscal year, and the lines of precise leveling leading down to tide water.

2. VERTICAL ANGLES.

The determination of heights by means of vertical angles has been made in connection with primary triangulation operations wherever carried out during the last year. They furnish a rapid, and in particular cases, highly satisfactory method of determining differences of height.

D. MAGNETISM.

1. GENERAL STATEMENT.

During this fiscal year a new division of the Survey, working in the line of terrestrial magnetism, has been created, and Dr. L. A. Bauer has been called to act as chief of this Division. The organization did not take place until Dr. Bauer became formally attached to the Survey, which was on May 1, and from this time until the close of the year 16 stations in Maryland, 5 in Delaware, and 1 in West Virginia were occupied by him for the usual determinations of magnetic elements.

2. DECLINATION, DIP, AND INTENSITY.

Eastern Division.—Considerable work was done during the past fiscal year in the line of terrestrial magnetism by Assistant J. B. Baylor. At the request of the State geologist of North Carolina, transmitted through the governor of the State, Assistant Baylor was given instructions to make a magnetic survey under his direction. This work continued from the 1st of July until the 16th of October, during which time 15 stations, all county seats, had been occupied in North Carolina.

At the beginning of the fiscal year Assistant Smith was engaged in West Virginia in magnetic determinations. Operations continued until August 3, when Assistant Smith was ordered to other duty, and he again took up magnetic observations on October 5, and continued them until the 23d of November, this time occupying a number of stations in the New England States.

3. MERIDIAN LINES.

In order that county surveyors might be provided with means to test their compasses and chains, meridian lines were established at all county seats where magnetic observations were made, and a standard of length was marked in the vicinity of the court-house, usually on the floor of the building itself. This will enable the surveying profession to readily determine any uncertainty in its instruments, whether compass or chain, and it is believed that the procedure will very much diminish the causes of litigation now so prevalent.

4. SECULAR VARIATIONS.

Whenever possible, stations were occupied for secular variation. This operation consists in reoccupying the old station and determining the same elements, declination, dip, and intensity which were determined many years previously. By this means it is possible to arrive at the changes taking place, and to formulate quite accurately the law which these variations follow.

E. GRAVITY.

1. EASTERN DIVISION.

During the year several determinations of relative gravity were made. Assistant E. Smith, basing his observations on Washington, swung pendulum apparatus B at Worcester Polytechnic Institute, Massachusetts, and at the Columbia University, New York. These pendulums were swung recently by Prof. J. H. Gore, of the Columbian University, Washington, D. C., at some extremely northern stations in Sweden, and were also used by Assistant Preston in Honolulu in 1891 and 1892, where consecutive observations were made for nearly fourteen months, 199 nights being obtained during this period.

2. WESTERN DIVISION.

The removal of the State University of Washington to its new location near Seattle made it desirable to determine the difference of the force of gravity between the old station in the town proper and the new site of the university. It is intended to make the last-named place the base station for operations of this character in the northwestern part of the United States and in Alaskan territory; so that one of the first duties necessary was the transferring of the old station in Seattle to the new one at the State university. This was done by Assistant Putnam during the winter of 1898-99 with gratifying results, the difference between the determinations of 1891 at the high school in Seattle and that at the present time being only $\frac{1}{800000}$ part. There appears to be, at both the high school in Seattle and at the State university, a defect of the force of gravity amounting to about thirteen one-hundredths of a dyne in both cases.

F. SPECIAL DUTY.

1. REPRESENTATIVE.

The Coast and Geodetic Survey has been represented during the past year at the magnetic conference at Bristol, England; at the International Geodetic Association conference at Stuttgart, Germany, and at the meeting of the American Association for the Advancement of Science, at Boston, Mass. At all of these meetings information of value was acquired. The Coast and Geodetic Survey delegates took a prominent part in the proceedings, and the discussion of the methods led to enlarged views and to economical prosecution of subsequent work at home.

a. Magnetic conference, Bristol, England.

At the Bristol conference[1] one of the principal topics was the establishment of permanent magnetic observatories. This action is becoming more imperative every year, and the United States, since the acquisition of the Hawaiian Islands, is in a position to carry out the project in a way most beneficial, first to science, then to commerce. The islands lie in the center of a region almost totally unexplored magnetically. The laws governing the change of declination ("variation of the compass") are imperfectly known throughout the Pacific, which is destined to be, more than ever before, a most important body of water for American shipping interests. No more important contribution to our knowledge of terrestrial magnetism could be made than the location of an observatory at Honolulu. This will be done as soon as possible.

b. International Geodetic Association, Stuttgart, Germany.

At Stuttgart several points of value were achieved. First, through the action taken by the American delegate, the reconnaissance for an arc of the meridian in Equador and Peru is now under way. This work will furnish data for a better determination of the shape of the earth. Second, a new determination of the difference of longitude between Paris and Greenwich will shortly be made. This knowledge, which would appear at first sight of no concern to Americans, is in reality not only interesting to us, but enters directly into the establishment of our relative position on the earth's surface. Incidentally, the Coast and Geodetic Survey solved this problem several years ago. A combination of European work, involving determinations through six of their important longitude centers, has only served to confirm the American value. It now only remains for the observatories at the points in question to bring their own results in accord with what must eventually be recognized as the nearest practical approach to the truth.

Third, a plan for the systematic study of the motion of the earth's pole was perfected; an important question, not only in astronomy but in geodesy as well, and valuable to this country from both standpoints. Of the six stations located around the world one-half are within the limits of the United States, which gives us a most prominent part in the study of a question the solution of which will benefit the rest of the world as well as ourselves. The work accomplished by the United States during the past fiscal year in the execution of this plan has been mentioned under the subhead "Astronomical determinations."

c. American Association for the Advancement of Science, Boston, Mass.

At Boston, not only did the representatives of the Coast and Geodetic Survey attend the meeting of the American Association, but they were instructed to be present also at the Congress of Astronomers and Astro-Physicists. At both meetings the interchange of ideas and the discussion of improved methods of investigations were productive of useful information. Among the subjects treated were star catalogues and the variation of latitude, to both of which the Survey is now devoting considerable attention.

2. PORTO RICO.

An officer of the Survey was sent to Porto Rico to establish tidal stations, to investigate the methods of making a triangulation of the island, and to make inquiries on the existing standard weights and measures and on the Spanish laws and regulations in regard to them. The results obtained were in every way satisfactory. Two automatic tide gauges were set up, one on the north side of the island, at San Juan, and the other on the south side, at Ponce. Both are now furnishing continuous records of tidal phenomena, which will aid materially in the predictions for West Indian ports.

At San Juan a broken series of Spanish automatic tide-gauge records, extending over about six years, was found, and by permission of the military authorities they were sent to this Office for reduction. An examination was made into the value of some trigonometric data which had been recommended for purchase by this Government by the military authorities, providing that actual tests in the field would establish their reliability. Field tests were applied, but the results indicated that the data were not as good as had been supposed. A valuable topographic map of the vicinity of San Juan was found and copied, and a tracing, made under the direction of Major Root, of the United States Volunteer Engineers, was obtained for the use of this Office.

Weights and Measures offices at Mayaguez, Ponce, and San Juan were visited, and inquiry was made into the laws relating to this subject and their administration, and by request of the commanding general a brief report was submitted to him on the result of these inquiries.

3. STATE BOUNDARIES.

The survey of the boundary between California and Nevada has been finished. Prominent among the auxiliary functions of the Coast and Geodetic Survey may be cited the impartial and disinterested information given on the subject of State-boundary disputes. Many adjustments based on data furnished by this service have been made, and the past year has seen the completion of the field work on the longest interstate boundary yet traced by the Survey. Four seasons have been employed and about $31 000 expended in surveying and temporarily marking the 400 miles between Lake Tahoe and the Colorado River. The difficulty of running this line was on account of the great elevations and the inhospitable nature of the region traversed. The line crosses the White Mountains at a height of 13 000 feet, and passes for more than 100 miles through Death Valley and the Amargosa Desert. This required the employment of a large party and a corresponding pack train for the transportation of the instruments, camp outfit, and forage.

4. MISSISSIPPI RIVER COMMISSION.

An officer of the Survey has been, as usual, detailed as a member of the Mississippi River Commission, performing this duty as occasion demanded, in connection with other duties on the Survey.

5. INTERNATIONAL LATITUDE OBSERVATIONS.

In accordance with authority granted by the Honorable Secretary of the Treasury, the Coast and Geodetic Survey has undertaken the supervision of the latitude observations carried out under the auspices of the International Geodetic Association, whose central office and direction is at Potsdam, Germany. During the year property has been secured and the preliminary steps taken to establish observatories at Gaithersburg, Md., and Ukiah, Cal., the necessary funds for the purpose being furnished by the International Geodetic Association and disbursed by the Superintendent of the Survey. The work thus far accomplished in this line has been referred to under the subhead "Astronomical determinations."

6. SUBOFFICES.

a. San Francisco.

The suboffice at San Francisco was in charge of Assistant A. F. Rodgers during the fiscal year. Besides the regular duties of a routine nature, Assistant Rodgers had charge of special operations, such as the tidal and astronomical stations at the Presidio; and also the steamers *Patterson* and *McArthur*, which were temporarily laid up in Oakland Harbor. In April, 1899, Assistant Rodgers made a report on the site proposed for the International Geodetic Association latitude station, at Ukiah, Cal. During the year he prepared tidal data, which were distributed weekly to the daily papers of San Francisco.

b. Seattle.

The suboffice at this place was in charge of Assistant J. F. Pratt—after his return from Alaska on October 16—to April 20, 1899. He was then detached, and was engaged in preparatory work for the coming season's work at the mouth of the Yukon. The suboffice was left in charge of Assistant F. A. Young, who performed this duty until the 13th of June, when he was relieved by Assistant J. J. Gilbert, who continued in this capacity until the close of the fiscal year.

7. NIAGARA RIVER BRIDGE.

The board convened by the Secretary of War for the purpose of determining the width of the pivot spans of the bridge crossing the Niagara River below Buffalo was composed of Rear-Admiral John G. Walker, chairman; Col. Jared Smith, Corps of Engineers, U. S. A.; and Henry L. Marindin, Assistant, Coast and Geodetic Survey. This board met in September and Assistant Marindin was detailed to attend its sessions. He was absent from his regular work between the 18th and 26th of September.

8. INSPECTION.

a. Chart agencies.

A tour of inspection was made by Assistant G. Bradford, of the chart agencies along the Atlantic seaboard and on the Gulf coast. The object was to acquire as much general and special information as possible in regard to the opinions and wants of the maritime public.

b. Topographic field parties, etc.

During the early part of the year Assistant H. G. Ogden made an inspection of the topographic and hydrographic parties working on Chesapeake Bay. Later his attention was given to the construction of the steamer *Pathfinder*, then under way at Elizabethport, N. J., and also the repairs of the steamer *Bache*, which was at the time lying at Mobile, Ala. At the conclusion of this work, continuing on to New Orleans, he made an inspection of the United States Coast and Geodetic Survey schooner *Quick*, in company with the local inspector of hulls. The result of this action was the practical condemnation of the schooner *Quick*. Toward the close of the fiscal year Assistant Ogden proceeded to the Pacific coast and made an inspection of the topographic and hydrographic parties then fitting out for the next season's work in Alaska.

c. Ninety-eighth meridian.

During the month of June, 1899, Assistant J. F. Hayford, Inspector of Geodesy, proceeded to the scene of operations on the ninety-eighth meridian. He visited successively the parties of Assistants Forney, Eimbeck, Baldwin, and Granger, the first two being engaged on reconnoissance, the third on leveling, and the last on triangulation. The result of this inspection tour was to systematize the method of dealing with the records and, in some cases, the methods of observation.

II. SEA OPERATIONS.

A. HYDROGRAPHY.

1. GENERAL STATEMENT.

Hydrography has been pushed vigorously during the entire fiscal year in various localities. In the Eastern Division, comprising the Atlantic and Gulf coasts and the island of Porto Rico, there have been 11 parties employed. In the Middle Division 1 party has been at work, in Texas. In the Western Division 7 parties were employed, and an equal number were occupied in Alaska. Five vessels were engaged in these operations in the Eastern Division, 1 in the Middle Division, 2 on the Pacific coast, and 4 in Alaska.

2. OFF-SHORE.

Off-shore hydrography was not prosecuted to any very great extent during the past year, the operations being chiefly confined to in-shore work. The party of Assistant Pratt, however, made an examination of the bar off the mouth of the Yukon River, which is reported to extend 40 miles to the southward from the shore proper. This was examined in part only.

The work at the Brunswick bar, pursued by Assistant Marindin, may be classified as off-shore work. This was finished during the last fiscal year. It was described under "D. Special duty."

3. IN-SHORE.

a. Eastern Division.

The work in Chesapeake Bay formed a large portion of the hydrography in the Eastern Division. The operations were confined principally to the localities of Magothy and Elk rivers, the vicinity of Havre de Grace, and the region around Baltimore and the Patapsco River. A hydrographic survey was made of Portsmouth Harbor, New Hampshire, and a part of Charleston Harbor, South Carolina. The steamer *Blake*, under command of Assistant Hodgkins, was detailed for work in Porto Rico, and passed the greater portion of the last half of the fiscal year doing hydrography on the southern shore of the island, and incidentally in the harbor of San Juan, on the northern shore. The hydrographic survey of Lake Maurepas was finished under the direction of Assistant French. Special work was done by Assistant Marindin on the Brunswick outer bar, above mentioned, and also by Assistant Perkins in the passes leading to the inner harbor of the town of Brunswick. A resurvey of the Hudson River in the vicinity of New York was made, and a special investigation in Quicks Hole, Massachusetts, was made at the close of the season by the same party.

b. Middle Division.

An examination of the Aransas Pass, by the steamer *Bache*, under command of Assistant Welker, was made in January and February, 1899.

c. Western Division.

The hydrographic work on the Pacific coast has been confined to four localities, namely, Grays Harbor, San Diego, San Pedro, and San Francisco. At the latter place work in the southern part of the bay was entirely finished in the month of January, and hydrography was taken up in San Pablo Bay. Some work was done in the location of buoys at the entrance of Mare Island Straits, at the request of the Commandant of the navy-yard, as well as the location of a new beacon at the mouth of the straits; and one in Petaluma Channel was located.

Assistant Young, while in charge of the suboffice at Seattle, was detailed to make an examination of Bainbridge Reef, in Washington Sound. This work was done in consequence of a rock being reported in the direct course of vessels of the Navy going from Admiralty Inlet to the Puget Sound Naval Station. The investigation showed that the report was unfounded, and that enough water exists on the reef to float the deepest draft vessel at low water.

d. Alaska.

The hydrographic operations in Alaska consisted in soundings and current observations at the Yukon River delta and at the mouth of the Copper River. In the former work, the water front at St. Michaels was developed, sounding lines were run from the pass between Stuart and St. Michaels Island to the Aproon Entrance, and a running hydrographic survey was made of the Kwikpak River to the head of the passes, and down the Kwiklok Entrance to its mouth.

On the Copper River sufficient hydrography was executed to give all the information necessary for the entrance of ordinary sized vessels.

B. TIDAL.

1. TIDAL OBSERVATIONS.

a. Eastern Division.

During the year automatic tide gauges have been kept in operation at Fort Hamilton, N. Y.; Reedy Island, Delaware; Washington, D. C.; Morehead City, N. C.; Fernandina, Fla., and San Juan and Ponce, P. R. The gauge at Morehead City was discontinued on October 30, 1898. The series at Ponce extended from January 24 to April 25, 1899; while that at San Juan began February 5, and was continued to the close of the fiscal year. All the other stations extended throughout the year. Tidal indicators, showing automatically the state of the tide, as well as its direction of movement, were in operation throughout the year at Fort Hamilton, N. Y., and Reedy Island, Delaware.

Early in July, 1898, the steamer *Blake*, under the personal command of the Inspector of Hydrography and Topography, was engaged in establishing a series of tide gauges throughout the entire length of Chesapeake Bay. This was done to determine the uniform plane of reference, by comparison with the plane at Fort Monroe. Observations were commenced in the middle of July and continued for one month. Frequent inspection of the stations was made by Assistant Yates, in command of the steamer *Endeavor*, to insure uniformity and reliability. The results have been found very satisfactory, the series through intermediate staffs checking very closely with the planes derived from extended observations in the Patapsco River and at the head of the bay. The establishment of well-determined tidal bench marks at intervals throughout the bay will enable the hydrographic parties to secure their planes of reference soon after reaching their working grounds, and will greatly facilitate the office work aboard ships.

Other tidal observations were made by hydrographic parties, in connection with the work in hand. These operations will be mentioned in connection with the field work for which they were executed.

b. Western Division.

At San Francisco, Seattle, and Bremerton, Wash., tide gauges are established. That at San Francisco has been in operation for many years and furnishes a complete record for the past fiscal year. The one at Seattle was established on December 10, 1898, by Assistant Pratt, and its record extends to June 30, 1899. At Bremerton, Wash., the Commandant of the Puget Sound Naval Station has courteously furnished this office, each week, with a copy of the record of their self-registering tide gauge at that place.

c. Alaska.

Very good series of tidal observations were secured from the Alaska parties, both from Assistant Pratt, operating at the mouth of the Yukon, and Assistant Ritter at the Copper River delta. This information will be of great value in the Alaska predictions, and will furnish improved data for the construction of our new charts of the region

d. Hawaii.

For many years the tracings of the tide curve from the automatic tide gauge at Honolulu have been furnished by Prof. W. D. Alexander, surveyor-general. These have been continued during the past fiscal year, and add important data to that already accumulated in this Office, relating to the tides in the middle of the Pacific Ocean.

2. CURRENT OBSERVATIONS.

A careful study of the currents in Portsmouth Harbor was made by Assistant Welker, on the United States Coast Survey steamer *Bache*, during the months of September and October, 1898. Observations were made from the steamer and a launch anchored at selected stations. A weighted pole was used with a float attached, and a cord marked in distances, allowed to run out, gave the velocity by the length passing out in a stated period. The direction of the current was determined by sextant angles between the float and known signals.

Assistant Welker also pursued the same method in a study of the currents at Aransas Pass, Tex., during the period of his hydrographic and topographic work in that locality.

C. COAST PILOT PARTY.

During this fiscal year no field work was done by the Coast Pilot party, both on account of the diminished number of officers employed, and also on account of the accumulation of the office work. The time of the party was fully occupied in reducing observations and preparing bulletins for publication.

D. SPECIAL DUTY.

1. BRUNSWICK BAR.

The special duty at the Brunswick bar has already been referred to in the off-shore hydrographic work. This work was carried out in pursuance of an act of Congress authorizing the work to be done by an officer of the Coast and Geodetic Survey, under the direct personal supervision of the Secretary of War.

The survey was for the purpose of ascertaining whether the contractor for the improvement of the channel over the bar had secured the depths and widths claimed. These dimensions were: 24 feet depth at average high tide, with 200 feet width; and 25 feet depth, with 100 feet width.

The bar is 5 miles offshore. Its exposed position, the unusually strong tidal currents, and the required accuracy of the survey all conspired to prolong the work, which lasted from November, 1898, to April, 1899. The expense of making the measurements was therefore considerable, but was fully justified by the important interests involved. The extreme refinement of the observations, which materially increased the field work, was also warranted by the large pecuniary consideration at stake. The funds for party expenses were furnished by the War Department. The instruments were provided and the officers' salaries were paid by the Coast and Geodetic Survey.

2. STEAMER PATHFINDER.

Just before the close of the last fiscal year a contract was made for the construction of a single-screw steel vessel for service in Alaska and the Aleutian Islands. The speed of this vessel was to be not less than 12 knots per hour under natural draft, and the cost was to be $150 000.

On the 17th of March, 1899, a trial trip was made under the supervision of a board appointed by the Honorable the Secretary of the Treasury, and consisting of two Coast and Geodetic Survey officers, two officers of the Revenue-Marine Service, and a United States local inspector of boilers. The report of this board established the fact that the vessel fully complied with the requirements of the contract, and she was duly accepted. Besides having a speed of more than 12 knots per hour under natural draft, tests were made under forced draft, which demonstrated her ability to run easily more than 13 knots per hour, and maintain it indefinitely.

As above intimated, the *Pathfinder* is built entirely of steel and is of exceptional strength. She has 3 decks, 7 water-tight transverse bulkheads, and 15 water-tight compartments. Her length over all is 196 feet, with a breadth of beam of 36 feet 6 inches. The gross tonnage is 690, and the displacement on a mean draft of 10 feet is 875 tons. She is brigantine rigged, with a sail area of 4 478 square feet. Her engines are vertical triple-expansion, with 28-inch stroke. The bunkers have a capacity for 240 tons of coal, sufficient to give a steaming radius of about 5 000 miles.

This vessel, being intended for service on the Pacific coast, left Newport News on the 16th of June, 1899, and arrived at San Francisco on the 18th of September, having made a comparatively short trip, and having demonstrated good qualities as a seaworthy vessel.

For a detailed description of the *Pathfinder*, the trial trip, and her voyage to San Francisco, as well as general information regarding the entire Coast and Geodetic Survey fleet, see Appendix No. 2, p. ——.

3. COMPASS RANGES.

In the beginning of January, 1899, Assistant Westdahl, then in command of the steamer *Gedney*, doing hydrography and topography in San Diego Bay, was directed to determine certain objects to be used as compass ranges. In carrying out these instructions he determined by triangulation 8 points and established 30 or more ranges for the determination of the compass errors.

APPENDIX No. 1.

REPORT 1898-1899.

DETAILS OF OFFICE WORK.

APPENDIX No. 1. 1898-99.

DETAILS OF OFFICE WORK.

INTRODUCTION.

In the present paper it is proposed to state somewhat more in detail than was possible in the Superintendent's Report the operations of the Office. The divisions will be treated consecutively and in the order given in the synopsis at the first part of the Superintendent's Report.

The plan of making an appendix of this material arose from the fact that the publication of the separate reports from the different divisions, and signed by the chiefs thereof, has been discontinued. In order that the details of the office work may be made a matter of record, as it is proposed to do with the field work, a continuous statement, embracing all the divisions, has been drawn up, and is as follows:

TABLE OF CONTENTS.

I. ADMINISTRATION.

A. SUPERINTENDENT'S OFFICE.

The details of the duties in the Office of the Superintendent are largely of a routine nature, a full statement of which would be devoid of interest, and would, moreover, be of little permanent value. Beyond the statement made in the preceding pages of the Report the following information may be given:

From the beginning of the fiscal year until April 18 the personnel of the Office was as follows:

Dr. Henry S. Pritchett	Superintendent.
Mr. E. D. Preston	Executive officer.
Mr. W. B. Chilton	Clerk.
Mr. W. H. Emery	Stenographer and typewriter.

On April 19 a partial reorganization of this Office, as well as that of the Assistant in Charge, took place. Mr. O. H. Tittmann, who had acted as Assistant in Charge of Office and Topography, was assigned to duty in the Office of the Superintendent, under the title of Assistant Superintendent; Mr. E. D. Preston was made editor of publications and chairman of the publication committee, and Mr. A. Braid was given charge of the Office, under the designation of Assistant in Charge. Mr. D. B. Wainwright was detailed for duty in the Office of the Superintendent as assistant to Mr. O. H. Tittmann.

These assignments held throughout the remainder of the fiscal year.

B. ACCOUNTING DIVISION.

Personnel.

Name.	Occupation.
Mr. Scott Nesbit	Disbursing Agent, Chief of Division.
N. G. Henry	Confidential clerk and cashier.
Ida M. Peck	Typewriter and clerk.
Jennie H. Fitch	Clerk.
F. R. Green	Clerk in charge of miscellaneous section.
Harlan C. Allen	Writer.
Charles Over	Superintendent's messenger.
Thomas McGoines	Messenger.

1. DISBURSING SECTION.

The detailed statement of the disbursements made in the fiscal year 1898-99, including the adjustment of all accounts to January 1, 1900, will be submitted to Congress early in January, and is as follows:

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899.

[Prepared pursuant to the act approved March 3, 1853.]

SALARIES—PAY OF FIELD OFFICERS, 1899.

To whom paid.	Time employed.	Amount.
SUPERINTENDENT.		
Henry S. Pritchett	One year	$5 000·00
ASSISTANTS.		
Charles A. Schott	One year	4 000·00
Aug. F. Rodgers	do	4 000·00
Otto H. Tittmann	do	3 200·00
Andrew Braid	do	3 000·00
A. T. Mosman	do	3 000·00
Herbert G. Ogden	do	3 000·00
Will Ward Duffield	do	3 000·00
Erasmus D. Preston	do	2 500·00
Cephas H. Sinclair	do	2 500·00
William Eimbeck	do	2 500·00
Frank D. Granger	do	2 500·00
Frank Walley Perkins	do	2 200·00
J. J. Gilbert	do	2 200·00
Henry L. Marindin	do	2 200·00
John F. Pratt	do	2 200·00
Edmund F. Dickins	do	2 200·00
Dallas B. Wainright	do	2 200·00
Isaac Winston	do	2 200·00
William C. Hodgkins	do	2 000·00
Philip A. Welker	do	2 000·00
James B. Baylor	do	2 000·00
John Nelson	do	2 000·00
John A. Flemer	do	2 000·00
Fremont Morse	do	2 000·00
Stehman Forney	do	2 000·00
Gershom Bradford	do	1 800·00
Walter B. Fairfield	do	1 800·00
W. Irving Vinal	do	1 800·00
George R. Putnam	do	1 600·00
Fred. A. Young	do	1 600·00
Ferdinand Westdahl	do	1 600·00
E. B. Latham	do	1 400·00
Albert L. Baldwin	do	1 400·00
Homer P. Ritter	do	1 400·00
Robert L. Faris	do	1 200·00
George L. Flower	do	1 200·00
Owen B. French	do	1 200·00
Charles C. Yates	do	1 200·00
John E. McGrath	Eight months and twenty-nine days	893·47
Edwin Smith	Ten months and twenty-eight days	1 089·09

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

SALARIES—PAY OF FIELD OFFICERS—Continued.

To whom paid.	Time employed.	Amount.
AIDS.		
Hugh C. Denson	One year	$900·00
R. B. Derickson	....do	900·00
William Bowie	....do	900·00
Harry F. Flynn	....do	900·00
Edgar R. Frisby	Eleven months and twenty-seven days	712·10
Gurley S. Phelps	Eleven months and twenty-six days	710·17
Hugh C. Mitchell	Ten months and ten days	618·37
Royal J. Mansfield	Seven months and fourteen days	447·99
Expenditures		94 871·19
Appropriation		95 680·00
Expenditures		94 871·19
Unexpended balance		808·81

SALARIES—PAY OF OFFICE FORCE, 1899.

To whom paid.	Time employed.	Amount.
DISBURSING AGENT.		
Scott Nesbit	One year	$2 200·00
CHIEF OF DIVISION OF LIBRARY AND ARCHIVES.		
Edw. L. Burchard	Eight months and eleven days	1 252·20
CLERKS.		
William B. Chilton	One year	1 650·00
Nicholas G. Henry	....do	1 650·00
John H. Smoot	....do	1 400·00
William C. Maupin	....do	1 400·00
Freeman R. Green	....do	1 400·00
Adelbert B. Simons	....do	1 400·00
Eugene B. Wills	....do	1 200·00
Frank W. Edmonds	....do	1 200·00
J. Henry Roeth	....do	1 200·00
Asa G. Randall	Twenty-one days	68·48
Sophie S. Hein	One year	1 200·00
William H. Emery	Ten months and ten days	1 031·87
Ida M. Peck	One year	1 200·00
R. D. Chase	Twenty-seven days	89·01
Herbert M. Fitch	Fourteen days	56·04
Jennie H. Fitch	One year	1 000·00
Alice G. Reville	....do	1 000·00
Patrick V. Dolan	....do	1 000·00
CHART CORRECTORS.		
Edward H. Wyvill	One year	1 200·00
Henry R. Garland	....do	1 165·72
Archie Upperman	....do	720·00
Mary L. Handlan	....do	720·00

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

SALARIES—PAY OF OFFICE FORCE, 1899—Continued.

To whom paid.	Time employed.	Amount.
WRITERS.		
Lily A. Mapes	One year	$900·00
Mary E. Campbell	.....do	900·00
Kate Lawn	.....do	888·61
Albert F. Zust	.....do	790·80
Deane S. Bliss	Twenty-five days	48·91
James M. Griffin	Ten months and twelve days	623·04
Henry Warrington	One month and seven days	74·30
Charles A. Wolfe	Six months and seventeen days	393·56
El Bie K. Foltz	Thirty-one days	60·00
Joseph B. Quinlan	Three months and seventeen days	214·00
William W. Manning	Two months and twenty-six days	170·44
Albert E. Gorham	Three months and twenty-one days	222·75
H. C. Allen	One month and twenty-two days	102·82
Edward W. Mollohan	Thirty-one days	61·32
R. D. Chase	One month and thirty days	92·97
Edgar W. Ford	Sixteen days	31·61
Mary A. Grant	One year	515·35
BUOY COLORIST.		
Edward Belford	One year	720·00
DRAFTSMEN.		
Edwin H. Fowler	One year	2 400·00
Henry Lindenkohl	.....do	2 200·00
Adolph Lindenkohl	.....do	2 000·00
William C. Willenbucher	.....do	2 000·00
Ernest J. Sommer	.....do	1 800·00
Frank C. Donn	.....do	1 800·00
David M. Hildreth	.....do	1 800·00
Charles H. Deetz	.....do	1 400·00
Edmund P. Ellis	.....do	1 400·00
John T. Watkins	Eight months and twenty days	867·42
Harlow Bacon	One year	970·01
Paul Erichsen	.....do	1 000·00
Benj. E. Tilton	.....do	994·60
Sully B. Maize	Two months and eighteen days	214·71
James P. Keleher	One year	900·00
E. M. Sunderland	Eleven months and seven days	829·09
Charles Mahon	One year	700·00
COMPUTERS.		
John F. Hayford	Eleven months and twenty-three days	2 347·80
Edward H. Courtenay	One year	1 991·85
Myrick H. Doolittle	.....do	2 000·00
Leland P. Shidy	.....do	1 800·00
John B. Boutelle	.....do	1 600·00
Frank M. Little	.....do	1 552·17
Daniel L. Hazard	.....do	1 600·00
Rollin A. Harris	.....do	1 600·00
Artemas Martin	.....do	1 400·00
Lilian Pike	.....do	1 200·00
William H. Dennis	.....do	1 000·00
George A. Fairfield	.....do	1 000·00
Deane S. Bliss	Eleven months and six days	932·10

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

SALARIES—PAY OF OFFICE FORCE, 1899—Continued.

To whom paid.	Time employed.	Amount.
COPPERPLATE ENGRAVERS.		
William A. Thompson	One year	$2 000·00
Henry M. Knight	do	2 000·00
Theodore Wasserbach	do	2 000·00
William H. Davis	do	1 800·00
Edward H. Sipe	do	1 800·00
William F. Peabody	do	1 600·00
Harry L. Thompson	do	1 600·00
William A. Van Doren	do	1 400·00
Alfred H. Sefton	do	1 200·00
Peter H. Geddes	do	1 200·00
Harry R. McCabe	do	994·56
William Mackenzie	do	1 000·00
George Hergesheimer	do	900·00
Frank G. Wurdemann	do	900·00
William H. Holmes	do	900·00
Hugo Franke	do	900·00
Rowland H. Ford	do	700·00
ELECTROTYPER AND PHOTOGRAPHER.		
Louis P. Keyser	One year	1 800·00
ASSISTANT ELECTROTYPER AND PHOTOGRAPHER.		
Roy Thomas	One year	700·00
PLATE PRINTERS.		
D. N. Hoover	One year	1 600·00
Eberhard Fordan	do	1 000·00
Neil Bryant	do	1 000·00
James L. Smith	do	1 000·00
Frank C. Gohre	Ten months	832·40
Charles J. Harlow	Six months and twenty-six days	570·65
Charles F. Locraft	Seven months	572·23
PLATE PRINTERS' HELPERS.		
Louis L. Williams	Eleven and one-half days	21·87
William M. Conn	One year	692·39
Charles F. Locraft	Five months	291·86
Charles Buckingham	One year	700·00
R. J. Fondren	Seven months and twenty-three days	452·75
E. F. Campbell	One month and twelve days	80·78
INSTRUMENT MAKERS.		
Ernest G. Fischer	One year	1 800·00
Clement Jacomini	do	1 200·00
William R. Whitman	do	1 000·00
Michael Lauxmann	do	1 000·00
Thomas A. Gibson	do	900·00
J. A. Clark	do	900·00
CARPENTERS.		
Horace O. French	One year	1 200·00
George W. Clarvoe	do	1 000·00
Charles N. Darnall	do	1 000·00

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

SALARIES—PAY OF OFFICE FORCE, 1899—Continued.

To whom paid.	Time employed.	Amount.
WATCHMEN.		
Davis Parker	One year	$880·00
John W. Drum	do	880·00
FIREMAN.		
Horace Dyer	One year	630·00
MESSENGERS.		
Edward D. Scott	Eight months and seven days	601·31
Thomas McGoines	Three months and twenty-four days	278·69
Charles Over	One year	820·00
Charles H. Jones	do	820·00
Wm. R. McLane	do	820·00
Vicente Denis	Four months	274·10
William H. Butler	Eight months	545·90
John W. Reed	Ten months and twenty-nine days	597·11
George Newman	Four months	234·00
Attrell Richardson	Twenty-five days	48·08
Wm. J. Diercks	Eight months	466·80
John W. Minor	One year	640·00
J. W. Hunter	do	640·00
Owen E. McNeille	do	630·00
PACKER AND FOLDER.		
Attrell Richardson	Eleven months and five days	586·75
LABORERS.		
Frank Thomas	One year	630·00
Hans Bowdwin	do	550·00
John H. Brown	do	555·50
John H. Mason	do	377·66
Virginia McGlincy	do	365·00
Expenditures		133 593·14
Appropriation		136 090·00
Expenditures		133 593·14
Unexpended balance		2 496·86

RECAPITULATION.

Pay of field officers	$94 871·19
Pay of office force	133 593·14
Expenditures	228 464·33
Total sum appropriated for salaries	231 770·00
Total sum expended for salaries	228 464·33
Unexpended balance	3 305·67

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES, 1899.

ATLANTIC COAST, ETC.

To whom paid.	On what account.	Amount.
Adams Express Co	Transportation	$4·90
A. M. Avery	Stores for schooners Spy and Transit	110·40
J. B. Baylor	Triangulation	441·79
W. H. H. Bixler & Co.	Outfit for steamer Bache	22·80
J. B. Boutelle	Combined operations, schooners Eagre and Matchless.	2 878·34
Wm. Bowie	Topography	1 225·95
Gershom Bradford	Traveling expenses	46·72
Bureau of Equipment, Navy	Coal and water for steamer Bache	191·20
Campbell & Zell Co	Supplies for steamer Blake	23·88
C. L. J. Carroll	Coal for steam launch	5·75
D. Derickson	Services	55·00
John W. Donn	Topography	3 104·70
Geo. L. Flower	Hydrography, schooner Eagre	12·45
O. B. French	Topography	2 978·43
Geo. W. Knox Express Co	Transportation	2·74
J. K. Glennon & Co	Storage	60·00
W. C. Hodgkins	Topography and hydrography, steamer Blake.	5 808·28
Henry L. Marindin	Hydrography, schooner Eagre	1 525·16
J. T. Marsh	Lumber for signals	58·44
Thos. S. Martin	Traveling expenses	10·28
R. McD. Moser	do	25·50
Herbert G. Ogden	Combined operations	1 296·69
F. Walley Perkins	Triangulation and hydrography, schooner Eagre.	5 052·33
People's Dispatch Co	Transportation	1·25
Henry S. Pritchett	Traveling expenses and commutation	162·15
Revenue-Cutter Service	Flags and bunting	220·00
The E. G. Bernard Co	Electric plant for steamer Blake	1 723·60
Benj. E. Tilton	Traveling expenses	36·25
O. H. Tittmann	do	11·75
W. Irving Vinal	Combined operations	2 664·79
D. B. Wainwright	Hydrography, steamer Blake	3 811·59
P. A. Welker	Combined operations, steamer Bache	9 292·39
A. B. Wilson	Services and traveling expenses	127·05
Chas. C. Yates	Hydrography, steamer Endeavor	4 879·84
Amount disbursed		47 872·39
Railroad accounts referred for settlement		49·60
Expenditures		47 921·99
Appropriation		44 400·00
Add 10 per cent from tides, etc		500·00
Add 10 per cent from off-shore work, etc		1 010·00
Add 10 per cent from State surveys, etc		2 200·00
Total		48 110·00
Expenditures		47 921·99
Unexpended balance		188·01

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES, 1899—Continued.

PACIFIC COAST, ETC.

To whom paid.	On what account.	Amount.
Adams Express Co	Transportation	$5·55
Chas. R. Allen	Coal for steamer McArthur	245·00
W. M. Atkinson	Traveling expenses	9·15
Milton W. Boyd	Commutation	23·00
Clothing and small stores fund	Outfit for steamer Pathfinder	238·39
E. F. Dickins	Hydrography, steamers McArthur and Gedney.	7 799·42
John C. Dow	Services	99·72
Dunham, Carrigan & Hayden Co	Outfit for steamer McArthur	104·65
A. H. Dutton	Services and traveling expenses	22·88
R. L. Faris	Combined operations	3 349·32
J. A. Flemer	Topography	3 372·30
J. J. Gilbert	Triangulation and topography	577·03
W. F. Glover	Traveling expenses	13·10
John T. Goldsborough	Services and traveling expenses	349·39
James Reilly Repair and Supply Co.	Outfit for steamer Pathfinder	5 409·05
G. M. Josselyn & Co	Stores for steamer McArthur	180·22
Moore Brothers	Outfit for steamer Pathfinder	31·50
Fremont Morse	Topography	1 456·88
A. T. Mosman	Triangulation	10 147·83
Lewis Nixon	Outfit for steamer Pathfinder	451·50
F. Walley Perkins	Transferring steamer Pathfinder to Pacific coast.	1 224·58
Henry S. Pritchett	Traveling expenses	407·21
G. R. Putnam	Combined operations	3 413·78
Revenue-Cutter Service	Flags and bunting	170·67
Aug. F. Rodgers	Triangulation and topography and hydrography, steamers Paterson and McArthur.	1 618·14
John Ross	Outfit for steamer Pathfinder	4 447·38
Strawbridge & Clothier	do	1 128·17
United States Express Co	Transportation	1·50
Ferdinand Westdahl	Hydrography, steamers Gedney and McArthur.	7 824·23
Amount disbursed		54 121·54
Railroad accounts referred for settlement		544·93
Expenditures		54 666·47
Appropriation		54 400·00
Add 10 per cent from objects not named		400·00
Total		54 800·00
Expenditures		54 666·47
Unexpended balance		133·53

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES, 1899—Continued.

TIDES, ETC.

To whom paid.	On what account.		Amount.
Adams Express Co	Transportation		$1·95
E. R. Conant	Services		10·00
F. M. Little	Traveling expenses and Washington tidal.		45·44
J. F. Pratt	Seattle tidal		64·95
Aug. F. Rodgers	San Francisco tidal		1 004·85
L. P. Shidy	Washington tidal		26·06
J. G. Spaulding	Fort Hamilton tidal		1 046·73
Harry V. Webb	Morehead City tidal		100·00
W. B. Weeks	Fernandina tidal		608·25
Chas. C. Yates	Morehead City tidal		·83
Expenditures			2 909·06
Appropriation			5 000·00
Less 10 per cent transferred to Atlantic coast, etc		$500·00	
Expenditures		2 909·06	
			3 409·06
Unexpended balance			1 590·94

OFF-SHORE WORK, ETC.

To whom paid.	On what account.		Amount.
D. Ballauf	Deep-sea sounding machines		$1 260·00
H. L. Ford	Services		416·67
G. Cramer Dry Plate Co	Photograph plates for steamer Patterson.		40·75
H. C. Graves	Services		1 575·06
James M. Griffin	....do		121·18
J. F. Pratt	Hydrography, steamer Patterson		1 943·70
Talbot Pulizzi	Services		900·00
Revenue-Cutter Service	Flags for steamer Patterson		14·34
Aug. F. Rodgers	Hydrography, steamer Patterson		12·00
John Ross	Services, commutation, and traveling expenses.		1 314·44
Union Iron Works	Outfit for steamer Patterson		1 250·00
Expenditures			8 848·14
Appropriation			10 100·00
Less 10 per cent transferred to Atlantic coast, etc		$1 010·00	
Expenditures		8 848·14	
			9 858·14
Unexpended balance			241·86

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES, 1899—Continued.

STATE SURVEYS, ETC.

To whom paid.	On what account.		Amount.
A. L. Baldwin	Precise leveling		$1 190·70
Baltimore and Ohio Railroad Co	Transportation		11·80
L. A. Bauer	Traveling expenses and magnetics		224·47
J. B. Baylor	Magnetics		232·50
M. G. Copeland & Co	Tents and instrument shades		143·50
John Dice	Storage		9·00
Wm. Eimbeck	Triangulation		1 654·33
O. W. Ferguson	Precise leveling		604·90
Stehman Forney	Reconnaissance		4 430·66
F. D. Granger	Triangulation		4 759·15
John F. Hayford	Traveling expenses		60·93
H. W. Lawrence	Storage		3·87
Fremont Morse	Geographical positions		291·78
G. R. Putnam	Gravity observations		6·00
C. H. Sinclair	Geographical positions		621·53
Edwin Smith	Magnetics, gravity experiments, and geographical positions.		1 627·85
United States Express Co	Transportation		22·60
Frank Williams	Pasturage		81·87
Isaac Winston	Precise leveling		2 822·89
Amount disbursed			18 800·33
Railroad accounts referred for settlement			448·04
Expenditures			19 248·37
Appropriation			22 000·00
Less 10 per cent transferred to Atlantic coast, etc		$ 2 200·00	
Expenditures		19 248·37	
			21 448·37
Unexpended balance			551·63

CALIFORNIA BOUNDARY.

To whom paid.	On what account.		Amount.
Adams Express Co	Transportation		$10·90
John Barlow	Pasturage		105·30
H. F. Flynn	Traveling expenses		137·75
C. H. Sinclair	Boundary survey		9 393·89
Amount disbursed			9 647·84
Railroad accounts referred for settlement			113·80
Expenditures			9 761·64
Appropriation			10 000·00
Less 1 per cent transferred to Navy travel, etc		$100·00	
Expenditures		9 761·64	
			9 861·64
Unexpended balance			138·36

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES, 1899—Continued.

NAVY TRAVEL, ETC.

To whom paid.	On what account.	Amount.
J. B. Boutelle	Traveling expenses of enlisted men	$6·00
Milton W. Boyd	Traveling expenses	6·40
M. Crichton	....do	4·80
C. F. Deichman	....do	6·90
Geo. L. Flower	Traveling expenses of enlisted men	11·60
Harry L. Ford	Traveling expenses	82·25
Owen B. French	Traveling expenses of enlisted men	116·60
W. C. Hodgkins	Special survey	2 113·09
T. W. Lentze	Traveling expenses	31·00
Henry L. Marindin	Traveling expenses, special survey	43·36
James E. Marsh	Traveling expenses	39·25
J. W. McGrath	....do	73·20
Herbert G. Ogden	Traveling expenses of enlisted men	10·50
Geo. Olsen	Traveling expenses	6·50
F. Walley Perkins	Traveling expenses of enlisted men	33·65
Wm. B. Proctor	Traveling expenses	16·46
John Ross	Traveling expenses of enlisted men	24·25
Wm. Sanger	Traveling expenses	5·75
J. E. Shepherd	....do	45·90
Standard Oil Co	Oil for steamer Blake, special survey	49·20
Eugene Veith	Traveling expenses	41·95
W. Irving Vinal	Traveling expenses of enlisted men	26·25
Julius Wall	Traveling expenses	3·00
P. A. Welker	Traveling expenses of enlisted men	49·55
Amount disbursed		2 847·41
Accounts settled by Auditor for coal for steamer Blake		463·68
Railroad accounts referred for settlement		112·63
Expenditures		3 423·72
Appropriation		3 400·00
Add 1 per cent from California boundary		100·00
		3 500·00
Expenditures		3 423·72
Unexpended balance		76·28

OBJECTS NOT NAMED.

To whom paid.	On what account.	Amount.
Bureau of Equipment, Navy	Coal for steamer Blake	$369·75
C. Caspersen	Services	328·07
W. R. Gherardi	Commutation	91·00
Chas. Hansen	Services and subsistence	340·88
R. A. Harris	Traveling expenses	29·70
John F. Hayford	....do	30·00
W. C. Hodgkins	Combined operations in Porto Rico	756·92
Herbert G. Ogden	Traveling expenses	97·48
E. D. Preston	Traveling expenses as delegate to the International Geodetic Conference.	331·93
Henry S. Pritchett	Traveling expenses	154·26
Wm. W. Reissinger	Transportation of stores	6·24
Aug. F. Rodgers	Astronomical work	77·40
Chas. A. Schott	Traveling expenses as delegate to the Magnetic Conference at Bristol, England.	281·30

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES, 1899—Continued.

OBJECTS NOT NAMED—continued.

To whom paid.	On what account.		Amount.
O. H. Tittmann	Reconnoissance and tidal observations in Porto Rico.		$365·31
Chas. C. Yates	Storage and steam launches		106·80
Amount disbursed			3 367·04
Railroad accounts referred for settlement			156·25
Expenditures			3 523·29
Appropriation			4 000·00
Less 10 per cent transferred to Pacific coast, etc		$400·00	
Expenditures		3 523·29	
			3 923·29
Unexpended balance			76·71

CLASSIFICATION OF EXPENDITURES FOR PARTY EXPENSES, 1899.

On what account.	Amount.
Triangulation	$41 889·65
Topography	22 879·41
Hydrography	65 898·52
Coast Pilot	4 327·35
Leveling	4 634·49
Magnetics	998·87
Gravity	199·22
Geographical positions	1 815·04
Tidal operations	2 909·06
Astronomical work	77·40
Traveling expenses, transportation, etc	4 673·67
Total	150 302·68

RECAPITULATION.

[Showing expenditures in gross by sub-items.]

Sub-items.	Amount.
Atlantic coast, etc	$47 872·39
Pacific coast, etc	54 121·54
Tides, etc	2 909·06
Off-shore work, etc	8 848·14
State surveys, etc	18 800·33
California boundary	9 647·84
Navy travel, etc	2 847·41
Objects not named	3 367·04
Amount disbursed	148 413·75
Railroad accounts referred for settlement	1 425·25
Accounts settled by Auditor for coal for steamer Blake	463·68
Expenditures	150 302·68
Total amount appropriated for party expenses, 1899	153 300·00
Total amount expended for party expenses, 1899	150 302·68
Unexpended balance	2 997·32

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

REPAIRS OF VESSELS, 1899.

To whom paid.	On what account.	Amount.
A. M. Avery	Schooner Transit	$7·36
W. H. H. Bixler & Co	Steamer Bache	50·17
J. B. Boutelle	Schooner Matchless	187·03
Gershom Bradford	Steamers Blake and Bache	4·35
Campbell & Zell Co	Steamer Blake	1 088·25
W. L. Denny	Steam launches Nos. 22 and 23	4·69
E. F. Dickins	Steamer McArthur	638·95
R. L. Faris	Steamer Taku	264·93
Owen B. French	Schooners Quick and Spy	230·28
Gas Engine and Power Co., and Chas. L. Seaburry Co., Con.	Schooner Quick	109·67
Gibson & Kirk	Steamer Bache	3·55
Hay & Wright	Steamer Gedney	83·00
Herreshoff Manufacturing Co	....do	35·00
W. C. Hodgkins	Steamer Blake	377·18
W. Y. Huff	....do	750·00
C. J. Johnson	Schooner Transit	32·38
J. D. Mallory	Steam launches Nos. 22 and 23	13·22
Henry L. Marindin	Schooner Eagre	433·91
Mullin Manufacturing Co	Steamer Bache	24·00
Herbert G. Ogden	Traveling expenses	149·22
M. V. O'Neal	Steamer Bache	50·00
F. Walley Perkins	Schooner Eagre and steamer Pathfinder	633·71
J. F. Pratt	Steamers Patterson and McArthur and traveling expenses	3 709·93
Chas. Reeder & Sons	Steamer Bache and steam launches Nos. 22, 23, and 25.	1 695·58
R. M. Spedden Co	Steamer Pathfinder and schooner Eagre.	825·64
Aug. F. Rodgers	Steamers Patterson and McArthur, and steam launch No. 28.	99·59
Geo. F. Sloan & Bro	Steamer Bache	70·18
W. Stibbins & Sons	Steam launches Nos. 22 and 23	3·50
W. Irving Vinal	Schooner Matchless	235·01
D. B. Wainwright	Steamer Blake	1 206·39
Wallace & Gale	Steam launches Nos. 22 and 23	24·75
P. A. Welker	Steamer Bache	5 850·86
Ferdinand Westdahl	Steamers McArthur and Gedney	1 879·50
W. G. Henkel Co	Steamer Bache	9·75
Williamson Bros. Co	....do	195·00
Wm. E. Woodall & Co	Steamer Blake and schooner Eagre	1 990·99
Chas. C. Yates	Steamer Endeavor	1 562·75
Fred. A. Young	Steamer Fuca	234·51
Zellers & Co	Schooner Matchless	232·00
Expenditures		24 996·72
Appropriation		25 000·00
Expenditures		24 996·72
Unexpended balance		3·28

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

REPAIRS OF VESSELS, 1899—Continued.

CLASSIFICATION OF EXPENDITURES FOR REPAIRS OF VESSELS.

Name of vessel.	Amount.
Steamer Bache	$7 729·49
Steamer Blake	5 320·06
Schooner Eagre	1 200·77
Steamer Endeavor	1 562·75
Steamer Fuca	234·51
Steamer Gedney	1 004·66
Steam launches Nos. 22, 23, 25, and 28	271·30
Schooner Matchless	654·04
Steamer McArthur	1 716·88
Steamer Pathfinder	787·49
Steamer Patterson	3 709·83
Schooner Quick	327·95
Schooner Spy	12·00
Steamer Taku	264·93
Schooher Transit	39·74
Traveling expenses of inspection officers	160·32
Total	24 996·72

PUBLISHING OBSERVATIONS, 1899.

To whom paid.	On what account.	Amount.
L. A. Bauer	Services	$300·00
Arthur F. Belitz	do	10·99
James H. Gore	do	75·00
John F. Hayford	do	38·71
E. P. Moulton	do	472·00
Expenditures		896·70
Appropriation		1 000·00
Expenditures		896·70
Unexpended balance		103·30

GENERAL EXPENSES, 1899.

To whom paid.	On what account.	Amount.
Adams Express Co	Transportation	111·59
A. S. Aloe & Co	Instruments	22·50
American Engineer, Car Builder, and Railroad Journal.	Subscriptions	2·00
American Institute and Electric Engineering.	Books	23·00
American Journal of Science	Subscriptions	6·00
American Steel and Copper Plate Co.	Copper plates	19·20
American Wood Working Machine Co.	Carpenter shop	46·00

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

GENERAL EXPENSES, 1899—Continued.

To whom paid.	On what account.	Amount.
D. Appleton & Co	Books	$5·00
Edward F. Ball	Maps	150·00
R. Carter Ballantyne	Stationery	173·51
Wm. Ballantyne & Sons	....do	11·60
D. Ballauf	Instrument shop	21·00
Barber & Ross	Miscellaneous	1·00
H. Baumgarten	Stationery	47·26
J. Baumgarten & Sons	....do	13·13
Charles E. Barrick	Repairs	12·00
John D. Bartlett	....do	13·00
Bausch & Lomb Optical Co	Instruments and photographing supplies.	156·38
Benedict & Burnham Manufacturing Co.	Instrument shop	6·60
D. W. Beveridge	Repairs	54·00
John Bliss & Co	Instruments and books	389·66
Blue Line Transfer Co	Transportation	·35
Blum Bros	Furniture, repairs, and miscellaneous	131·42
R. R. Bowker	Books	7·50
Andrew Boyd	....do	25·00
Frank Boyden	Miscellaneous	4·00
Gershom Bradford	Office travel	235·60
Andrew Braid	....do	21·25
Brown & Sharpe Manufacturing Co.	Instrument shop	50·15
Bureau of Engraving and Printing	Printing supplies	1 077·46
Wm. H. Butler	....do	23·65
James H. Callender & Co	Miscellaneous	·35
Cameron, Amberg & Co	Stationery	1·75
Carpenter Cycle Co	Photograph supplies and miscellaneous.	57·10
S. C. Chandler	Books	10·00
Chesapeake and Potomac Telephone Co.	Exchange rental	71·44
A. S. Clark	Books	·60
Rufus P. Clarke	Printing supplies, drawing division, and miscellaneous.	606·94
Clendenin Bros	Copper plates	622·63
James Connor	Office horse	33·63
M. G. Copeland & Co	Miscellaneous	2·65
J. B. Cornell	Carpenter shop	13·16
H. S. Croker Co	Books	5·00
Pearre E. Crowl & Co	Stationery	8·96
Joseph L. Crupper	Carpenter shop	6·60
C. A. Cutter	Miscellaneous	4·50
Wm. J. Diercks	Extra labor	60·00
Directeur des Acieries d'Imphy	Instrument shop	27·80
Dodd, Mead & Co	Books	2·00
Doremus & Just Co	Repairs and instrument shop	7·00
M. Du Perow	Instrument shop and miscellaneous	7·90
Chas. R. Edmonston	Miscellaneous	12·75
Eimer & Amend	Photograph supplies	14·38
E. Morrison Paper Co	Chart paper and stationery	2 545·87
George T. Ennis	Instrument shop	97·98
John B. Espey	Carpenter shop, instrument shop, and miscellaneous.	260·84
Eureka Fire Hose Co	Miscellaneous	196·50
Evening Star Newspaper Co	Advertising	3·60
Fauth & Co	Instruments	22·50
F. E. Okie Co	Printing supplies	10·00
Flannery Bros	Instrument shop	19·50

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

GENERAL EXPENSES, 1899—Continued.

To whom paid.	On what account.	Amount.
Samuel Fleet	Miscellaneous	$4·00
Stehman Forney	Stationery	2·60
R. J. Fondren	Extra labor	211·67
E. H. Fowler	Office travel	28·00
Geographical Publishing House	Subscriptions	3·50
Geo. W. Knox Express Co	Transportation	77·79
Z. D. Gilman	Instrument shop, drawing division, and miscellaneous.	198·35
Andrew B. Graham	Photolithographing	673·42
Lee M. Graham	Miscellaneous	13·00
Henry J. Green	Instruments	164·00
Louis P. Griffith	Miscellaneous	2·00
Jacob Grinder	Stationery	35·00
W. & L. E. Gurley	Instruments	7·60
Edward J. Hannan	Repairs	25·00
Jeremiah Hawkins	Extra labor	540·00
Charles W. Hayes	Miscellaneous	7·22
D. Heise	Books	7·60
Albinor Hellmuth	Washing	111·43
Richard W. Henderson	Carpenter shop	16·40
Hill & Miller	Repairs	965·00
J. Hillengass	....do	242·50
Charles T. Holloway & Co	....do	1·10
George C. Hough	....do	186·75
H. J. M. Howard	Instrument shop	3·20
Victor A. Huard	Books	1·70
Wm. S. Hutchinson	Repairs	26·00
Independent Ice Co	Ice	204·30
International Cable Directory Co	Books	15·00
James Clark Distilling Co	Miscellaneous	1·00
Johnson Bros	Fuel	24·54
James H. Johnson	Repairs	403·75
V. Baldwin Johnson	Fuel	870·24
Jordan & Christie	Miscellaneous	24·06
J. W. Jordan & Co	Printing supplies	·70
M. E. Kahler	Instruments	104·85
S. Kahn's Sons & Co	Miscellaneous	·18
Thomas Keely	....do	154·52
Kennedy & Schaefer	Repairs	201·28
J. H. Keuhling	....do	37·50
Charles C. Kibbey	....do	3·50
Max Kuner	Instruments	12·00
James B. Lambie	Instrument shop and carpenter shop	26·31
Lansburgh & Bros	Instrument shop and miscellaneous	29·85
W. H. Larmon	Repairs	162·00
E. S. Leadbeater & Sons	Books and stationery	26·20
Nannie D. Lee	Washing	6·80
R. F. Le Mat	Extra labor	340·32
Lemcke & Buechner	Books	189·32
John S. Leng's Son & Co	Instrument shop	2·14
Solomon Lewis	Miscellaneous	6·50
Library Bureau	Books and stationery	106·40
H. Lindenkohl	Repairs	1·05
Melville Lindsay	Instrument shop and miscellaneous	29·96
F. M. Little	Carpenter shop	2·50
W. H. Lowdermilk & Co	Books	410·90
Lutz & Co	Miscellaneous	10·00

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

GENERAL EXPENSES, 1899—Continued.

To whom paid.	On what account.	Amount.
Mackall Bros	Printing supplies, carpenter shop, and instrument shop.	$72·98
Charles Mahon	Miscellaneous	6·00
W. E. Maloney	Repairs	345·55
Thomas Manning	Books	7·50
A. N. Marquis	....do	2·75
F. P. May & Co	Miscellaneous	8·65
McFadden Co	Instrument shop	10·57
Virginia McGlincey	Washing	5·19
W. F. McNeal	Miscellaneous	3·60
Murdock McPhee	Carpenter shop	·80
W. H. Mehler	Repairs and miscellaneous	214·40
George Meier & Co	Drawing division and instrument shop	5·00
Chas. E. Miller & Bro	Miscellaneous	3·70
Francis Miller	Carpenter shop	89·98
Thomas Miller	Repairs	35·80
Mitchell & Reed	Miscellaneous	1·78
F. J. Monrote	Instrument shop	18·75
W. S. Moore's Sons	Repairs	16·23
W. B. Moses & Sons	Furniture and miscellaneous	1 776·00
J. L. Moss, financial agent	Books	37·50
Mount Holly Paper Co	Chart paper	349·20
C. A. Muddiman & Co	Repairs and miscellaneous	14·95
Munn & Co	Books	7·00
Harrison Murray	Extra labor and miscellaneous	20·11
N. Murray	Subscriptions	7·00
George F. Muth & Co	Drawing division, stationery, printing supplies, and miscellaneous.	740·62
J. M. Meyers	Stationery	21·00
J. P. Nawrath	....do	20·20
T. S. & J. D. Negus	Instruments	185·00
Niagara Clip Co	Stationery	7·50
Thomas O'Brien	Miscellaneous	9·50
Oehm & Co	Instrument shop	3·00
John C. Parker	Books, stationery, and miscellaneous	115·84
W. A. Pate	Miscellaneous	·74
William C. Peake	Repairs	677·50
Postal-Telegraph Cable Co	Telegrams	11·71
Postmaster, Washington, D. C	Post-office box rent	17·00
J. F. Pratt	Instruments	22·25
E. D. Preston	Office travel	8·50
Publishers' Weekly	Books	3·50
E. J. Pullman & Son	Photograph supplies	183·44
John G. Rau	Miscellaneous	85·00
Reed & Alvard	Stationery	2·00
Josephine Reed	Extra labor	12·86
Revenue-Cutter Service	Flags	26·15
E. S. Ritchie & Sons	Instruments	88·00
Rochester Optical Co	....do	105·65
August F. Rodgers	Suboffice expenses	72·76
Maj. E. A. Root	Maps	20·00
Royce & Marean	Instrument shop and miscellaneous	21·22
Rudolph, West & Co	Carpenter shop and miscellaneous	81·82
C. P. Rydholm, jr	Miscellaneous	4·20
G. H. Saegmuller	Instruments	70·00
E. G. Schafer & Co	Repairs and miscellaneous	75·91

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

GENERAL EXPENSES, 1899—Continued.

To whom paid.	On what account.	Amount.
Fred A. Schmidt	Stationery, drawing division, and printing supplies.	$605·32
Schmedtie Bros	Instrument shop	13·00
C. A. Schneider's Sons	Repairs	95·00
J. Schonerberger	Stationery	2·23
Science	Subscription and books	5·15
E. D. Scott	Stationery	·60
Frank P. Serrin	Miscellaneous	3·00
Seth Thomas Clock Co	Instruments	93·60
Charles W. Sever & Co	Stationery	3·27
B. F. Shaw	Office horse	244·50
William Shedrick	Miscellaneous	5·95
George A. Shehan	Carpenter shop	639·80
Shoemaker & Busch	Electrotyping and photographing supplies.	262·56
M. Silverberg & Co	Carpenter shop	35·33
Thomas W. Smith	....do	70·00
Smith Premier Typewriter Co	Typewriter and repairs	110·90
Smithsonian Institution	Transportation	23·80
Frank C. Snyder	Instrument shop	2·50
Specialty Soap Manufacturing Co	Miscellaneous	11·93
Standard Oil Co	Printing supplies	6·40
G. E. Stechert	Books and subscriptions	198·21
Charles H. Strothers	Extra labor	11·29
The Automatic Telephone Exchange Co.	Rent of telephones	293·78
S. Thaxter & Sons	Charts	18·07
The Century Co	Maps	3·00
The E. F. Brooks Co	Furniture	11·10
The E. E. Jackson Co	Carpenter shop	34·65
The Engineering Magazine	Subscriptions	3·00
The Hansen & Van Winkle Co	Instrument shop	21·34
The Hartman Printing Co	Books	3·00
The Helman-Taylor Co	....do	5·00
The Howard Lockwood Publishing Co.	....do	2·00
The J. C. Ergood Co	Miscellaneous	85·48
The Julius Lansburg Furniture and Carpet Co.	Furniture	7·48
The Kenney Co	Repairs	527·76
The Lufkin Rule Co	Instrument shop	178·13
The Mackey Co., Limited	Photograph supplies	47·47
The McDermott Carriage Co	Repairs	7·90
The McMillan Co	Subscriptions	2·50
The Neal Co	Stationery	20·75
The New York Steel and Copper Plate Co.	Copper plates	91·00
The Norris Peters Co	Printing charts	32·00
The Phosphor Bronze Smelting Co., Limited.	Instrument shop	6·12
The Randolph Paper Box Co	Stationery	182·87
The Washington Post Co	Advertising	3·25
Eugene M. Tilden	Stationery	19·45
O. H. Tittmann	Office travel	18·00
J. S. Topham	Miscellaneous	7·00
United States Electric Lighting Co	Electricity	42·47
United States Express Co	Transportation	55·60
United States Naval Institute	Subscriptions	3·50

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

GENERAL EXPENSES, 1899—Continued.

To whom paid.	On what account.	Amount.
United States Radiator Co	Repairs	$6·62
United States Steel and Copper Plate Co.	Copper plates	293·33
United States Typewriter and Supplies Co.	Typewriter and stationery	102·45
University of Chicago Press	Subscriptions	4·00
Charles C. Van Horn	Miscellaneous	4·25
Wagner Typewriter Co	Typewriter and supplies	92·20
John Walsh	Repairs	8·50
Washington Gas Light Co	Gas	1 393·30
William Waterall & Co	Carpenter shop	12·45
C. W. Walker	Miscellaneous	4·00
Welsbach Commercial Co	do	9·35
William West	Extra labor	184·68
Western Union Telegraph Co	Telegrams	329·67
Louis Weule	Instruments and instrument shop	66·90
Willard Manufacturing Co	Stationery	·55
Williams, Brown & Earle	Miscellaneous	39·84
B. M. Winters	Extra labor	600·00
Woodruff Manufacturing Co	Stationery	9·00
Wyckoff, Seamans & Benedict	Typewriters and attachments	228·25
Lilian M. Yost	Washing	39·94
J. H. Yundt	Instrument shop and miscellaneous	4·00
Amount disbursed		27 922·39
Accounts for stationery, etc., settled by Auditor		777·43
Expenditures		28 699·82
Appropriation		28 500·00
Received from War Department for tracing of Porto Rico		180·00
Received from Hydrographic Office, Navy Department, for electrotyping		90·00
Received from Navy Department for level vial for model tank		13·00
		28 783·00
Expenditures		28 699·82
Unexpended balance		83·18

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

GENERAL EXPENSES, 1899—Continued.

CLASSIFICATION OF EXPENDITURES FOR GENERAL EXPENSES, 1899.

On what account.	Amount.	On what account.	Amount.
Instruments	$1 374·40	Transportation of instruments and supplies	$269·13
Instrument shop	784·32	Fuel	894·78
Carpenter shop	1 163·33	Gas	1 393·30
Drawing division	797·31	Electricity	42·47
Books	983·32	Telegrams	342·33
Maps	193·40	Ice	204·30
Charts	33·42	Washing	156·56
Subscriptions	96·70	Miscellaneous expenses and contingencies of all kinds	2 704·93
Copper plates	1 026·16	Office furniture	1 539·92
Chart paper	2 694·32	Repairs	4 498·15
Engraving, printing, photographing, and electrotyping supplies	2 266·77	Extra labor	1 980·68
Photolithographing and printing from stone and copper for immediate use	734·51	Traveling expenses (Office)	312·25
Stationery	1 927·93	Total	28 699·82
Office horse and wagon	285·13		

STEAMER FOR COAST SURVEY.

To whom paid.	On what account.	Amount.
Thos. H. Barrett	Traveling expenses	$27·17
J. J. Gilbert	.....do	31·40
J. T. Goldsborough	.....do	·60
Frank W. Grogan	Services and traveling expenses	1 107·13
C. A. McAllister	Traveling expenses	116·62
J. C. Moore	.....do	41·80
Lewis Nixon	Construction, equipment, and outfit	62 797·94
Herbert G. Ogden	Traveling expenses	131·44
Revenue-Cutter Service	Outfit (flags)	17·19
R. M. Spedden Co	Construction	632·14
John Ross	Equipment	336·25
Edward F. White	Traveling expenses	26·90
Chas. C. Yates	.....do	32·40
Expenditures		65 298·98
Balance on hand, report for 1898		50 305·18
Appropriation—Sundry Civil Act, March 3, 1899		15 000·00
Total amount available		65 305·18
Expenditures, as above		65 298·98
Present unexpended balance		6·20

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

SALARIES—OFFICE OF STANDARD WEIGHTS AND MEASURES, 1899.

To whom paid.	Time employed.	Amount.
ADJUSTER.		
Louis A. Fischer	One year	$1 500·00
VERIFIER.		
Frank A. Wolff, jr	One year	1 500·00
MECHANICIAN.		
Otto Storm	One year	1 250·00
ASSISTANT MESSENGERS.		
Wm. H. Butler	Four months	240·60
George Newman	Eight months	479·40
WATCHMEN.		
Henry D. Hall	Seven months	422·00
James A. McDowell	Five months	298·00
Expenditures		5 690·00
Appropriation		5 690·00
Expenditures		5 690·00
Unexpended balance		0·00

CONTINGENT EXPENSES, OFFICE OF STANDARD WEIGHTS AND MEASURES, 1899.

MATERIALS AND APPARATUS AND INCIDENTAL EXPENSES.

To whom paid.	On what account.	Amount.
Adams Express Company	Transportation	$8·15
Christian Becker	Apparatus	30·00
Benedict & Burnham Mfg. Co	Contingencies	2·74
James G. Biddle	Apparatus	1·87
Blue Line Transfer Co	Transportation	·35
Wm. J. Bohm	Apparatus	88·35
M. Du Perow	....do	292·30
Eimer & Amend	Apparatus and contingencies	249·36
Electric Storage Battery Co	Apparatus	181·27
Forest City Electric Co	....do	18·00
Geke & Co	Contingencies	1·70
Geo. W. Knox Express Co	Transportation	·79
Z. D. Gilman	Materials and contingencies	6·23
M. L. Greiner	Apparatus	11·00
C. A. F. Kahlbaum	Materials	9·03
Library Bureau	Incidentals and apparatus	17·75
Melville Lindsay	Apparatus and contingencies	6·81
Mackall Bros	Contingencies	19·50
W. H. Mehler	Apparatus and contingencies	18·75
Merck & Co	Materials	2·15
Thos. Miller	Incidentals	11·00
Geo. F. Muth & Co	Contingencies	5·20
National Electric Supply Co	....do	2·50
Queen & Co., Inc	Apparatus	2·14
Royce & Marean	....do	20·70

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

CONTINGENT EXPENSES, OFFICE OF STANDARD WEIGHTS AND MEASURES, 1899—Continued.

MATERIALS AND APPARATUS AND INCIDENTAL EXPENSES—continued.

To whom paid.	On what account.	Amount.
Franz Schmidt & Haensch	Apparatus	$186·96
Theo. Schuchardt	Materials	3·52
W. H. Speiser	Contingencies	·28
The J. C. Ergood Co	....do	·28
United States Express Co	Transportation	75·77
J. T. Walker's Sons	Materials and contingencies	13·38
Washington Gas Light Co	Apparatus	2·50
Welsbach Commercial Co	....do	4·60
Frank A. Wolff, jr	Incidentals	·38
Otto Wolff	Apparatus	613·92
Woodward & Lothrop	Contingencies	3·90
Zeigler Electric Co	Apparatus	27·80
Expenditures		1 940·93
Appropriation		2 475·00
Expenditures		1 940·93
Unexpended balance		534·07

PARTY EXPENSES.

ATLANTIC COAST, ETC.

To whom paid.	On what account.	Amount.
Blue Line Transfer Co	Transportation	$1·08
J. B. Boutelle	Hydrography, schooners Eagre and Matchless.	491·11
Wm. Bowie	Topography	966·23
John W. Donn	....do	1 550·84
J. A. Flemer	....do	862·65
Owen B. French	....do	300·86
James K. Glennon & Co	Storage	32·50
W. F. Glover	Traveling expenses	130·25
N. G. Henry	....do	30·60
W. C. Hodgkins	Hydrography, steamer Blake	1 973·96
Sully B. Maize	Services	30·97
John Nelson	Triangulation and topography	1 187·56
W. C. F. Nespital	Services	11·61
Philadelphia, Wilmington & Baltimore R. R. Co.	Transportation	68·21
Revenue-Cutter Service	Flags and bunting	242·73
W. Irving Vinal	Combined operations, schooner Matchless	1 675·67
P. A. Welker	Combined operations, steamer Bache	2 688·19
Wm. E. Woodall & Co	Storage	20·00
Chas. C. Yates	Hydrography	1 083·34
Expenditures		13 348·36
Appropriation		70 000·00
Expenditures		13 348·36
Unexpended balance		56 651·64

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES—Continued.

PACIFIC COAST, ETC.

To whom paid.	On what account.	Amount.
American Steel and Wire Co.	Sounding wire for steamer Pathfinder	$175·50
Bureau of Equipment, Navy	Coal for steamer Gedney	560·11
Carpenter Cycle Co.	Photograph supplies for steamer Pathfinder.	14·58
Castner, Curran & Bullett	Coal for steamer Pathfinder	342·85
E. F. Dickins	Hydrography, steamer Gedney	1 730·82
Geo. W. Knox Express Co.	Transportation	4·10
J. J. Gilbert	Triangulation and topography	408·29
E. B. Latham	Traveling expenses	116·20
Fremont Morse	Topography	595·25
A. T. Mosman	Triangulation	4 020·31
F. Walley Perkins	Transferring steamer Pathfinder to Pacific coast.	7 958·80
E. J. Pullman	Photograph supplies for steamer Pathfinder.	19·05
Revenue-Cutter Service	Flags and bunting	54·44
Riggs National Bank	Foreign exchange	16·53
Homer P. Ritter	Combined operations	4 559·83
Aug. F. Rodgers	Traveling expenses	17·50
The E. G. Bernard Co.	Outfit for steamer Pathfinder	1 000·00
Ferdinand Westdahl	Hydrography, steamer McArthur	798·19
Amount disbursed		22 392·35
Railroad accounts referred for settlement		238·93
Expenditures		22 631·28
Appropriation		70 000·00
Expenditures		22 631·28
Unexpended balance		47 368·72

RECAPITULATION.

[Showing expenditures in gross by subitems.]

Subitems.	Amount.
Atlantic coast, etc	$13 348·36
Pacific coast, etc	22 392·35
Amount disbursed	35 740·71
Railroad accounts referred for settlement	238·93
Expenditures	35 979·64
Total amount appropriated for party expenses	140 000·00
Total amount expended for party expenses	35 979·64
Unexpended balance	104 020·36

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES—Continued.

CLASSIFICATION OF EXPENDITURES FOR PARTY EXPENSES.

On what account.	Amount.
Triangulation	$8 265·81
Topography	7 879·59
Hydrography	10 482·43
Outfitting and transferring steamer Pathfinder to Pacific coast	9 351·81
Total	35 979·64

PARTY EXPENSES, 1899 AND 1900.

PAY OF PROFESSIONAL SEAMEN.

To whom paid.	On what account.	Amount.
F. H. Ainsworth	Services	$240·00
W. M. Atkinson	do	212·66
G. B. Beardsley	do	406·45
J. B. Boutelle	Pay of professional seamen	120·00
E. F. Dickins	do	933·54
John C. Dow	Services	430·64
W. F. Glover	do	240·00
J. T. Goldsborough	do	243·23
Y. D. Griffiss	do	348·39
W. C. Hodgkins	Pay of professional seamen	310·00
V. R. Lyle	Services	850·00
F. Walley Perkins	Pay of professional seamen	2 560·00
J. F. Pratt	do	2 555·00
Aug. F. Rodgers	do	733·86
John Ross	do	130·00
P. A. Welker	do	1 477·26
Ferdinand Westdahl	do	550·81
Expenditures		12 341·84
Appropriation		27 500·00
Expenditures		12 341·84
Unexpended balance		15 158·16

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

SURVEY OF YUKON RIVER, 1898 AND 1899.

To whom paid.	On what account.	Amount.
Edward F. Ball	Services	$190.78
R. L. Faris	Traveling expenses	9.25
J. F. Pratt	Combined operations	1 462.41
Revenue-Cutter Service	Flags	29.54
E. S. Ritchie & Sons	Outfit (instruments)	102.50
Homer P. Ritter	Reconnoissance, Copper River	139.43
Fred. A. Young	Combined operations	126.94
Amount disbursed		2 060.85
Railroad accounts referred for settlement		724.60
Transferred to Survey of Yukon River		28 719.31
Expended and transferred		31 504.76
Balance on hand, report for 1898		31 504.76
Expended and transferred		31 504.76

PUBLISHING CHARTS, 1898 AND 1899.

To whom paid.	On what account.	Amount.
Joseph E. Boyle	Services	$102.58
E. F. Campbell	do	230.65
Clarence Conard	do	145.16
Andrew B. Graham	Photolithographing	853.68
Acheson F. Hassen	Services	45.16
F. W. Hart	do	196.77
Albert O'Neill	do	54.84
Sully B. Maize	do	500.00
Mount Holly Paper Co	Chart paper	229.80
A. B. Simons, jr	Services	300.00
John C. Swan	do	100.00
Chas. A. Thompson	do	200.00
Williams Welch	do	93.33
Expenditures		3 051.97
Balance on hand, report for 1898		3 057.08
Expenditures since, as above		3 051.97
Present unexpended balance		5.11

PARTY EXPENSES, 1897.

STATE SURVEYS.

To whom paid.	On what account.	Amount.
John Dice	Storage	$18.00
Balance on hand, report for 1897		78.26
Expended since, as above		18.00
Present unexpended balance		60.26

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES, 1897—Continued.

RECAPITULATION.

[Showing expenditures in gross by subitems.]

Subitems.	Amount.
State surveys	$18·00
Balance on hand, report for 1898	6 424·65
Expended since, as above	18·00
Present unexpended balance	6 406·65

GENERAL EXPENSES, 1897.

COPPER PLATES, CHART PAPER, PRINTING INK, ETC.

To whom paid.	On what account.	Amount.
R. F. Bartle & Co	Extra engraving	$2 375·00
Balance on hand, report for 1898		3 582·64
Expended since, as above		2 375·00
Present unexpended balance		1 207·64

RECAPITULATION.

[Showing expenditures in gross by subitems.]

Subitems.	Amount.
Balance on hand, report for 1898	$7 315·97
Expended since, as above	2 375·00
Present unexpended balance	4 940·97

PARTY EXPENSES, 1898.

PACIFIC COAST.

On what account.	Amount.
Railroad accounts referred for settlement	$176·90
Balance on hand, report for 1898	2 120·09
Expended since, as above	176·90
Present unexpended balance	1 943·19

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

PARTY EXPENSES, 1898—Continued.

ALASKA.

On what account.	Amount.
Railroad accounts referred for settlement	$61·51
Balance on hand, report for 1898	122·56
Expended since, as above	61·51
Present unexpended balance	61·05

TIDES, ETC.

To whom paid.	On what account.	Amount.
B. W. Weeks	Incidentals	$0·40
Balance on hand, report for 1898		696·95
Expended since, as above		·40
Present unexpended balance		696·55

STATE SURVEYS.

To whom paid.	On what account.	Amount.
John Dice	Storage	$18·00
Railroad account referred for settlement		10·90
Expenditures		28·90
Balance on hand, report for 1898		158·00
Expended since, as above		28·90
Present unexpended balance		129·10

RECAPITULATION.

[Showing expenditures in gross by subitems.]

Subitems.	Amount.
Pacific coast	$176·90
Alaska	61·51
Tides, etc	·40
State surveys	28·90
Expenditures	267·71
Balance on hand, report for 1898	9 746·63
Expended since, as above	267·71
Present unexpended balance	9 478·92

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

REPAIRS OF VESSELS, 1898.

To whom paid.	On what account.	Amount.
Chas. C. Yates	Steamer Endeavor	$784·50
Balance on hand, report for 1898		1 267·23
Expended since, as above		784·50
Present unexpended balance		482·73

GENERAL EXPENSES, 1898.

INSTRUMENTS, INSTRUMENT SHOP, ETC.

To whom paid.	On what account.	Amount.
S. C. Chandler	Books	$5·00
Lemcke & Buechner	Books and subscriptions	32·05
Macmillan Co	Subscriptions	2·50
Queen & Co	Instrument shop	17·09
G. E. Stechert	Books and subscriptions	47·20
Expenditures		103·84
Balance on hand, report for 1898		409·88
Expended since, as above		103·84
Present unexpended balance		306·04

STATIONERY, TRANSPORTATION OF INSTRUMENTS, ETC.

To whom paid.	On what account.	Amount.
Fred A. Schmidt	Stationery	$300·00
Western Union Telegraph Co	Telegram	·22
Expenditures		300·22
Balance on hand, report for 1898		703·69
Expended since, as above		300·22
Present unexpended balance		403·47

RECAPITULATION.

[Showing expenditures in gross by subitems.]

Subitems.	Amount.
Instruments, instrument shop, etc	$103·84
Stationery, transportation of instruments, etc	300·22
Expenditures	404·06
Balance on hand, report for 1898	1 182·57
Expended since, as above	404·06
Present unexpended balance	778·51

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1899—Continued.

SURVEY OF YUKON RIVER.

To whom paid.	On what account.	Amount.
J. J. Gilbert	Office rent	$147·25
R. McD. Moser	Services and traveling expenses	194·63
J. F. Pratt	Combined operations	3 288·36
Expenditures		3 630·24
Transferred from Survey of Yukon River, 1898 and 1899		28 719·31
Expenditures		3 630·24
Unexpended balance		25 089·07

GENERAL RECAPITULATION.

[Showing appropriations, expenditures, and balances for the fiscal year ended June 30, 1899, and also for other accounts included in this Report.]

Name of appropriation.	Appropriated.	Expended.	Balances.
Salaries, sundry civil act, July 1, 1898:			
Pay of field officers	$95 680·00	$94 871·19	$808·81
Pay of office force	136 090·00	133 593·14	2 496·86
Party expenses, sundry civil act, July 1, 1898	153 300·00	150 302·68	2 997·32
Repairs of vessels, sundry civil act, July 1, 1898	25 000·00	24 996·72	3·28
Publishing observations, sundry civil act, July 1, 1898	1 000·00	896·70	103·30
General expenses, sundry civil act, July 1, 1898: Appropriation $28 500·00; Received from War Department 180·00; Received from Hydrographic Office, Navy 90·00; Received from Navy Department 13·00	28 783·00	28 699·82	83·18
Steamer for Coast Survey: Balance on hand last report 50 305·18; Appropriation, sundry civil act, March 3, 1899 15 000·00	65 305·18	65 298·98	6·20
Salaries, Office of Standard Weights and Measures, legislative act, March 15, 1898	5 690·00	5 690·00	....
Contingent expenses, Office of Standard Weights and Measures, legislative act, March 15, 1898	2 475·00	1 940·93	534·07
Party expenses, sundry civil act, March 3, 1899	140 000·00	35 979·64	104 020·36
Party expenses, 1899 and 1900, sundry civil act, March 3, 1899	27 500·00	12 341·84	15 158·16
Survey of Yukon River, 1898 and 1899, balance on hand last report	31 504·76	31 504·76	....
Publishing charts, 1898 and 1899, balance on hand last report	3 057·08	3 051·97	5·11
Party expenses, 1897, balance on hand last report	6 424·65	18·00	6 406·65
General expenses, 1897, balance on hand last report	7 315·97	2 375·00	4 940·97
Party expenses, 1898, balance on hand last report	9 746·63	267·71	9 478·92
Repairs of vessels, 1898, balance on hand last report	1 267·23	784·50	482·73
General expenses, 1898, balance on hand last report	1 182·57	404·06	778·51
Survey of Yukon River, transferred from survey of Yukon River, 1898 and 1899	28 719·31	3 630·24	25 089·07
Totals	770 041·38	596 647·88	173 393·50

2. MISCELLANEOUS SECTION.

The details of the duties performed in the miscellaneous section of the Accounting Division may be most easily shown by giving the following tables, which show the number of publications received and distributed during the year.

The distribution of the annual reports ranged from that for the year 1851 to that for the year 1897, and the total number sent out was 1 002, of which 503 belong to the last year mentioned. The other publications issued were as follows:

a. Publications issued.

	Page.
Appendixes to annual reports	1 442
Tide Tables	3 043
United States Coast Pilot, Atlantic coast	894
Pacific Coast Pilot, Alaska	61
Pacific Coast Pilot: California, Washington, and Oregon	51
Bulletins	1 442
Treatise on Projections	7
Deep-sea Sounding and Dredging, Sigsbee	9
Tidal Researches, Ferrel	3
General Instructions for Hydrographic Parties	33
Tables for Converting Customary and Metric Weights and Measures	137
Special publications	164

The following publications were received from the Public Printer during the year:

b. Publications received.

	No. of copies.
Report of the Superintendent of the United States Coast and Geodetic Survey, showing the progress of the work during the fiscal year ending with June, 1897	1 830
Appendix No. 1—Report for 1897, "Distribution of the magnetic dip and magnetic intensity in the United States for the epoch January 1, 1900"	700
Appendix No. 2—Report for 1897, "The telegraphic longitude net of the United States, and its connection with that of Europe, 1866-1896"	250
Appendix No. 3—Report for 1897, "Resulting longitudes of Kadiak, Unalaska, and Unga, as determined chronologically from Sitka in 1896, by the party under the charge of Assistant Fremont Morse"	100
Appendix No. 4—Report for 1897, "Heights from geodetic leveling between Holliday and Salina, Kans., from observations by Isaac Winston, Assistant, between July and October, 1895"	250
Appendix No. 5—Report for 1897, "Results of magnetic observations made in connection with the Greenland Expedition of 1896, under the charge of Prof. A. E. Burton"	100
Appendix No. 6—Report for 1897, "Results of pendulum observations made in 1895 and 1896".	100
Appendix No. 7—Report for 1897, "Notes relating to self-registering tide gauges as used by the United States Coast and Geodetic Survey"	250
Appendix No. 8—Report for 1897, "Manual of tides, Part I"	300
Appendix No. 9—Report for 1897, "Manual of tides, Part II"	300
Appendix No. 10—Report for 1897, "Photo-topographic methods and instruments"	300
Appendix No. 11—Report for 1897, "The new duplex base apparatus of the United States Coast and Geodetic Survey, and directions for its use in the field"	200
Appendix No. 12—Report for 1897, "Report on the measurement of the Salt Lake base line	200
Tide Tables of the Pacific Coast of the United States for 1899	500
Supplement to first edition, United States Coast Pilot, Atlantic Coast, Parts I and II, from the St. Croix River to Cape Ann	400
Supplement to first edition, United States Coast Pilot, Atlantic Coast, Part VI, Chesapeake Bay and Tributaries, May 2, 1899	400

b. Publications received—Continued.

	No. of copies.
Supplement to United States Coast Pilot, Atlantic Coast, Parts I, II, III, IV, V, VI, VII, and VIII, "Rules of the road at sea and in harbors, rivers, and inland waters (except the Great Lakes and their connecting and tributary waters as far east as Montreal, and the Red River of the North, and rivers emptying into the Gulf of Mexico and their tributaries)"	1 500
Supplement to the first edition, United States Coast Pilot, Atlantic Coast, Part VI, Chesapeake Bay and tributaries, September 15, 1898	300
Supplement to United States Coast Pilot, Part VIII, Gulf of Mexico, from Key West to Rio Grande	300
Catalogue of Charts, Coast Pilots, and Tide Tables, 1899	2 500
Price list of publications, 1899	50
Special publication No. 2, "Descriptive catalogue of publications relating to the Coast and Geodetic Survey, 1807 to 1896, and United States Standard Weights and Measures, 1790 to 1896"	500
Title page and index for bulletins, Vol. II	2 000
Regulations for enlistments, discharges, etc	200
Rules governing routine and discipline aboard ship, 1899	225
Bulletin No. 37, "Hydrographic notes and sailing directions relating to portions of Alaska, from Dixon Entrance to Yakutat Bay, including reconnoissance surveys of Cordova Bay, Bucarelli Bay, and Red Fish Bay, 1897"	2 500
Bulletin No. 38—Alaska; "Hydrographic notes, sailing directions relating to the vicinity of Prince William Sound, Cook Inlet, Kadiak Island, and route from Unalaska to Chignik, through Unimak Pass and inside the islands, 1897"	3 000
Bulletin No. 40—Alaska; "Coast Pilot notes of the Fox Island passes, Unalaska Bay, Bering Sea, and Arctic Ocean as far as Point Barrow"	490
Notices to mariners, comprising chart corrections for each month, except June, 1899; from July, 1898, to January, 1899, inclusive, for each month	4 400
For the months February, March, April, and May, 1899, each month	4 700
Tables for converting customary and metric weights and measures	500

C. OFFICE OF THE ASSISTANT IN CHARGE.

Personnel.

Name.	Occupation.
Andrew Braid, assistant	Assistant in Charge.
A. B. Simons	Clerk.
E. B. Wills	Clerk.
Miss S. S. Hein	Clerk.
Miss K. Lawn	Clerk.

The details of the duties performed in the office of the Assistant in Charge are such as grow out of the routine work of the different Divisions. A statement of these may be found, each under its appropriate heading, in the present Appendix.

II. TECHNICAL DIVISIONS.

A. HYDROGRAPHIC DIVISION.

Personnel.

Name.	Occupation.
H. G. Ogden, assistant	Inspector of Hydrography and Topography, chief of division.
John H. Roeth	Clerk.
John Ross	Nautical expert.
H. C. Graves	Nautical expert.
Harry L. Ford	Nautical expert.
Talbot Pulizzi	Clerk.

The details of the Hydrographic Division have been fully stated in the Superintendent's report, and require no further development in this place.

B. COMPUTING DIVISION.

Personnel.

PERMANENT.

Name.	Occupation.
C. A. Schott, assistant	Chief of division.
John F. Hayford, assistant	Inspector of Geodesy.
Edward H. Courtenay	Computer.
Myrick H. Doolittle	Computer.
Daniel H. Hazard	Computer.
Lilian Pike	Computer.
William H. Dennis	Computer.
George A. Fairfield	Computer.

TEMPORARY.

E. R. Frisby, aid	Computer.
H. C. Mitchell, aid	Computer.
J. J. Gilbert, assistant	Computer.
R. L. Faris, assistant	Computer.
W. Eimbeck, assistant	Computer.
J. E. McGrath, assistant	Computer.
I. Winston, assistant	Computer.
J. B. Baylor, assistant	Computer.
J. B. Boutelle, acting assistant	Computer.
A. L. Baldwin, assistant	Computer.
H. F. Flynn, assistant	Computer.

The work of this division during the year has been of a routine nature, with little change from the lines followed during the previous fiscal year. Special duty was performed in connection with the Massachusetts State Survey. Mr. J. B. Tolley of that service was assigned a desk in the Computing Division, and was assisted with advice while making the adjustment of the State work of the preceding season.

Early in May a new division of the office was established, for the investigation of terrestrial magnetism. This was placed in charge of Dr. L. A. Bauer, and on June 1, 1899, all manuscript matter, records, computations, and charts heretofore kept in the Computing Division were turned over to him. All duties relating to the subject of terrestrial magnetism will be performed in the new division from this date onward.

Besides the routine matters incident to the work of the Computing Division, time has been devoted to the computations of the transcontinental triangulation, and incidentally to the measure of the arc on the thirty-ninth parallel of latitude. A report on this great work has been submitted, and consists of 7 parts.

Much information, both magnetic and astronomic, has been collected in relation to the islands acquired through the recent war. The revision of star places has been taken up and carried on as fast as circumstances would permit. At the same time abstracts of latitudes were made and miscellaneous work of a similar nature done. The collection of geodetic data and other information called for by field parties has taken up much time during the year. Geographic registers containing the results of triangulation have been prepared, and the duplicate geodetic, astronomic, and magnetic records were duly scrutinized and filed away.

The traverse line across the peninsula of Florida, the observations of which were made in 1897–98, has been computed; the same computer assisting in checking conditional equations and revising the triangulation computations of the transcontinental triangulation.

The adjustment of the primary triangulation on the thirty-ninth parallel, already alluded to, formed a very laborious part of the computations in this line. Mention has already been made of the rapid solution of 99 normal equations, the same having been effected by Mr. Doolittle in twenty-four working days. The service of the same computer was utilized in the computation of other triangulation sides in the great arc west of Salina Base and extending to Point Arena, California.

The heights of primary stations in eastern Colorado, and thence across the Rocky Mountains to California, have been adjusted, and abstracts of vertical measures in California, made in 1898, have been made. The geographic positions of the principal arc stations from Hays, Kans., to the Pacific coast, both for the Clarke and the Bessel spheroids, and from Hays to the Atlantic coast for the latter spheroid, have been prepared. In addition to this, abstracts of horizontal and vertical measures of the primary triangulation in Alabama have been made, and the triangulation of the oblique arc from Montgomery to the Gulf coast has been adjusted.

The computation of the telegraphic longitude of Green River and Oasis, Utah; the azimuth of Bronson, Fla., and the chronometric longitudes of three stations in the Yukon Delta, Alaska, have been completed.

Spirit-level observations between Salina, Kans., and Hugo, Colo., and the geodetic connection of astronomic stations with the primary triangulation of the thirty-ninth parallel in Nevada and California have been brought to completion. Other work of similar nature was carried out in connection with the hypsometric results of the primary stations in the Rocky Mountains, and in the various magnetic observations in West Virginia.

A number of astronomic latitudes were computed under the direction of Mr. Hayford, and these include Marysville and Presidio, Cal.; Oasis and Green River, Utah, and three stations in the Yukon Delta, Alaska. The latitude computation of Unalaska has also been nearly completed.

Besides the foregoing, several computers were engaged at intervals in supplying copies of data called for in connection with Office correspondence, and the adjustment of the reconnoissance triangulation in southeastern Alaska, in order to connect the same with astronomic stations in that locality, was pursued.

Miscellaneous work was done by officers temporarily attached to the division, as follows: geodetic positions, magnetic, and star-place computations; computation of length of speed trial line for the Navy, and the computation of two azimuth stations in Alabama. To the above may also be added the computation of the supplementary triangulation on Chesapeake Bay, and the check computation of spirit levels in Colorado.

C. TIDAL DIVISION.

Personnel.

Name.	Occupation.
Mr. L. P. Shidy	Chief of Division.
F. M. Little	Computer.
R. A. Harris	Computer.
Artemas Martin	Computer.
Deane S. Bliss	Computer.
Alice G. Reville	Clerk.
Mary E. Campbell	Writer.
Mary A. Grant	Writer.
E. Phillips Moulton	Predictor.
Edgar W. Ford	Writer.

The annual volume of Tide Tables for the year 1900 was prepared as usual. While this volume is essentially similar to those of preceding years, it includes for the first time the predicted tides for St. Michael, Alaska, during the season of navigation, with tables of the times of slack current for each day of the year at Seymour Narrows, Discovery Passage, British Columbia, and at Sergius Narrows, Peril Strait, Alaska. Similar data for these three stations were also prepared for a portion of the year 1899, and issued as bulletins, it being too late to include them in the Tide Tables for that year. As this is the first time the Survey has issued full predictions of the times of slack current, a brief statement of the method of making the predictions will not be out of place. The observations, furnished by the party of Lieut. Commander E. K. Moore, U.S.N., commanding the steamer *Patterson*, consisted of the times of the beginning and ending of slack waters for about six months, as mentioned in my report for 1898. The observed times of middle slack water were tabulated, and the luni-current intervals computed, using only the upper transits of the moon. These intervals were plotted, to smooth out irregularities and interpolate short breaks in the series. A double argument table, using the time of the year and the exact hours of the moon's upper transit as arguments, was then formed. In order to extend this table to the portion of the year not covered by the observations, advantage was taken of the fact that in a period of 192 days there are approximately 6½ synodic months, 7 tropical, and 7 anomalistic months. The use of 6½ synodic months causes the time of the moon's upper transit to differ approximately by 12 hours at intervals of 192 days. In this period there is a practical recurrence of the phase, declinational, and parallax effects. To avoid the labor of interpolation in using the computed table, it was plotted so that the curves gave direct readings at any time desired.

The series of current observations, made by Lieut. E. H. Tillman, U.S.N., at two stations in Chesapeake Bay, Maryland, and one station occupied by Assistant R. L. Faris in the same vicinity, were subjected to harmonic analysis. The observed directions and velocities of the current for each hour were resolved into directions and velocities along north and south and east and west lines, thus dividing each series into two parts, each of which was analyzed separately. Only four components, M_2, S_2, K_1, and O_1, were obtained, because the velocity of the current at these stations is too slight to warrant putting more work upon it. These are the only cases of the application of the principles of the harmonic analysis to current observations that this Survey has accomplished.

The plane of mean low water has been determined for about 40 stations in Chesapeake Bay, Maryland and Virginia, from simultaneous tidal observations. At 13 stations distributed along the bay a month of day-and-night hourly heights of the sea were obtained simultaneously, and intermediate stations were occupied from a few days to a few weeks each. The tide is usually small in this bay, being about 2½ feet at the entrance, diminishing to less than a foot in the middle, and increasing again to about 2 feet at the head of the bay. The surface is affected very much by winds, which often causes a variation of 3 feet in the mean level.

The series of tides observed by the party of Assistant H. P. Ritter, in the Copper River Delta, Alaska, were found to contain a most interesting type of tide, in which the upper portion of the tide wave is normal and the lower part is very nearly a straight line. No soundings were available at the time of making the reductions, but it is very probable that the outside reef prevents the water from falling below a certain level, at which it remains dammed up until the rising tide overflows the barrier.

The series of tides observed by the party of Assistant J. F. Pratt, in the Yukon River Delta, Alaska, showed a rapid transition from an almost strictly diurnal tide at St. Michael to a well-marked semidiurnal tide at the Kusilvak Entrance to the Yukon.

Harmonic analyses were completed for quite a number of short series of from one to two months each of hourly ordinates, the total work being equivalent to the complete analysis of two years of continuous record.

The nonharmonic reductions completed during the year consist of 64 series, the equivalent of about ten years of continuous records of high and low waters.

Dr. R. A. Harris has continued his work upon the Manual of Tides, referred to in my last year's report. Part IV, now in progress, relates to tidal theory. Considerable progress has been made in the study of the tidal oscillations in the great oceanic basins. So far as this work has progressed, it goes to show that the dominant tides of most localities owe their origin to one of two methods of generation. The first is that implied in the corrected equilibrium theory, and pertains to rather small and well-inclosed bodies of water; the second, and far more important method, is that implied in stationary oscillations, whose free periods approximately coincide with the periods of the tidal forces.

In either case the tidal forces are required for various latitudes. Accordingly, diagrams for each 10 degrees of latitude have been constructed, showing their magnitude and direction for a semidiurnal or a diurnal component at each component hour. These diagrams may also be made to represent cotidal lines radiating from the no-tide point of a small and deep lake or sea.

Suppose we assume a uniform canal half-a-wave length long, or one of several half-wave lengths. This canal is supposed to follow any prescribed course, and generally to extend through various latitudes. Let the force diagrams be scattered along this canal. By this arrangement it is easy to see, at any given instant, what are the tidal forces resolved along the canal. A numerical value proportional to the virtual work imparted to the oscillating system by the forces by which the oscillation is sustained can now be found for any given time. With several such values in hand, the time of high or low water with reference to the tidal body is easily ascertained.

In oceans where tides of considerable magnitude are generated we are now to imagine "oscillating areas" resembling somewhat the canal just mentioned. But many difficulties arise in practice. For example, the want of tolerably complete lateral boundaries, and the necessity of simultaneously considering the movements in intersecting or adjacent areas, because their motions are not independent and so are not capable of easy superposition. The "oscillating areas" may thus come to have shapes much less simple than the one first considered. For this reason laboratory experimentation upon moderately long stationary waves under numerous conditions has been undertaken, although upon a rather limited scale.

The results, however, are in several respects satisfactory, for they assist in deciding whether or not a proposed movement is possible in nature, and they are also suggestive in various ways. The apparatus used consists of simply a rectangular tank, with means for partitioning off in it areas of almost any required shape. This is mounted upon a table capable of some yielding, so that the forces impressed upon it may set up oscillations in the liquid.

The coast of America, from New Foundland to Florida, constitutes one end of an "oscillating area," to which the tides of the Atlantic coast of the United States are due. This area resembles in many respects a broad canal, whose axis extends from New York southeasterly, one wave length, to a point west of South Africa; thence south, following nearly the meridian of Greenwich, half-a-wave length, to the Antarctic Continent.

Considering this area by itself for simplicity's sake, it will be found that the Greenwich cotidal hour for our Atlantic coast and for the western coast of southern Africa should not be far from 12 or 0; while for the region extending from Brazil to Cape Verde Islands and for the Antarctic Continent, in the longitude of Greenwich, the cotidal hour should not be far from 6. As observations in the last-named locality are entirely wanting for proving or disproving this hypothesis, it seems that attention of Antarctic explorers should be called to the desirability of observing tides for a day or more at as many places as possible along the Antarctic Continent.

The nodal line, one-fourth-wave length from our coast, extends from the Lesser Antilles northeasterly. This explains why it is that the semidiurnal tide in the Caribbean Sea and the Gulf of Mexico is so very small as compared with the tide along the outer or northern coast of Cuba and Haiti. Porto Rico lies west of this line of no tides and so the tide on its northern or outer coast ought to be nearly simultaneous with that of northern Cuba and eastern United States, although the range should be much reduced because of the proximity of the nodal line. The nodal line, three-fourths-wave length from our coast, should cross the axis of the area not far from Ascension Island. Hence the smallness of the tides upon that island.

The other "oscillating areas" of the Atlantic Ocean, and those of the Indian Ocean, seem to present no insurmountable difficulties and to give results fairly consistent with observation. The tides in the Arctic are derived from those of the North Atlantic and so require no special consideration.

On account of the broad expanse of the waters of the Pacific, and the partial barriers formed by islands and submerged plateaus, the tides of this ocean are by far more difficult than those of any other known body of water. Then, too, observations are as yet quite insufficient for deciding many important questions. The case, however, is not hopeless, and great efforts should be made for obtaining observations at as many foreign stations as possible.

So far we have had reference mainly to the semidiurnal tide. Somewhat similar statements are in a measure true for the diurnal portion.

There seems to be one oceanic region where the corrected equilibrium theory may possibly apply to the diurnal components; this is the western portion of the North Atlantic Ocean. The hypothesis just mentioned accords tolerably well with the fact that the diurnal tides in the Gulf of Mexico are about thirteen or fourteen hours later than the diurnal tides east of Georgia and northern Florida. The time required for a free wave to travel from the Lesser Antilles, where the diurnal tide must enter, to the shores of the Gulf of Mexico, is probably about ten hours.

The ratio of the masses of the moon and the sun, if derived from K_1, O_1, and P_1 of this region of the ocean, is fairly correct, as should be the case on the above supposition. But it is probable that this ratio can be best determined from observations made upon such inland bodies of water as Lake Superior and the Black Sea.

D. DRAWING AND ENGRAVING DIVISION.

Personnel.

Name.	Occupation.	Name.	Occupation.
Assistant Will Ward Duffield.	Chief of Division.	Wm. Mackenzie	Engraver.
John H. Smoot	Clerk.	H. R. McCabe	Do.
James M. Griffin	Writer.	W. F. Peabody	Do.
George Newman	Messenger.	A. H. Sefton	Do.
Hans Bowdwin	Laborer.	E. H. Sipe	Do.
Harlow Bacon	Draftsman.	H. L. Thompson	Do.
Chas. H. Deetz	Do.	W. A. Thompson	Do.
F. C. Donn	Do.	W. A. Van Doren	Do.
E. P. Ellis	Do.	F. G. Wurdemann	Do.
P. von Erichsen	Do.	Theo. Wasserbach	Do.
Edwin H. Fowler	Chief draftsman.	C. W. Buckingham	Printer's helper.
D. M. Hildreth	Draftsman.	John H. Brown	Laborer.
Jas. P. Keleher	Do.	W. M. Conn	Printer's helper.
A. Lindenkohl	Do.	E. F. Campbell	Do.
H. Lindenkohl	Do.	Eberhard Fordan	Plate printer.
Charles Mahon	Do.	R. J. Fondren	Printer's helper.
E. J. Sommer	Do.	F. C. Gohre	Plate printer.
E. M. Sunderland	Do.	F. N. Hoover	Foreman of printing section.
B. E. Tilton	Do.	C. J. Harlow	Plate printer.
J. T. Watkins	Do.	C. J. Locraft	Do.
William Welch	Do.	A. D. Levi	Skilled laborer.
W. H. Davis	Engraver.	R. F. LeMat	Extra laborer.
H. E. Franke	Do.	J. L. Smith	Plate printer.
R. H. Ford	Do.	Frank Thomas	Laborer.
P. H. Geddes	Do.	L. L. Williams	Printer's helper.
Geo. Hergesheimer	Do.	L. P. Keyser	Electrotyper and photographer.
W. H. Holmes	Do.	Thomas Roy	Assistant electrotyper.
H. M. Knight	Do.		

The work accomplished in each section of this division has been entirely satisfactory, and, considering the force employed, the output has been very large. The continued use of the engraved plate notes, compasses, etc., has facilitated the work in the drawing section, and the adoption of the standard chart on prepared mellowed paper, upon which all corrections are made, enables the engravers to make the corrections and tracings direct from the proof without making adjustments for shrinkage and expansion, the charts being true to scale. We have now in the drawing section standards from nearly all the plates printed from copper, which are obtained and filed as evidences of corrections applied. Whenever it is necessary to apply corrections to a location previously corrected on the standard proof, a new standard proof is obtained and the old one filed away. In this manner these standards become the best possible record of corrections applied to plates, as on each one is entered not only the corrections themselves, but also the authorities for the data shown and the date applied to the plate.

With all these improved facilities, however, the drawing section is far in arrears, and the force should be increased at the earliest possible date. The draftsmen have done excellent work and a large amount of it, but the increased quantity of work required is beyond the ability of the present force.

The output of charts in the printing section has not been as large as that of last year, which was increased by the war demand, but still we have met all demands and to a large extent controlled the back orders. With the printing of charts controlled by this division, as it now is, it is confidently believed that in the future all back orders can be eliminated, save where the corrections are of such extent as to require new plates.

A larger number of plates, both altos and bassos, have been made in the electrotyping section for the past year than for a number of years past. This has been occasioned by the efforts of this division to replace old and worn-out plates with new bassos, to say nothing of the new charts completed during the year.

The introduction in the photograph rooms of the Van Dyke black and white paper has enabled us to preserve negatives of all small tracings made for the United States Engineer Corps or the public, whereby we are able to reproduce these drawings as well as from the original tracings. Van Dyke negatives are preserved of all progress sketches and duplicate copies can be furnished at any time with little cost or trouble and in any quantity.

During the year 264 calls for information were made upon the division, involving areas, shore lines, distances between various points, tracings from both original topographic and hydrographic sheets, copies of old and canceled charts, construction of special maps for use of the President, negatives, blue prints, etc., involving a vast amount of work in addition to the regular work of the division. Copies of all this information, in the shape of blue prints and negatives of all tracings made or copied, and letterpress copies of other data and information furnished, is on file in this division.

The duties of the chief draftsman have been largely those of supervision. Maps and material were supplied for the war room of the White House; methods of drawing were inspected in various Departments; proofs were verified, and information prepared for the public. Considerable time was given to the examination of drawings of applicants for positions as draftsmen and making estimates on work for outside parties.

The work of the drawing division has been so extensive that it is neither necessary nor desirable to give a detailed account of all the pieces of work taken up and finished. A general idea of the activity of the force, as well as the wide geographical limits comprised in the preparation of charts, may be seen from the following statement of drawings, which have been classified for the sake of ready reference:

In the Eastern Division work was done on New Bedford Harbor, Buzzards Bay, Baltimore Harbor, Fernandina and Jacksonville, Gunpowder River, Boston Bay, and approaches. In the Middle Division: At Brazos River, Texas; triangulation of Salt Lake City; tracing of Galveston Bay, Texas. In the Western Division: A Mercators chart of California; San Francisco Bay Entrance; Grays Harbor, Washington. In Alaska: White Water Bay; Dixon Entrance to head of Lynn Canal; San Juan de Fuca to Dixon Entrance; Dixon Entrance to Cape St. Elias; Assistant Pratt's work on the Yukon Delta; Red Fish Bay, southeastern Alaska; Sitka Bay; Sitka Sound to Salisbury Sound; Salisbury Sound to Peril Strait; drawing for Cordova Bay and Yukon River; indexing topographic sheet of St. George Island; Cape Dyer to St. Michael; Yukon River maps, from the delta inland to the Porcupine River—10 maps in all. The following miscellaneous drawings were also finished: San Juan, P. R., Hawaiian Islands, Guam Island, Ladrone Islands, new chart of Philippine Islands, and projections for field parties.

The following drawings have been completed for photolithographing or engraving during the year:

1. DRAWINGS COMPLETED.

Chart No.	Title.	Scale.
252	New Bedford Harbor and approaches	1–20 000
3214	St. Paul, Otter, and Walrus Islands	1–20 000
7002	Straits of Fuca to Dixon Entrance (suspended) Mercator projection.	
8233	White Water Bay, Chatham Strait	1–20 000
910	Porto Rico	1–400 000
8002	Dixon Entrance to Cape St. Elias (suspended) Mercator projection.	
4100	Hawaiian Islands	1–600 000
274	Harlem River	1–10 000
297	Cuttyhunk Harbor	1–10 000
8068	Custom-House Cove and Mary Island anchorage	1–10 000
	Cordova Bay, for Bulletin No. 37	1–200 000
	Red Fish Bay, for Bulletin No. 37	1–100 000
8101	Klahwah Inlet and Buscarelli Bay, for Bulletin No. 37	1–20 000
	Porto Rico, for War Department	2–150 000
525	Brazos River Entrance	1–10 000
249	Buzzards Bay	1–40 000
3231	Guanica Harbor	1–10 000
9370	Cape Dyer to St. Michaels	1–1 300 000
9372	Yukon River, Aproon Mouth	1–180 000
911	Ponce Harbor	1–20 000
9373	Yukon River, Kwiklok Mouth	1–80 000
3095	Glacier Bay	1–200 000

Two hundred and nineteen charts were revised, corrected, and verified for new editions or reprints. Twenty-eight topographic and 7 hydrographic sheets were inked and lettered. Twenty-seven topographic and 45 hydrographic projections have been constructed for field parties and 8 projections on copper plates have been made.

The following original plates were completed during the year:

2. ORIGINAL PLATES COMPLETED.

Chart No.	Plate No.	Title.	Scale.
272	2488	New Rochelle to Throgs Neck	1-10 000
337	2495	Boston Harbor	1-40 000
381	2439	Schuylkill River, Philadelphia water front	1-9 600
381	2440	Same	1-9 600
443	2510	San Carlos Bay and Caloosa River	1-40 000
490	2517	Entrance to Pensacola Bay	1-30 000
542	2509	Jamaica Bay and Rockaway Inlet	1-20 000
5261	2512	Santa Barbara and approaches	1-20 000
5525	2463	Mare Island Strait	1-10 000
6185	2464	Willapa Bay	1-40 000
6265	2462	Cape Flattery	1-40 000
6303	2465	Port Angeles	1-10 000
8240	2414	Sitka Sound, Alaska	1-80 000
50	2442	Map of the District Survey (4 plates)	1-4 800
59	2443	Same	1-4 800
60	2444	Same	1-4 800
69	2445	Same	1-4 800
70	2446	Same	1-4 800
79	2447	Same	1-4 800
80	2448	Same	1-4 800
90	2449	Same	1-4 800

New editions of the following plates were completed:

3. NEW EDITIONS COMPLETED.

Chart No.	Plate No.	Title.	Scale.
T.	2540	General Chart of Alaska	1-3 600 000
19	2208	Mobile Bay to Atchafalaya Bay	1-400 000
103	2467	Mount Desert Island	1-80 000
108	2576	Wells to Cape Ann	1-80 000
126	1935	Penns Neck to Philadelphia	1-80 000
131	2536	Chesapeake Bay Entrance	1-80 000
154	1910	Long Island to Hunting Island	1-80 000
156	2534	Savannah to Sapelo Island	1-80 000
203	2353	Sabine Pass to High Island	1-80 000
265	2482	East Bridgeport to Fairfield	1-10 000
311	2537	Penobscot River and Belfast Bay	1-40 000
345	2329	Robinson Hole and Quicks Hole	1-10 000
348	2458	Woods Hole	1-10 000
369	2518	New York Bay and Harbor	1-40 000
369	2520	Same	1-40 000
369A	2318	Hudson and East Rivers	1-10 000
376	2201	Delaware and Chesapeake Bays	1-400 000
380	2590	Delaware River, Philadelphia water front	1-9 600
380	2606	Same	1-9 600
384	2406	Baltimore Harbor and approaches	1-40 000
428	2450	Winyah Bay	1-40 000
431	2472	Charleston Harbor	1-30 000
5523	1006	San Pablo Bay	1-50 000
6100	2276	Cape Lookout to Grays Harbor	1-200 000
6378	2541	Bellingham Bay	1-40 000
6450	2181	Admiralty Inlet	1-80 000
8100	2417	Clarence Strait, Revillagigedo Channel, and Portland Canal	1-200 000

The work done in the engraving section of the Division may be recapitulated as follows:

4. RECAPITULATION OF WORK DONE.

New charts, completed	13
New editions of charts, completed	28
New miscellaneous plates, completed	5
New charts, commenced	11
New editions of charts, commenced	48
New miscellaneous plates, commenced	5
Section maps of the District of Columbia, completed (4 plates each)	8
Chart plates corrected for printing	626
Sketches and illustrations corrected for printing	19
Plates in progress, not completed	36
Unfinished plates on hand:	
New charts	17
New editions	19
Sketches	16

The work done in the Printing Section is summarized in the following table:

5. PRINTING DONE.

Impressions for the Chart Section	54 990
Impressions for Assistant in Charge	1 853
Impressions for Engraving Section	627
Impressions for Drawing Section (standards)	183
Impressions from District of Columbia plates (4 impressions to each chart)	1 651
Impressions for lithographer (transfers)	113
Total	59 417

The following table shows the results accomplished in the Photographing and Electrotyping Section:

6. PHOTOGRAPHIC WORK.

Negatives made	217
Blue prints made	836
Bromide prints	338
Silver prints	139
Nigrocene prints	113
Black and white prints	141
Lantern slides	80
Number of prints mounted	95

7. ELECTROTYPING RESULTS.

Pounds of copper deposited	2 010½
Square inches on which deposited	76 254
Basso plates finished	42
Alto plates finished	29

E. CHART DIVISION.

Personnel.

Name.	Occupation.
Assistant Gershom Bradford	Chief of Division.
Miss L. A. Mapes	Bookkeeping, correspondence, and direction of routine.
H. R. Garland	Correcting and issuing charts.
Neil Bryant	Receiving, stamping, and issuing charts.
Miss M. L. Handlen	Coloring and issuing charts.
Edward Belford	Coloring charts.
Archie Upperman	Mounting sheets and maps, correcting charts.
O. E. McNeill	Messenger.
A. G. Randall	Correcting charts.
J. T. Watkins	Coloring charts.
A. B. Simons, jr.	Correcting and coloring charts.
A. S. Gorham	Miscellaneous work.
P. V. Dolan	Bookkeeping and clerical work.
E. H. Wyvill	Chart corrector.
W. C. Willenbucher	Draftsman.
F. C. Donn	Draftsman.

A general summary of the work of the Chart Division has been given in the report of the Superintendent. The following additional details will serve to show the general character of the work and the results thereof.

In order to compare the output of the past year with previous ones, the following table has been drawn up. It represents, in brief, the more important features of the chart issue in years from 1889, when the division was established, to the present time:

1. TABLE I.—COMPARISON OF ISSUES OF CHARTS DURING THE FISCAL YEARS NOTED BELOW.

Year.	Totals.		Free distribution.		Gross sales.		Net sales.	
	Copies.	Values.	Copies.	Values.	Copies.	Values.	Copies.	Values.
1889	49 312	$20 096	21 088	$8 266	28 224	$11 830	26 540	$11 280
1890	63 152	26 178	30 112	12 121	33 040	14 057	31 806	13 575
1891	52 959	23 457	20 811	8 846	32 148	14 611	28 473	13 141
1892	52 675	23 041	23 451	9 831	29 224	13 209	27 214	12 506
1893	55 026	24 215	27 310	11 805	27 716	12 409	25 366	11 605
1894	51 671	22 476	27 702	11 845	23 969	10 631	21 230	9 595
1895	51 456	22 280	24 892	10 507	26 564	11 773	23 136	10 405
1896	64 541	26 440	36 516	14 037	28 025	12 403	25 278	11 249
1897	57 188	23 987	31 977	12 820	25 211	11 166	21 673	9 731
1898	103 588	41 219	68 128	26 691	35 460	14 528	33 276	13 645
1899	83 197	34 496	47 518.	18 800	35 679	15 696	33 734	14 932

In the comparison of 1899 with the preceding years 1898 is omitted, the demand for charts in that year having been abnormal on account of the gold discoveries in Alaska and vicinity and of the war with Spain.

The total issue is 50 per cent larger than the average. The free distribution is 75 per cent larger than the average. The net sales (gross sales less copies returned by sale agents) have increased in copies 32 per cent, and in value 30 per cent, as compared with the average.

The increase in free distribution is due partly to the greater demand for naval use, corresponding to the increase in the number of vessels. The number of charts sold is slightly in excess of that of 1898.

The edition of the Chart Catalogue for 1899 was received in May, and 1 059 copies have been distributed.

On January 1, 1899, the entire business with the agencies for the sale of charts, Coast Pilots, and Tide Tables was transferred to this division, where a part of it had previously been conducted. The result of the change has so far been satisfactory. The statistics for the six months are as follows:

Quarterly statements of agents examined and verified	122

ISSUES.

	Volumes.
United States Coast Pilot, Atlantic coast	724
Pacific Coast Pilot (California, Oregon, and Washington)	31
Pacific Coast Pilot, Alaska, Part I	43
Tide Tables, United States and foreign ports	427
Tide Tables, Pacific coast	2 458

In April there were sent to each of eleven post-offices on the Atlantic coast a chart of the vicinity, framed, for wall display. In March, April, and May there were sent to a number of postmasters in coast towns a circular with a view to the establishment of new sales agencies, in consequence of which 35 have been added to our list, to whom 242 charts have since been issued. These agencies are mostly in places of minor importance, and the direct result of sales may not be great at first, yet the indirect benefit to the public should be considerable, in the spread of information as to the scope and character of our chart work.

There have been delivered to this section for issue 19 new charts and maps, 17 printed by lithography and 2 from copperplate, viz:

Catalogue No.	Subject.
3220	Polivina, Polivina Cliffs, and Little Polivina rookeries, St. Paul Island.
482	Cuba.
571	Port Royal Sound, South Carolina.
3214	St. Paul Island, Alaska.
E.	Straits of Florida and approaches.
6444.	Port Orchard, southern part, Washington.
252	New Bedford Harbor and approaches.
910	Porto Rico.
4100	Hawaiian Islands.
6300	Gulf of Georgia and Strait of Juan de Fuca.
274	Harlem River, New York.
297	Cuttyhunk Harbor, Massachusetts.
542	Jamaica Bay and Rockaway Inlet, New York.
3231	Guanica Harbor, Porto Rico.
9373	Yukon River, Kwiklok mouth.
9372	Yukon River, Aproon mouth of, head of passes.
9370	Cape Dyer to St. Michael, Alaska.
911	Ponce Harbor, Porto Rico.
249	Buzzards Bay, Massachusetts.

Thirty-five new copper-plate editions of charts, and 18 new lithographic ones—53 in all—have been delivered to this division for issue.

The receipts, issues, and general distribution of charts are given in the following tables:

2. TABLE II.—ISSUES OF CHARTS FROM JULY 1, 1898, TO JUNE 30, 1899.

Disposition.	Copies.	Values.
Sales agents	34 210	$15 145·05
Sales by Office and Chart Division	1 469	551·25
Congressional account	2 907	1 223·60
Hydrographic Office, Navy Department	16 240	6 640·40
Light-House Board	1 532	613·10
Coast and Geodetic Survey Office	4 266	1 755·20
Executive Departments	15 386	5 954·45
Foreign governments	571	191·35
Libraries	4 507	1 556·25
Miscellaneous	2 109	865·15
Total	83 197	34 495·80
Condemned	3 508	1 347·80
Total issued and condemned	86 705	35 843·60

3. TABLE III.—CHARTS ON HAND AND RECEIVED FROM JULY 1, 1898, TO JUNE 30, 1899.

Source of supply.	Copies.	Values.
On hand by count July 1, 1898	53 474	$19 584·15
Received from Drawing and Engraving Division	52 862	23 399·15
Received from lithographers	19 449	6 680·40
Returned	2 092	783·70
Total on hand and received	127 877	50 447·40
Total issued and condemned	86 705	35 843·60
On hand by book July 1, 1899	41 172	14 603·80
Difference between book and count	84	39·80
On hand by count July 1, 1899	41 088	14 564·00

F. INSTRUMENT DIVISION.

Personnel.

Name.	Occupation.
E. G. Fischer	Chief of division.
W. C. Maupin	Clerk.
J. W. Hunter	Messenger.
C. Jacomini	Instrument maker.
W. R. Whitman	Do.
M. Lauxmann	Do.
J. A. Clark	Do.
T. A. Gibson	Do.
H. O. French	Carpenter.
C. W. Clarvoe	Do.
C. N. Darnall	Do.

This division, consisting of the office, instrument shop, and carpenter shop, attends to the accounting for all instruments and general property, whether in the field, on the various vessels, in storage, or at the Office, and the necessary correspondence arising therefrom; to the repairing and putting in thorough working order of all instruments before being issued; to the designing and construction of new instruments and apparatus; to the experimental work, trials, etc., arising from proposed applications of new discoveries, etc., to the purposes of the Survey; to the determination of instrumental constants, as far as practicable, at the Office; to the selection and purchase of new instruments and material, and to the repair of office furniture and minor repairs of the office buildings.

The aim of the division, as heretofore, has been to devote its energies to keeping in repair and working order the instruments owned by the Survey, and to engage in new work only when special designs, experiments, etc., required by the specific and peculiar needs of the Survey, make purchase in the open market impossible.

1. WORK DONE.

Instruments cleaned, adjusted, and sent to the field	1 021
Instruments received from field and elsewhere	825
Articles of general property packed and sent to the field	1 282
Articles of general property received from the field	713
Miscellaneous requisitions received from Office, necessitating time and labor of skilled workmen	401

2. STATISTICS.

Total number of instruments owned by the Survey at this date	8 089
Instruments in the Office	2 769
Instruments in the field	5 320

The two 10-horsepower gas engines furnishing power for the instrument and carpenter shops, the elevator, hydraulic press, and the printing presses; also the pneumatic time system, the call-bell circuits, and a 1·5 kilowatt dynamo, were attended to and kept in good running order by the employees of the Instrument Division.

Minor repairs to the office buildings and furniture, including the putting in place and removal of awnings, storm windows, etc., were attended to as usual, the work chargeable to the buildings occupying twenty-four days, and to the furniture thirty-eight days' labor of skilled workmen.

By direction of the Superintendent, a number of the principal charts, maps, and other publications of the Survey, and such instruments as illustrate most readily the means employed in their production, together with some standards of length, mass, and volume, from the Office of Weights and Measures, were organized into an exhibit at the Central High School building in this city during the meeting of the National Educational Association in July, 1898.

An inventory of all the property of the Survey in the keeping of the Instrument Division, begun in the last fiscal year, was completed in July and reported upon.

The opening of a new set of books for the office and field accounts of instruments, and also one to account for expenditures in storage of property, involved considerable clerical labor beyond the usual amount.

The Office of Weights and Measures having made preparations to compare and standardize electrical testing apparatus, the demands upon the Instrument Division for skilled labor of high order were much increased. The standardizing, or marking, of 100^{cc} water bottles, and the testing and correcting of 200^{mm} sugar tubes used in the United States customs revenue service, is also attended to by employees of this division.

All instruments and articles of general property found on examination to be worn out, or no longer useful for other reasons, were condemned and sold at public auction. The sale of this property realized $1 382·99.

Demand being made upon the Instrument Division for the design of a geodetic level as far as possible free from changes due to temperature variation, communication was had with Prof. Ch. Ed. Guillaume, of Paris, with the view of procuring for the construction of such instruments a quantity of his nickel-steel alloy with low temperature coefficient. Finding that he could not furnish such an alloy suitable for casting, experiments were made, whose outcome was an alloy which can readily be cast into required shapes and has a temperature coefficient of 0·000004 per degree centigrade; that of steel being 0·000011, and of brass 0·000018. Geodetic levels Nos. 1, 5, and 6 were remodeled and provided with new telescopes and stride levels of this new metal. They are now in use, and it is expected that results will show a large reduction, or practically an elimination of certain discrepancies ascribed to want of constancy of the older instruments under the temperature conditions prevailing in the field. In the designs for remodeling these instruments provision was made to enable the observer to read the level and rod practically at the same time, thus avoiding change of position of instrument due to shifting of the observer's weight on the ground, and also parallax in reading the scale on the level vial. This is accomplished by an arrangement, consisting of a mirror, two prisms, and a lens, which projects the images of the ends of the bubble and the scale of the level into one eye, while the other is in position to observe the rod through the telescope.

Four new geodetic level rods, designated as R, S, T, and U, were made and completed in time to be issued with these levels. The cross section of these is the same as that of rods P and Q. As in the case of rods P and Q, the new rods were treated with paraffin to protect them against hygrometric influences; but, while the weights of the former were increased by almost 90 per cent, the treatment of the new ones was modified so as to increase their weights by only about 17 per cent.

One of the three new 12-inch position theodolites for primary triangulation, begun in the last fiscal year (No. 145), was completed and issued to the field at the beginning of the season. The other two, Nos. 167 and 168, are approaching completion.

It is regretted that but little progress could be made in the construction of the new tide-predicting machine during the year, the amount and urgency of other work, together with the loss of over thirteen months of time by the temporary and permanent transfer of two instrument makers, allowing but thirty-six days to be assigned to that work.

G. LIBRARY AND ARCHIVES DIVISION.

Personnel.

Name.	Occupation.
Mr. Edw. L. Burchard	Chief of division.
A. F. Zust	Accession and delivery clerk.
B. M. Winters	Labeling books and archives, classifying maps, charts, etc.
W. H. Butler	Messenger, preparing books for bindery, answering calls, replacing returned materials.
J. B. Quinlan	Cataloguing.

The work of the year in the Library and Archives Division may be summarized briefly as follows:

1. SUMMARY.

The entire library (15 000 volumes) has been labeled and classified according to the decimal system, as used in several hundred libraries of the country. The shelving was thoroughly cleaned. In order to provide shelf room for increase on the ground floor certain classes of infrequently used books were sent to the second floor. The rear archives room was refitted with shelving, and the entire series of original computations and observations, except tides, soundings, and currents, comprising about 10 000 pieces, were assembled in one room, labeled, classified, and shelf labeled. The tube racks were extended, necessitating the handling of 5 000 tubes containing original sheets. All of the miscellaneous maps were classified in portfolios and placed on the ground floor of the library, where they are convenient for frequent reference. The Coast and Geodetic Survey, Hydrographic Office, and Admiralty charts were revised and placed in strict numerical order. All other charts were arranged according to the Cutter geographical system, as used throughout the library and archives. The photo negatives, prints, and lantern slides were labeled, classified, and indexed. All of the sea-bottom specimens were unboxed and arranged in the new specimen cases by localities, according to the uniform geographical classification. The correspondence files of the Superintendent, Assistant in Charge, etc., were removed from the fourth floor to the shelving provided for the purpose on the third floor and chronologically arranged. Shelving was erected on the fourth floor for the duplicates and for overflow from the library of unused books. Four hundred and fifty-five volumes of books, serials, and original archives were prepared for the bindery, of which 96 were arranged by Mr. Courtenay, of the Computing Division. The working force and outfit were moved into the front office, which was prepared for occupancy, and the book alcoves were fitted up for the undisturbed use of readers.

2. SHELF ARRANGEMENT.

For a number of reasons the revision of the shelf arrangement of the library and archives was found imperative. By the "fixed-shelf" system accessions to the library could not be placed in their proper place in the classification whenever the shelves were already full. Hence the relative system originally used, the Dewey decimal, was readopted. As a matter of convenience it was found desirable to have the miscellaneous maps and atlases on the ground floor, where they would be of easy access. The maps and atlases, therefore, have been brought down from the top floor, placed in portfolios, and classified according to a printed geographical scheme (the Cutter Local List).

The purpose in reshelving the archives, scattered through the three rooms on the ground floor, was to assemble them together in a manner facilitating reference and handling, and also to gain much-needed room. As a result of these changes there are two quiet places for readers, a front reading room, where the current periodicals and the most used reference works can be consulted, and the rear alcoves, with tables and writing materials, where free access can be had directly to the books. There is an open shelf arrangement of the archives in one separate room, with shelving for several years' growth; there is a new library office, more accessible to the main building and to the street, together with closet room in the hallway for photographs and library paraphernalia; and, last but not least, all of the most used books, atlases, maps, and archives, by a process of selection, have been conveniently grouped on the ground floor.

The changes in shelf arrangements on the upper floors were made with reference to the requirements on the ground floor and to provide much-needed additional shelf room. The hallways of the two upper floors have been fitted up with the old shelving removed from the ground floor. This affords accommodations on the third floor for the correspondence of the Assistant in Charge and the Superintendent and on the fourth floor for duplicate and overflow books from the library and for the miscellaneous files of the Disbursing Office.

3. ACCESSIONS.

Every new piece received in the library is entered chronologically in an accession book. Five accession books are regularly kept up, namely, for the library, the archives, the original sheets, the maps and charts, the photographs and lantern slides. Every piece in the division has been or will be recorded in an accession book and individually numbered. Of old material only some maps and charts and miscellaneous pamphlets still remain unrecorded in this way. A list of the accessions for the year follows.

a. Accessions in archives.

	Volumes.	Cahiers.	Sheets.	Miscellaneous.
Astronomy:				
Observations—				
Original	29	1	16	2 rolls.
Duplicate	28	1		
Computations—				
Field	1	10		
Office		10		
Geodesy proper:				
Observations—				
Original	122	30		
Duplicate	106	4		
Computations—				
Field		38		
Office		13		
Hypsometry:				
Observations—				
Original	83	2		
Duplicate	39	1		
Computations—				
Field	1	10		
Office		6		
Magnetism:				
Observations—				
Original	6	21		
Duplicate	4	49		
Computations—				
Office		3		
Pendulum work:				
Observations—				
Original	3	6		
Duplicate	2			
Surveys, hydrographic and topographic:				
Soundings—				
Original	295			
Duplicate	243			
Sheets—				
Hydrographic sheets			42	
Topographic sheets			64	
Descriptive reports		22		
Sketches and tracings			40	
Miscellaneous—				
Specimens of sea bottom				115 bottles.
Notes on navigation	1			
Pathfinder's plans and contract		1	163	1 package.
Log books, Coast and Geodetic Survey vessels	73			
Tides:				
Observations—				
Original	136	81	160	140 rolls and 11 packages.
Duplicate	79	5		
Computations—				
Field		1		
Views:				
Photographs—				
Original				353 copies.
Duplicate				268 copies.
Negatives				288
Slides				11
Blue prints				2

The following is a detailed list of the hydrographic and topographic sheets received in the archives during the past year:

Hydrographic sheets.

No.	Locality.	State.	Scale.	Year.
2348	Hydrography, Dry Tortugas, southern part	Florida	10 000	1898
2349	Hydrography, Dry Tortugas, northern part	do	10 000	1898
2350	Approaches to harbor of Dry Tortugas	do	20 000	1898
2351	Garden Key Channel, harbor of Dry Tortugas	do	600	1898
2352	Bear, Humphries, Welshmans, North Point, and Shoal creeks, Chesapeake Bay.	Maryland	10 000	1898
2353	Curtis Creek, Chesapeake Bay	do	10 000	1898
2354	Stony, Rock, and Bodkin creeks	do	10 000	1898
2355	Quicks Hole (sounding sheet)	Massachusetts	10 000	1898
2356	Baltimore Harbor, from Light street to Anderson's wharf.	Maryland	2 400	1898
2357	Baltimore Harbor, from Anderson's wharf to Fort McHenry.	do	2 400	1898
2358	Patapsco River, from Fort Carroll to Seven Foot Knoll Light.	do	10 000	1898
2359	Chesapeake Bay, vicinity of North Point	do	10 000	1898
2360	Approaches to Portsmouth Harbor	New Hampshire	20 000	1898
2361	Portsmouth Harbor	do	10 000	1898
2362	Entrance to the Aproon mouth of the Yukon River.	Alaska	20 000	1898
2363	Entrance to St. Michael and Aproon mouth	do	80 000	1898
2364	St. Michael Canal	do	20 000	1898
2365	Magothy River	Maryland	20 000	1898
2366	Elk River, Turkey Point to Bohemia River	do	10 000	1898
2367	Elk River, Bohemia River to Back Creek	do	10 000	1898
2368	Hydrography and topography of the Kusilvak Entrance to the Yukon River, Alaska.		20 000	1898
2369	Hydrography and topography of the Kripniyuk River Entrance, Alaska.		20 000	1898
2370	Kusilvak Bar, Yukon River		20 000	1898
2371	Entrance to Grays Harbor	Washington	10 000	1898
2372	Back Creek, Elk River to Chesapeake Bay City.	Maryland	5 000	1898
2374	Aransas Pass	Texas	10 000	1899
2375	Chester River, resurvey of Chesapeake Bay	Maryland	20 000	1898
2376	Chester River, Grays Inn to Langford Creek	do	10 000	1898
2377	Chester River, Queenstown Harbor, Tilghmans, Reeds, and Grove creeks.	do	10 000	1898
2378	Reconnoissance survey of Copper River Delta, Alaska.		40 000	1898
2379	Bainbridge Reef, Richs Passage	Washington	10 000	1899
2380	Northern half of Lake Maurepas	Louisiana	20 000	1899
2381	Southern half of Lake Maurepas	do	20 000	1899
2382	Jobos Harbor and approaches	Porto Rico	10 000	1899
2383	Sassafras River	Maryland	10 000	1898
2384	Hudson River, from Spuyten Duyvil to Yonkers.	New York	5 000	1898
2385	Hudson River, from Yonkers to Hastings	do	5 000	1898
2386	Hudson River, from Hastings to Ardsley	do	5 000	1898
2387	Key West	Florida		1898

Topographic sheets.

No.	Locality.	State.	Scale.	Year.
2315	Resurvey of San Francisco Bay, Mountain View to Alviso.	California	10 000	1897
2316	Shore line of Chesapeake Bay, Granberry Point to Thomas Point.	Maryland	20 000	1898
2317	Survey of fort near Grays Ferry (received from Drawing and Engraving Division).			1863
2318	Right bank of Schuylkill River (received from Drawing and Engraving Division).			1863
2319	Part of Chestnut Hill (received from Drawing and Engraving Division).			1863
2320	Fort Dana (received from Drawing and Engraving Division).			1863
2321 2321*a* 2321*b*	Jefferson Barracks (received from Drawing and Engraving Division).	Missouri		1863
2322	Vicinity of Girard Avenue bridge (received from Drawing and Engraving Division).			
2323	Improvements of Harlem and East River water fronts (received from Drawing and Engraving Division).	New York		1890
2324	Chestnut Hill and Sugar Loaf (received from Drawing and Engraving Division).			1863
2325	Magothy River and vicinity, Chesapeake Bay.	Maryland	20 000	1898
2326	Patapsco Neck below Colgate Creek and Back River, western shore of Chesapeake Bay.	do	20 000	1898
2327	Vicinity of Point Romanoff and Pikmiktalik River, Alaska.		20 000	1898
2328	Aproon Channel, Yukon River, Alaska		30 000	1898
2329	Delta of the Yukon River, Alaska		50 000	1898
2330	Tracings of the King plats, Washington (received from Drawing and Engraving Division).	District of Columbia		
2331	Elk River, from Chesapeake Bay to Bohemia River.	Maryland	10 000	1898
2332	Kwemeluk Channel, Yukon River, Alaska		20 000	1898
2333	Seminole Point to Big Marco Pass	Florida	80 000	1891
2334	Cape Sable to Seminole Point	do	80 000	1891
2335	St. Michael to Aproon Entrance, Alaska		80 000	1898
	NOTE—The following five sketches were drawn by Joe Kakryook, an Esquimaux native of Port Clarence.			
2336	Sketch containing addenda to the proposed chart, St. Michael to Cape Dyer.			
2337	Coast line from St. Michael to Point Barrow, Alaska.			
2338	Coast line from Cape Dyer to St. Michael, including the Yukon Delta.			
2339	Yukon River, from Autokokot River to head of Delta.			
2340	Yukon River, from Dawson to Nulato			
2341	Aproon Entrance, Yukon River, Alaska		20 000	1898
2342	Pikmiktalik River and vicinity, Alaska		20 000	1898
2343	Point Romanzof, Alaska		20 000	1898
2344	West part of St. Michael Canal, Alaska		20 000	1898
2345	Part of the coast east of Pastoliak River, Alaska.		20 000	1898
2346	Kusilvak Entrance to the Yukon River, Alaska.		20 000	1898
2347	South Side of Point Romanzof, Alaska		20 000	1898
2348	Part of Kusilvak Entrance, Yukon River, Alaska.		20 000	1898

Topographic sheets—Continued.

No.	Locality.	State.	Scale.	Year.
2349	Kripniyuk River Entrance, Alaska		20 000	1898
2350	Reconnoissance Survey of Copper River Delta and vicinity, Alaska.		80 000	1898
2351	Elk River, Bohemia River to Back Creek	Maryland	10 000	1898
2352	Back Creek, Elk River to Chesapeake City	....do	5 000	1898
2353	Alameda Creek to Beards Creek	California	10 000	1896
2354	Aransas Pass	Texas	10 000	1899
2355	Sumner Strait, Southeast Alaska (Sheet No. 1)		80 000	1886
2356	Reconnoissance of the Katsehin Valley, Chilkoot Inlet, Alaska.		80 000	1898
2357	Reconnoissance of the Skagway River Valley, Taiya Inlet, Alaska.		80 000 20 000	1898
2358	Hudson River, Spuyten Duyvil to Yonkers	New York	5 000	1898
2359	Hudson River, Yonkers to Hastings	....do	5 000	1898
2360	Hudson River, Hastings to Ardsley	....do	5 000	1898
2361	Lake Maurepas and Pass Manchac, Northern Half.	Louisiana	20 000	1899
2362	South end of Lake Maurepas	....do	20 000	1899
2363	Patapsco River, vicinity of Annapolis road and railroad crossing.	Maryland	10 000	1899
2364	Highlandtown, Canton, and Eastern approaches to Baltimore.	....do	1 000	1898
2365	Part of San Pedro Bay and Harbor	California	5 000	1899
2366	Bush River	Maryland	10 000	1898
2367	Sassafras River, Ordinary Point to Swan Creek.	....do	10 000	1898
2368	Chesapeake Bay, Still Pond to Howells Point	....do	20 000	1898
2369	Sassafras River, Howells Point eastward	Maryland	10 000	1898
2370	Part of San Diego Bay	California	10 000	1898
2371	Phototopographic reconnoissance of the Chilkat River Valley, southeast Alaska		80 000	1898
2372	St. Simon Sound and Brunswick River entrance to national quarantine	Georgia	10 000	1899
2373	Brunswick and Turtle rivers, from national quarantine to Gilsons Creek	....do	10 000	1899
2374	Brunswick water front, Brunswick	....do	5 000	1899
2375	Portsmouth Harbor and vicinity	New Hampshire	10 000	1898

b. Accessions in library.

	Purchase.	Gift and exchange.	Total.
Books	211	870	1 081
Pamphlets	2	534	536
Serials	75	293	368
Total	298	1 697	1 985

4. CATALOGUING.

Indexing old and new material will be the main occupation of this Division for some years to come. This year a rough index was prepared of the photographs and lantern slides, and the new maps, books, pamphlets, and serials were regularly indexed, as received. Indexing the archives has gone forward haltingly. At the beginning of the fiscal year the current indexing was several years in arrears. Unfortunately the necessary assignments of the cataloguer for work outside of the Division had to be made, leaving the back work, as well as the current cataloguing, still to do. Everything is now in readiness to move vigorously as soon as a writer is detailed to take up this important work. The revision of the old card catalogue of the books and of the maps and charts is progressing slowly, current work demanding the first attention.

5. BINDING.

The books sent to the bindery were chiefly unbound periodicals. Little binding of this class had been done for several years. A large number of incomplete serials have been made ready and will be sent to the bindery as soon as the missing title pages and indexes can be obtained. Several hundred books and periodicals remain to be prepared. This work must necessarily be done at odd intervals. The arrangement of computations and observations requires expert assistance, and is usually performed by divisions of the Office or by such Assistants from the field force as can be detailed from time to time to make it up. Temporary covers have been used to cover the unbound computations, but this is merely an expedient for the time being to protect the records until they are permanently bound. About 10 000 pieces are awaiting permanent bindings. Nothing whatever has been done toward binding the tide and sounding books.

6. REFERENCE WORKS.

Looking up items of information desired occupies no small amount of time, but is one of the most valuable ways in which the Division can be employed. The contents of the sets of serials are now much more accessible since the Poole and the German and French indexes to periodical literature are in use. Constant lookout is kept for new bibliographies and indexes in the special fields occupied by the Survey.

7. APPROPRIATION.

The $600 allotted for the purchase of books is inadequate to keep the library up to the standard of coordinate Government scientific bureaus. One-third of this appropriation is required for periodicals. The allotments made by other scientific bureaus range from $2 000 to $10 000, and their increase yearly of purchased books is from twice to ten times the number obtained by this Survey. Scientific books are traditionally expensive. A working library only, consisting of such books as are constantly used from day to day in the field or Office, would not make a large library necessary. The present situation, however, seems to require that a more comprehensive library, exhaustive in the specialties of the Survey's work, should be maintained, and that the field and marine force should be kept more thoroughly informed as to the progress in these specialties, even to the extent of establishing for their benefit a circulating library of new books and periodicals. Other libraries in Washington will not, to any extent, enter the particular fields of geodesy, hydrography, topography, cartography, astronomy, mathematics, and instrumental sciences that fall within the range of the Survey's operations. An allotment of $2 000 is not a large appropriation to maintain the library up to the standard along these lines.

III. PUBLICATION.

Personnel.

Name.	Occupation.
E. D. Preston, Assistant	Editor.
A. F. Belitz	Stenographer and typewriter.

On the assumption of editorial duties by the present incumbent, on April 19, 1899, the report for the fiscal year 1897–98 was in hand. A number of changes were made at this time in the general form and arrangement of the volume, which involved considerable rewriting. The illustrations were, moreover, modified so as to reduce nearly all of them to full-page or double-page cuts. Nothing larger was admitted except three sheets of general progress, which were given place in a pocket attached to the cover of the Report. The size of the printed page was changed, in the interest of legibility, and numerous modifications were introduced in the binding. The increased duties consequent upon the aforesaid changes considerably retarded the transmission of the Report to the Public Printer, so that it was not until September 1 that delivery was made in its finally accepted form.

The editor acknowledges his indebtedness to Mr. A. F. Belitz, stenographer and typewriter, who has given valuable assistance throughout the preparation of the Report.

IV. WEIGHTS AND MEASURES.

Personnel.

Name.	Occupation.
Dr. Henry S. Pritchett	Superintendent.
A. Braid, Assistant	In charge.
Louis A. Fischer	Adjuster.
Dr. F. A. Wolff, jr	Verifier.
Otto Storm	Mechanician.
Jas. A. McDowell	Watchman.
Dorsey Suber	Assistant messenger.

No additional details beyond those appearing in the Superintendent's Report are submitted in this appendix. The files of the office contain full statements of information furnished to the public and routine work accomplished.

APPENDIX No. 2.

REPORT 1898-1899.

DETAILS OF FIELD WORK.

APPENDIX No. 2. 1898-99.

DETAILS OF FIELD WORK.

INTRODUCTION.

The details of the field operations are here given in somewhat different order of treatment from that followed in the Superintendent's Report. In order to describe the work of each party as a unit, the entire scope of activity is classified in geographical order, and the operations are given consecutive numbers based on position purely. The occupation of each party is then given in detail, including all classes of work carried on during the season in the locality under consideration. This method enables the reader to note in a continuous narrative the progress made in local surveys.

The paper opens with a tabular statement Table (I) of the different parties, showing the locality, character of work, and the officers under whose direction the operations were performed.

The classification is geographic and deals with the material in five divisions, namely, Eastern, Middle, Western, Alaska, and Special Duty. A page column indicates where the work is described in detail.

Following this is an index Table (II) in which the work is classified according to the synopsis in the Report proper. The number of operation is indicated, which enables the reader to at once refer to all the localities in which any particular class of work was done. A column is added giving the page.

An alphabetical index Table (III) of the officers in charge and those attached to parties is added, making it possible to find readily all the work executed by each officer, whatever may have been the locality.

Then appears the detailed statement (IV), arranged also in geographical order. For convenience of reference the name of the chief of party, the class of work, the locality, and a short table of statistics, are given for each operation.

A description of the fleet of the Coast and Geodetic Survey now follows, in which the general statistics are given in tabular form, as well as other information of interest on the subject. The trial trip of the *Pathfinder* is alluded to, as well as her voyage from Washington to San Francisco. A full description of this vessel by her first commander, Capt. John Ross, also appears.

Finally a brief note of the tidal work at all stations during the year is added.

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TABLE I.—TABULAR INDEX OF FIELD WORK EXECUTED DURING THE FISCAL YEAR 1898–99.

A. EASTERN DIVISION—EAST OF THE MISSISSIPPI RIVER.

1. Maine.
2. New Hampshire.
3. Vermont.
4. Massachusetts.
5. Rhode Island.
6. Connecticut.
7. New York.
8. New Jersey.
9. Pennsylvania.
10. West Virginia.
11. Maryland.
12. District of Columbia.
13. Delaware.
14. Virginia.
15. North Carolina.
16. South Carolina.
17. Georgia.
18. Florida.
19. Michigan.
20. Wisconsin.
21. Illinois.
22. Indiana.
23. Ohio.
24. Kentucky.
25. Tennessee.
26. Alabama.
27. Mississippi.

No. of Operation.	Locality.	Assistants and aids.		Character of work.	Page.
		Chief of party.	Members of party.		
1	Maine. New Hampshire: Portsmouth Harbor.	Welker.	Duffield.	Steamer Bache. Hydrography. Topography. Triangulation. Current observations.	144
2	Maine. New Hampshire. Vermont. Massachusetts.	Smith.		Magnetic.	148
3	Massachusetts: Marthas Vineyard.	Hodgkins.		Topography.	146
4	Massachusetts: Quicks Hole.	Wainwright.		Steamer Blake. Hydrography.	161
5	New York: Hudson River.	Wainwright.	Smith. McGrath.	Steamer Blake. Hydrography. Topography. Triangulation. Tidal observations.	161
6	New York: Fort Hamilton.	Spaulding. Tidal observer.		Tide gauge.	239
7	Massachusetts. New York. District of Columbia.	Smith.		Gravity.	148
8	District of Columbia:	McGrath.		Time.	150

A. EASTERN DIVISION—EAST OF THE MISSISSIPPI RIVER—Continued.

No. of operation.	Locality.	Assistants and aids.		Character of work.	Page.
		Chief of party.	Members of party.		
9	District of Columbia. Washington, D.C.	Bliss. Tidal observer.		Tide gauge.	239
10	West Virginia. Maryland. Delaware.	Bauer.		Magnetic.	167
11	West Virginia.	Smith.		Magnetic.	148
12	Maryland: Chesapeake Bay.	Ogden.		In charge of parties on resurvey.	229
13	Maryland: Chesapeake Bay.	Boutelle.	Faris. Bowie.	Schooner Matchless. Triangulation. Topography. Hydrography. Schooner Eagre.	156
14	Maryland: Chesapeake Bay.	Marindin. Perkins. Flower.	Flower.	Schooner Eagre. Hydrography.	154
15	Maryland: Chesapeake Bay.	Wainwright. Yates.	Yates. Phelps. Frisby.	Steamer Endeavor. Hydrography.	161
16	Maryland: Chesapeake Bay.	Bowie.		Topography.	153
17	Maryland: Chesapeake Bay.	Vinal.		Hydrography.	151
18	Maryland: Chesapeake Bay.	Donn.		Reconnoissance. Topography.	159
19	Maryland: Chesapeake Bay.	French.		Topography.	158
20	Maryland: Chesapeake Bay.	Hodgkins.	Weld.	Topography.	146
21	Maryland: Chesapeake Bay.	Ogden.		Steamer Blake. Tide gauges.	229
22	Maryland: Chesapeake Bay.	Perkins.	Flynn.	Triangulation.	160

A. EASTERN DIVISION—EAST OF THE MISSISSIPPI RIVER—Continued.

No. of operation.	Locality.	Assistants and aids.		Character of work.	Page.
		Chief of party.	Members of party.		
23	Maryland: Chesapeake Bay.	Vinal.		Schooner Matchless. Hydrography.	151
24	Maryland: Chesapeake Bay.	Yates.		Tidal observations.	166
25	Maryland: Chesapeake Bay.	Yates. Gilbert.		Steamer Endeavor. Reconnoissance.	163
26	Maryland: Chesapeake Bay.	Donn.		Topography.	159
27	Delaware: Reedy Island Quarantine Station.	Fuss. Hehl. Tidal observers.		Tide gauge.	239
28	Virginia: Cherrydale.	Preston.		Magnetic.	221
29	North Carolina.	Baylor.		Magnetic.	168
30	North Carolina.	Baylor.		Magnetic.	168
31	North Carolina: Morehead City.	Webb. Tidal observer.		Tide gauge.	239
32	South Carolina: Charleston.	Welker.		Steamer Bache. Hydrography.	170
33	Georgia: Vicinity of Brunswick Harbor.	Perkins.	Frisby. Flower.	Schooner Eagre. Hydrography.	172
34	Florida.	Baylor.		Azimuth.	168
35	Florida: Fernandina.	Weeks. Tidal observer.		Tide gauge.	239
36	Michigan. Ohio: Gibraltar to Cincinnati.	Ferguson.		Precise levels.	174

B. MIDDLE DIVISION—BETWEEN THE MISSISSIPPI RIVER AND THE ROCKY MOUNTAINS.

28. Louisiana.
29. Arkansas.
30. Missouri.
31. Iowa.
32. Minnesota.
33. North Dakota.
34. South Dakota.
35. Nebraska.
36. Kansas.
37. Oklahoma.
38. Indian Territory.
39. Texas.

No. of operation.	Locality.	Assistants and aids.		Character of work.	Page.
		Chief of party.	Members of party.		
37	Louisiana: Lake Maurepas.	French.	Frisby. Phelps. Mitchell. Mansfield.	Schooner Quick. Schooner Spy. Triangulation. Hydrography. Topography.	175
38	Nebraska: Ninety-eighth meridian.	Granger.		Triangulation. Reconnoissance.	182
39	Nebraska: Ninety-eighth meridian.	Granger.		Triangulation. Reconnoissance.	182
40	Kansas: Ninety-eighth meridian.	Eimbeck.	Little.	Reconnoissance. Triangulation.	181
41	Kansas: Ninety-eighth meridian.	Baldwin.		Precise levels.	184
42	Oklahoma. Indian Territory. Texas: Ninety-eighth meridian.	Forney.		Reconnoissance. Base lines.	179
43	Indian Territory. Texas: Ninety-eighth meridian.	Forney.		Reconnoissance. Base lines.	179
44	Indian Territory. Texas: Ninety-eighth meridian.	Smith.	McGrath.	Longitude.	149
45	Texas: Aransas Pass.	Welker.	Flemer.	Steamer Bache. Hydrography. Current observations. Topography.	177

C. WESTERN DIVISION—WEST OF THE ROCKY MOUNTAINS.

40. New Mexico.
41. Arizona.
42. Colorado.
43. Wyoming.
44. Montana.
45. Idaho.
46. Utah.
47. Nevada.
48. California.
49. Oregon.
50. Washington.

No. of operation.	Locality.	Assistants and aids.		Character of work.	Page.
		Chief of party.	Members of party.		
46	Colorado: Thirty-ninth parallel.	Winston.		Precise levels.	186
47	Colorado.	Winston.		Precise levels.	186
48	Utah. California.	Sinclair.	Morse.	Latitude. Longitude. Triangulation.	188
49	California: Northern part.	Gilbert.		Precise levels.	202
50	California: Southern part.	Mosman.	Morse. Fairfield.	Reconnoissance. Hypsometry. Astronomical.	198
51	California: Southern part.	Mosman.	Fairfield.	Triangulation.	198
52	California: San Diego Harbor.	Westdahl.		Steamer Gedney. Triangulation. Hydrography. Topography. Compass ranges.	193
53	California: San Pedro Harbor.	Westdahl.		Steamer Gedney. Hydrography. Topography.	193
54	California: San Francisco.	Morse.		Triangulation. Topography.	190
55	California: Presidio, San Francisco Bay.	Ballard. Tidal observer.		Tide gauge.	240
56	California: San Francisco Bay.	Westdahl.		Steamer Gedney. Hydrography.	193

C. WESTERN DIVISION—WEST OF THE ROCKY MOUNTAINS—Continued.

No. of operation.	Locality.	Assistants and aids.		Character of work.	Page.
		Chief of party.	Members of party.		
57	California: San Francisco Bay	Dickins.		Hydrography.	196
58	California: San Francisco Bay	Dickins.		Steamer McArthur. Hydrography.	196
59	California: San Pablo Bay.	Dickins.		Steamer McArthur. Hydrography.	196
60	Washington: Grays Harbor.	Westdahl.		Steamer Gedney. Hydrography. Topography.	193
61	Washington: Seattle.	Putnam.		Gravity.	205
62	Washington: Seattle.	Pratt.		Tide gauge.	240
63	Washington: Seattle.	Derickson.		Tide gauge.	240
64	Washington: Bremerton, Puget Sound Naval Station.	Commandant.		Tide gauge.	240

D. DIVISION OF ALASKA.

No. of operation.	Locality.	Assistants and aids.		Character of work.	Page.
		Chief of party.	Members of party.		
65	Alaska: Head of Lynn Canal.	Flemer.	Nelson.	Reconnoissance. Triangulation. Topography.	206
66	Alaska: Chatham Strait. Sumner Strait.	Dickins.		Steamer Gedney. Triangulation. Hydrography. Topography.	196
67	Alaska: Copper River Region.	Ritter.	Latham. Denson.	Triangulation. Hydrography. Topography. Tidal observations. Hypsometry. Astronomical.	209
68	Alaska: Copper River Region.	Ritter.	Latham. Denson.	Triangulation. Hydrography. Topography. Hypsometry.	209
69	Alaska: Yukon River mouth.	Pratt.	Baldwin. Faris. Derickson. Putnam. Young.	Steamer Patterson. Triangulation. Hydrography. Topography. Base lines. Magnetic. Astronomical. Tidal observations. Reconnoissance.	212
70	Alaska: Yukon River mouth.	Pratt.	Young.	Steamer Patterson. Hydrography. Triangulation. Topography.	212
71	Alaska: Yukon River mouth. Scammon Bay.	Putnam.	Flower. Frisby. Mansfield.	Steamer Yukon. Hydrography. Topography. Reconnoissance. Astronomical.	218
72	Alaska: St. Michael Island. Stuart Island.	Faris.	Flynn. Phelps. Derickson.	Steamer Taku. Hydrography. Topography.	219

E. SPECIAL DUTY.

No. of operation.	Locality.	Assistants and aids.		Character of work.	Page.
		Chief of party.	Members of party.		
73	England: Bristol.	Schott.		Representative, Magnetic Conference.	220
74	Germany: Stuttgart.	Preston.		Representative, International Geodetic Association.	221
75	Massachusetts: Boston.	Hayford. Harris.		Representative, American Association for Advancement of Science Meeting.	222
76	New Jersey: Elizabethport.	Ogden. Ross.		Construction steamer Pathfinder.	233 236
77	New York: New York.	Gilbert, President.	Yates, Recorder. Barrett. Moore. McAllister.	Board on trial trip of steamer Pathfinder.	233
78	New York: New York.	Perkins.		Take command steamer Pathfinder.	238
79	Porto Rico.	Tittmann.		Tide gauges. Triangulation. Weights and measures.	62
80	Porto Rico: San Juan.	Gherardi, Ensign, U. S. N. Tidal observer.		Tide Gauge.	239
81	Porto Rico.	Hodgkins.	Bowie. Nelson.	Steamer Blake. Hydrography. Topography. Triangulation. Tidal observations. Astronomical.	146
82	Porto Rico: San Juan Harbor.	Hodgkins.	Bowie. Nelson.	Steamer Blake. Hydrography.	146
83	California. Nevada. State Boundary.	Sinclair.	Flynn.	Reconnoissance. Triangulation. Base lines. Topography.	223
84	California. Nevada. State Boundary.	Sinclair.	Edmonds.	Magnetic. Triangulation. Topography.	223

E. SPECIAL DUTY—Continued.

No. of operation.	Locality.	Assistant and aids.		Character of work.	Page.
		Chief of party.	Members of party.		
85	California. Nevada. State Boundary.	Sinclair.	Fairfield.	Triangulation.	223
86	Maryland: Gaithersburg.	Smith.		International Latitude Observations.	149
87	California: Ukiah.	Rodgers.		International Latitude Observations.	203
88	California: San Francisco.	Rodgers.		In charge of suboffice.	203
89	Georgia: Brunswick Outer Bar.	Marindin.	Frisby. Flower.	Hydrography.	226
90	Mississippi River.	Marindin.		Mississippi River Commission.	226
91	New York: Niagara River.	Marindin.		Determine width of bridge spans.	155
92	Washington: Seattle.	Gilbert. Young.		In charge of suboffice.	202 204
93	Washington: Bainbridge Reef.	Young.		Hydrography.	204
94	Atlantic and Gulf Coasts.	Bradford.		Inspection of chart agencies.	228
95	Alabama: Mobile. Louisiana: New Orleans. Washington: Seattle. California: San Francisco.	Ogden.		Inspection of vessels and field parties.	229
96	Oklahoma. Kansas: Ninety-eighth Meridian.	Hayford.		Inspection of reconnoissance, triangulation, and leveling.	230

TABLE II.—TECHNICAL INDEX OF FIELD WORK INCLUDED IN TABLE I.

Classification.	Number of operation.	Page.
I. LAND OPERATIONS:		
A. Geodesy.		
1. Reconnoissance.		
Chesapeake Bay	18	159
Chesapeake Bay	25	163
Ninety-eighth meridian	38	182
Ninety-eighth meridian	39	182
Ninety-eighth meridian	40	181
Ninety-eighth meridian	42	179
Ninety-eighth meridian	43	179
Ninety-eighth meridian	96	230
California	50	198
California and Nevada	83	223
Lynn Canal	65	206
Yukon River	69	212
Yukon River	71	218
2. Base lines.		
Ninety-eighth meridian	42	179
Ninety-eighth meridian	43	179
California and Nevada	83	223
Yukon River	69	212
3. Triangulation.		
Portsmouth	1	144
Hudson River	5	161
Chesapeake Bay	13	156
Chesapeake Bay	22	160
Lake Maurepas	37	175
Ninety-eighth meridian	38	182
Ninety-eighth meridian	39	182
Ninety-eighth meridian	40	181
Ninety-eighth meridian	96	230
Utah	48	188
California	51	198
California	52	193
San Diego	52	193
California and Nevada	83	223
California and Nevada	84	223
California and Nevada	85	223
Lynn Canal	65	206
Chatham Strait	66	196
Copper River	67	209
Copper River	68	209
Yukon River	69	212
I. LAND OPERATIONS—Cont'd.		
A. Geodesy—Continued.		
3. Triangulation—C't'd.		
Yukon River	70	212
Porto Rico	79	62
Porto Rico	81	146
4. Astronomical determination.		
Florida	34	168
Ninety-eighth meridian	44	149
Utah	48	188
California	50	198
Copper River	67	209
Yukon River	69	212
Yukon River	71	218
Porto Rico	81	146
International Latitude Observations	74	221
International Latitude Observations	86	149
International Latitude Observations	87	203
B. Topography.		
Portsmouth	1	144
Marthas Vineyard	3	146
Hudson River	5	161
Chesapeake Bay	13	156
Chesapeake Bay	16	153
Chesapeake Bay	18	159
Chesapeake Bay	19	158
Chesapeake Bay	20	146
Chesapeake Bay	26	159
Lake Maurepas	37	175
San Diego	52	193
San Pedro	53	193
San Francisco	54	190
Grays Harbor	60	193
Lynn Canal	65	206
Aransas Pass	45	177
Chatham Strait	66	196
Copper River	67	209
Copper River	68	209
Yukon River	69	212
Yukon River	70	212
Yukon River	71	218
Yukon River	72	219
Porto Pico	81	146
California and Nevada	83	223
California and Nevada	84	223
C. Hypsometry.		
Ohio	36	174
Ninety-eighth meridian	41	184
Ninety-eighth meridian	96	230
Colorado	46	186
Colorado	47	186
California	49	202

TABLE II.—TECHNICAL INDEX OF FIELD WORK INCLUDED IN TABLE I—Continued.

Classification.	Number of operation.	Page.
I. LAND OPERATIONS—Cont'd.		
C. Hypsometry--Continued.		
California	50	198
Copper River	67	209
Copper River	68	209
D. Magnetism.		
New England	2	148
West Virginia	11	148
West Virginia, Maryland, Delaware	10	167
Virginia	28	221
North Carolina	29	168
North Carolina	30	168
California and Nevada	84	223
Yukon River	69	212
Magnetic Conference	73	220
E. Gravity.		
New York, Massachusetts, District Columbia	7	148
Seattle	61	205
F. Special duty.		
1. Representative.		
Bristol, England	73	220
Stuttgart, Germany	74	221
Boston, Mass	75	222
2. Porto Rico.		
Tittmann	79	62
Gherardi	80	239
Hodgkins	81	146
Hodgkins	82	146
3. State boundaries.		
California and Nevada	83	223
California and Nevada	84	223
California and Nevada	85	223
4. Mississippi River Commission	90	226
5. International Latitude Observations.		
Gaithersburg	86	149
Ukiah	87	203
Stuttgart Conference	74	221
6. Suboffices.		
San Francisco	88	203
Seattle	92	202
7. Niagara River Bridge	91	155
8. Inspection.		
Chart agencies	94	228
Field parties	95	229
Vessels	95	229
Ninety-eighth meridian	96	230
II. SEA OPERATIONS:		
A. Hydrography.		
Portsmouth	1	144
Quicks Hole	4	161
Hudson River	5	161
II. SEA OPERATIONS—Cont'd.		
A. Hydrography—Cont'd.		
Chesapeake Bay	13	156
Chesapeake Bay	14	154
Chesapeake Bay	15	161
Chesapeake Bay	17	151
Chesapeake Bay	23	151
Chesapeake Bay	25	163
Charleston	32	170
Brunswick	33	172
Lake Maurepas	37	175
Aransas Pass	45	177
San Diego	52	193
San Pedro	53	193
San Francisco	56	193
San Francisco	57	196
San Francisco	58	196
San Pablo Bay	59	196
Grays Harbor	60	193
Bainbridge Reef	93	204
Chatham Strait	66	196
Copper River	67	209
Copper River	68	209
Yukon River	69	212
Yukon River	70	212
Yukon River	71	218
Yukon River	72	219
Porto Rico	81	146
Porto Rico	82	146
Brunswick Bar	89	226
B. Tidal.		
1. Tide gauges.		
Hudson River	5	161
Fort Hamilton	6	239
Chesapeake Bay	21	229
Chesapeake Bay	24	166
Reedy Island	27	239
District Columbia	9	239
Morehead City	31	239
Fernandina	35	239
Porto Rico	79	62
Porto Rico	80	239
Porto Rico	81	146
San Francisco	55	240
Seattle	62	240
Seattle	63	240
Bremerton	64	240
Copper River	67	209
Yukon River	69	212
2. Current observations.		
Portsmouth	1	144
Aransas Pass	45	177
C. Coast pilot	.....	.....
D. Special duty.		
Brunswick Bar	89	226
Steamer Pathfinder	76	233
Steamer Pathfinder	77	233
Steamer Pathfinder	78	238
Compass ranges	52	193
Quicks Hole	4	161
Bainbridge Reef	93	204

TABLE III.—ALPHABETICAL INDEX OF PERSONNEL APPEARING IN TABLE I.

Name.		Number of operation.	Page.
Baldwin	Ninety-eighth meridian.	41	184
	Yukon River	69	212
Ballard	San Francisco	55	240
Barrett	Trial trip Pathfinder.	77	233
Bauer	West Virginia, Maryland, and Delaware.	10	167
Baylor	North Carolina	29	168
	North Carolina	30	168
	Florida	34	168
Bliss	Washington, D.C.	9	239
Boutelle	Chesapeake Bay	13	156
Bowie	Chesapeake Bay	13	156
	Chesapeake Bay	16	153
	Porto Rico	81	146
	Porto Rico	82	146
Bradford	Atlantic and Gulf coasts.	94	228
Commandant	Puget Sound Naval Station.	64	240
Denson	Copper River	67	209
	Copper River	68	209
Derickson	Seattle	63	240
	Yukon River	69	212
	St. Michael	72	219
Dickins	San Francisco	57	196
	San Francisco	58	196
	San Pablo Bay	59	196
	Chatham and Sumner straits.	66	196
Donn	Chesapeake Bay	18	159
	Chesapeake Bay	26	159
Duffield	Portsmouth	1	144
Edmonds	California and Nevada.	84	223
Eimbeck	Ninety-eighth meridian.	40	181
Fairfield	California	50	198
	California	51	198
	California and Nevada.	85	223
Faris	Chesapeake Bay	13	156
	Yukon River	69	212
	St. Michael	72	219
Ferguson	Michigan and Ohio.	36	174
Flemer	Aransas Pass	45	177
	Lynn Canal	65	206
Flower	Chesapeake Bay	14	154
	Brunswick, Ga	33	172
	Yukon River	71	218
	Brunswick, Ga	89	226
Flynn	Chesapeake Bay	22	160
	St. Michael	72	219
	California and Nevada.	83	223
Forney	Ninety-eighth meridian.	42	179
	Ninety-eighth meridian.	43	179
French	Chesapeake Bay	19	158
	Lake Maurepas	37	175
Frisby	Chesapeake Bay	15	161
	Brunswick, Ga	33	172
	Lake Maurepas	37	175
	Yukon River	71	218
	Brunswick, Ga	89	226
Fuss	Reedy Island	27	239
Gherardi	San Juan, Porto Rico.	80	239
Gilbert	Chesapeake Bay	25	163
	California	49	202
	New York, trial Pathfinder.	77	233
	Seattle	92	202
Granger	Ninety-eighth meridian.	38	182
	Ninety-eighth meridian.	39	182
Harris	Boston, Mass	75	222
Hayford	Boston, Mass	75	222
	Ninety-eighth meridian.	96	230
Hehl	Reedy Island	27	239
Hodgkins	MarthasVineyard	3	146
	Chesapeake Bay	20	146
	Porto Rico	81	146
	San Juan, Porto Rico.	82	146
Latham	Copper River	67	209
	Copper River	68	209
Little	Ninety-eighth meridian.	40	181
Mansfield	Lake Maurepas	37	175
	Yukon River	71	218
Marindin	Chesapeake Bay	14	154
	Brunswick, Ga	89	226
	Mississippi River	90	226
	Niagara River Bridge.	91	155
McAllister	Trial trip Pathfinder.	77	233
McGrath	Hudson River	5	161
	District of Columbia.	8	150
	Indian Territory and Texas.	44	149
Mitchell	Lake Maurepas	37	175
Moore	Trial trip Pathfinder.	77	233
Morse	Utah	48	188
	California	50	198
	San Francisco	54	190
Mosman	California	50	198

TABLE III.—ALPHABETICAL INDEX OF PERSONNEL APPEARING IN TABLE I—Continued

Name.		Number of operation.	Page.	Name.		Number of operation.	Page.
	California	51	198		West Virginia	11	148
Nelson	Lynn Canal	65	206		Indian Territory and Texas.	44	149
	Porto Rico	81	146		Gaithersburg	86	149
	San Juan, Porto Rico.	82	146	Spaulding	Fort Hamilton	6	239
Ogden	Chesapeake Bay	12	229	Sinclair	Utah and California.	48	188
	Chesapeake Bay	21	229		California and Nevada.	83	223
	Construction Pathfinder.	76	233	Tittmann	Porto Rico	79	62
	Inspection	95	229	Vinal	Chesapeake Bay	17	151
Perkins	Chesapeake Bay	14	154		Chesapeake Bay	23	151
	Chesapeake Bay	22	160	Wainwright	Quicks Hole	4	161
	Brunswick, Ga	33	172		Hudson River	5	161
	Command of Pathfinder.	78	238		Chesapeake Bay	15	161
Phelps	Chesapeake Bay	15	161	Webb	Morehead City	31	239
	Lake Maurepas	37	175	Weeks	Fernandina	35	239
	St. Michael	72	219	Weld	Chesapeake Bay	20	146
Pratt	Seattle	62	240	Welker	Portsmouth	1	144
	Yukon River	69	212		Charleston	32	170
	Yukon River	70	212		Aransas Pass	45	177
Preston	Cherrydale	28	221	Westdahl	San Diego	52	193
	Stuttgart	74	221		San Pedro	53	193
Putnam	Seattle	61	205		San Francisco	56	193
	Yukon River	69	212		Grays Harbor	60	193
	Yukon River	71	218	Winston	Transcontinental arc.	46	186
Ritter	Copper River	67	209		Colorado	47	186
	Copper River	68	209	Yates	Chesapeake Bay	15	161
Rodgers	Ukiah	87	203		Chesapeake Bay	24	166
	San Francisco	88	203		Chesapeake Bay	25	163
Ross	Construction Pathfinder.	76	236		Trial trip Pathfinder.	77	233
Schott	Bristol, England	73	220	Young	Yukon River	69	212
Smith	New England States.	2	148		Yukon River	70	212
	Hudson River	5	161		Seattle	92	204
	Massachusetts and New York.	7	148		Bainbridge Reef	93	204

IV. DETAILED STATEMENT OF FIELD WORK.

A. EASTERN DIVISION.

WELKER, Steamer *Bache:* NEW HAMPSHIRE, Portsmouth.

TRIANGULATION.
TOPOGRAPHY.
HYDROGRAPHY.

W. W. DUFFIELD, *Assistant.*
CHARLES DEETZ, *Draftsman.*
J. L. DUNN, *Chief Yeoman.*
WM. G. INSLEY.

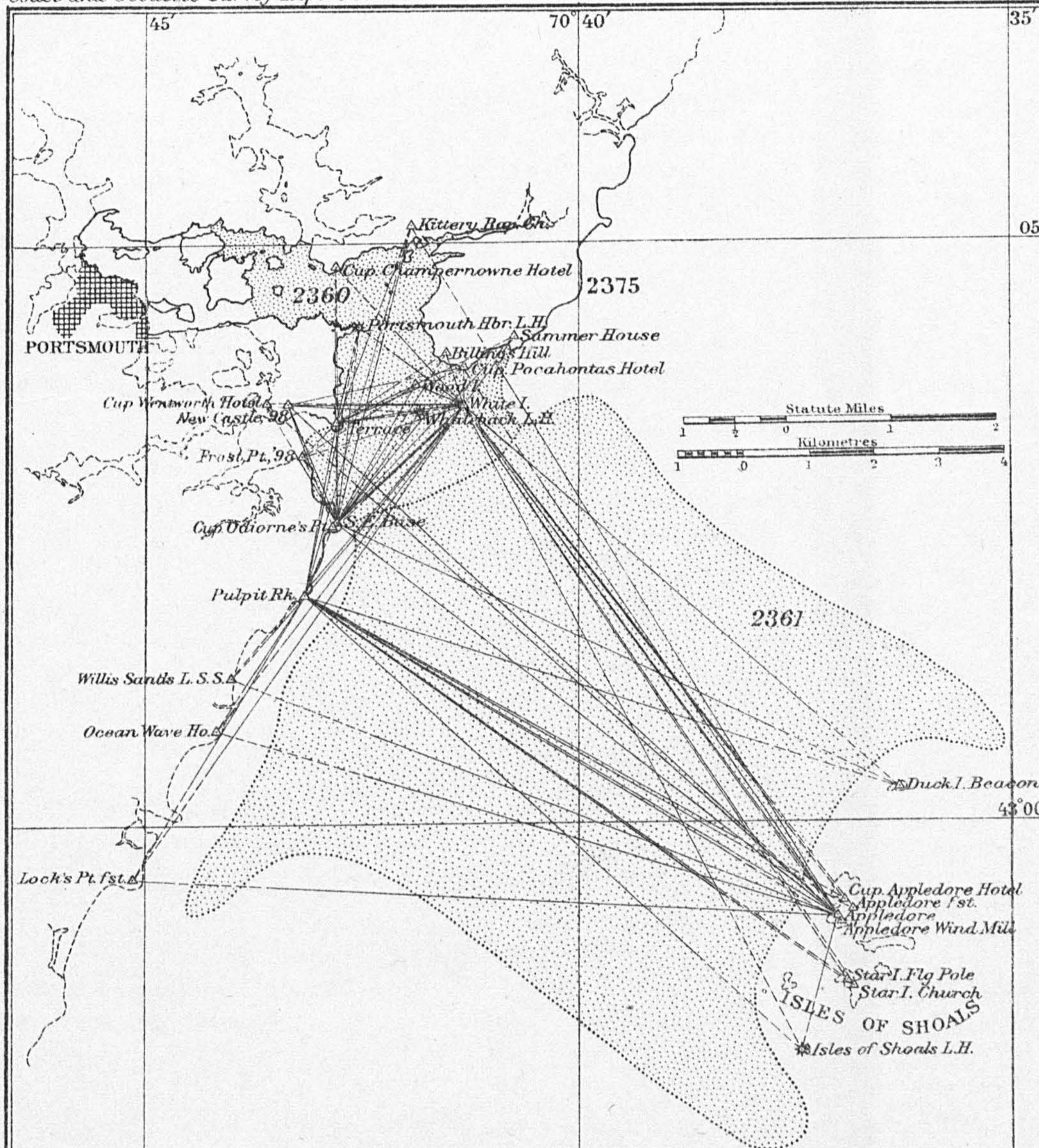
Aug. 26 to Oct. 31, 1898.

SUMMARY OF OPERATIONS.

20	square miles triangulation.
7	triangulation stations occupied.
24	geographical positions determined.
39·8	miles coast-line topography.
16·6	miles low-water line topography.
1	topographic sheet, scale 1 : 10 000.
10	square geographical miles hydrography.
323·4	geographical miles sounding lines.
4 382	angles measured.
2	tidal stations established.
13	current stations occupied.
3	hydrographic sheets, scale 1 : 10 000–1 : 20 000.

From the beginning of the fiscal year until the 19th of August Assistant P. A. Welker was engaged in directing the repairs of the steamer *Bache*, at Baltimore, and organizing a party for combined operations at Portsmouth, N. H. Sailing on the 20th of August, he arrived on the 26th, having had three days' delay at Edgartown, Mass., on account of bad weather.

Points for the execution of the hydrographic and topographic work proposed were furnished by the Coast and Geodetic Survey Office, but as they were mostly determined by the Corps of Engineers, U. S. A., between 1840 and 1844, together with a few from the Borden Survey of Massachusetts, and the Coast Survey, equally as old, very few of them could be recovered. For outside hydrography only three points were available. The Isle of Shoals light-house was determined by Borden, but it was not connected for distance or azimuth with any other point. The other points determined were Pulpit Rock and Whales Back light-house. With this scanty supply and the uncertainty which attached to the positions found, a triangulation was necessary. Many stations were occupied in efforts to reproduce a given triangle, which were subsequently abandoned on account of the angles not corresponding with those given. Finally the points White Island and Southeast Base were recovered, and these, with Wood Island, were



PROGRESS SKETCH SHOWING

TRIANGULATION, TOPOGRAPHY AND HYDROGRAPHY

PORTSMOUTH HARBOR

NEW HAMPSHIRE

June 30, 1899.

42° 55'

Shoreline resurveyed is shown by a full line.

Hydrography (partially completed) is shown by a dotted surface.

THE NORRIS PETERS CO., PHOTO LITHO., WASHINGTON, D. C.

occupied, and furnished a triangle on which subsequent work was based. The resulting lines were checked by azimuths, and the geographical positions were verified sufficient to make sure that the points employed were absolutely identical with those of the older surveys.

The topographic work was in charge of Mr. Charles Deetz, who was temporarily detailed from the Drawing and Engraving Division of the Office. Operations began on September 1, the method employed being that of the plane table. The work was controlled by points and directions determined by triangulation. By September 12, sufficient shore line and enough points had been located by triangulation and by plane table to commence hydrographic work. The general system of this part of the scheme was rectangular, the lines of sounding being from 25 to 100 meters apart. Over shoals and sunken rocks, in order to bring out the character of the obstructions, closer lines were run.

The inside hydrography, by J. L. Dunn, chief yoeman, U. S. N., was executed in the whaleboat. On account of the strong currents prevalent this work was exceedingly difficult. In certain localities sounding was impossible except at slack water.

The outside hydrography was executed by the steamer *Bache* whenever the weather was favorable, and the steam launch was brought into requisition for developing the shoals and sunken rocks before referred to. At least one-half of the time was lost on account of stormy weather, and the work was necessarily left unfinished on account of lack of time.

A tide station was established at Fort Constitution, and the mean low-water readings were referred to a bench mark of the United States Engineers. The plane of reference was established by observations night and day during two lunar months. A careful study was also made of the currents in the harbor, both in velocity and direction, by observations from the steamer and a launch anchored at selected stations.

Work was closed at the end of October, and on November 1 the party started for Washington. A stop was made between the 3d and 12th, in New York, in order to obtain supplies and outfit. On reaching Fortress Monroe, on the 13th, Assistant Welker received instructions to proceed to Baltimore for repairs. These having been completed by the 18th, the party started for Aransas Pass, Texas, arriving on January 15, after having been delayed by stormy weather.

Assistant Welker speaks in high terms of the services rendered in the work by Assistant Will Ward Duffield, temporarily detached from the Office in Washington, and also by Messrs. Deetz and Dunn.

The result of the work was one hydrographic sheet, on a scale of 1:20 000, of the approaches to Portsmouth; one hydrographic sheet of the harbor, on a scale of 1:10 000; and one topographic sheet of the harbor and approaches, on a scale of 1:10 000. The topographic sheet was finished, but both the hydrographic ones require more work to bring them to completion.

HODGKINS, Steamer *Blake:* MASSACHUSETTS, MARYLAND, PORTO RICO.

TOPOGRAPHY.
HYDROGRAPHY.
TRIANGULATION.

JOHN NELSON, *Assistant.*	
WM. BOWIE, *Aid.*	
THOMAS S. MARTIN, *First Watch Officer.*	
F. F. WELD, *Recorder.*	July 1 to July 30, 1898.
J. T. WATKINS, *Draftsman.*	
L. M. HOPKINS, *Chief Machinist.*	Aug. 12 to Nov. 30, 1898.
R. K. CLEBORNE, *Medical Officer.*	
GEO. B. BEARDSLEY, *Second Watch Officer.*	Jan. 11 to June 2, 1899.
Y. D. GRIFFISS, *Third Watch Officer.*	
T. W. LEUTZE, *Chief Yeoman.*	
E. F. RODGERS, *Yeoman, Second Class.*	

SUMMARY OF OPERATIONS.

1 base line measured.
Triangulation, hydrography, and topography from Ponce to Point Viento.

On the 1st of July, 1898, Assistant W. C. Hodgkins was in charge of a double topographic party engaged in the resurvey of Marthas Vineyard and No Mans Land, Massachusetts. This work had been under way during the last season, and was completed on the 30th of July, when the party was transferred to topographical work on Chesapeake Bay.

Leaving Vineyard Haven on the 6th of August, Assistant Hodgkins arrived in Washington on the 8th, and after a few preliminary operations the field work was begun in the vicinity of Havre de Grace, Md., the party arriving there on the 12th of August. Headquarters were made at Havre de Grace, as this locality was nearly central for the work to be taken up.

The field operations included a general survey of the shore line of the bay, together with the estuaries and creeks leading into it near this locality. Considerable topographical work was also filled in between the Bush River and the Susquehanna. Two plane-table parties were kept in the field, one of which was in the charge of F. F. Weld, recorder, the other being conducted by the chief of party, Assistant Hodgkins. All the work outlined in the Superintendent's instructions was completed by the 20th of November, at which time Assistant Hodgkins reported at Washington, where he was joined two days later by Mr. Weld, who remained to close up the work of the party.

On reporting at the Office in Washington, Assistant Hodgkins was directed to take up the inking of the field sheets just completed, but on the 2d of December it became necessary to detail him to the command of the steamer *Blake*, which was then fitting out at Baltimore for a cruise to Porto Rico. He immediately took command of the vessel and superintended the necessary repairs, which were in progress at the time he assumed command.

The work being completed by December 22, the vessel was given a trial trip on the

Patapsco River, at which the Superintendent of the Survey was present with a number of invited guests. After testing the compasses and taking on a supply of coal the *Blake* left Baltimore on the 27th of December and arrived at Norfolk on the following day. A short stay was made for the purpose of getting necessary ship stores and a moderate armament from the Navy Department. When the coal bunkers and water tanks had been filled the *Blake* put to sea and passed the capes at 1 p. m. on the 30th of December.

The ship's company included 50 persons all told, of whom 13 were officers. Assistant Superintendent, Mr. O. H. Tittmann, was also on board as a passenger, charged with a special scientific mission to Porto Rico, reference to which work is made in the Report proper, under the head of "Special duty" (see p.62).

It was the intention to make a direct course from the Capes to the Mona Passage, but after crossing the Gulf Stream heavy seas were encountered, and it was deemed advisable to change the course so as to run through the Crooked Island Passage. Two days were spent at anchor behind Acklins Island, on account of continuous high seas, and then the course was laid through the Windward Passage and the Caribbean Sea, along the southern coast of Haiti, to Porto Rico.

The vessel came to anchor, off Ponce, early on the morning of January 11 and entered the harbor soon after sunrise. Work was immediately begun by the measurement of a base line 2 572.6 meters long, on the railroad southwest of Ponce, and the observation of an astronomical azimuth at Cardona Island light-house. A scheme of triangulation was developed from the base line, thus furnishing points for the topographic and hydrographic parties, both of which operations were prosecuted continuously thereafter.

The month of April, however, was devoted to a survey of the bar and anchorage at the important harbor of San Juan, on the north coast. The work at this point verified the fact that 35 feet could be found on the bar at low water.

The most important anchorages developed on the south coast were Ponce, Jobos, and Arroyo.

The field work of the season was closed on June 2, at which date a general survey of the south coast had been made extending eastward from Ponce to Point Figuera, and the triangulation and topography had been carried to Point Viento, still farther east.

The *Blake* left Ponce on the 8th of June and spent the following day searching for a reported rock in the Mona Passage, which, however, was not found. San Juan was reached on the 10th, and the following week was spent in coaling ship, cleaning bottom, and taking on sea stores. Sail was made on the 18th of June, Hatteras sighted on the afternoon of the 24th, and Norfolk reached on the 25th. The following day Assistant Hodgkins received instructions to proceed to Washington, which he did, arriving on the 27th. From that time until the close of the fiscal year the ship lay at anchor in the harbor of Washington.

Assistant Hodgkins acknowledges the faithful services of the officers and men of the steamer *Blake*. He specially commends Assistant Nelson and Aid Bowie for intelligent cooperation in their respective lines of work. Acknowledgments are also due to the officers of the Army and Navy stationed at Ponce and San Juan for assistance rendered.

SMITH: WEST VIRGINIA AND NORTHEASTERN STATES, TEXAS.

MAGNETIC OBSERVATIONS.
TRIANGULATION.
LONGITUDE AND LATITUDE.
GRAVITY WORK.

July 1 to July 7, 1898.
July 18 to Aug. 4, 1898.
Aug. 12 to Oct. 4, 1898.
Oct. 15 to Nov. 23, 1898.
Dec. 23 to Mar. 16, 1898–1899.
Apr. 14 to June 14, 1899.

SUMMARY OF OPERATIONS.

18 magnetic stations.
11 meridian lines.
3 gravity stations.
1 astronomic station.

Instructions were issued to Assistant Edwin Smith on the 18th of April, 1898, for magnetic observations in West Virginia. This work was in progress on the 1st of July, and during the present fiscal year observations were made at Buckhannon, Pickens, and Weston. Besides the regular magnetic determinations, meridian lines were established at Buckhannon and Weston.

From July 8 to 18, by special direction of the Superintendent, Assistant Smith was on duty in the office at Washington. On the 19th the magnetic work in West Virginia was resumed and the following stations were occupied before August 4: Wheeling, Grafton, Philippi, Beverly, Hendricks, and Keyser, at three of which—Wheeling, Philippi, and Beverly—meridian lines were laid out in connection with the magnetic observations.

On August 3 instructions were given to Assistant Smith to report to Assistant D. B. Wainwright on the steamer *Blake* in the Hudson River. From the 11th of August until the 4th of October he was engaged with his party in tertiary triangulation of the Hudson River from New York to Tarrytown in connection with the resurvey in charge of Assistant Wainwright.

At the close of the Hudson River operations Assistant Smith reported to the office at Washington on October 5 and immediately thereafter resumed magnetic work in the New England States. Stations were occupied at Rutland, Burlington, Montpelier, and Brattleboro, Vt.; Hanover, N. H.; Williamstown, Plum Island, and Worcester, Mass., and Kittery Point, Me. Meridian lines were established at Rutland, Burlington, Montpelier, Brattleboro, and Worcester. These operations extended until the 23d of November.

In accordance with telegraphic instructions on this date Assistant Smith reported to the office in Washington and was engaged there in work connected with the selection of the international latitude station at Gaithersburg, Md., until December 16. At this date magnetic computations were again taken up and prosecuted until the 23d.

During the time in which the party was engaged in magnetic work in the past season 35 stations were occupied, generally on two days each, and 25 meridian lines were established. All this was completed within one hundred and four working days.

Under instructions of December 21 preparations were made for gravity determinations. On the 1st of January Assistant Smith began operations in this line, the first station being Washington, and this being followed by similar observations at Worcester Polytechnic Institute, Massachusetts, and at Columbia University, New York. Pendulum apparatus B was used in this work. These pendulums were swung in northern Europe by Professor Gore during the summer of 1898, and had previously been swung by Assistant E. D. Preston in the Hawaiian Islands during 1891 and 1892. At the latter place one hundred and ninety-nine nights were observed, covering a period of about fourteen months.

Two complete series of eight-hour swings with the three pendulums were made by Assistant Smith; the first from January 11 to 14 and the second from January 23 to 25, the final results of both series being identical. The pendulum work at Worcester, Mass., and Columbia University, New York, was finished before the 1st of March, when the pendulums were again swung, from the 10th to the 16th, at Washington.

Assistant Smith was also charged with special duty in January in the Office of Standard Weights and Measures, and also laid out the lot at Gaithersburg, Md., for use of the International Geodetic Association latitude service.

In order to determine the difference of longitude between Austin, Tex., and Marlow, Ind. T, Assistant Smith, together with Assistant McGrath, proceeded South early in April. The stations were prepared and the instruments ready for work before the 18th. On account of an unusual spell of bad weather no longitude work could be accomplished before the 13th of May, one month after the arrival of the party at the station. During this interval latitude observations were made. Four complete determinations of longitude were effected before May 20. An exchange of observers then took place, and four additional nights were secured between June 3 and 11. The latitude of Marlow was determined by 60 observations on 15 pairs of stars, during five nights. The micrometer value was determined on two nights.

After having determined the geographical position of Marlow, it was furnished to Mr. W. A. Lindsay, of the United States Geological Survey, by direction of the Superintendent of the Coast and Geodetic Survey. The party arrived in Washington on the 17th of June and continued office work until the 20th. The ten days remaining before the end of the fiscal year were devoted by Assistant Smith to the establishment of the International Geodetic Association latitude station at Gaithersburg, Md.

TOPOGRAPHY.
TIME.
LONGITUDE.

Oct. 3 to Nov. 14, 1898.
Mar. 10 to Mar. 16, 1899.
Apr. 14 to June 14, 1899.

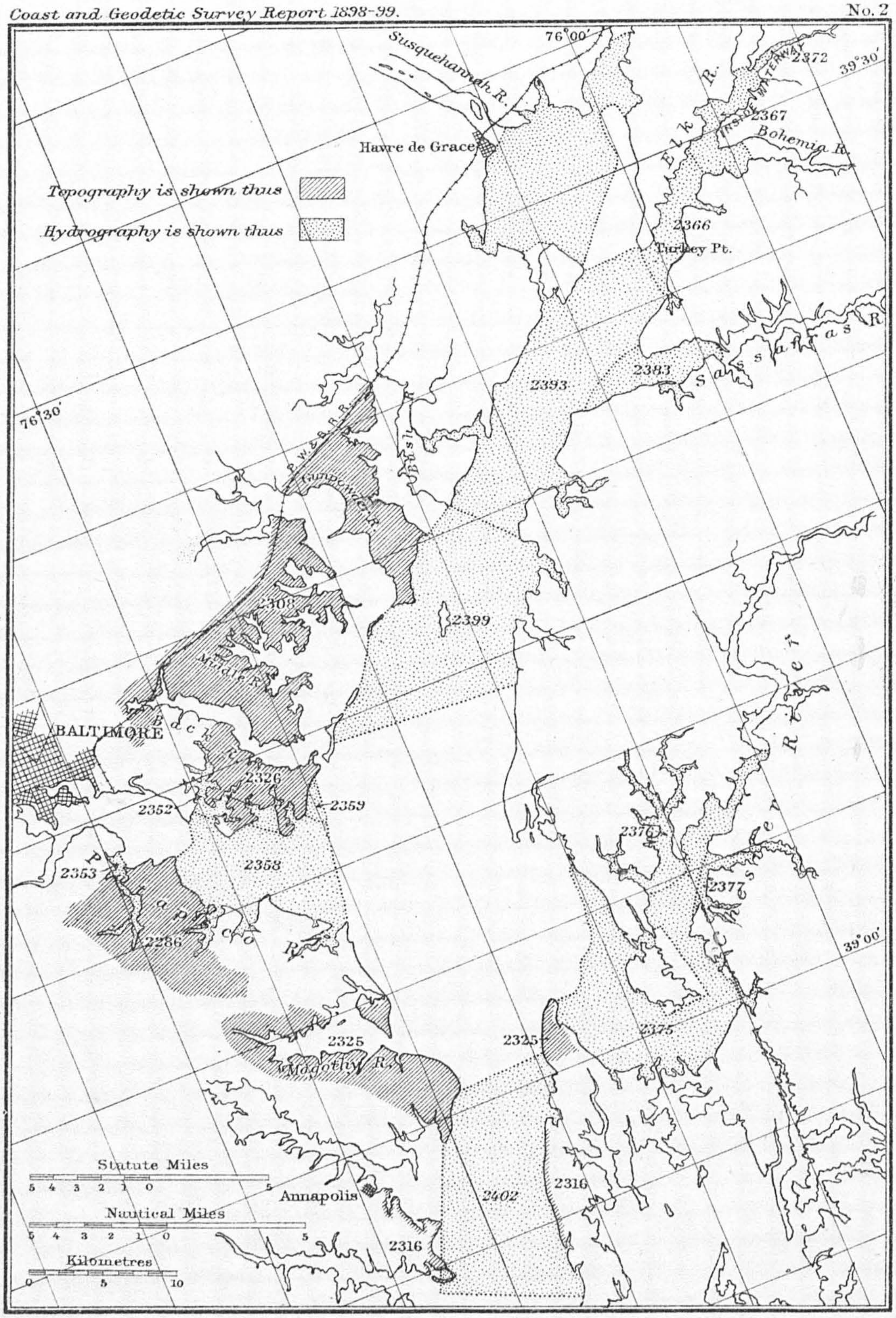
SUMMARY OF OPERATIONS.
1 astronomic longitude determined.
(Marlow, Ind. T.)

After having successfully passed the Civil Service Commission examination, Assistant J. E. McGrath received a temporary appointment for six months on August 1, 1898. He was granted a furlough, without pay, for two months to complete certain geodetic work then in hand for the New York State Land Survey. At the end of this time he reported on board the steamer *Blake*, doing hydrography and topography on the Hudson River, near Riverside. His services in this party consisted in making topographical surveys and computations.

On November 14 the season closed, and Assistant McGrath reported to the Superintendent, in Washington, for office duty. He was assigned to the computing division and was engaged in hypsometric computations of observations recently made in Florida and Colorado. In April he was detached from the computing division and was engaged in revising the manuscript of the Annual Report, in the meantime making time observations for the reduction of gravity determinations by Assistant Smith. The manuscript for the Report was submitted April 10.

On the 11th, in conformity with instructions issued on the 7th, he left Washington for Austin, Tex., for the purpose of cooperating with Assistant Smith in the determination of the longitude of Marlow, Ind. T. The work was undertaken to supply the geographical position of an initial station from which could be run that section of the ninety-eighth meridian forming the boundary between Oklahoma and Indian Territories, and also between the reservations of the Comanche and Chickasaw nations. The observers changed stations on the 3d of June. Only four nights' simultaneous observations had been obtained since the 17th of April. The last half of the work was much more expeditious and observations closed on June 11. On the 13th Assistant Smith returned from Austin. On the 14th the field computations and the necessary data for finding the location of the initial point were completed and, by authority of the Superintendent, given to Mr. W. A. Lindsay, an officer of the United States Geological Survey.

Assistant McGrath reported at Washington on June 19 and was engaged in computations of his recent work until the 30th.



TOPOGRAPHY AND HYDROGRAPHY, CHESAPEAKE BAY, MD.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

VINAL, Schooner *Matchless:* MARYLAND, Chesapeake Bay.

HYDROGRAPHY.

WM. SANGER, *Chief Yeoman, U. S. N.*	
GEORGE OLESON, *Carpenter's mate, U. S. N.*	
JULIUS WALL, *Machinist, U. S. N.*	July 1 to Oct. 22, 1898.
C. L. GARDNER, *Observer.*	
SWEPSON EARLE, *Yeoman, U. S. N., Recorder.*	May 2 to June 30, 1999.
JOHN KENNEY, *Leadsman.*	

SUMMARY OF OPERATIONS.

June 4 to October 22, 1898.

45	square miles triangulation.
30	triangulation stations occupied.
14	permanent positions determined.
12	buoys determined.
30	square geographic miles hydrography.
306·6	geographic miles sounding lines.
4 180	angles measured.
2	stations established.
2	hydrographic sheets, scale 1:20 000.

May 2 to June 30, 1899.

58	square geographic miles hydrography.
719·75	geographic miles sounding lines.
6 208	angles.
2	tidal stations.
3	hydrographic sheets, scale 1:10 000–20 000.

While in charge of the Division of Library and Archives in the Coast and Geodetic Survey Office, Assistant Vinal received instructions to organize a party for the execution of hydrography in the neighborhood of Queenstown, Md. On account of office duties he was unable to personally organize the work, and the crew was enlisted by Assistant Ogden and sent to the scene of operations. Mr. Vinal took charge on the 10th of June, and operations began on the 13th. The work was therefore thoroughly in hand by the 1st of July, 1898, and sounding went on uninterruptedly with a whaleboat while developing the shoals and flats near by.

A reorganization of the party was soon made in the interest of greater efficiency. The new régime gave good results, and the work was thereby much facilitated. Mr. William Sanger, Chief Yeoman, U. S. N., was assigned temporarily on August 5, and remained with the party until the end of the month. Work closed on the 22d of October, and the Chester River, with small tributaries, was completed at this time. The party was in readiness to move, after the 15th of October, to the upper Chesapeake

Bay, but after a personal inspection by the Superintendent it was deemed best to defer the work until spring.

Three hydrographic sheets, scales 1:20 000 and 1:10 000, and 23 volumes of records contain the results of the season's work.

Office work was carried on until January 21. From this date to February 11 Mr. Vinal was unable to perform duty on account of sickness. Returning on February 11, office work was continued until March 31, when orders were issued for him to relieve Assistant J. B. Boutelle, Coast and Geodetic Survey, of the command of the *Matchless*, and to make a hydrographic survey of the head of Chesapeake Bay, including the Susquehanna and Northeast rivers.

The *Matchless* sailed from Washington Navy-Yard on April 5, arrived in Baltimore on the 7th, and after transferring several of her crew to the *Pathfinder*, on April 9 was engaged in enlisting men and repairing and refitting until the end of the month. She sailed from Baltimore with steam launch No. 23 on the morning of May 1, arriving at Havre de Grace on the 2d. The time between her arrival and May 9 was employed in recovering points of triangulation and determining positions of hydrographic signals. Actual sounding began at the latter date and continued until the end of the fiscal year. The work will probably be finished before the end of July, 1899.

BOWIE: Chesapeake Bay, MARYLAND; PORTO RICO.

TOPOGRAPHY.

DONALD DERICKSON, *Rodman.*	July 1 to Oct. 19, 1898.
HOMER SMITH, *Rodman.*	
L. L. TAYLOR, *Plane-Tableman.*	Jan. 11, 1898, to June 2, 1899.

SUMMARY OF OPERATIONS.

44 square miles topography.
6 miles coast shore line.
41 miles river shore line.
7 miles creek shore line.
67·6 miles marsh line.
155·2 miles roads.
1 topographic sheet, scale 1:20 000.

During the beginning of the fiscal year the party of Mr. William Bowie, Aid, Coast and Geodetic Survey, was at Middle River station, Pennsylvania Railroad, engaged in a topographical survey of the shores of the upper Chesapeake Bay. From this station the topography of Patapsco Neck and Gunpowder and Middle rivers was executed as far as could be conveniently done.

On the 11th of August the party moved to Chase, and from this point took up the shores of Gunpowder River and Saltpetre and Seneca creeks. The Bay shore from Ricketts Point to Lego Point was also surveyed. In this work the operations were greatly facilitated by the use of a naphtha launch and rowboats. The topography south of the Gunpowder River was also finished while the party was at Chase. The remaining work of the season was finished from the station Edgewood, and operations were closed on October 19. On the 20th the party disbanded and Mr. Bowie reported at Washington.

The work done in this locality, during the two seasons of 1897 and 1898, extends from the north shore of Patapsco River to the south shore of Bush River. The inland limit is the Philadelphia, Wilmington and Baltimore Branch of the Pennsylvania Railroad, except on Patapsco Neck, where Colgate Creek and a line from Colgate Creek to the head of Back River are the limits.

On October 25 Mr. Bowie joined the party of Assistant Boutelle, on the schooner *Matchless*, and was engaged in the survey of the Elk River until November 13. He returned to Washington on account of sickness and was granted leave of absence until December 3. After this date and until December 31 he was engaged on office duty, when he was instructed to report to Assistant Hodgkins, in command of the steamer *Blake*, for duty in Porto Rico. This assignment held until June 5, when he was detached. He reached Washington on June 16, and was engaged until the 27th in the preparation for field work in the vicinity of Havre de Grace, Md.

His work on Chesapeake Bay is shown on one topographic sheet, on a scale of 1:20 000.

MARINDIN: Chesapeake Bay, MARYLAND; Niagara River Bridge, NEW YORK.

SCHOONER EAGRE.
TOPOGRAPHY.
TRIANGULATION.
HYDROGRAPHY.
SPECIAL DUTY.

G. L. FLOWER, *Assistant.*	
W. B. PROCTOR, *Chief Yeoman, Executive Officer.*	
EUGENE VEITH, *Yeoman, Second Class, Draftsman.*	
JNO. J. OSTERGREN, *Observer.*	July 1 to Sept. 11, 1898.
JAMES L. LAWRENCE, *Recorder.*	
NILLS S. HANSON, *Recorder.*	
CHARLES SELDEN, *Recorder.*	Sept. 19 to 26, 1898.
WM. L. MILLS, *Machinist, Second Class.*	
E. C. KEITHLY, *Carpenter's Mate.*	
G. W. SIREN, *Quartermaster, Second Class.*	Sept. 18 to Nov. 11, 1898.
E. V. BROOKS, *Quartermaster, Third Class, Leadsman.*	
ANDY WHITE, *Leadsman.*	
WELB CARPENTER, *Tidal Observer.*	

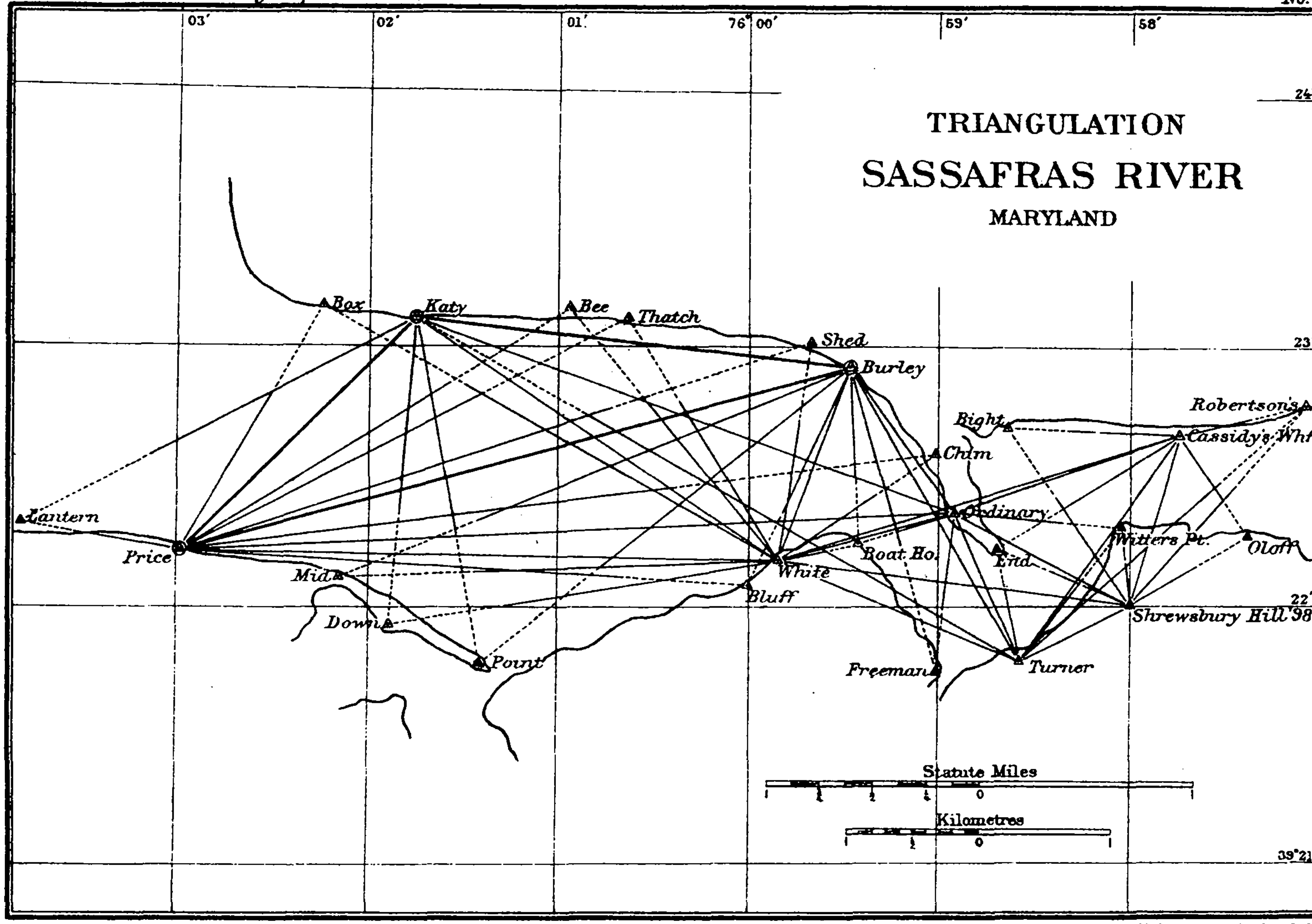
SUMMARY OF OPERATIONS.

June 1 to September 11, 1898.

6	square miles triangulation.
8	triangulations occupied.
22	geographic positions determined.
16·5	miles coast shore-line topography.
1	topographic sheet, scale 1:10 000.
1 351	geographic miles sounding lines.
18 916	angles measured.
13	tidal stations established.
7	hydrographic sheets, scale 1:10 000–20 000.

Under instructions of May 16, 1898, Assistant Marindin was engaged on the hydrography of Curtis Creek, Chesapeake Bay, during the remainder of the previous fiscal year. On July 1 the hydrography of Patapsco River, from Fort Carroll to Seven Foot Knoll light-house, was taken up. At the same time the creeks lying to the north, namely, Bear, Humphries, North Point, and Shoal, were begun, and later those to the south, namely, Stony, Rock, and Bodkin, were also completed. The hydrography of the river was executed with the steam launch No. 22. The whale boat and dingy were assigned to the work in the creeks. The creeks to the north were finished by the end of July, and appear on one sheet, on a scale of 1:10 000. The creeks to the south were not done until the end of August. The work in the river proper, with steam launch No. 22, was finished early in September.

The vessel now proceeded to Baltimore for repairs, which were concluded on the 17th of September. During this interval the office work was carried on uninterruptedly, the soundings were reduced and plotted, and the records were duplicated.


TRIANGULATION
SASSAFRAS RIVER
MARYLAND
03'
02'
01'
76° 00'
59'
58'
24'
23'
22'
39° 21'
Box
Katy
Bee
Thatch
Shed
Burley
Robertson's
Bight
Cassidy's Whf.
Chim
Lantern
Price
Ordinary
Witters Pt.
Oloff
Boat Ho.
End
White
Mid
Bluff
Shrewsbury Hill '98
Down
Point
Freeman
Turner
Statute Miles
Kilometres
THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON, D. C.

On the 18th the *Eagre* proceeded to Sassafras River, in charge of Assistant G. L. Flower. At the same time Assistant Marindin went to Buffalo, N. Y., to attend the meeting of the board, consisting of Rear Admiral John G. Walker, chairman; Col. Jared Smith, Corps of Engineers, U. S. A., and Henry L. Marindin, Assistant, Coast and Geodetic Survey, convened by the Secretary of War to determine the width of the pivot spans of the proposed bridge across the Niagara River, below Buffalo. He returned to Chesapeake Bay and joined the *Eagre*, off Betterton, on the 26th of September. The work was now continued until the season closed, on November 11.

Five hydrographic sheets, on a scale of 1 : 10 000, show the work in Patapsco River, and two hydrographic and one topographic sheet result from the work in the vicinity of Sassafras River. This particular work includes the Chesapeake Bay proper from Turkey Point, at the mouth of the Elk River, southward to Bush River, including Romney Creek and the Sassafras River.

Under instructions dated November 9, the command of the party was turned over to Assistant Flower. Assistant Marindin reported in Washington immediately for duty in connection with the resurvey of Brunswick Outer Bar, in accordance with the provisions of the river and harbor act of June 3, 1896. An account of Assistant Marindin's subsequent operations will be found under the head of "Special duty."

BOUTELLE: MARYLAND, Chesapeake Bay.

TRIANGULATION.

TOPOGRAPHY. HYDROGRAPHY.

SCHOONER MATCHLESS.

SCHOONER EAGRE.

WM. SANGER, *Chief Yeoman*. J. W. CLIFT, *Yeoman, Second Class*. E. PHILLIPS MOULTON, *Recorder*. WM. BOWIE, *Aid* (attached to party Oct. 25 to Nov. 13, on topographic work). R. L. FARIS, Nov. 16 to 23, Triangulation and Topography, vicinity of Chesapeake City.	July 1 to Nov. 25, 1898.

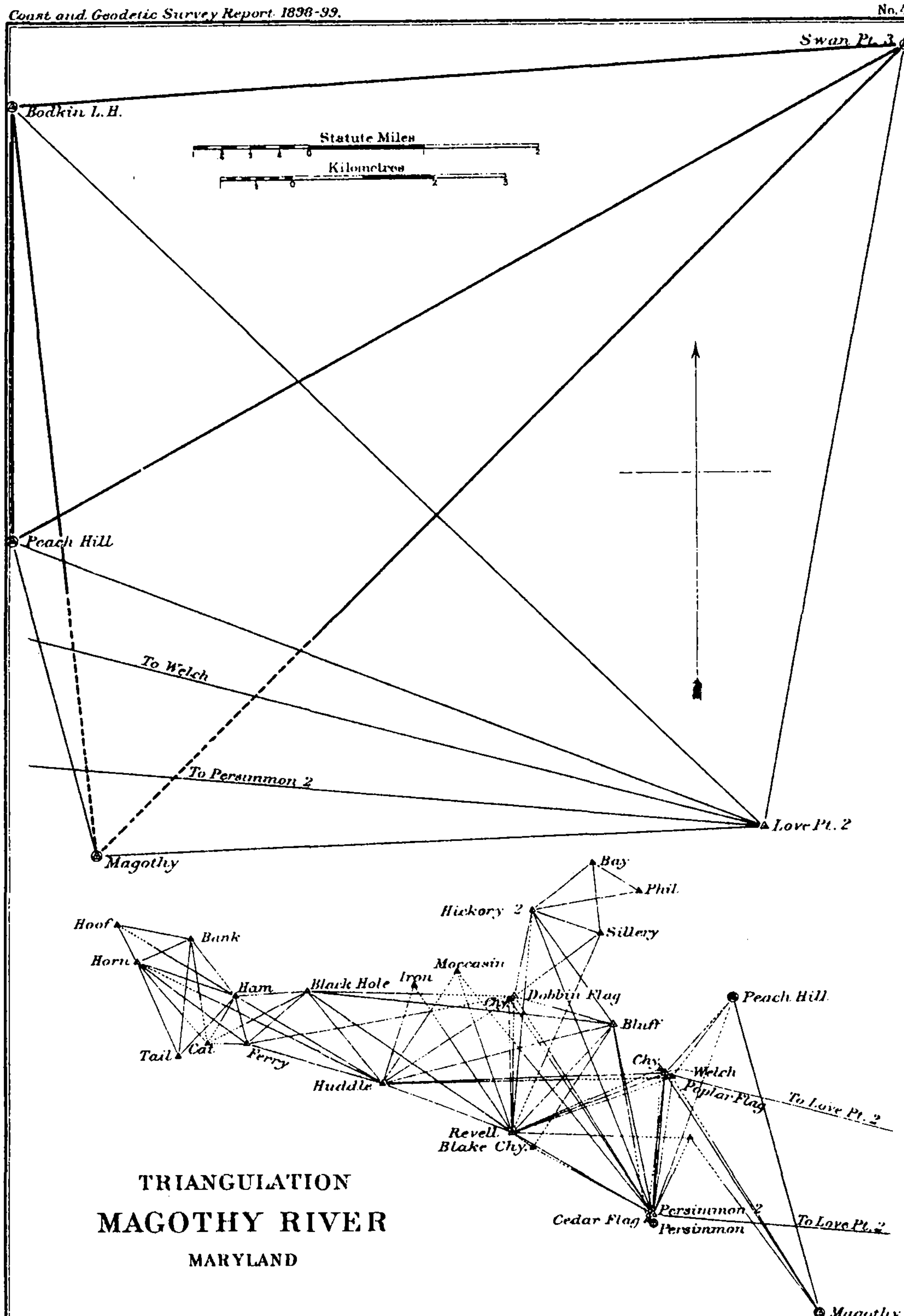
SUMMARY OF OPERATIONS.

June 7 to November 25, 1898.

47 square miles triangulation.
93 geographic positions determined.
185·4 miles shore-line topography.
20 square miles hydrography.
541·5 geographic miles sounding lines.

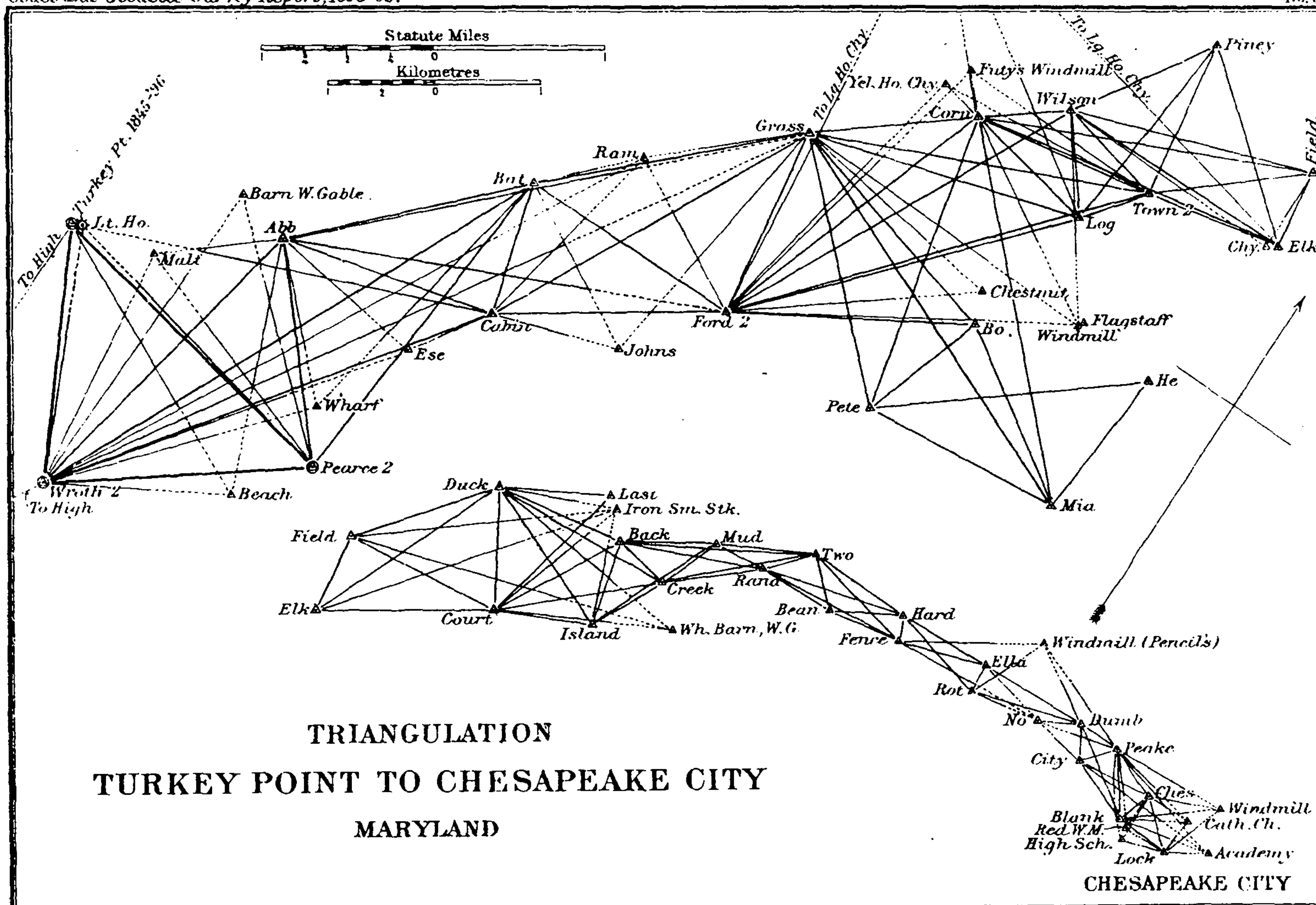
The field work undertaken by Assistant J. B. Boutelle, under instructions of May 16, 1898, was in progress on the 1st of July. Signals had been erected at Peach Hill, Magothy, and Bodkin lighthouses, on Chesapeake Bay, and tide gauges established as far as the head of the river before the 17th of June. The topographic and hydrographic surveys of Magothy River and creeks were completed before the 5th of August. On the 6th the vessel proceeded to Baltimore for stores and supplies, returning on the 12th. At this time the topographic survey of the shore line of Chesapeake Bay, in Annapolis Harbor, was taken up and completed to a short distance below Thomas Point, on the west side of the bay. The work ended on the 31st of August, 54 miles of shore line having been run.

The party now proceeded to Elk River (September 7), and made a survey as far as Chesapeake City. Four old triangulation stations were recovered and signals were erected. Points were first determined by a plane table triangulation, and by this means the sounding boat was able to start work three days after the arrival of the vessel in the locality of work. Stations were then occupied with the theodolite and the topography of the shore line was begun. Triangulation, topography, and hydrography were all carried along together, the work extending over two additional sheets, and reaching to Chesapeake City. Sixty-six geographical positions were determined, 39 of which were occupied with the theodolite. The work was completed on November 25, and the vessel reached Baltimore on the 28th, after having encountered a heavy storm.



TRIANGULATION
MAGOTHY RIVER
MARYLAND

THE NORRIS PETERS CO. PHOTO LITHO. WASHINGTON, D.C.



TRIANGULATION
TURKEY POINT TO CHESAPEAKE CITY
MARYLAND

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON, D.C.

Office work was continued until the 9th of December, when the vessel left for the Washington Navy-Yard. She arrived on the 13th of December, and Assistant Boutelle reported at the Office on the same date. He was engaged in completing the records and topographical and hydrographical sheets of the season's work until the 31st of March, when he was detached from the command of the schooner *Matchless*. From this date until May 8 Assistant Boutelle was sick and unable to attend to official duties. Reporting, after his leave of absence, he was assigned to the command of the United States Coast and Geodetic Survey schooner *Eagre*, at Baltimore, Md., and under instructions of May 18 he brought the vessel to Washington, D. C.

From the 10th of May, 1899, to the end of the fiscal year the party was engaged in completing the records, topographic and hydrographic sheets, etc., of the resurvey of Brunswick, executed under the direction of Assistant F. W. Perkins during the past winter.

FRENCH: MARYLAND, Chesapeake Bay.

TOPOGRAPHY.

Aug. 11 to Nov. 3, 1898.

SUMMARY OF OPERATIONS.

44 square miles topography.
20 miles rivers and ponds shore line.
47 miles creeks shore line.
231 miles roads.
2 topographic sheets, scale 1:20 000.

On the 12th of April, 1898, Assistant O. B. French received instructions to report to the Inspector of Hydrography and Topography, for the execution of topography between Stony and Curtis creeks, on the west shore of the Patapsco River, and also on the Magothy River. The heavy timber and irregular topography of this section required continual application of the 3-point problem to establish his position. The north part of the Patapsco River work depends largely on traverse lines. Some difficulty was encountered with the irregular shrinkage of the sheet, which required a proportionate distribution of the accumulated discrepancies. The work between Stony and Curtis creeks was completed by September 15.

The party was then transferred to the Magothy River and the topography of this section taken up. It was completed on the 31st of October.

Additional work was now begun on the north end of Kent Island, which was required by the proposed new map of this portion of Chesapeake Bay. Many orchards, which are scattered over this region, caused trouble in carrying satisfactory traverse lines through a greater part of the country, but with occasional checks for azimuths a satisfactory survey was made. The elevations were obtained by the vertical circle on the alidade, the results being satisfactorily given by this method, since all checks applied agreed within 2 feet. An error of as much as 1 foot was possible from individual references to mean tide. The datum plane was taken from the beach wherever the line was started.

Between November 1 and 7 Assistant French's party determined the positions of 3 beacons and 9 buoys, marking the dredged channel through the bar entrance to Rock Hall and Swan creeks. In order to accomplish this, 2 triangulation stations of the Chesapeake Bay work were occupied with a small theodolite. The graphic positions of the beacons were then computed and the positions of buoys determined by plotting, by directions and distances. The field work of these operations only required one day.

Assistant French reported to the Office in Washington on the 7th of November. From this time until January 3, with the exception of twenty days spent on leave, Assistant French was at the office in Washington completing the records of the season and making preparations for the next season's work.

DONN: MARYLAND, Baltimore.

TOPOGRAPHY.

July 1, 1898, to Feb. 1, 1899.

JOHN M. DONN, *Foreman.*
HAROLD E. WILLIAMS, *Recorder.*
ROBERT E. SHAW, *Recorder.*

SUMMARY OF OPERATIONS.

29	square miles topography.
27·75	miles river shore line.
54·25	creek shore line.
6·75	pond shore line.
147·25	miles roads.
3	topographic sheets, scale 1:10 000.

Under instructions dated July 1, 1898, Mr. J. W. Donn, Extra Observer, Coast and Geodetic Survey, made a reconnoissance to the south and southeast of Baltimore from the southern boundary at Gwynns Falls to Curtis Bay, on the south side of the Patapsco. This reconnoissance was made for the purpose of selecting points for a scheme of triangulation, and also for graphic determination of positions by means of the plane table. The work brought out the fact that sufficient points could be determined by means of the plane table to thoroughly control the topography, and, in order to avoid cutting long lines, this method of triangulation was exclusively followed. Within three days sufficient points for the southern sheet, Curtis Bay to Washington Road, had been established. No signals were necessary on account of the great number of standing structures. The work progressed satisfactorily in spite of the excessive heat during the months of July and August, and the almost continual clouds of dust from the shell roads. The first sheet was completed by September 1.

The party then moved to the north side of the Patapsco on the east side of Baltimore. This region was much better supplied with trigonometrical data than the southern portion. The triangulation was largely expanded by plane-table determinations, which were secured during the first three days. After this, work was carried on uninterruptedly. Exceptionally unfavorable weather conditions existed during November and December. The sheet was completed by the first of the year.

The third projection covered the triangular area of several square miles between the western part of the first sheet and the work done by Assistant O. B. French. The work was taken up and finished by February 1. Great extremes of temperature were experienced during the season, ranging from 104° F. in July and August, to 9° below zero in January. In spite of these extreme conditions not one day was lost by sickness through excessive heat or cold, or through casualty, by any member of the party.

From February 1 to June 1, 1899, Mr. Donn was engaged in office work at Washington. From June 1 to 13 preparations were made for field work, and on the latter date the topography of Kent Island, Eastern Bay, etc., was taken up. This was in progress at the end of the fiscal year.

PERKINS: MARYLAND, Chesapeake Bay.

TRIANGULATION.

H. F. FLYNN, *Aid.*
J. S. BILBY, *Foreman.*
JOHN A. WHITNEY, *Recorder.*

July 1 to Nov. 9, 1898.

SUMMARY OF OPERATIONS.

177 triangulation stations occupied.
2 226 directions determined.
292 points determined.
2 188 square miles triangulation.
1 340 square miles available for topographic and hydrographic work.

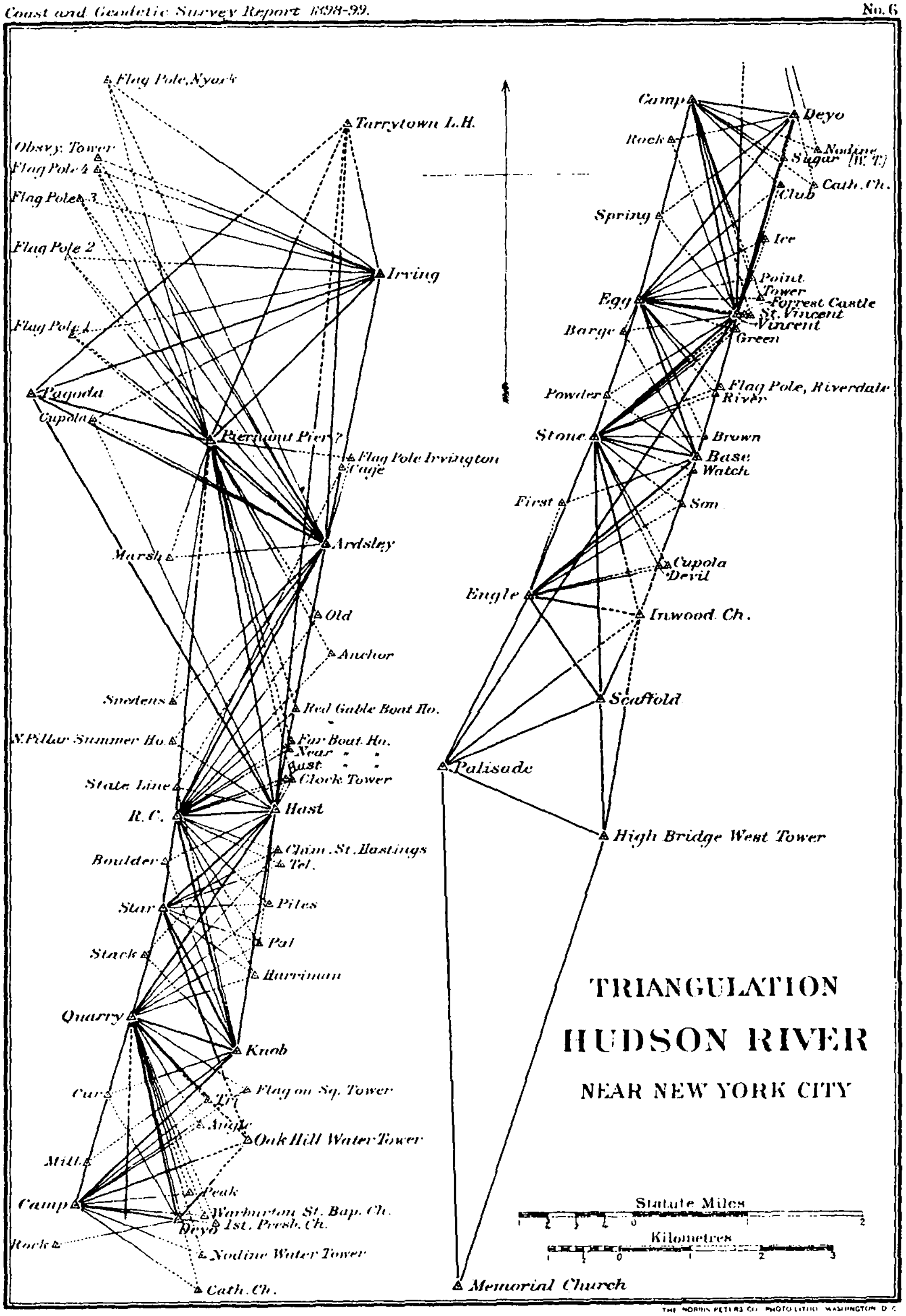
During the latter part of the previous fiscal year Assistant F. W. Perkins was engaged in triangulation on the Chesapeake Bay. His instructions, which were dated April 14, directed him to determine points for the use of hydrographic and topographic parties in the locality above mentioned. This work was taken up immediately, and by June 30, 1898, the observing parties, of which Assistant Perkins had immediate charge of one and Mr. H. F. Flynn, Aid, the other, were at Fairhaven and Tilghmans Island. The construction party, which had charge of the erection of signals, had proceeded south as far as the Patuxent River. Up to the date above mentioned, i. e., the close of the former fiscal year, 125 signals had been erected and 74 stations occupied. The work covered about 260 square miles of the bay.

The operations continued on the same general lines until the 26th of September, when the number of signals erected had increased to 298, supplying points on an average of 1½ miles apart, on both sides, from Havre de Grace to Mobjack Bay. The construction party was then disbanded.

The observation of horizontal angles was continued until November 9. During the 6⅓ months 177 stations had been occupied and some 292 points were determined. Local triangulations by Assistants Baylor and Hodgkins, made for the State Boundary Commission of Maryland and Virginia, and also by Assistant Wainwright for a speed trial course, at the request of the United States Navy, were included in the regular scheme of triangulation, and when necessary their trigonometrical points were reoccupied, so that the angular measurements by the several parties can be combined in one general scheme. Watts Island Light is an old triangulation station of the original survey of the bay and was included in the present work, which gives a check.

The great width between the shores of the bay from the mouth of the Potomac River southward, made it necessary to use light-houses, whenever available, in connection with scaffolds. By this means a strong system of work was carried out, and tertiary points on either side were determined from the main network. The observations have now been carried on the Eastern Shore to the capes, and the party was on the Western Shore, working northward, when operations closed. The detachment of Mr. Flynn in October left the Western Shore untouched beyond Point Lookout.

Assistant Perkins speaks in the highest terms of the services of the members of his party—Aid Flynn as to observing and computations, and Foreman Bilby in the erection of signals. Recorder Whitney is also highly commended by Assistant Perkins for great efficiency, even while laboring under the effects of malaria.



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WAINWRIGHT: MARYLAND, Chesapeake Bay; NEW YORK, Hudson River; MASSACHUSETTS, Quicks Hole.

TRIANGULATION.
TOPOGRAPHY.
HYDROGRAPHY.

E. SMITH, *Assistant.*	
J. E. MCGRATH, *Assistant.*	
C. L. GREEN *Chief Yeoman.*	July 1 to July 15, 1898.
T. W. LEUTZE, *Chief Yeoman.*	
D. B. WAINWRIGHT, JR., *Second-Class Yeoman.*	Aug. 4 to Nov. 14, 1898.
L. M. HOPKINS, *Chief Machinist.*	
Dr. R. K. CLEBORNE, *Apothecary.*	Oct. 26 to Nov. 2, 1898.
DEAN HALFORD, *Recorder.*	
OSCAR STRAUBE, *Recorder.*	
E. F. RODGERS, *Rodman.*	

SUMMARY OF OPERATIONS.

August 4 to November 14, 1898.

15	square miles triangulation.
20	triangulation stations occupied.
77	geographic positions determined.
20	miles river shore line topography.
3	topographic sheets, scale 1:5 000.
9·5	square geographic miles hydrography.
247	geographic miles sounding lines.
4 334	angles measured.
4	tidal stations established.
3	hydrographic sheets, scale 1:5 000.

The hydrographic resurvey of Chesapeake Bay was continued, in the vicinity of Pooles Island, by Assistant Wainwright, in command of the steamer *Endeavor*, from July 1 to 15, 1898. At the latter date he was directed to relieve Assistant Ogden in command of the steamer *Blake*. Repairs were undertaken at once, and on the completion of these she came to Washington, in order to leave part of her outfit for deep sea work. This took place in the latter part of July.

Early in August the resurvey of Hudson River, from Spuyten Duyvil Creek to Piermont Pier, was begun. The topography and hydrography was completed from Spuyten Duyvil to Ardsley, a distance of about 10 miles. The triangulation on which this work is based necessarily extended a greater distance, beginning at a base in New York City and reaching to Tarrytown on the north. Many changes were noted during the progress of the new survey, principal among which may be mentioned the increased docking facilities to meet the demands of greater population and commerce. Few changes of a substantial character appear on the west side of the river. The hydrography of the old survey was executed in 1855, by Lieut. R. Wainwright, U. S. N.

The changes noticed in this branch of the work have been in the improvement of the channel, both in depth and width. From Spuyten Duyvil Creek to Yonkers, however, little change was noticed in the contour of the bottom up to the 5-fathom curve. The breadth of area between the 6-fathom curves, on either side above Mount St. Vincent, was found somewhat increased. This was also the case with the 7-fathom curve. The most notable change, however, was in the increase of area between the curves of 8 fathoms. In the survey of 1855 this is shown as a surface 550 meters in length by 120 meters in breadth, the northern limit being a half mile below Riverdale. In the present survey this limit is opposite Mount St. Vincent, and the area extends southward 2 500 meters, with an average breadth of 200 meters. From Yonkers to Hastings no important differences were discovered. From Hastings to Ardsley the 8-fathom curve extends from a point opposite Dobbs Ferry to about five-eighths of a mile to the southward. The old work did not indicate this.

For the prosecution of the hydrographic work, 2 projections were furnished by the office. Not one of the old triangulation points could be found, as they were probably located on wharves and temporary structures long since abandoned or destroyed. The present triangulation was placed in charge of Assistant Edwin Smith, and the computations were made, while the work was under way, by Assistant Wainwright, as time and data would permit. Tide gauges were located at Riverdale, Glenwood, and Dobbs Ferry, and were connected by simultaneous observations on two days at the slack ebb and slack flood. A current period was determined according to the method described in Appendix No. 11, Report for 1870. During the greater part of the sounding the steam launch was in charge of Chief Yeoman C. L. Green, who was afterwards replaced by Chief Yeoman T. W. Leutze. The remainder of the hydrographic party was made up of Second-Class Yeoman D. B. Wainwright and Seaman Recorder Oscar Straube.

The longitudinal lines of soundings were run by the steamer and the transverse filled in by the use of the steam launch. The topography was restricted principally to the shore line, except in certain instances where towns ran to the water's edge, when a survey was made.

In the latter part of October the vessel repaired to Buzzards Bay to investigate an uncharted ledge in Quicks Hole. Assistant McGrath continued the shore line at Yonkers during this absence.

Mr. L. M. Hopkins served as chief engineer of the vessel during her season's work, and deserves special commendation for his ability. The season closed early in November. The *Blake* then proceeded to Baltimore, and was undergoing repairs and outfitting for winter work in Porto Rico until the close of the calendar year.

Assistant Wainwright was taken sick in the latter part of November, and was unable to perform duty until the 10th of January. He was relieved of the command of the *Blake* by Assistant Hodgkins, who continued to act in this capacity until the close of the fiscal year. Assistant Wainwright was engaged upon a report of his season's work and miscellaneous duties, from January 10 to April 18, on which date he was assigned to duty in the office of the Superintendent, and in addition to this was engaged in the preparation of a new edition of a plane table manual. His work on the Hudson River is comprised on 3 topographic sheets, scale 1:5 000; and also 3 hydrographic sheets on the same scale.

YATES, Steamer *Endeavor*: MARYLAND, Chesapeake Bay; NEW YORK.

HYDROGRAPHY.
HYD. RECONNOISSANCE.
TIDAL WORK.
TEST OF PATHFINDER.

Pooles Island:

E. R. FRISBY, *Aid, in charge of launeh.*
G. S. PHELPS, *Aid, Observer.*
WM. BAUMAN, JR., *Chief Yeoman, U. S. N., Draftsman.*
J. C. RICHARDS, *Chief Machinist, U. S. N.*
D. B. WAINWRIGHT, JR., *Yeoman, U. S. N.*
A. C. L. ROETH, *Yeoman, U. S. N.*
C. E. TERRY, *Yeoman, U. S. N.*
OLE ANDERSEN, *Carpenter's Mate, U. S. N.*

Other Work:

Between July 16, 1898, and May 29, 1899.

J. J. GILBERT, *Assistant, Temporary Commander.*
WM. BAUMAN, JR., *Chief Yeoman, U. S. N.*
M. F. FLANNERY, *Chief Machinist, U. S. N.*
A. C. L. ROETH, *Yeoman, U. S. N.*
D. B. WAINWRIGHT, *Yeoman, U. S. N.*
C. E. TERRY, *Yeoman, U. S. N.*
OLE ANDERSEN, *Carpenter's Mate, U. S. N.*

SUMMARY OF OPERATIONS.

July 16 to 18 and 20 to 26, 1898, and Aug. 6 to 10 and 19 to 24, 1898.

9 tidal stations.

July 27 to Sept. 25 and Nov. 15 to Dec. 3, 1898.

27 square geographic miles hydrography.
419 geographic miles sounding lines.
5 508 angles measured.
3 tidal stations established.
25 specimens of sea bottom.
1 hydrographic sheet.

Sept. 26 to Nov. 14 and Dec. 9 to 21, 1898.

31 square geographic miles hydrography.
414 geographic miles sounding lines.
5 002 angles measured.
2 tidal stations established.
1 hydrographic sheet.

Apr. 14 to 30 and May 13 to 29, 1899.

367 square geographic miles hydrography.
173 geographic miles sounding lines.
1 213 angles measured.
4 tidal stations established.
3 hydrographic sheets.

As executive officer on the steamer *Endeavor* Assistant Charles C. Yates was engaged in hydrography near Pooles Island on the 1st day of July, 1898. On the 14th Assistant D. B. Wainwright, the commanding officer, was relieved and placed in charge of the steamer *Blake*. Assistant Yates succeeded to the command of the *Endeavor*. From the 14th to the 17th the party was reorganized, and tidal stations were established at Reybolds Wharf and Pooles Island. During this interval, on the 19th of July, the *Endeavor* proceeded to Baltimore, to enable the officers to attend the funeral of Lieut. J. J. Blandin, U. S. N., a former commander of the vessel.

From July 27 to September 25 the hydrography of Chesapeake Bay was continued in the vicinity of Pooles Island. The work extends several miles north of Worton Point, and includes Fairlee Creek, Worton Creek, and what is known as the Pooles Island "Holes and Shoals." Some remarkable features were developed in this work. The bottom was found to be exceedingly uneven, and the cry of the leadsman, "Seven fathoms and no bottom," was frequently heard between two soundings of less than 2 fathoms. In one case a hole 87 feet deep was found between two 8-foot lumps. Instructive comparisons were made between the surveys of 1898 and those of 1846. These show that the average depth at present is less than the average depth fifty-two years ago. This is especially noticeable in the channel opposite Pooles Island. The navigable channel now running out from Pooles Island has a fathom less water than in 1846; also the 4 and 5 fathom channels extending from the capes to abreast of Pooles Island now end here, while in 1846 the northern limit was near the mouth of the Sassafras River. The work in this locality is comprised on one hydrographic sheet and includes 27 square miles of area and 419 miles soundings. Three tidal stations were established, 25 bottom specimens obtained, and 25 hydrographic signals erected. The number of angles measured was 5 508.

Subsequent to the work in the neighborhood of Pooles Island that in the vicinity of Kent Island was taken up. It extends between Sandy and Thomas Point, and began on the 26th of September. The operations were continued without interruption until November 14, except three days, when the vessel was used by the Superintendent of the Coast and Geodetic Survey and the Inspector of Hydrography and Topography on a tour of inspection in the bay.

When the soundings in the vicinity of Pooles Island were completed and plotted, and while the vessel was at Kent Island, a further development was found necessary in the former work, and the vessel returned to finish the hydrography on November 15. This was completed on the 3d of December, when the *Endeavor* proceeded to Baltimore to await orders.

The Kent Island work was resumed on December 9 and completed on the 21st.

The vessel now again returned to Baltimore, and was at anchor in the harbor during the holidays. Immediately thereafter the *Endeavor* underwent repairs, and during this time the party on board was engaged in compiling the reports, making up the records, and finishing the sheets already commenced.

The work at Kent Island was greatly retarded by the rough seas and cold weather.

On several occasions the boats were compelled to return to the steamer, the lead lines being frozen and therefore too stiff for good work. Few indications of important changes since the survey of 1848 were found in this latter locality, except a 9-foot shoal which was found to be making out near the southern end of Kent Island.

Assistant Yates recommends the clear marking of the 4 and 5 fathom curves on charts of this locality as of great assistance to navigators of deep-draft vessels. He states that the value of commerce passing through these waters in vessels drawing between 3 and 5 fathoms is certainly as great as in vessels of lesser draft.

Assistant Yates expresses his high appreciation of the efficient and harmonious services of all the officers and crew.

The Kent Island work is comprised on one hydrographic sheet and embraces 131 square miles of area, 414 miles of soundings, 2 tidal stations, and 27 signals; 5 002 angles were measured.

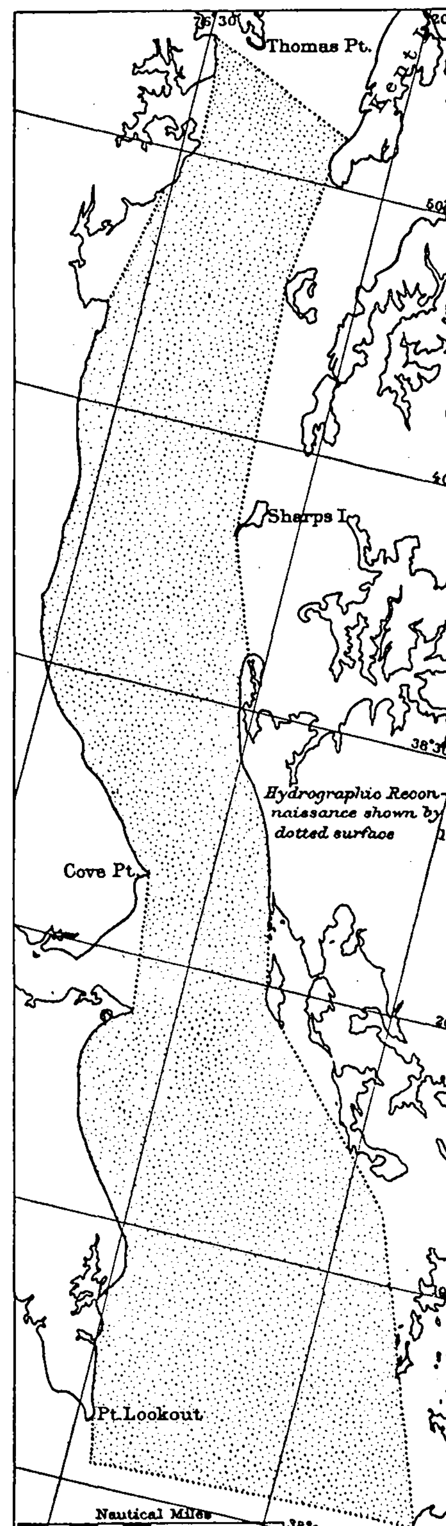
RECONNOISSANCE.

An official trip of the *Endeavor* was made on April 13 to test the repairs made at Baltimore during the winter. This proving satisfactory, a reconnoissance was undertaken and was continued until the 30th of April. Assistant Yates was sick after the 30th of April, and was compelled to relinquish active command of the vessel for one month. During the first twelve days of this time the *Endeavor* was in Annapolis Harbor, the party being engaged in completing records and drafting. On the 13th, Assistant Gilbert was placed in command of the vessel and completed the reconnoissance before the 29th of May, when Assistant Yates resumed work.

Since as many signals are necessary for this class of work as would be required for work executed in detail, much time was devoted to signal building; in fact quite as much as was given to the sounding work proper. These signals were necessarily large and high, as they were used in locating soundings at distances of from 10 to 12 miles.

The reconnoissance accomplished covers 367 square miles and joins the work of the *Endeavor*

No. 7.



Hydrographic reconnoissance, Chesapeake Bay.

of the preceding fall, extending 60 miles south, to the mouth of the Potomac. The limits of work adopted on either side were the 3-fathom curves.

In this connection it may be said that the results of simultaneous tidal observations of previous seasons saved much time and uncertainty by furnishing data at convenient stations. After the soundings were reduced and plotted cross sections of the main channel, approximately 5 000 metres apart, were drawn and compared with similar cross sections obtained fifty years ago. Few changes in the main channel in depth over 3 fathoms were noticeable, and where they do occur seem to be more in the direction of a displacement of the channel to the east or west than in depth.

The reconnoissance just executed will prove very useful in indicating the amount of hydrography to be done in the resurvey by comparison of the cross sections just completed with the old ones. Much needless work will, therefore, be avoided.

Four tidal stations were established in this area, and the work is comprised on three hydrographic sheets. Fifteen signals were erected and 173 miles of soundings made.

In connection with the hydrographic work of Assistant Yates in the Chesapeake Bay during the past fiscal year (for mention of which see p. 163), tidal stations were established at Pooles Island and Reybolds Wharf. Between July 20 and 26 these two stations and seven others, distributed between Turkey Point, at the head of the Bay, and Stingram Point, at the mouth of the Rappahannock River, were inspected. Between August 6 and 10 and August 19 and 24 inspection trips were made to each of the nine stations; and twenty-one days were spent on this work independent of the completion of records and disestablishment of stations. A careful description of the stations and the connecting bench marks were added to the records and forwarded to the Office.

On February 6, 1899, Assistant Chas. C. Yates was appointed by the honorable Secretary of the Treasury as a member of the trial board to test the steamer *Pathfinder* before her final acceptance by the Department. From the above date until March 30, when the board was relieved from further duty, fifteen days were devoted to this occupation. A report of the inspection and trial trip was submitted to the Superintendent by the board on the 29th of March, and is referred to in detail toward the end of this Appendix.

BAUER: WEST VIRGINIA, MARYLAND, DELAWARE.

MAGNETIC WORK.

May 1 to June 30, 1899.

SUMMARY OF OPERATIONS.

22 magnetic stations occupied.

Dr. L. A. Bauer was formally attached to the Survey on May 1, 1899, in the capacity of expert in terrestrial magnetism. He was assigned to magnetic work in Maryland and Delaware, and between the time of his joining the Survey and the close of the fiscal year he had occupied 16 stations in Maryland, 5 in Delaware, and 1 in West Virginia.

BAYLOR: NORTH CAROLINA, FLORIDA.

MAGNETISM.

July 1 to Oct. 16, 1898.
Nov. 9 to Dec. 20, 1898.
Mar. 23 to June 30, 1899.

SUMMARY OF OPERATIONS.

31 magnetic stations occupied.
31 meridian lines established.

At the request of the State geologist of North Carolina, transmitted through the governor of the State, Assistant J. B. Baylor was given instructions to make a magnetic survey under his direction. This work was in progress on the 1st of July and continued until the 16th of October, during which time meridian lines were established at the following county seats: Newbern, Bayboro, Beaufort, Jacksonville, Wilmington, Smithville, Salisbury, Marion, Asheville, Marshall, Bryson City, Murphy, Franklin, Webster Brevard.

All three magnetic elements—the declination, dip, and horizontal intensity—were determined at the above places, except Beaufort, which had already been occupied during the fiscal year 1897–98. In order that county surveyors might be provided with means to test their chains, standards of length were marked on the court-house floors. The surveying profession will therefore be enabled not only to determine at all times the condition of their compasses employed in running the boundary lines, but also will have an invariable standard to which their measures of length can be referred. It is believed that this procedure on the part of the State will result in the doing away of many sources of litigation in the settlement of boundary disputes.

The conditions upon which this work was done were that the State, or, rather, the counties, should pay all the expenses of making the observations, except the salary of the observer, this and the necessary instruments being provided for by the Coast and Geodetic Survey. Mr. J. A. Holmes, State geologist, had immediate direction of the work, and it went on satisfactorily and uninterruptedly.

From October 17 to November 2 Assistant Baylor was granted annual leave. From November 3 to 8 he was engaged in office work at Washington. The connection between the coast triangulation on the Gulf and that on the Atlantic side of Florida had recently been undertaken by the Coast and Geodetic Survey. There remained, in order to complete this work, a few angles to be measured. This was undertaken by Mr. Baylor on November 9 and finished on the 20th of December, at which time he returned to Washington and was engaged on computations until the 23d of January. The period between this date and the end of February was passed in the Computing Division, under the direction of Assistant C. A. Schott, making triangulation computations for the Chesapeake Bay work.

Between the 1st of March and the 23d Assistant Baylor resumed magnetic computations, and also employed part of the time in determining the constants of his instrument. On the latter day preparations were made to resume the magnetic survey of North Carolina, and the work went on without interruption until the close of June.

As in the previous season, standards of length for surveyors' chains were established in the court-houses, and meridians were laid out and marked. The usual magnetic observations, including all three of the elements, were made at Hertford, Columbia, Gatesville, Winton, Jackson, Halifax, Tarboro, Nashville, Wilson, Kinston, Goldsboro, Fayetteville, Smithfield, Raleigh, Snow Hill, Clinton.

WELKER: SOUTH CAROLINA, Charleston; MARYLAND, Chesapeake Bay.

STEAMER BACHE.
HYDROGRAPHY.
TOPOGRAPHY.

C. L. GREEN, *Executive Officer.*
F. H. AINSWORTH, *2d Watch Officer.*
WM. B. PROCTOR, *3d Watch Officer.*
W. G. INSLEY, *4th Watch Officer.*
J. J. MURPHY, *Medical Officer.*
M. M. GORDON, *Engineer.*
R. McD. MOSER, *Recorder.*
J. A. McGREGOR, *Recorder.*

May 15 to May 19, 1899.

SUMMARY OF OPERATIONS.

2·75	miles coast line topography.
1	square geographic mile hydrography.
92·5	geographic miles sounding lines.
2 762	angles measured.
1	tidal station.
1	hydrographic sheet, scale 1:10 000.

June 27 to Aug. 5, 1899.

Statistics for work in Baltimore Harbor will be given in next Annual Report.

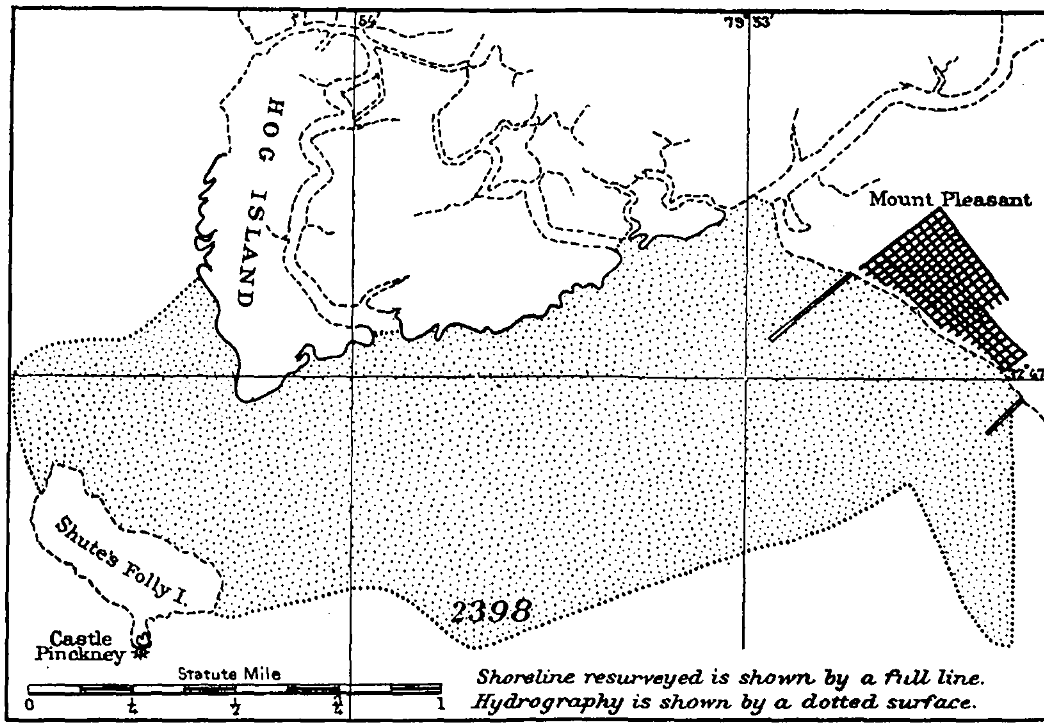
After having finished the work at Aransas Pass, Tex., the steamer *Bache*, under command of Assistant P. A. Welker, Coast and Geodetic Survey, sailed for Galveston on the 7th of March, arriving on the following day. Water, provisions, and coal were taken here, and on the 11th the party left for Mobile. They arrived on the 14th, having encountered head winds and heavy seas most of the way. The vessel was here inspected by the United States local inspector of hulls, and repairs being found necessary, these were authorized by the Superintendent under date of April 6, not to exceed $3 000. They were made before April 25, and on the 26th the steamer swung for compass deviation and left the same day for Charleston, S. C., instructions to this effect having been issued on the 13th of April. They arrived on the 6th of May, having been delayed at Key West and Brunswick, Ga., by bad weather.

A consultation was immediately held with Mr. George B. Edwards and other members of the board of trade of Charleston on the morning of the 8th, and on the 15th the hydrographic survey of the Hog Island Channel was begun. This was completed on the 19th, two hydrographic parties being employed, one using an oil launch and the other a whaleboat. The former was in charge of Mr. C. L. Green and the latter of Mr. William B. Proctor. A rectangular system of lines was adopted, running north and south and east and west. These were also crossed by a diagonal system, and the shore line was surveyed.

Assistant Welker acknowledges the valuable services of Mr. C. L. Green, executive officer.

On May 20 Assistant Welker received instructions to proceed with the *Bache* to Baltimore. Leaving Charleston on the 26th, he arrived at his destination on the 28th. The time remaining before the close of the fiscal year was employed in reorganizing the party and repairing the vessel, as well as in making an examination for shoal spots in

No. 8.



Hydrography, Charleston Harbor.

Patapsco River, and arrangements for hydrographic work at the mouth of Rock Creek, Maryland, supplementing that done by Marindin during the season of 1898.

The plan adopted for the examination of shoal spots was as follows: The launch was first placed in position, indicated by projection, and then allowed to move slowly, with the lead kept vertical at the bottom. The shoal spot was thus located and its position carefully recorded. Several lines were also run parallel with the axis of the channel. With few exceptions the places examined were found to be in error to the extent of a fathom upon the original sheet of 1898. This work was completed on the 5th of July, and the *Bache* returned to Baltimore.

PERKINS, Schooner *Eagre;* Steamer *Pathfinder:* GEORGIA, Brunswick.

HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

G. L. FLOWER, *Assistant.*
RITCHIE, *Recorder.* Dec. 9, 1898, to Apr. 23, 1899.
VEITH, *Draftsman.*
DUNN, *Yeoman,* June 1 to June 30, 1899.
WHITNEY, *Recorder.*

SUMMARY OF OPERATIONS.

3	old stations recovered.
15	stations occupied.
321	angles measured.
74·5	square miles triangulation.
399·2	miles sounding lines.
15	miles roads (topography).
8·25	miles creek topography.

On the 9th of November Assistant F. W. Perkins was assigned to the command of the schooner *Eagre.* He joined the vessel on the 15th. At this time surveying operations were under way on the Sassafras River, Chesapeake Bay, hydrography and topography being carried on simultaneously. Before work could be regularly taken up orders were received detaching Messrs. Flower and Ritchie, and the following day the vessel was ordered to Baltimore.

Reaching the latter port on the 21st, necessary repairs were undertaken, and on the 1st of December the party set sail for Brunswick, Ga. A northeast gale prevented the continuance of the trip, and the vessel came to anchor inside the Capes until the 5th, when she got under way in a moderate gale from the westward, arriving at Brunswick on the morning of the 9th. A heavy storm at this point prevented entering the harbor, and Assistant Perkins put to sea until the 11th, when the weather moderated and he was able to make port.

The instructions given the party at this point were to furnish officers and men and facilities for the survey of the outer bar, which was being made for the United States Engineer Corps, by Assistant Marindin. Assistant Perkins was to employ spare time in making a resurvey of the harbor.

After considerable labor, three original triangulation points were recovered and a sufficient number of signals were erected and determined. The work then progressed as rapidly as the circumstances under which it was done permitted, and before April 23 three sheets of hydrography and topography were completed, covering the entrance, the harbor, the river, and some miles beyond. On the latter day the vessel put to sea on its return north.

From December 31, 1898, to May 3, 1899, Assistant Flower was attached to the party of Assistant Perkins.

The party arrived at Baltimore on the 1st of May. Assistant Perkins was thereupon relieved of the command of the *Eagre* and ordered to make preparations to take the steamer *Pathfinder* to San Francisco. On the 1st of June he relieved Captain Ross as commander of that vessel, and went to sea on the 11th. Some defects on the lower air ports, however, made it necessary to return to Newport News for repairs. These were completed by June 16, and the vessel again got under way, passing out of the Capes of Virginia and taking its course for the island of Santa Lucia, in the West Indies. The harbor of Castries was entered early on the morning of the 23d. After coaling and making some magnetic observations, the vessel got under way on the 25th for Pernambuco, which place was reached on the 6th of July, 1899. Further details of the voyage of the *Pathfinder* to San Francisco will be found toward the end of this appendix (see page 238).

FERGUSON: OHIO.

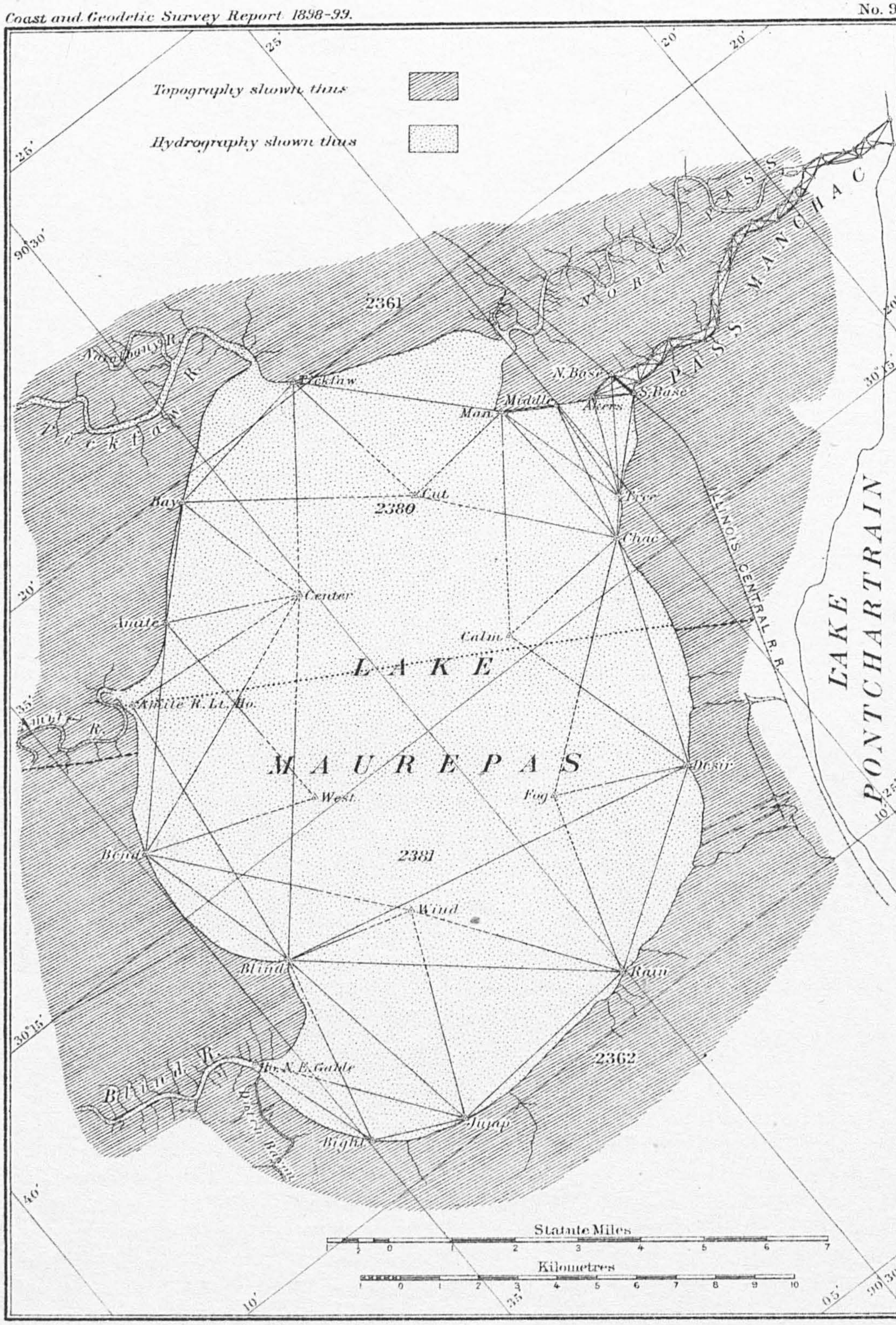
LEVELING.

June 3 to June 30, 1899.

SUMMARY OF OPERATIONS.

39 miles levels.

As the result of a civil-service examination, Mr. O. W. Ferguson was appointed an Assistant on the 1st of July, 1899. Previous to this time he was employed as an extra observer, and was instructed to carry on field work in the line of precise leveling. His appointment as extra observer dates from May 11. The oath of office was taken on the 16th, and after a few days spent in Washington, preparing for the field, he proceeded to Gibraltar, Mich., at the west end of Lake Erie, and organized a party. On June 3 the work upon the line Gibraltar, Mich., to Cincinnati, Ohio, was actually begun, and at the end of the fiscal year the leveling operations were complete to Toledo, Ohio, a distance of 39 miles.



TRIANGULATION, TOPOGRAPHY AND HYDROGRAPHY, LAKE MAUREPAS, LA.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

B. MIDDLE DIVISION.

FRENCH, Schooners *Quick* and *Spy:* LOUISIANA, Lake Maurepas.

TRIANGULATION.
TOPOGRAPHY.
HYDROGRAPHY.

E. R. FRISBY, *Aid.*
G. S. PHELPS, *Aid.* — Jan. 22 to April 5, 1899.
H. C. MITCHELL, *Aid.*
R. J. MANSFILD, *Aid.*

SUMMARY OF OPERATIONS.

768·62	metres base line measured.
100	square miles triangnlation.
48	stations occupied.
50	geographic positions determined.
1	azimuth station occupied.
102	square miles topography.
107	miles coast and river shore line.
62	miles creek shore line.
9	miles roads.
2	topographic sheets, scale 1:20 000.
80	square geographic miles hydrography.
477·6	geographic miles sounding lines.
2 760	angles measured.
2	stations established.
2	hydrographic sheets, scale 1:20 000.

In compliance with orders of the 30th of December to organize a party on board schooners *Quick* and *Spy* for the resurvey of Lake Maurepas, Louisiana, Assistant French left Washington on the 3d of January. Remaining at Pensacola until January 6, in order to make arrangements for the transfer of the schooner *Spy*, he arrived in New Orleans on the 7th. Here the necessary arrangements were made for the speedy prosecution of the work.

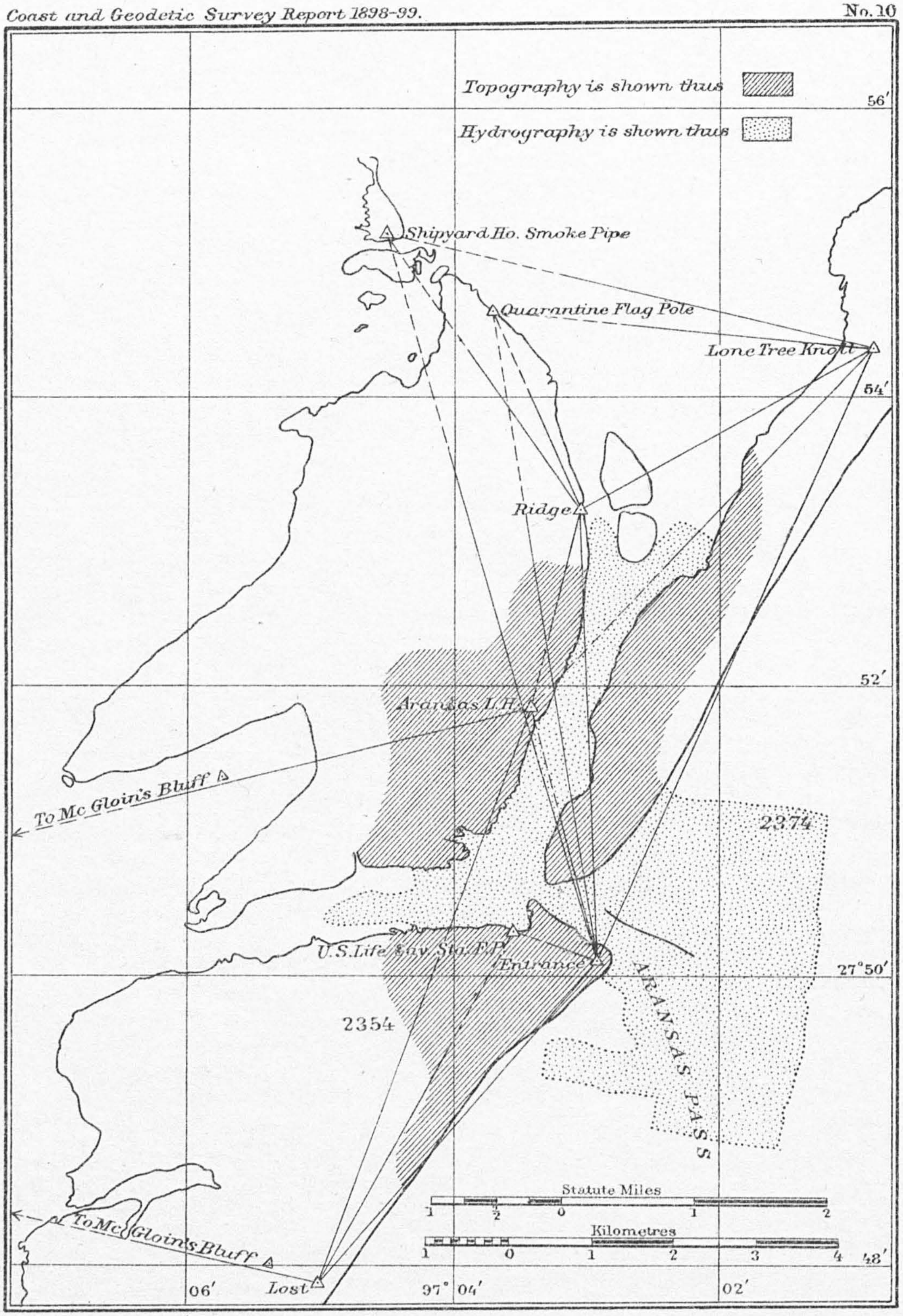
The schooner *Quick* arrived at West End on January 14. The time between this date and the 20th was employed in procuring supplies, enlisting crew, and making necessary preliminary arrangements. The field work began on the 23d by the location of a base line on the trestle of the Illinois Central Railway across Pass Manchac. Three measures of this line were made with a 25-metre steel tape, stretched on top of the rail. The astronomical azimuth at the north end of the Pass was used in the computation of the position of the triangulation stations around the lake. The stations through the Pass to the base line were computed from the azimuth obtained from the Lake Pontchartrain work. On account of the difficulty of securing a firm foundation, the signals around the lake were made by cutting off a tree, setting a pole alongside, and nailing a cap block to the stump. The observing scaffold was then built around the central pole. Owing to the thick undergrowth, it was entirely impracticable to carry the triangulation on shore around the lake, so that the use of water signals, a scheme often employed in Southern work, was adopted. By erecting signals several miles from land and making suitable trigonometrical connections, the distances may be calculated without occupying any of the latter points. This was done successfully in this, as it had been in many other cases.

Triangulation was carried on by two parties, one vessel working to the south and the other to the north, coming together on the opposite side of the lake. The lines ranged in length from 2 to 4 miles, the joining line of the two schemes of triangles being 4 miles long and showing a discrepancy between the two schemes of work of only 6 centimetres.

The latitudes and longitudes were determined by computation from the Lake Pontchartrain work, a chain of triangles furnishing this data coming through Pass Manchac.

After finishing the computations the triangulation stations were transferred to the topographic and hydrographic sheets, and the schooner *Spy* then undertook the hydrography of the southern half and the *Quick* that of the northern half, together with the topography entirely around the lake. Both the topography and hydrography of this lake are simple, there being very little detail to be inserted and the depths of the water remaining quite uniform. The only points requiring special consideration were the development of the bars at the entrance to the rivers and the passes. The datum for soundings was determined from two tide staffs, read every hour, from 7 a. m. to 6 p. m., during the hydrographic work. One of these staffs was on the trestle across Pass Manchac and the other was near the entrance to the Amite River. The readings of the reference plane on these two staffs were determined by differential comparisons with the old staff at Pass Manchac, from two weeks' simultaneous readings, the reference plane on this old staff being established by Assistant Welker in 1897.

On the 11th of April the schooner *Quick* was inspected by Captain Barker, inspector of steamboats, and also by Assistant Ogden, Inspector of Hydrography and Topography. (In this connection see also notice of the schooner *Quick* in report of special duty by Assistant H. G. Ogden, p. 229.) The field work closed on the 17th of April. The crew was discharged on April 22, and Assistant French reported in the office at Washington on the 26th. From this date until the end of the fiscal year he was engaged in office work in connection with the survey of Lake Maurepas.



TRIANGULATION, TOPOGRAPHY AND HYDROGRAPHY, ARANSAS PASS, TEX.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

WELKER, Steamer *Bache*: TEXAS, Aransas Pass.

TRIANGULATION.
TOPOGRAPHY.
HYDROGRAPHY.

J. A. FLEMER, *Assistant*.
C. L. GREEN, *Chief Yeoman*.

Jan. 15 to Mar. 3, 1899.

SUMMARY OF OPERATIONS.

35	square miles triangulation.
5	triangulation stations occupied.
7	geographic positions determined.
6	square miles topography.
15	miles river shore line.
28·8	miles creek shore line.
1	topographic sheet, scale 1:10 000.
3	geographic miles hydrography.
187·5	geographic miles sounding lines.
5 048	angles measured.
1	tidal station established.
9	current stations established.
2	hydrographic sheets, scale 1:10 000–5 000.

Instructions were issued on November 28 to Assistant P. A. Welker for the execution of triangulation, topography, and hydrography at Aransas Pass. The steamer *Bache*, having received outfit and supplies at New York and undergone repairs at Baltimore, left the latter port on December 18 for the scene of operations. The party arrived at Key West on the 28th, having stopped several days at Hampton Roads on account of bad weather. Leaving Key West on December 31, a violent gale was encountered on the following day, and they were obliged to run before the wind in the direction of the jetties of the Mississippi River, distant 210 miles. For forty-eight hours the ship rolled and pitched terrifically and was in a precarious position. They fortunately reached the mouth of the river on the 3d of January, the officers and crew being much fatigued by the voyage. The *Bache* was overhauled and repaired, and Assistant Welker awaited good weather until the 8th, when he left for Galveston, arriving the following afternoon. Lumber, provisions, and other necessary articles for the season's work were here taken on board, and on the evening of the 14th they sailed for Aransas Pass, entering the harbor at 8 a. m. on January 15.

At Galveston, in conformity with instructions from the Superintendent, Assistant Welker called on Mr. H. C. Ripley, C. E., and obtained from him a blue print of his recent survey of Aransas Pass and data for the plane of reference for the reduction of the soundings. The coordinates for the location of signals of his recent survey were also furnished. These, however, were not used, because subsequent connection was made with the Coast and Geodetic Survey triangulation.

The three following days after his arrival Assistant Welker engaged in a search for old points, and also erected signals for hydrography and topography. On the 19th both these operations were commenced. The points, McGloins Bluff and Aransas Light-

House, were recovered, and a line joining these points was used as a base from which the necessary triangulation was developed. McGloins Bluff, however, was not occupied. (See sketch showing triangulation, topography, and hydrography). The plane table was used for topography, and the position of the boat while sounding was located by simultaneous sextant angles. The hydrography was rectangular, the lines being 20 to 100 meters apart. For special development of critical points, diagonal and zigzag lines were also run.

The velocity and direction of the currents were determined by the same system as that used at Portsmouth, N. H. (See ante, p. 144.)

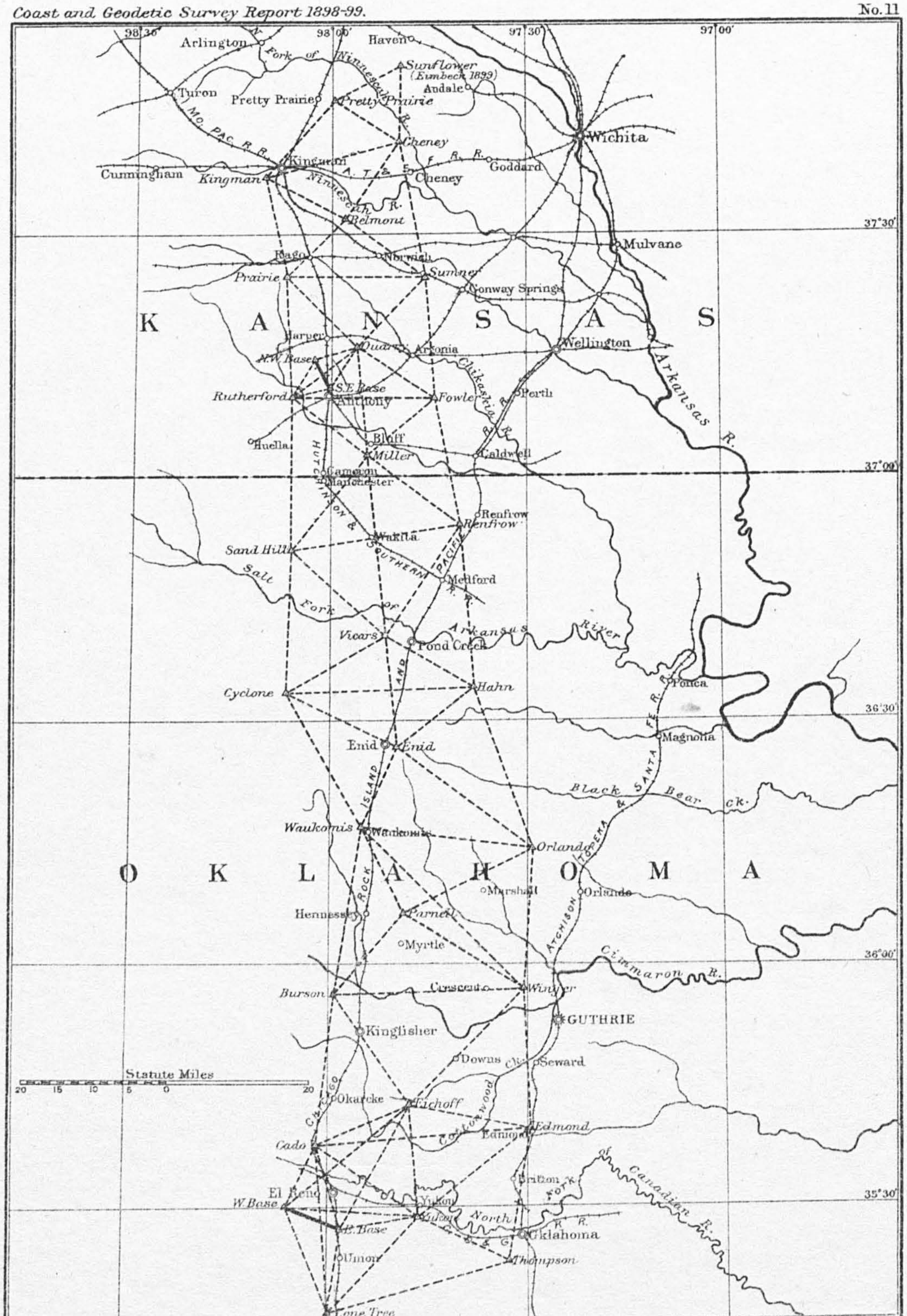
Notwithstanding the low latitude of the place, where one might usually expect passably good weather, the season was very stormy, not more than one day in seven being possible for work on the bar. Whenever a good day was available the entire force was thrown upon this part of the work. A severe storm broke over the locality and raged without intermission from February 9 to 13, with the wind shifting from NE. to NW. As a result of this storm the depths of water in some parts of the Pass were changed as much as 4 feet. The thermometer descended to 12° below zero C. Fruit trees and vegetables were destroyed, cattle were frozen, etc. During the entire stay at Aransas the work was impeded on many days by fog, and only one-third of the available time was used for work of any kind.

A number of times efforts have been made to increase the depth of water at Aransas Pass by the construction of jetties. Two attempts were made on the south side of the entrance, where the Mansfield and Nelson jetties were partially constructed. In 1895 the Aransas Harbor Company partially constructed a jetty, in the form of a letter S, on the north side of the entrance. The present channel, however, crosses the Mansfield jetty, portions of which are still in existence. The Nelson jetty is entirely destroyed, with the exception of a piece of wall along the south shore of the Pass.

Few opportunities were had for obtaining current observations, the indications are, however, that currents prevail during the winter months from the northward. A bar is forming at the northeast end of Mustang Island by southerly winds and the eddy formed by the current through the Pass.

The results of the survey show an inner channel of about 15 feet width at the entrance. On account of narrowness it is not safe for vessels more than 150 feet in length or 11 feet draft to enter. Extreme care is necessary even with such a vessel, and the time must be chosen when there is little swell on the bar. The steamer *Bache*, 110 feet long, entered drawing 10 feet 2 inches, and passed out drawing 9 feet 6 inches. Good anchorage ground, ranging from one-eighth to one-fourth mile in width and about 1¼ miles long, may be had inside the Pass. The bottom is good holding material and the anchorage perfectly landlocked. The best position is in the Pass abreast the lighthouse, near the St. Joseph Island shore entrance. In thick weather the lead may be depended upon, as the bottom is gradual, with no outlying dangerous shoals. Care must be taken to avoid the submerged portion of the jetty, which extends one-fourth of a mile to the southward beyond the visible part.

During the work at this place Assistant J. A. Flemer had charge of the topographic survey and the location of hydrographic points with the plane table. He also assisted in the hydrographic work. Mr. C. L. Green was in charge of the whaleboat while sounding, and also served with great credit as executive officer of the steamer.



RECONNAISSANCE ALONG THE 98 TH. MERIDIAN

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

RECONNOISSANCE.

J. S. BILBY, *Foreman.*

July 1 to Nov. 3, 1898.

Apr. 1 to June 30, 1899.

SUMMARY OF OPERATIONS.

April 15 to November 3, 1898.

16 800	square miles reconnoissance.
167	lines of intervisibility determined.
75	points selected for schemes.
108	points examined and observed from.
5	miles base line measured.
480	lineal miles reconnoissance along 98th meridian.

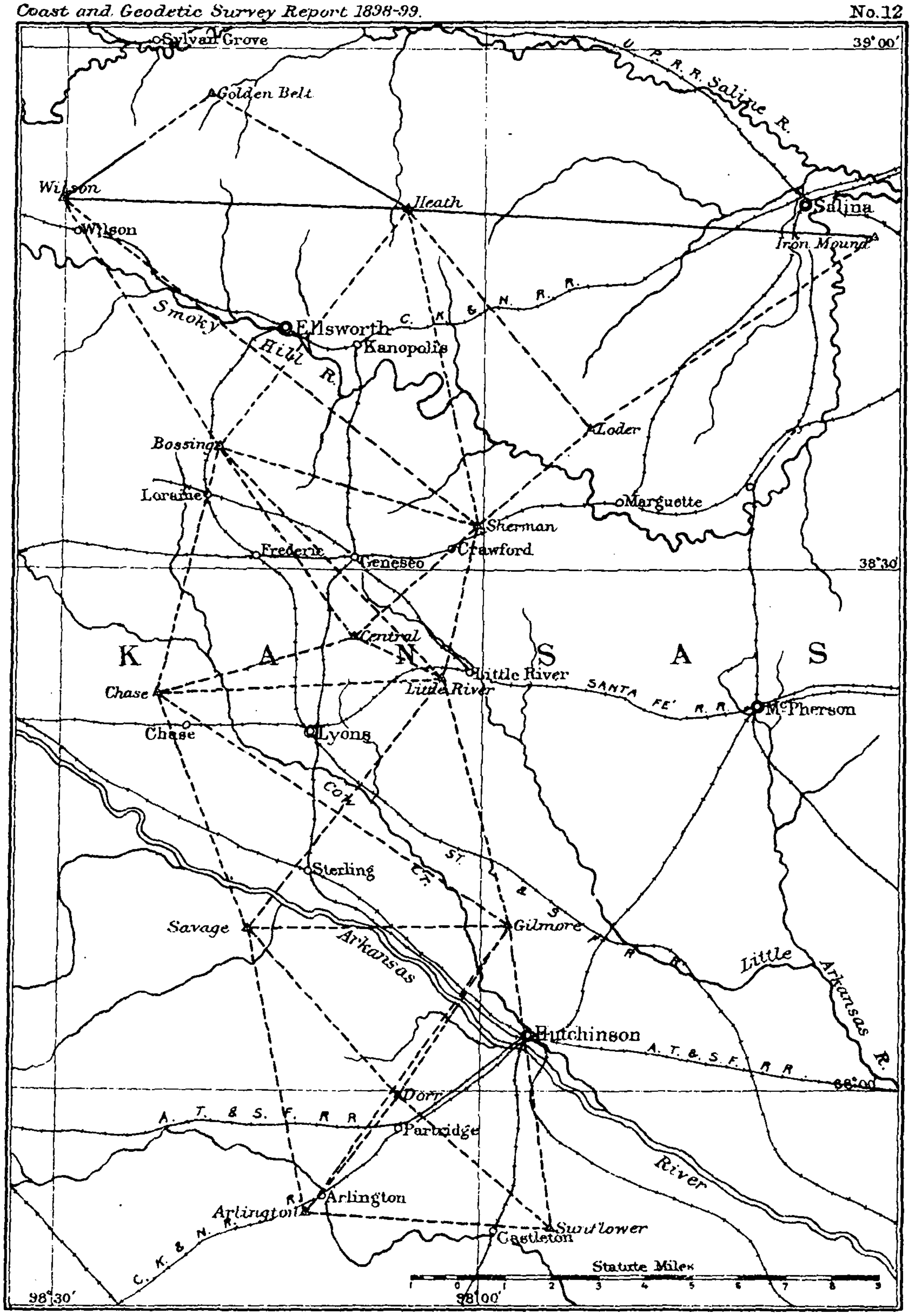
April 1 to June 30, 1899.

4 178	square miles reconnoissance.
80	lines of intervisibility determined.
34	points selected for scheme.
19·4	kilometers base lines measured.

A reconnoissance on the ninety-eighth meridian was under way on the 1st of July, and was continued without interruption until November. During the season, which includes the latter part of the last fiscal year and the first part of the fiscal year 1898–99, 480 miles along the ninety-eighth meridian were covered with a scheme of unbroken quadrilaterals, with points on each side of the meridian, furnishing sides with an average length of 24 miles. This reconnoissance scheme embraces 20 triangulation stations of the United States Geological Survey, established between 1884 and 1898. The area covered is nearly 17 000 square miles, and the work embraces 75 triangulation stations. One hundred and eight points were examined and actually observed and occupied. The operations extend from latitude 29° to latitude 35° 30′, leaving 3° 30′ on the north, between the terminus and the thirty-ninth parallel triangulation in Kansas. There also remain, to complete the reconnoisance to the Rio Grande, 3 degrees of latitude on the south. In the remaining country, not yet covered by the reconnoissance, shorter lines will be found necessary, as the topographical features are flat. A 5-mile base line has been selected 3 miles east of Addington, Chickasaw Nation, Indian Territory, and another base, equally long, has been chosen 8 miles northeast of Rush Springs in the same nation. The country is comparatively easy of access, but the river crossings are treacherous on account of quicksands. No accommodations can be procured with the farmers in this region, and a camp outfit is necessary for any party doing work of this character. The wagon roads through Indian Territory are fair, but in Oklahoma Territory they are much better in every respect. The atmospheric conditions for the measurements of horizontal angles are poor during the day, on account of the haze and smoke; but the nights are exceptionally clear, and for this reason night work is recommended for observations on primary points, reserving the daylight observations, near sundown, if necessary, for secondary points. The extremes of temperature are great, the mercury standing at 110° in the shade on many days between June and October. The nights, however, are cool.

From November 3 to April 1, Assistant Forney was stationed at the Office in Washington, completing the computations and reductions of his season's work.

On the latter date, receiving instructions to resume the field work in Indian Territory, he arrived at El Reno on the 4th. Four stations were chosen and a base line, 12·8 kilometers long, was selected before the 9th. The party then moved to Guthrie. From Lone Tree station, Indian Territory, to the valley of the Arkansas River, the country is settled and well adapted for triangulation. Night signals should be used for the regular work, and daylight observations for tertiary points. Assistant Forney estimates that single stations should occupy five days. From Lone Tree to Pretty Prairie station, 31 tripods and signals are necessary, varying in height from 15 to 90 feet. The signals along the triangulation cost $19 per statute mile. But two base lines are established—one at El Reno, 12·8 kilometers as before mentioned, and one at Anthony, 6·6 kilometers long.



RECONNAISSANCE, KANSAS

THE NORRIS PETERS CO. PHOTO-LITHO., WASHINGTON, D. C.

Eimbeck : Kansas.

RECONNOISSANCE.

F. M. Little, *Recorder*. May 13 to June 30, 1899.

SUMMARY OF OPERATIONS.

2 800 square miles reconnoissance.
85 lines of intervisibility determined.
30 points selected for scheme.

Assistant William Eimbeck was engaged, from July 1 until the month of October, in charge of the Library and Archives Division. After having been relieved from this duty he was occupied in miscellaneous work in connection with the transcontinental arc in Colorado until December. He was then transferred to the Computing Division and was engaged in the computations of latitude, time, and azimuth, the observations having been made by Assistant G. R. Putnam in the vicinity of St. Michael, Alaska.

Under instructions of April 7 he was assigned to duty on the ninety-eighth meridian, the work to be taken in hand being, first, reconnoissance, and afterwards triangulation. He left Washington on May 2, proceeding to Salina, Kans. On May 13, in order that the party might be nearer the scene of operations, it was transferred to Ellsworth, Kans. Here the organization was completed and the reconnoissance was continued by examination of the stations Heath, Wilson, and Bunker Hill, already occupied in the transcontinental triangulation. The line of departure adopted was the one joining the stations Wilson and Heath, and from this as a base 4 distinct trigonometrical figures, extending about 70 miles to the southward and crossing the valley of Arkansas River, were established. The scheme closes with the line between Sunflower and Arlington, 18 miles long. Here the work joins with the reconnoissance of Assistant Stehman Forney, brought northward from Texas.

On the 18th of June the party started back toward Ellsworth, and on the way located a central station near Partridge. At the end of the fiscal year they were established at Ellsworth, completing the office work and preparing a report on that already accomplished.

GRANGER: NEBRASKA.

RECONNOISSANCE.
TRIANGULATION.

E. E. TORREY, *Foreman*.	July 1 to Nov. 4, 1898.
D. E. LEWIS, *Driver, Recorder*.	April 11 to June 30, 1899.

SUMMARY OF OPERATIONS.

3 triangulation points selected.
945 square miles triangulation.
1 300 tertiary triangulation points.
11 triangulation stations occupied.
11 stations occupied for vertical measures.
11 geographical positions determined.
42 tertiary geographic positions determined.
11 primary elevations determined trigonometrically.
10 tertiary elevations determined trigonometrically.

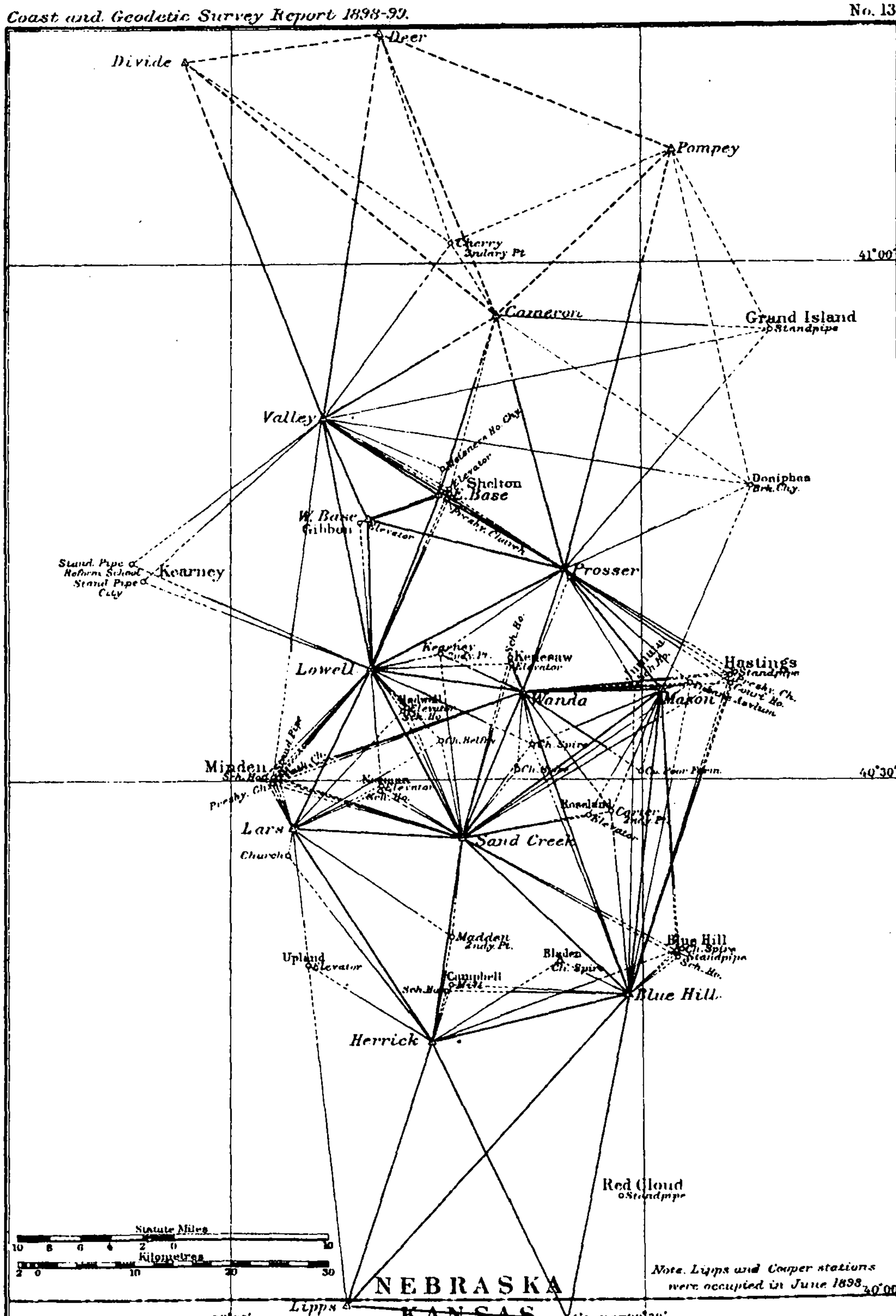
The party of Assistant F. D. Granger was in full operation on the 1st of July. On this particular date camp was being moved from station Cooper to Blue Hill, in Nebraska.

After having established the party at Blue Hill, it was found necessary to make a reconnoissance near Hastings, to establish the station Mason. The old scheme of triangulation was changed somewhat as a result of this work and the work considerably strengthened thereby. The horizontal and vertical angles were entirely completed at Blue Hill on the 20th of July, and the party immediately moved to Herrick Station. Work was finished at this point by August 6. Observations on Sand Creek were not completed before the signal was partly carried away by storm. As the replacing of this signal would have involved considerable expense, and as nearly all the observations had already been made upon it, it was not deemed necessary to delay the work to make the record complete.

Much bad weather now ensued and the work was considerably retarded. However, the station Lars was completed between September 14 and 20 and Mason was occupied before October 5. Signals were erected at Valley, Cameron, and Pompey, and observations were finished at Prosser by the 4th of November. The horizontal directions were now complete, except those on the proposed Shelton base terminals. This base line, between the towns of Shelton and Gibbon, about 56 feet north and parallel to the track of the Union Pacific Railway, along a roadway of 100 feet width between these towns.

The party was disbanded on November 16 and Assistant Granger reported in Washington immediately thereafter. The office work was continued until the 2d of December, when Assistant Granger took leave of absence until the 22d. Returning to duty, the computations were continued until the 31st of March, 1899.

Early in April the party was reorganized and proceeded to the field, arriving at



TRIANGULATION IN NEBRASKA

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Prosser on the 12th. A reconnoissance was found necessary, and considerable difficulty was found in locating a base line, since one of the terminal points was to be an interior station of a quadrilateral. It was finally selected, and the signals at the terminal points of the base were completed by the 26th of April. Observations began at Prosser on the 29th. West base was occupied between May 8 and 12, and east base between the 15th and 22d. Lowell Station was occupied before June 7. Valley was next taken up and the observations at this point concluded before the end of the fiscal year. During the year 15 signals were erected and 11 stations occupied.

BALDWIN: KANSAS, NEBRASKA.

LEVELING.

B. E. TILTON, *Recorder and Chief of Party.*
C. H. HOLZWARTH, *Recorder.* May 6 to June 30, 1899.
D. V. VANDIVER, *Rodman.*
G. C. BALDWIN, *Rodman.*

SUMMARY OF OPERATIONS.

149 kilometres of leveling line completed.
21 bench marks established and connected.
21 bench marks established but not connected.

Assistant Baldwin was attached to the party of Assistant J. F. Pratt, doing work at the mouth of the Yukon River, Alaska, until October 19, 1898, when the party arrived at Seattle. Acting under telegraphic instructions, Assistant Baldwin proceeded to Washington, arriving on November 3, having had leave of absence en route. From November 5 to the close of the calendar year he was engaged in various duties in the Tidal Division and in the Office of Weights and Measures. From the beginning of the year until February 14, he was unable to attend to duty on account of illness. At the latter date he was attached to the Computing Division and engaged on the Alaska computations. During the month of December he served as a member of the committee to consider the subject of precise leveling.

On the 30th of March, 1899, instructions were issued to take up the work of precise leveling at Abilene, Kans., and to continue northward on the line of the ninety-eighth meridian, or as near this locality as possible. The route approved by the Superintendent was from Abilene, Kans., to Superior, Nebr.; thence to Lester and Hastings; thence to Grand Island, and from that point, by the Union Pacific Railway, to Columbus and Norfolk. From the latter point connection was to be made to Sioux City, Iowa, with the precise levels of the Mississippi River Commission.

Having obtained permission for the use of velocipede cars, Assistant Baldwin first passed over 109 miles of the proposed line and arranged quarters for the party, and also established the required bench marks. Returning to Abilene on the 6th of May, and the instruments arriving on the 8th, the organization of the party was completed immediately, and the work of observing began. The necessity of connecting with two bench marks of the transcontinental line compelled Assistant Baldwin to run parallel to this work between Abilene and Solomon, a distance of 14·5 kilometres.

The instrumental outfit and method of observing were entirely new, but the same personnel was required—an observer, recorder, 2 rodmen, and 2 hands. In order that the work might be accelerated, Assistant Baldwin adopted the method of moving ahead from station to station with the instrument, by riding on the velocipede car, which was propelled by one of the men. By this means it was possible for the chief of party to carry the instruments himself, and shorten very perceptibly the interval between stations. Frequent and serious delays were experienced by high winds, which prevailed continuously during both May and June. After the party became well organized a speed of 1 mile an hour was regularly made nearly every day. On June 15 and 16 Assistant J. F. Hayford, Inspector of Geodesy, was with the party and gave advice and directions concerning the prosecution of the work.

On the 17th Assistant Baldwin left the party, turning over the organization to Mr. Tilton, and established necessary bench marks for the continuation of the line in Nebraska, at 16 points, as far as Silver Creek. The line of levels was continued by Mr. Tilton, and at the end of the fiscal year the party had reached Lovewell, Kans., at which time 149 kilometres had been run and 21 bench marks established and connected.

Assistant Baldwin returned to Washington on the 21st of June, in compliance with telegraphic instructions of the 16th, and was engaged in the Computing Division until the close of the fiscal year.

The personnel of the party is spoken of in high terms by Mr. Baldwin—Mr. B. E. Tilton as recorder, and afterwards as observer; Mr. C. H. Holzwarth as recorder, and Messrs. D. V. Vandiver and G. C. Baldwin as rodmen.

C. WESTERN DIVISION.

WINSTON: COLORADO.

LEVELING.

H. A. KELLEY, *Recorder*.

July 1 to Nov. 11, 1898.
May 12 to June 30, 1899.

SUMMARY OF OPERATIONS.

April 19 to November 11, 1898.

412 kilometres leveling line.
50 bench marks established.

May 12 to June 30, 1899.

111 kilometres double line.
15 bench marks established.

Assistant I. Winston received instructions on the 3d of March, 1898, to resume leveling operations in Colorado. He left Washington on the 15th of April, and arrived at Hugo, Colo., the point of beginning work, on the 19th. On the 1st day of July the work was progressing in the direction of Colorado Springs. It was decided to run a loop, following the line: Limon, Colorado Springs, Denver, and back to Limon; and this long piece of work was successfully accomplished before the end of the season. This was made possible by the fact that the work was greatly facilitated through the use of an observing tent designed by Assistant Winston. The line ran along the Union Pacific Railway to Limon; thence via the Chicago, Rock Island and Pacific Railway to Colorado Springs; thence along the Denver and Rio Grande Railway to Denver; thence along the Union Pacific Railway back to Limon. All three railways granted the privilege of using velocipede cars, which procedure saved much time and money to the Government. For this privilege, as well as for numerous courtesies extended, the thanks of this Bureau are due to the managing officers of the railways.

In this season's work differences of elevation were measured greater than in any previous work of the Survey. Connection was made, en route, with two stations of the transcontinental triangulation, namely, Divide and West Base. This was desirable, because a system of vertical angles had been carried through the transcontinental triangulation from the Sierra Nevadas to the Mississippi Valley, and a connection with the spirit levels would supply a much desired test of the vertical angle measures. At Colorado Springs connection was also made with bench marks left by Assistant Eimbeck in measuring differences of elevation between Colorado Springs and Pikes Peak by means of vertical angles. The top of Pikes Peak was also visited, and the bench marks of the cog-wheel railway were connected with marks established by Assistant Eimbeck when he occupied this elevated station as a triangulation point. Moreover, a careful connection was made checking the vertical angle determination of the elevation of Pikes Peak, through the railway levels.

Several connections with United States Geological Survey bench marks established in Denver were made, as well as with the railroad tracks at the Union Depot.

The wind is a serious cause of delay in this work, and at least one-third of the time would have been lost if the privilege of using a tent had not been granted by the railroads. The velocipede cars proved economical and expedited the work, as usual. During the season 412 kilometres were run and 50 bench marks established.

Assistant Winston reported in Washington on November 15. He was engaged on field records and computations until December 5, and had leave of absence until January 2. Under instructions of November 29 he became a member of the committee to consider the subject of precise leveling, and on return to duty, January 2, took an active part in the committee meetings until the final report was submitted, January 24. From this date computations of geographical positions in Chesapeake Bay, from observations by Assistant F. W. Perkins, were made, under the direction of the chief of the Computing Division. This was completed as far as possible in March. Other leveling operations were then taken up until May 1.

Under instructions of April 7, preparations were made for resuming operations in the field, and on May 5 he left Washington for Denver, Colo., resuming field work on the 12th. This work was continued westward until the close of the fiscal year, at which time 111 kilometres had been run, and 15 bench marks established.

SINCLAIR: UTAH, Green River; Oasis.

TRIANGULATION.
LONGITUDE.
LATITUDE.

F. MORSE, *Assistant*. July 18 to Sept. 27, 1898.

SUMMARY OF OPERATIONS.

At Green River, Utah.

9 signals erected.
124 angles measured.
60 observations of longitude.
8 exchanges of signals.
1 base measured (1 130 meters).

At Oasis, Utah.

13 signals erected.
76 angles measured.
8 exchanges of signals.
1 base measured (1 669·3 meters).

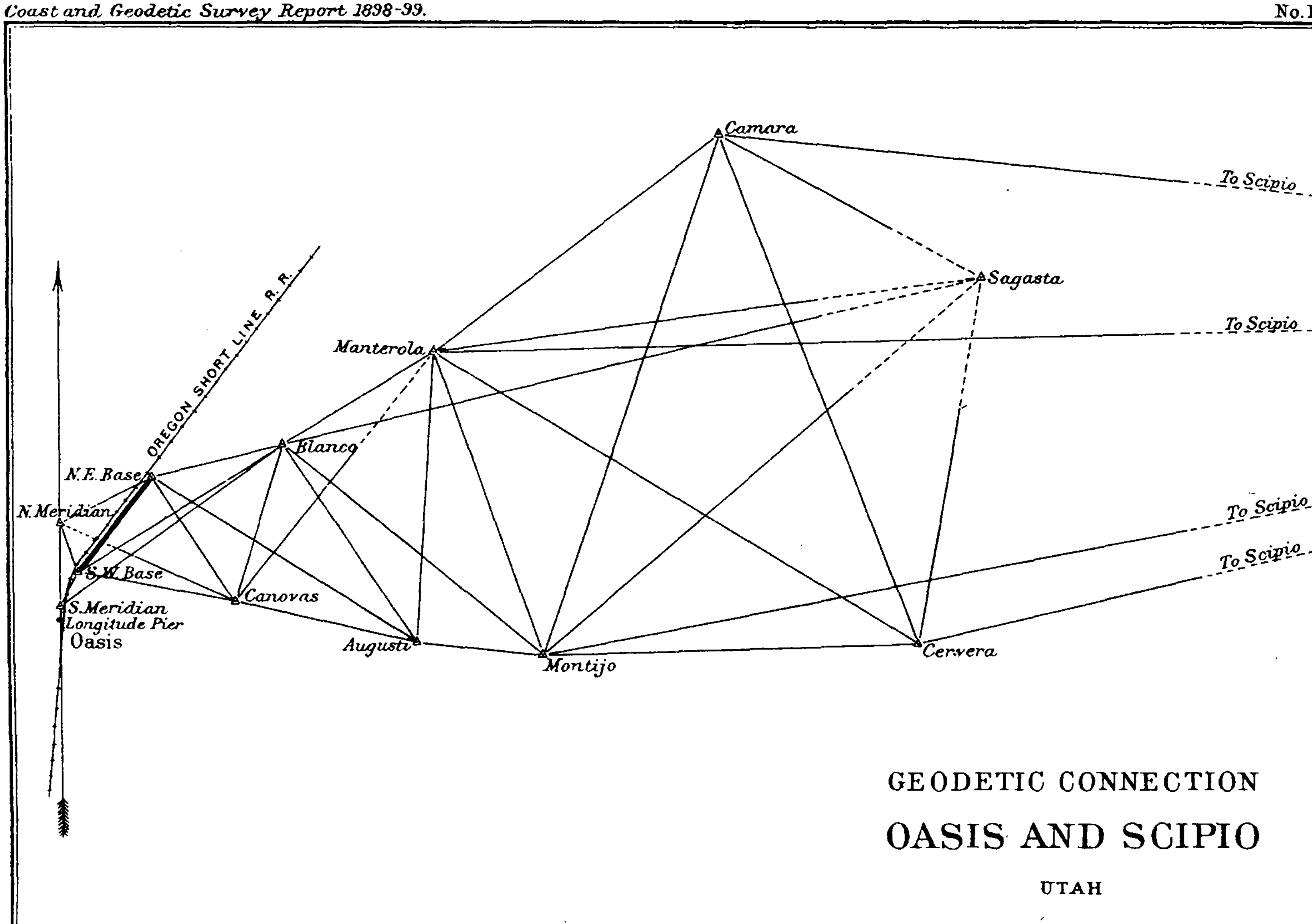
Under instructions of March 3, 1898, Assistant C. H. Sinclair was directed to make certain geodetic connections in California and Nevada, and also to determine the longitude of Green River and Oasis, in Utah. That part of the work which related to triangulation in the vicinity of Marysville, Cal., and Austin and Eureka, Nev., was completed before the 1st of July, and a description of this work was given in the last annual report.

From the 1st of July until the 16th Assistant Sinclair was engaged in overhauling the outfit stored at Salt Lake City, and shipping it to San Francisco, in the meantime disposing of the remaining Coast Survey property in Salt Lake City, in order to be able to vacate the storerooms at that place.

On Monday, July 18, he proceeded to Green River in order to prepare the longitude station at that place, and to make the geodetic connection at Valley. The material for this work was, of necessity, brought from Salt Lake City, as none could be found near the locality. The longitude station was first prepared, a pier was built, and all the necessary arrangements made for the transmission of signals.

While waiting for cooperation by Assistant Fremont Morse, who was officially engaged on other duties at that time, the geodetic connection was made with Valley Knob. A base line was measured on the railroad, 1 130 meters long and a triangulation executed comprising 8 stations. The measurement of the base was effected with a steel tape (No. 17) 30 meters long, under a tension of 5 pounds, indicated by an ordinary spring balance. The tape was laid on the rails and the temperature was noted for each tape length, the change being about 10 degrees during the measurement. The angles of the triangulation were measured with a 7-inch repeating theodolite, provided with 2 verniers, each reading to 10 seconds of arc. A meridian line for the orientation of the triangulation was established by astronomical observations, using the telescope mounted for longitude work. Latitude was determined on four nights, using 16 pairs and making 60 observations. The instrument used was zenith telescope No. 6.

On August 1 the exchange of signals began, Assistant Morse being at Salt Lake



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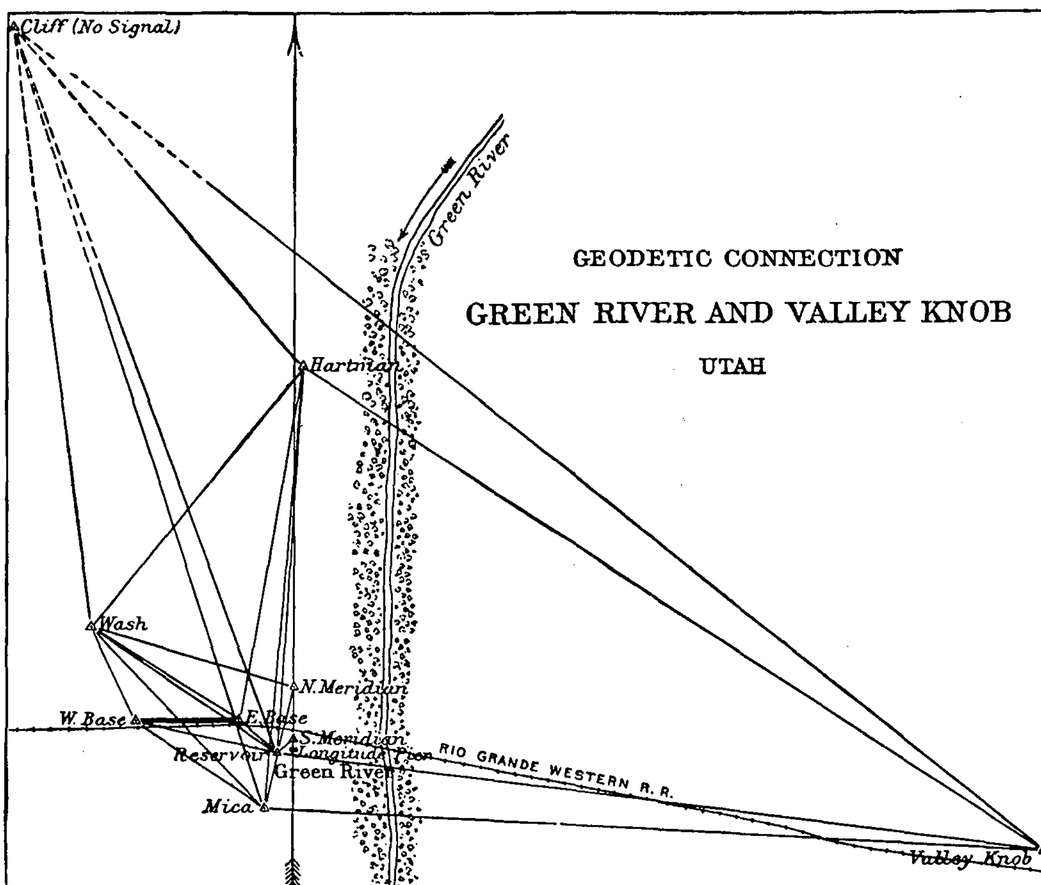
City and Assistant Sinclair at Green River. Successful nights were obtained on August 1, 2, 8, and 9. The observers then changed places and four additional nights were secured, namely, August 13, 14, 16, and 17. Assistant Morse now proceeded to Oasis and prepared the station. At this point, as at Green River, it was necessary to order all the material from Salt Lake City. Signals were exchanged with the latter place on August 27, 28, 30, and 31. The observers then changed places and repeated the work on September 1, 2, 3, and 4. At Oasis a base line 1 669·33 meters long was measured twice on the railroad, using a steel tape and spring balance, as in the work at Green

No. 14.



River. Thirteen triangulation signals were erected, and the scheme of work was carried 23 miles across the desert to the point of connection. A meridian line 1 184·5 meters long, laid out with the meridian telescope, furnished an azimuth for the orientation of the triangles.

All the necessary field operations being completed, the party left for Ogden and San Francisco on the 28th, reaching the latter place on the 30th. At Green River the geodetic connection was made by employing 9 signals, and measuring 48 horizontal angles. At Oasis, which was connected with Scipio, 13 signals were erected and 76 angles were necessary to establish the result.

MORSE: UTAH; CALIFORNIA, San Francisco.

LONGITUDE.
TRIANGULATION.
TOPOGRAPHY.

July 27 to Sept. 8, 1898.
Oct. 7, 1898, to Feb. 2, 1899.
Feb. 23 to June 30, 1899.

SUMMARY OF OPERATIONS.

29·6	square miles triangulation.
10	triangulation stations occupied.
12	ge graphic positions determined.
19·75	square miles topography.
16	miles coast line.
46	miles creek shore line.
70·75	miles roads.
1	topographic sheet.
1	latitude station occupied.
34	pairs stars observed.
3	longitude stations occupied.
16	nights' observations.

From July 1st to 27th Assistant Fremont Morse was engaged in the computation of levels, the field work of which observations had just been completed by him at the close of the last fiscal year. During this time preparations were also made for longitude work in Utah, instructions for which had been issued on the 12th of July.

On the 27th he left San Francisco for Salt Lake City, arriving at 11 a. m. of July 29. The instrument was set up in the same afternoon, adjusted in the evening, and on the following day the necessary telegraphic lines were run to the observatory, and the chronograph and auxiliary instruments were put in working order. In the evening star transits were observed to test the adjustments, and everything being in order the first regular observations were made on August 1.

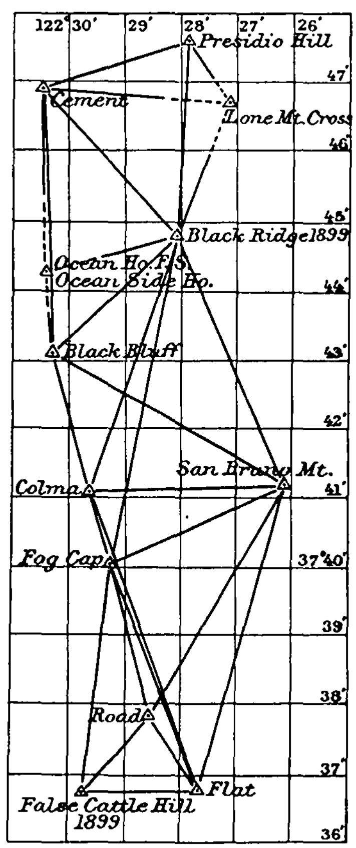
Four nights were obtained before the 9th, when an exchange of observers was made, Assistant Sinclair, who was at Green River, coming to Salt Lake, and Assistant Morse going to the former place. Four additional nights were obtained before August 17. This completed the longitude determination of Green River.

Assistant Morse now proceeded to Oasis, which place he reached on the 20th. No material for the construction of observatory or pier being available here, it was necessary to wait the arrival of this from Salt Lake City. The necessary four nights before the exchange of observers were obtained by August 31, and in the meantime latitude observations and those necessary for the determination of the value of the micrometer were made by Assistant Morse. Places were now exchanged by the observers and four additional nights were obtained by September 4. This closed the determination of the longitude of the two places.

Green River is situated on the Rio Grande Western Railroad about 200 miles southeast of Salt Lake, and Oasis is on the Oregon Short Line Railroad, in a direction southwest from the same place. This work has been referred to in a description of Assistant Sinclair's longitude work in Utah.

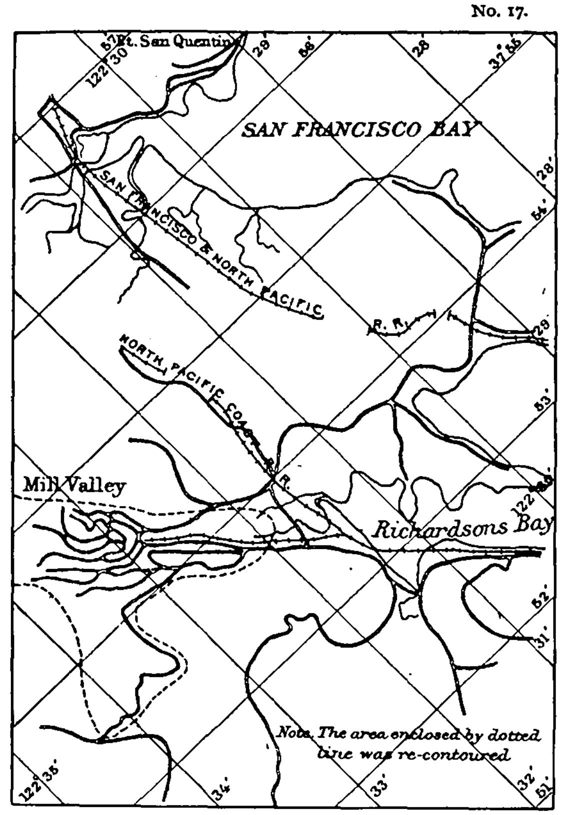
Assistant Morse reported at San Francisco on September 8. During the rest of the month he was engaged in the latitude computations for the station Oasis and other office work. On October 1 telegraphic instructions were sent him to relieve Assistant W. B. Fairfield, in the party of Assistant Mosman, operating in southern California on triangulation. Leaving San Francisco on the 5th of October, he reported to Assistant Mosman on the 7th. From this time until February 2, 1899, he was engaged in triangulation, occupying the stations Castro, Wilsons Peak, and Soledad, at the latter

No. 16.



Triangulation, vicinity of San Francisco.

No. 17.

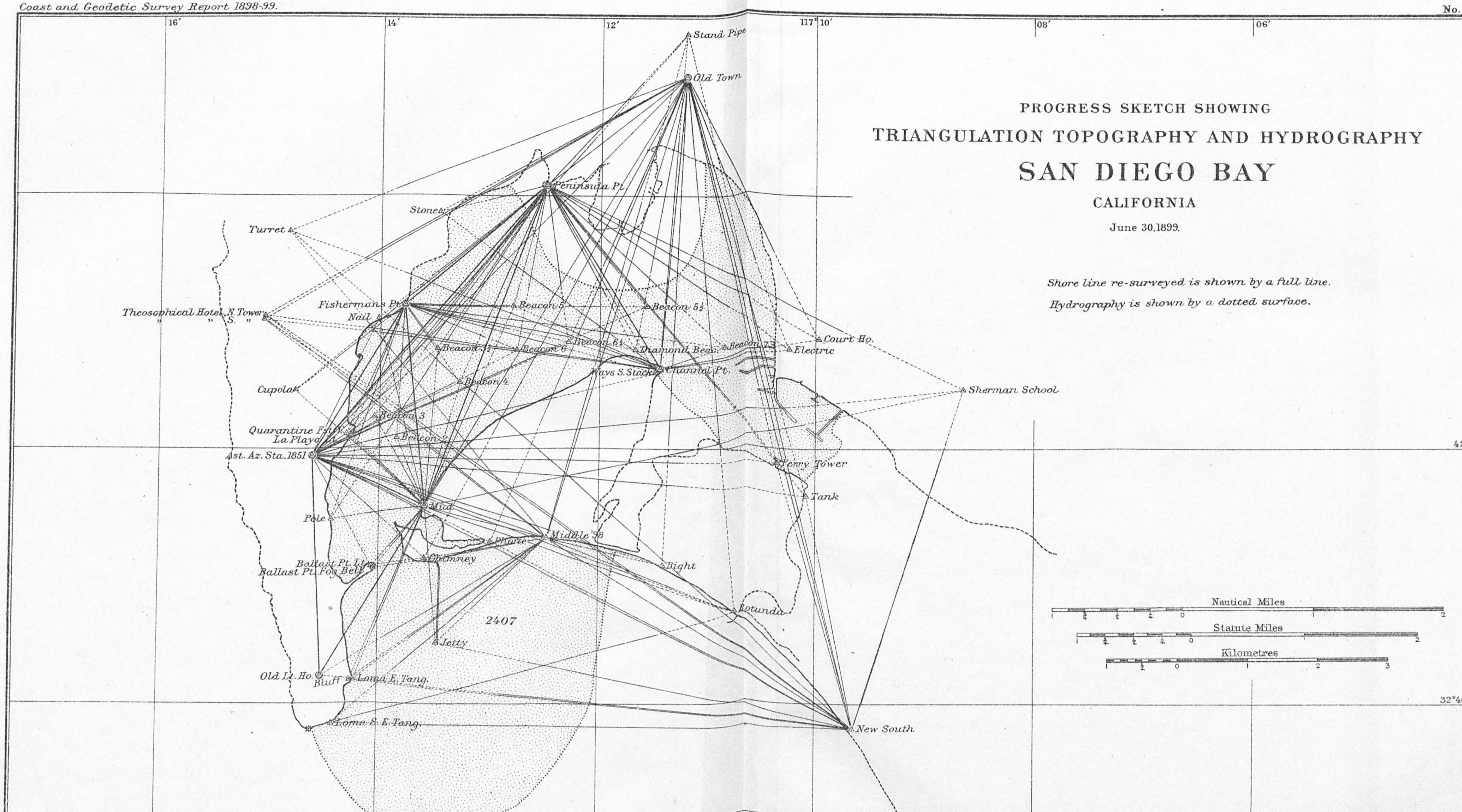


Topography, vicinity of San Francisco.

place making the astronomical observations. This work is more fully described in connection with Assistant Mosman's work, which see, p. 198.

On January 27 Assistant Morse received instructions to take up the topographic work around San Francisco Bay, three sheets remaining to complete the survey. The first sheet, which lay north of the bay, between Sausalito and San Quentin, was finished between February 23 and May 29. The two other sheets were on the west, or ocean, side of San Francisco Peninsula, and extended from the Golden Gate southward nearly to Point San Pedro. In order to obtain points for the lower sheet a triangulation was necessary. This started from the base line Cement–Presidio Hill and was carried southward, occupying three old stations, namely: Cement, Presidio Hill, and Black Ridge, and determining two new ones by concluded angles, namely: Lone Mountain cross and Ocean House flagstaff; and determining, by occupation, seven additional new ones, namely: Black Bluff, Colma, San Bruno, Fog Cap, Road, Flat, and False Cattle Hill. This triangulation is shown on the preceding sketch, together with the region covered by the three topographical sheets.

After the execution of the triangulation observations the computations of geographical positions were made. While this was in progress signals were erected for the plane-table work, and the topographic work proper was begun on June 28. This was in progress at the close of the fiscal year.



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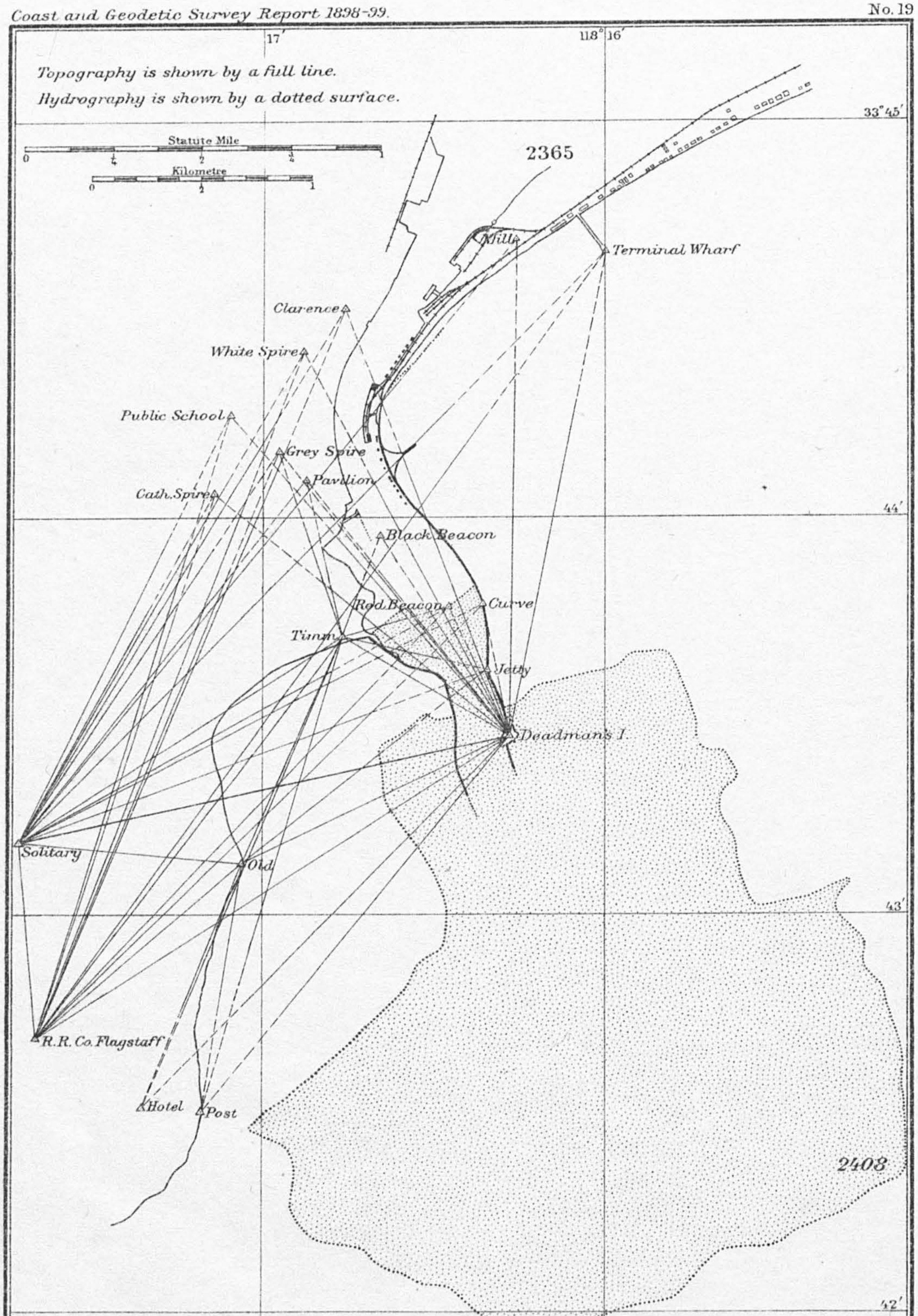

TRIANGULATION, TOPOGRAPHY AND HYDROGRAPHY, SAN PEDRO BAY, CAL.

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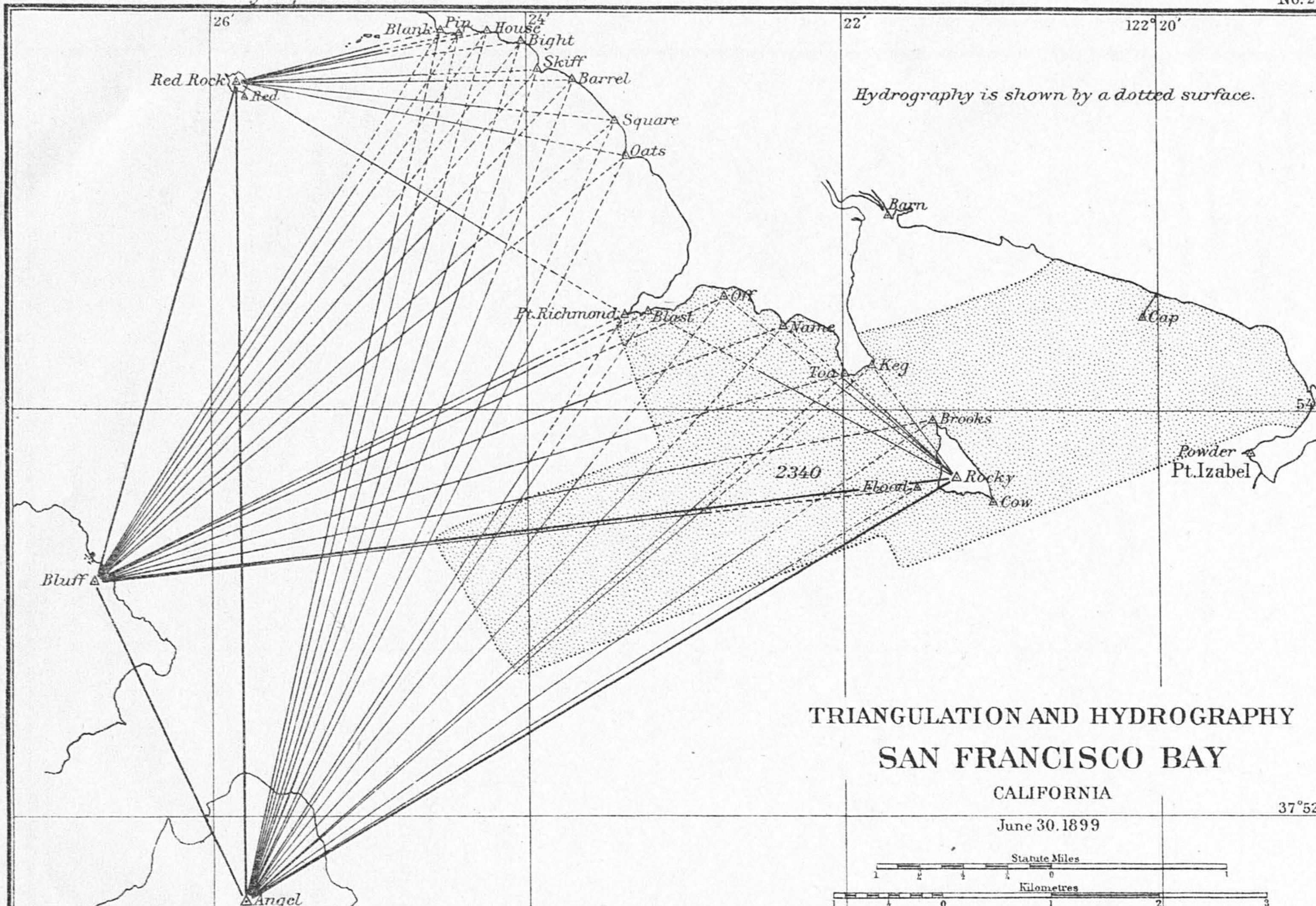

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WESTDAHL: CALIFORNIA, San Francisco, San Diego, San Pedro; WASHINGTON, Grays Harbor.

STEAMER GEDNEY.
TOPOGRAPHY.
HYDROGRAPHY.

B. J. CROWLEY, *Executive Officer.*
A. WOOLF, *Second Watch Officer.*
J. SULLIVAN, *Chief Machinist.*

Aug. 18 to Oct. 22, 1898.
Nov. 8, 1898, to Feb. 18, 1899.
Feb. 27 to Apr. 3, 1899.
Apr. 19 to May 20, 1899.

SUMMARY OF OPERATIONS.

34 square miles triangulation.
14 triangulation stations occupied.
55 geographic positions determined.
11 square miles topography.
43 miles coast shore line.
19 miles roads.
2 topographic sheets, scale 1: 20 000–10 000–5 000.
17 square geographic miles hydrography.
993 geographic miles sounding lines.
16 299 angles measured.
6 tidal stations established.
2 hydrographic sheets, scale 1:40 000, 1:20 000, 1:10 000, and 1:5 000.

In order to take up hydrographic work on the coast of Washington, Assistant F. Westdahl was instructed on June 21 to organize a party. The Coast and Geodetic Survey steamer *Gedney* was assigned to this work, and was formally turned over by Assistant Rodgers to Assistant Westdahl on the 11th of July. Considerable difficulty was experienced in enlisting a crew, and it was not until the 28th that the vessel was brought from San Antonio Estuary, where she had been lying for some time, to San Francisco for coal and stores. She was ready for sea by August 8, and was personally inspected by the Superintendent at this time, who happened to be in San Francisco. On August 9 she steamed across the ranges and made the necessary observations for adjustment of compass.

On the 10th the party sailed for Grays Harbor, arriving on the 18th, after having made short stops at Port Orford and Astoria. Hydrography and topography were executed here, the former near Grays Harbor light-house and opposite Cape Elizabeth, some miles to the north of it; the latter on both sides of the entrance to the harbor and for a short distance to the north and south of it. The object of the topographical work was to survey the shore line and to locate the Government improvements. The hydrographic and topographic work at the entrance to the harbor were not quite finished.

The work off Cape Elizabeth, begun by Lieutenant Crosby in 1894, was continued, but it was not completed.

At the end of the season the vessel sailed from Grays Harbor on the 23d of October for San Diego, Cal. She arrived there on November 4, having stopped at San Francisco on the way. The object of the work at San Diego was to execute the topography from the entrance to the city front, including the shore line and the Government improvements. The hydrography contemplated was the bar at the entrance to the channel, up to and including the San Diego City front. The ship was moored at La Playa on November 8. As a preliminary to the hydrography two tide gauges were established, one at La Playa and another at the end of the jetty outside of the entrance. Simultaneous observations were made during twenty-five hours to obtain the difference of time and range of tide, to be used in reducing soundings outside of the bay.

In order that the hydrographic work might be taken up as soon as possible, points were determined by the plane table, which gave all the required accuracy for this work. The work outside of Ballast Point was done with the steam launch under direction of Mr. Crowley, the executive officer, while the inside hydrography was executed by Mr. Woolf, second watch officer, using the whale boat. Assistant Westdahl, with two men and a dingey, took up the topography, which was finished by the end of November.

Many adverse circumstances impeded the progress of the hydrographic work, among which may be mentioned that the steam launch was three times hoisted from the water for repairs. She lost her propeller while doing outside work on December 6, and twice the *Gedney* was obliged to leave her moorings at La Playa and anchor at San Diego on account of violent gales.

The hydrography was practically finished in December, but on December 28 the party was authorized to extend the work so as to include the hydrography of the water front of the city of San Diego. On December 30 instructions were given to determine, by triangulation, objects for compass range, permanent aids to navigation, etc., and this was executed with as little delay as possible.

On the 14th of January the ship was moved to San Diego. Topographic work continued during the greater part of February. Hydrographic work was also continued to the extent of filling in lines and doing patchwork, which was required for a more complete development of the proposed undertaking.

On February 26 the vessel sailed from San Diego and arrived at San Pedro next morning. Both hydrography and topography were included in the work projected for this place. In topography the terminal beach and entrance to the harbor, mainly shore line and jetties, were taken up. In hydrography the entrance to the inner harbor was developed and extended to include the location of proposed breakwater. As at San Diego, the hydrographic signals were determined with the plane table in order that the sounding might suffer no delay.

Hydrography began March 3 by the whaleboat in charge of Mr. Woolf. A close examination of the mouth of the channel to the inner harbor was made, in order to find, if possible, the sounding of 13½ feet recorded on the Coast and Geodetic Survey chart. At the request of Captain Meyler, Corps of Engineers, U. S. A., the work was extended to cover the area of the proposed breakwater. Hydrographic work was carried on, both by the steam launch and the whaleboat, until the collapse of the former on April 3. The work was finished by the whaleboat.

All the proposed operations at San Pedro having been completed, the *Gedney* sailed for San Francisco on the 5th of April, arriving on the 7th. Necessary repairs were immediately undertaken, which occupied the time until April 17, when, in compliance with instructions of March 16, she proceeded to Point Richmond for hydrographic work in the neighborhood of Brooks Island. Sounding was begun on the 3d of May, but on account of unfavorable weather conditions only the time before noon could be utilized for this work.

On May 7 instructions were received to have the ship inspected by a local United States inspector of steam vessels, and to prepare her for work in Alaska near the Aleutian Islands. The inspection was completed by May 11 and the vessel was taken to Oakland Harbor, where necessary repairs could be made and the plotting of the San Diego work could be taken up. The repairs were finished on the 16th of June. On the 23d, Assistants Dickins and Westdahl formally exchanged commands in the presence of the Inspector of Hydrography and Topography, Assistant Westdahl taking the *McArthur* and Assistant Dickins the *Gedney*.

Assistant Westdahl speaks in high terms of Mr. B. J. Crowley, who as executive officer discharged his duties with marked ability.

DICKINS: CALIFORNIA, San Francisco.

STEAMER M'ARTHUR.
HYDROGRAPHY.

W. G. APPLETON, *Chief Yeoman.*	
L. H. WESTDAHL, *Tidal Observer.*	
HUGH SIMMONS, *Machinist.*	July 1, 1898, to Oct. 1, 1898.
C. W. FITZGERALD, *Chief Yeoman.*	Oct. 10, 1898, to Jan 17, 1899.
F. G. CRIST, *Master at Arms.*	Jan. 27 to May 24, 1899.
H. L. FORD, *Chief Yeoman, Acting Executive Officer.*	
G. F. THOMAE, *Watch Officer.*	

SUMMARY OF OPERATIONS.

44 hydrographic signals erected.
16 695 angles measured.
1 369 miles sounding lines.
21 tidal stations occupied.

Assistant E. F. Dickins began work, on the 1st of July, on the southern part of San Francisco Bay, near South Belmont, relieving Assistant Westdahl, who had charge of the party up to that time. Operations continued in this locality until the 6th of September, when the party moved to Menlo Oyster Camp. The work was pursued here until the 1st of October, when Assistant Dickins took charge of the steamer *McArthur*. After having enlisted a crew, he returned, on October 10, to Dumbarton Point, where the work was continued until November 16. At this date it was completed to the southward and the vessel moved to Redwood City Creek. The entire southern portion of San Francisco Bay was finished by the 17th of January. Before the work was done instructions had been issued, under date of December 30, to begin operations in San Pablo Bay.

This was taken up after the completion of the southern work, and, incidentally to the regular operations, the position was located of an extra channel buoy on Penole Shoal. The position of Buoy No. 7 and the beacon at the entrance of Mare Island Straits were also determined, at the request of the commandant of the Mare Island Navy-Yard. In addition to this, at the request of Major Davis, the proper position for a new beacon at the mouth of the Mare Island Straits was marked, and the new beacon in Petaluma Channel was determined. The work in this locality was finished on April 11, the operations in Petaluma Creek continuing until May 24.

The vessel was docked at the Union Iron Ship Works on June 2 for repairs. Preparations for the Alaska work and other incidental duties consumed the rest of the fiscal year. Among the duties just mentioned may be stated the reduction of the work of Lieut. Commander Osborn, U. S. N., who was formerly in command of the *McArthur*.

Assistant Dickins, as a result of his experience, makes note of the fact that the best season for work in San Francisco Bay is during the winter months. At this time there is some rain, but good weather exists between the storms, whereas in summer one is liable to have northwest winds and a choppy sea at all times, as well as fog, and straight lines of sounding are almost impossible.

FAIRFIELD: CALIFORNIA, Santa Barbara to Mexican line.

TRIANGULATION.

July 1 to Oct. 15, 1899
Oct. 18, 1898 to June 25, 1899.

SUMMARY OF OPERATIONS.

See Mosman, Cal. triang., p. 198;
Sinclair, Cal.-Nev. boundary, p. 223.

On the 1st of July, 1898, Assistant W. B. Fairfield was attached to the party of Assistant A. T. Mosman, doing primary triangulation in southern California, from Santa Barbara to the Mexican line. The station Santa Cruz E., on Santa Cruz Island, was occupied between July 5 and August 8. No connection could be had with the mainland until August 15, when the party and outfit left for the station Laguna. While the camp was being established at this place, Assistant Fairfield was engaged in posting heliotropes at Castro, San Pedro, and San Fernando. Operations at Laguna began on September 6; they were completed on the 18th. On the following day camp was moved to Castro. From September 20 to October 10, while the outfit was en route and being established at the latter station, signals were erected and heliotropes posted on Wilsons Peak. A line was also cut on Mount Lowe, and a pole erected on San Jacinto 11 000 feet high and very difficult of access. On October 11 instructions were received to report to Assistant C. H. Sinclair, at San Francisco, for duty on the California and Nevada boundary line. In compliance with these instructions the party was turned over at Castro, on October 15, to Assistant Morse, who had been detailed to take charge of the work.

Assistant Fairfield proceeded to San Francisco on October 18, reported to Assistant Sinclair, and was attached to his party until the 25th of June, 1899. During this time the work on the California and Nevada boundary comprised triangulation from station T 105 (Ash Meadows) to the Colorado River, connecting also with the triangulation coming northwest from Needles, executed by Assistant Fairfield in 1 93. On February 17 the party started back, correcting the line as they proceeded, and building cairns and mounds to mark the final stations. The cairns were from 4 to 6½ feet high, and 5 feet in diameter at the base. When stones were not available, earth mounds were made around a post. All stations were marked with drill holes in solid rock, when possible. This work lasted until the 18th of June, and on the final completion of the boundary work, which took place on the 25th of June, Mr. Fairfield reported to Assistant Mosman, at San Juan station, under instructions dated June 6, and was attached to his party until the end of the fiscal year.

The triangulation on the California and Nevada boundary line was executed by Assistant Fairfield.

MOSMAN: CALIFORNIA, Santa Barbara to Mexican boundary.

TRIANGULATION.
ASTRONOMICAL DETERMINATIONS.
LEVELING.

W. B. FAIRFIELD, *Assistant*, April 22 to Oct. 12.	
F. MORSE, *Assistant*, Oct. 7 to Feb. 2.	July 1, 1898, to Feb. 9, 1899.
A. W. LEWIS, *Recorder*.	
E. E. TORREY, *Foreman*.	June 5 to June 30, 1899.

SUMMARY OF OPERATIONS.

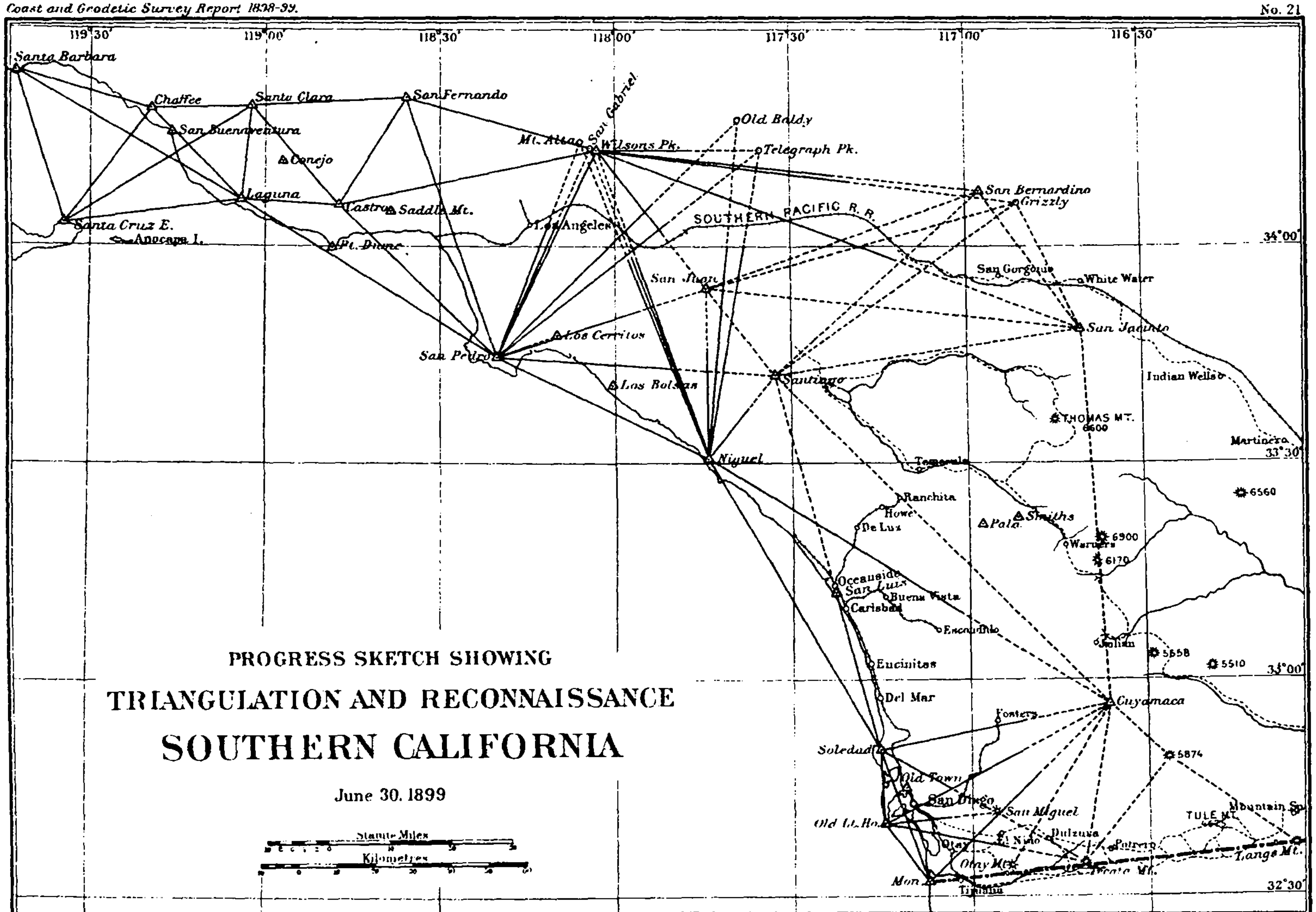
March 1, 1898, to February 20, 1899.

9 371 square miles triangulation.
13 triangulation stations occupied.
11 stations occupied for vertical measures.
28 geographic positions determined.
21 elevations determined trigonometrically.
1 elevation determined by spirit leveling.
6 miles spirit leveling.
1 latitude station occupied.
20 pairs stars observed.
1 azimuth station, 4 nights.

During the latter part of the fiscal year 1897–98 Assistant A. T. Mosman was in southern California, engaged in a reconnoissance from Santa Barbara to the Mexican boundary. This reconnoissance, which covered more than 10 000 square miles, was executed between March 11 and May 23. During this time 61 lines of intervisibility were determined, and 21 points were selected for stations.

A double party was contemplated for the execution of the triangulation, and at the beginning of the fiscal year 1898–99 both parties were to be found at the western extremity of this work; the first, under the immediate direction of Assistant Mosman, was at Santa Barbara; and the second, a cooperation party in charge of Assistant W. B. Fairfield, was at Santa Cruz E. From this time until the 9th of February observations went on uninterruptedly, and the work was carried from the aforesaid line, Santa Barbara-Santa Cruz E., to Soledad, in the vicinity of San Diego. With a view of prosecuting the work more rapidly the double party was put in the field: the one under Assistant Mosman commencing with the stations Santa Barbara, Chaffee, Santa Clara, and San Fernando; the other under Assistant Fairfield taking up the stations Santa Cruz E. and Laguna.

Santa Barbara was completed on August 5, and the camp on this date was moved to Chaffee. Observations were made here between the 19th and 28th of August, and



PROGRESS SKETCH SHOWING
TRIANGULATION AND RECONNAISSANCE
SOUTHERN CALIFORNIA
June 30. 1899
Statute Miles
Kilometres
Santa Barbara
Chaffee
Santa Clara
San Fernando
San Buenaventura
Conejo
Laguna
Castro
Saddle Mt.
Santa Cruz E.
Anacapa I.
Pt. Dume
Mt. Akao
San Gabriel
Wilsons Pk.
Old Baldy
Telegraph Pk.
Los Angeles
SOUTHERN PACIFIC R.R.
San Bernardino
Grizzly
San Gorgonio
White Water
San Juan
San Jacinto
Los Cerritos
San Pedro
Los Bolsas
Santiago
Indian Wells
THOMAS MT. 6600
Martinez
Niguel
Temecula
Ranchita
Howe
De Luz
Pala
Smiths
Warners
Oceanside
San Luis
Buena Vista
Carlsbad
Escondido
Julian
Encinitas
Del Mar
Cuyamaca
Fosters
Soledad
Old Town
San Diego
San Miguel
Old Lt. Ho.
Otay
Dulzura
Otay Mt.
Mon.
Tijuana
TULE MT.
Mountain Sp.
Lange Mt.
6560
6900
6170
5658
5510
6874
34°00'
33°30'
33°00'
32°30'
119°30'
119°00'
118°30'
118°00'
117°30'
117°00'
116°30'

the camp was moved to Santa Clara, at which station the outfit and instruments were hauled to the top on sleds, overcoming a vertical distance of 2 250 feet. Observations at Santa Clara were in progress from September 9 to 18.

In the meantime Assistant Fairfield had finished Santa Cruz E. on August 8. He left the island on the 17th and proceeded to Laguna (elevation 1 442 feet). This station was finished on September 22. While moving his camp to Castro opportunity was taken to open lines and build tripods for heliotropes at Wilsons Peak (5 700 feet) and San Jacinto (10 800 feet).

Assistant Mosman observed at San Fernando from October 6 to 11.

Assistant Fremont Morse, who had been ordered to relieve Assistant Fairfield, under instructions from the superintendent, reported to Assistant Mosman on October 7. At this time Mr. Fairfield was still absent on his trip to San Jacinto. He returned on the 12th, and the following day Assistants Morse and Fairfield proceeded to Castro, where the former made the necessary observations between the 15th and 25th. The instruments were now sent to Wilsons Peak, and while they were in transit heliotropes were posted at San Juan, Niguel, and Santiago, and a pole was erected at San Bernardino (10 300 feet). This signal was erected over a cairn marking the initial point of the principal meridian of the land survey of southern California. The determination of its geographical position was therefore of prime importance to the State work in southern California, and the opportunity was embraced to make a careful determination.

Assistant Mosman, who had finished observations at San Fernando on October 11, now moved to San Pedro, and was engaged at this point between November 2 and 19 in the measurement of horizontal angles. Leveling was also undertaken, and the difference of height between the bench mark at San Pedro and the triangulation station on San Pedro Hill was determined between November 17 and December 2. These observations suffered considerable delay on account of bad weather. After the conclusion of the work here the party moved to Niguel, and observations were made at the latter place between December 10 and 25, the transportation from San Pedro to Niguel occupying the time between November 27 and December 5. At the conclusion of the observations at Niguel the party proceeded to Soledad. This point was chosen for an astronomical station as well, and therefore time, latitude, and azimuth were undertaken, in addition to the usual horizontal and vertical angles.

After the execution of any system of triangulation, if the greatest accuracy is to be attained it is necessary to check the geographical positions obtained from the measurement of horizontal angles by an astronomical determination of the terminal points. No check of this nature had been obtained for some time, and it was, therefore, desirable, before determining the boundary line between the United States and Mexico, to supplement the work by astronomical determinations, both as a check on the triangulation and as a means of bringing out any anomalies in the deflections of the plumb line caused by an irregular distribution of the matter composing the earth's crust.

Signals were erected and connection made with the old light-house at Point Loma and with Monument No. 258 on the Mexican boundary, which marks its termination at the Pacific coast. An azimuth mark was erected in the vertical of Polaris at western elongation, 7.6 miles from Soledad. The first observations for horizontal and vertical angles were made on January 7; for time and latitude, on the 14th; the horizontals were finished on the 24th and the latitude on the 25th. The old light-house was occupied on the 25th and Monument No. 258 on the 26th. Azimuth observations were made on February 6, 7, 8, and 9, which closed the work for the season.

Assistant Morse left for San Francisco on February 2, under instructions from the Superintendent. The camp outfit was shipped, in part, to the suboffice at San Francisco, and in part to Los Angeles, to be placed in store for use in the next season's work. The duplicate records were sent to Washington as fast as the stations were occupied, and the original records were deposited in the suboffice at San Francisco for safe-keeping. Assistant Mosman arrived at the latter place on February 25.

During the season's work one hundred and fifteen days were devoted to the observations at the stations; two hundred and fourteen days were required to move between stations, construct roads, and do other necessary preliminary work. Twenty days were lost at Santa Barbara and Santa Cruz E., through fog; three or four were unavailable at Laguna and Chaffee, from the same cause; and at San Pedro, Niguel, and Soledad nearly a month was lost on account of rain, clouds, and fog.

In carrying out the observations in this work Assistant Mosman departed to a certain extent from the usual methods. This was done with the view of securing results equal in accuracy with less work, and consisted in observing three sets in each of four positions of the theodolite. These were arranged in the following form:

Setting for position.				Sets.			
	°	′	″				
Pos. I	0	0	20	*Set No. 1.*			
II	5	0	45	POSITIONS:			
III	10	1	10	I A. M.	IV A. M.	VII P. M.	X P. M.
IV	15	1	35				
V	20	2	0	*Set No. 2.*			
VI	25	2	25	POSITIONS:			
VII	30	2	50	II P. M.	V P. M.	VIII A. M.	XI A. M.
VIII	35	3	15				
IX	40	3	40	*Set No. 3.*			
X	45	4	5	POSITIONS:			
XI	50	4	30	III A. M.	VI P. M.	IX A. M.	XII P. M.
XII	55	4	55				

To meet the objection that the equal division of 60 degrees among 12 positions would make the reading on the point always come on the same part of the 5-minute graduation, the twelfth part of a space was added to each position, so that the distance between two successive positions was 5° 0′ 25″. When it was possible to divide the observations equally between a. m. and p. m. work it was done by so taking the positions that the result for each set should contain an equal number of each class. In general, however, no striking difference was found between the a. m. and p. m. results. The results, as regards the closing of triangles, compared favorably with those obtained, with the same instrumennts, in the Alleghanies, but the probable error was somewhat larger.

The heliotropes at the different stations were shown from sunrise to 9 a. m. and from 3 p. m. until sunset; and during these hours all the horizontal angle observations were made. Signals were also shown between 11 a. m. and 1 p. m., and at this time the vertical angles were measured. They consisted in, first, six measures of zenith distances, followed at once by six measures of nadir distances; and the mean of the two results was accepted.

Assistant Mosman speaks in the highest terms of the zeal, energy, and industry of Mr. Arthur W. Lewis, who served as recorder from July to February 11. Mr. E. E. Torrey, foreman, was with the party from December 16 to March 20, and as usual rendered valuable service.

Between May 15 and 26, under instructions of May 4, Assistant Mosman prepared to resume work in southern California. He arrived at Los Angeles on May 27. Organizing the party and posting heliotropes occupied the time until June 5. Camp was pitched at San Juan on June 13. Between June 10 and 30 the trail was built up San Jacinto Mountain, 12 miles long, with a vertical rise of 6 000 feet. The instruments were mounted at San Juan on the 15th of June, and the first observations were made the following day. The coast fog greatly delayed the observations on Niguel and San Pedro, but Wilsons Peak, San Jacinto, and Santiago showed above the fog and were satisfactorily observed. Observations at San Juan were finished on June 27.

Assistant Fairfield reported on the same date, and left for the occupation of San Jacinto on the 30th of June.

GILBERT: CALIFORNIA, Mount Lola, Sacramento.

LEVELING.

July 5 to July 28, 1898.

SUMMARY OF OPERATIONS.

4 elevations determined by spirit leveling.
22 miles of double-line spirit leveling.

At the beginning of the fiscal year Assistant J. J. Gilbert had just finished the observation of vertical angles at Pine Hill, Eldorado County, Cal. In order to connect this work with the vertical angles of the transcontinental triangulation, a line of levels was necessary from Truckee to Mount Lola. This was undertaken on July 5, and was carried on without interruption until the 26th. On the 28th a line of levels was run from the Southern Pacific Railroad car shops, Sacramento, to bench mark in State capitol, which was established by Assistant Morse when occupying the dome for vertical angles. The line was run forward and back, connecting both ways with the railroad tide gauge on Sacramento River.

From July 29 to September 12 the time was spent in making a report on the season's work, reviewing and duplicating the level records, and making computations, clear copies, etc., of the vertical-angle measures at Pine Hill. These records were sent, in duplicate, to Washington early in September. On the 12th he received instructions to report in Washington after the expiration of his leave of absence. Arriving on the 19th, he was immediately assigned to duty in the Computing Division, where he remained until the 14th of March.

From this time to the 22d he was acting as president of the board appointed by the Secretary of the Treasury to conduct the speed-trial tests of the Coast and Geodetic Survey steamer *Pathfinder*.

On the 22d he returned to the Computing Division, remaining here until the 12th of May, when he was instructed to take temporary charge of the steamer *Endeavor*, during the convalescence of Assistant Yates. On the 29th instructions were issued for him to proceed to Seattle, relieving Assistant F. A. Young of the charge of the suboffice. He arrived there on the 13th of June. Under instructions he proceeded to Lopez Island, and there made shipment of magnetic instruments at that point to Washington. Returning on the 18th, he took charge of the suboffice, and was engaged in collecting material for the new map of Seattle, attending to the marigraph, etc., until the end of the fiscal year.

SUBOFFICE,
SAN FRANCISCO,
AND SPECIAL DUTY.

July 1 to June 30, 1899.

Assistant A. F. Rodgers has been in charge of the suboffice at San Francisco during the entire fiscal year. He had also charge of the tidal and astronomical stations at the Presidio, and of the steamers *Patterson* and *McArthur*, laid up temporarily at Oakland Harbor. Arrangements for the construction of the tidal indicator in San Francisco Harbor were also made under his direction.

Among the many duties performed by him were: Reports on the steam launches belonging to the *Patterson* and *McArthur;* correspondence with the contractor for the building of the steamer *Taku;* duty pertaining to the Santa Barbara speed-trial courses, transmitted to the Union Iron Works; outfitting the steamer *McArthur*, transferred to Dickins on October 1; submitting estimates for repairs to tide gauge; report on examination of several sites for the International Geodetic Association latitude station at Ukiah, and correspondence as to marking the channel in San Pablo Bay to facilitate taking the U. S. S. *Iowa* to Mare Island Navy Yard.

On April 11, having visited Ukiah, he made a report on the site available for the International Geodetic Association latitude station, and on the 20th accepted an offer from Mr. George Luce, of Ukiah, to sell one-half of a 5-acre tract to the association. On August 17 a contract was entered into with the San Francisco Bridge Company to construct a tidal indicator on the southeastern extremity of Alcatraz Island. In addition to other duties during the year, on Saturdays tidal data were distributed to seven daily papers for publication.

YOUNG: WASHINGTON, Bainbridge Reef.

HYDROGRAPHY.

Mar. 25 to Mar. 30, 1899.

From the 1st of July, 1898, to the 15th of October, Assistant F. A. Young was attached to the party of Assistant J. F. Pratt, engaged in making a survey of a portion of the Yukon Delta. He continued in this party until the close of the season; and on the arrival at Seattle of the party, on the 15th of October, was assigned to duty in the suboffice at that place, being engaged principally in computing the triangulation and other work pertaining to the season's work.

It having been reported that there was a rock in the direct track of vessels of the Navy going from Admiralty Inlet to the Puget Sound naval station, and that less water was to be found than indicated on the chart, Assistant Young was directed to make an examination of the locality. The reef alluded to is known as Bainbridge Reef, and is situated in Richs Passage. A small steam tug was chartered on March 25, and Assistant Young proceeded with his party to the locality in order to secure such triangulation stations as might be needed for locating the reef, besides establishing and locating other necessary points. After the preliminary work had been completed, eight lines of soundings were run, each being from 500 to 900 metres in length, and intersecting near the spot. A line was then run encircling the central point, in order to define more exactly the limits of the reef. A number of soundings were made to determine its extent, the result of which was that the reef was found to be oval in shape and about 85 metres long and 50 metres wide. The least water to be found is on the extreme western edge, and the soundings range from 5 fathoms 4 feet to 8 fathoms. The investigation shows that there is enough water on the reef to float the deepest draft vessel at low water. It is entirely possible that there may be a sharp pinnacle that projects above the highest point found, but none such was developed by the soundings. There is no doubt, however, that this pinnacle, if it exists, is well within the limits of the reef, and can easily be avoided by vessels.

On April 20 Assistant Young succeeded Mr. Pratt in charge of the suboffice, Mr. R. B. Derickson, Aid, also remaining attached to the office. Most of the time was taken up by work pertaining to the Yukon River Delta survey, where a good deal of information pertaining to Alaska was given to sea captains and others.

On June 27, 1899, Assistant Young joined the steamer *Patterson*, in command of Assistant J. F. Pratt, the ship sailing for St. Michael on July 3.

GRAVITY.

Feb. 4 to Feb. 16, 1899.

During the winter of 1898–99 Assistant G. R. Putnam was charged with the determination of the relative forces of gravity at the State University, near Seattle, Wash., and at the high school in that city. The two places being very near the same degree of latitude, the principal object in the observations was to bring out any local deviations from the assumed force of gravity. At the State University the time necessary for these determinations was obtained from star observations, while at the high school in Seattle the chronometers were rated by telegraph noon signals sent out from the Mare Island Navy-Yard, in California. The result of the work furnishes an interesting test of the reliability of signals sent by telegraph over a long distance. If all the discrepancies between the two days' observations at the high school be ascribed to a change of rate, there would be an uncertainty of only 0·14 second per day in this quantity. The observations at the State University were rather unsatisfactory on account of unfavorable temperature conditions. The result, however, confirms previous experience that scarcely any measurable difference in the force of gravity may be expected between stations within a few miles of each other. The station at the high school was almost identical with that of 1891, and the results differ only by $\frac{1}{800000}$ part. The observations at Seattle confirm the result previously brought out—that when the force of gravity is corrected simply for the elevation above sea level and a comparison is made with the theoretical value there appears a greater defect of this quantity than has been observed elsewhere on the coasts of North America. The result is undoubtedly related to the unusual topographic situation, the town being situated on a great sound, almost encircled by high mountains. The difference of latitude between the two places is 3 minutes and 5 seconds. The difference of elevation is 16 metres, and we have for the computed defect of the force of gravity at the State University 0·131 of a dyne and at the high school 0·130.

D. DIVISION OF ALASKA.

FLEMER: ALASKA, Head waters of Lynn Canal.

RECONNOISSANCE.

J. NELSON, *Assistant.* July 1 to Sept. 9, 1898.

SUMMARY OF OPERATIONS.

May 7 to Sept. 9, 1898.

400 square miles topography.
130 miles river shore line.
50 miles creek shore line.
30 miles roads and railroads.
4 topographic sheets, scale 1:20 000 and 1:800 000.

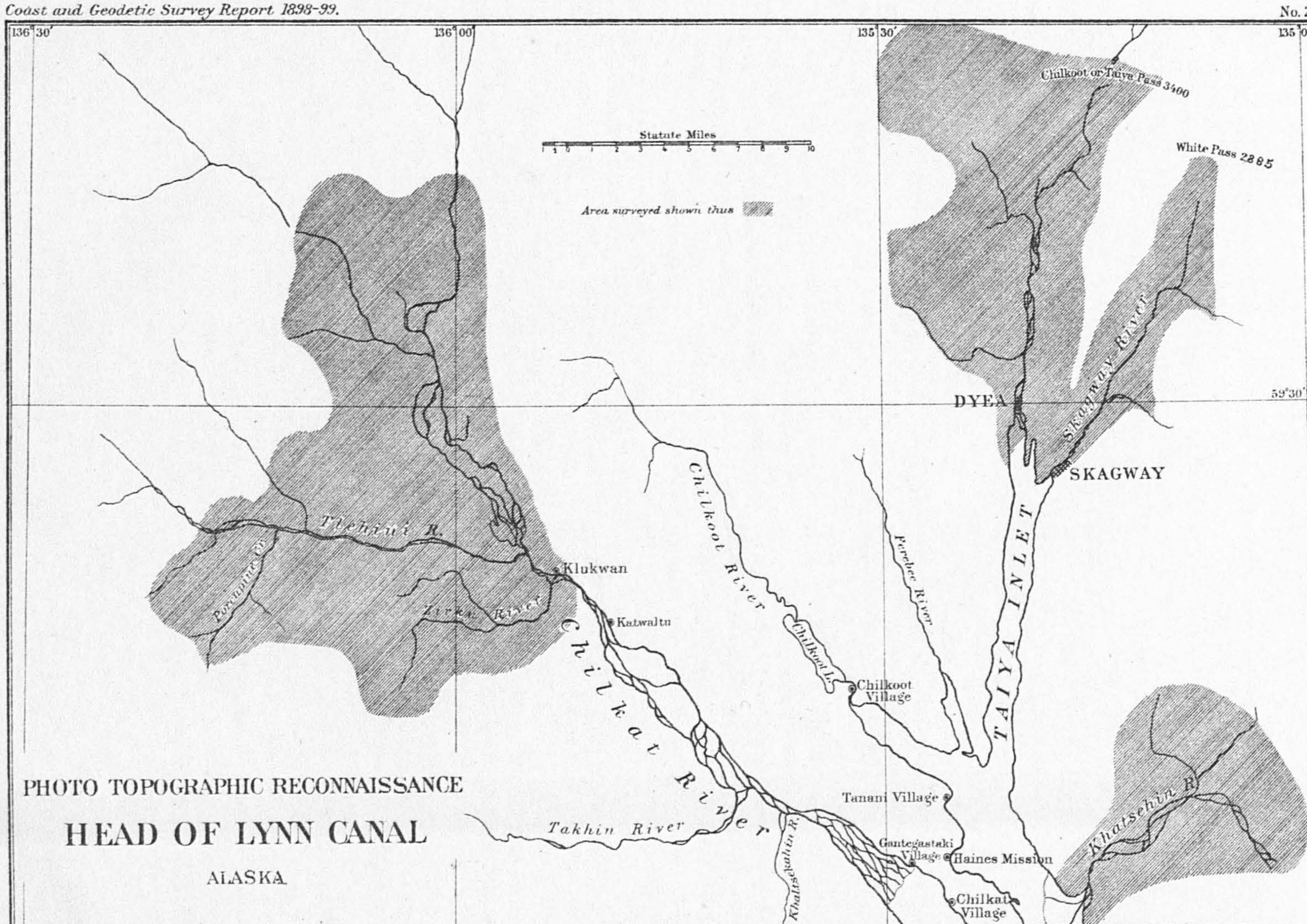
During the rush to the Klondike region in 1897, consequent upon the gold discoveries on Bonanza Creek, it is estimated that between thirty and forty thousand people entered the Yukon territory via the Chilkoot and White Pass routes. This made it incumbent on our service to so develop the geography of the region that the commercial interests of Alaska should be adequately subserved. Two parties were therefore sent to the head of Lynn Canal under the direction of Assistant J. A. Flemer.

The first party, under Mr. Flemer's personal supervision, took the country to the west and began a reconnoissance of the Chilkat River Valley and the adjoining territory. The second party, under Assistant John Nelson, gave attention to the Katsehin River Valley, lying to the eastward of the head of Lynn Canal. These parties began work during the summer of 1898 and were at work at the beginning of the fiscal year 1898–99 in the localities mentioned.

Both parties, during the entire season, covered an area of about 500 square miles, including the valleys of the following rivers: Chilkat, Tsirku, Tlehini, Katsehin, Skagway, and Dyea. Numerous tributaries of these branches were also explored. The work on the Chilkat and on the Katsehin was finished by July 17. The former involved the occupation of six camera stations in the mountains and two in the Chilkat River Valley. This was done between July 8 and 13. The iconometric plotting of the work was performed at the Office between April 8 and May 9, 1899. The Chilkat sheet shows the famous Dalton Trail from the Tsirku River to the bend in the Tlehini River. It crosses the watershed between the Chilkat and the Alsek drainage systems at an elevation of about 3 000 feet. This survey embraces the Porcupine gold district.

At the conclusion of the aforesaid work both parties were towed by lighters to Skagway. Assistant Nelson and party landed here and undertook the topographical reconnoissance of the valley of this name. Assistant Flemer, with party, continued on to Dyea for the purpose of developing this entrance to the Yukon territory.

Old stations established by Assistant Pratt in 1894, near the head of Dyea Inlet, were recovered, and photo-topographic stations occupied in the valley were connected with these points by triangulation, using the line between "Grunt" and "Court" as a base.



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

Reconnoissance of the lower valley was finished, including a survey of the town of Dyea, by August 10. The camp was then moved 5 miles upstream to Rosedale, which operation required three days' heavy packing, as every wagon in Dyea was engaged in commercial transportation on account of the recent gold discoveries.

On August 23 the camp was moved to Canyon City, and no further change was made until the end of the season. Side trips were made up both valleys containing the headwaters of the Dyea River. Eleven elevated camera stations were successfully occupied in Dyea Valley, and seven lower ones in the valley bottom. Triangulation was made as far as practicable, and a rough traverse line was run through the canyon, between Canyon City and Sheep Camp. Much difficulty was experienced with the weather, only thirteen days without rain occurring between July 1 and September 9. The area was charted on a scale of 1:80 000.

The necessity for new maps in such a region may be understood from the rapid transformation taking place. In August, 1897, but three wooden buildings were to be seen at Skagway. September of the same year found hundreds of tents on the ground, and in January, 1898, 700 buildings and over 3 000 inhabitants made up the existing town. Many of the conveniences of civilization are evident on all sides, including an electric-light plant, the power for which is derived from a mountain lake.

Assistant Nelson's work in the Skagway River Valley consisted of a detailed map of the town of Skagway, on a scale of 1:20 000, and a topographical survey of the valley from the town to White Pass, on a scale of 1:80 000. This map includes the White Pass and Yukon Railroad. From the summit of White Pass to the head of Lake Bennett there is a pack trail which joins, at the latter point, the old trail leading from the Chilkoot Pass. The Chilkoot route is shorter, but the one through White Pass offers better transportation facilities and crosses the Divide about 1 100 feet lower than the one through Chilkoot.

On the Dyea route, the Chilkoot wagon road follows the old Indian trail very closely. The wagon road leads from Dyea to Canyon City, a distance of 9 miles, crossing the stream many times by fords and bridges. From Canyon City an aerial wire tramway conveys merchandise, in wooden boxes or buckets, over the Chilkoot Pass to Crater Lake. A pack-trail also leads from Canyon City to The Scales, at the foot of the Chilkoot Pass. From Sheep Camp to The Scales, about 2½ miles, the rise is 1 600 feet; from The Scales to the Summit, a distance of about 3 000 feet, the increase in height is at least 1 000 feet. The last 500 feet of this route is very steep.

The drawing shown on the Dyea sheet is based on 60 photographs, taken from 18 camera stations; while that on the Chilkat sheet is from 42 photographic negatives obtained also from 18 camera stations.

NELSON: ALASKA, Head of Lynn Canal; PORTO RICO.

TRIANGULATION.
TOPOGRAPHY.
ASTRONOMICAL WORK, ETC.

July 1 to Sept. 9, 1898.
Dec. 13, 1898, to June 20, 1899.

SUMMARY OF OPERATIONS.

See Flemer, Reconnoissance, Alaska.
Hodgkins, Topog., etc., Porto Rico.

In order to push the Alaska work as rapidly as possible, a cooperating party was assigned to Assistant Flemer in the work near the head of Lynn Canal. This was under the immediate direction of Assistant John Nelson, who had in charge a phototopographic and plane table survey of the Katsehin and Skagway rivers and the country lying between the head of Lynn Canal and the summit of White Pass.

Assistant Nelson was attached to the party of Assistant Flemer until October 3, at which date they had arrived at Washington from the head of Lynn Canal. Office work was taken up, and between October 4 and December 3 the time was devoted to the triangulation computations and to developing photographic negatives of the season's work.

For additional reference to work of Assistant Nelson, see details of field work by Assistant Flemer's party.

Assistant Nelson had leave of absence from December 4 to 13. He was then assigned to the steamer *Blake*, under the command of Assistant W. C. Hodgkins, for duty in Porto Rico. His work here consisted of astronomical determinations, triangulation, and topography, a report of which will be found in a description of the season's work by Assistant Hodgkins. Assistant Nelson was detached on June 20, 1899, and remained on duty in Washington until June 30, preparing estimates for field work in Porto Rico and on Chesapeake Bay.

RITTER: ALASKA, Copper River.

TRIANGULATION.
TOPOGRAPHY.
HYDROGRAPHY.

E. B. LATHAM, *Assistant*. July 1 to Oct. 1, 1898.
H. C. DENSON, *Aid*.

SUMMARY OF OPERATIONS.

May 23 to October 17, 1898.

1 000 square miles reconnoissance.
1 697 meters secondary base lines.
1 000 square miles triangulation.
19 triangulation stations.
5 stations for vertical angles.
65 geographic positions.
47 elevations determined trigonometrically.
3 latitude stations.
2 chronometric longitude stations.
2 azimuth stations.
2 magnetic stations.
500 square miles topography.
100 miles coast-line topography.
300 miles rivers and creeks and ponds.
1 topographic sheet, scale 1:80 000.
70 square miles hydrography.
48 geographic miles sounding lines.
246 angles measured.
4 tidal stations established.
1 current station.
1 hydrographic sheet, scale 1:40 000.
180 photographic views.

The entrance to the Copper River has assumed, within the past few years, an importance much greater than it previously had. In order to develop the geography of this region, a Coast and Geodetic Survey party was sent there in the summer of 1898. Landing in the vicinity of Orca on May 22, Assistant H. P. Ritter, under whose direction the operations were being conducted, immediately began a triangulation of the surrounding country. His party consisted of E. B. Latham, Assistant; H. C. Denson, Aid; one foreman, and eight hands.

Astronomical observations were made at several points, notably at Orca and at Kokinhenic. The work lasted from the end of May to the beginning of October, and comprised a survey of the delta and vicinity, roughly embracing about 1 000 square miles. The triangulation, of which the base was in the vicinity of Kokinhenic astronomical station, covers the entire delta, and many observations were taken on the mountains lying to the east, north, and west. This work served to locate them in position and to determine their heights.

Hydrographic examinations were made at the mouth of the river and other places. The plane-table work covered the shore line, positions of sloughs, reefs, etc., and the tidal observations were used in reducing the hydrographic work. Meteorological observations were also made, as well as magnetic observations, at Orca and at a point in the middle of the delta. A large part of the topography was executed by application of the photo-topographic method. A map on a scale of 1:80 000 was prepared from the results of the season's work.

The scientific operations, stated somewhat more in detail, were as follows: A base line of 1 697 meters was measured on Kokinhenic Island, with a 50-meter steel tape. The triangulation was extended from the base line in such directions and for such distances as to control the area of the delta. Observations for elevation of mountain peaks were made by the measurement of double zenith distances of each peak, from several stations. These observations were made by Aid H. C. Denson.

The latitude and longitude of Orca was determined, the former by the observation of 9 pairs of stars, 29 determinations being secured in all. The longitude depends on the transportation of chronometers determining a sea rate from observations at San Francisco and Seattle and a land rate after having carried the chronometer ashore and made sufficient observations for this purpose. A second astronomical station was made at Kokinhenic, at which both latitude and longitude were determined. No azimuth observations, however, were obtained at either Orca or Kokinhenic Island. A third astronomical station was made at station "Pete," at which only latitude determinations were made.

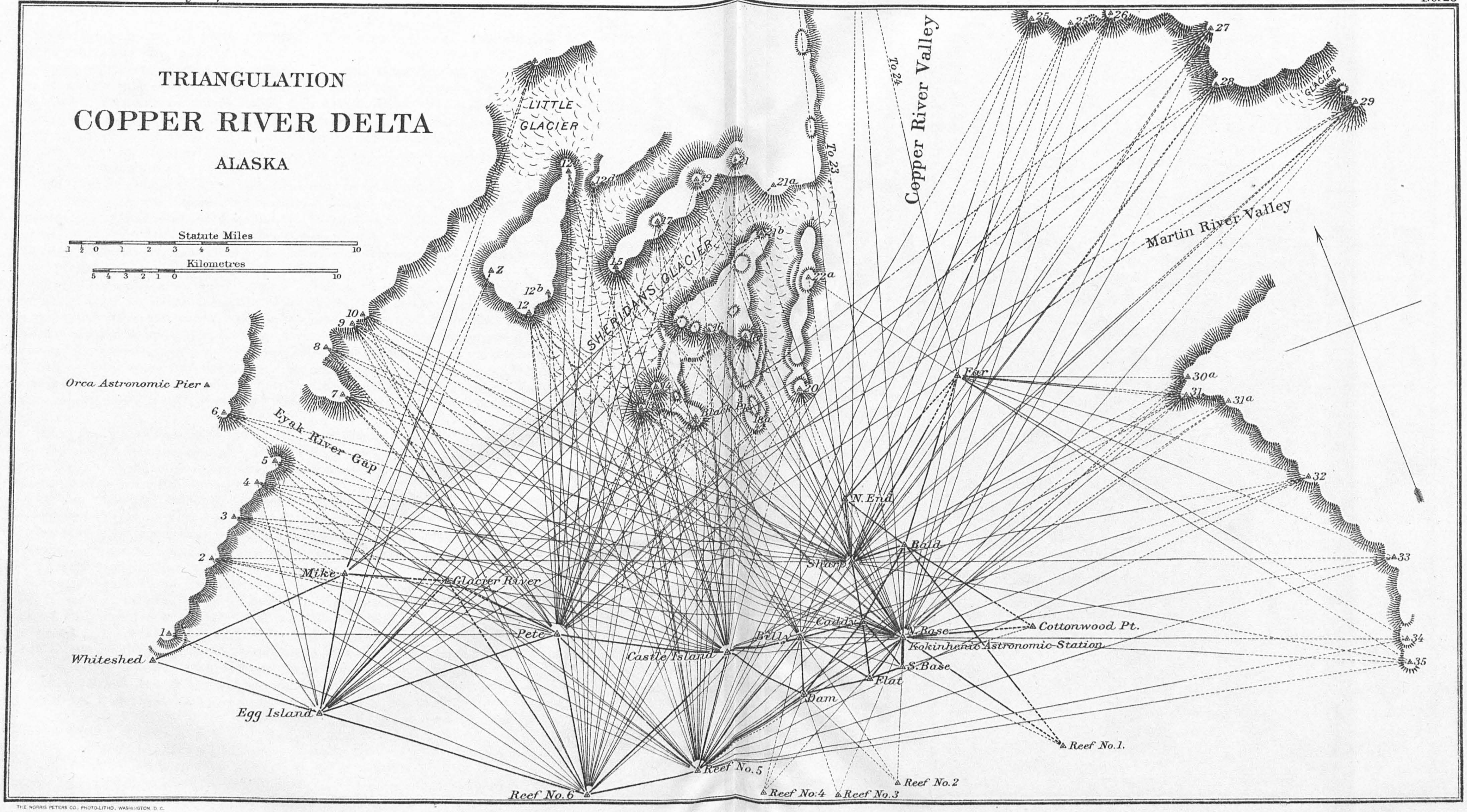
Tidal observations were carried on at all stations occupied by the party, namely: Orca, Kokinhenic, Pete Dahl Slough, and Eyak River. These observations were made in such a way that the series for consecutive stations overlap, thus fixing the relation between the tides at the two stations.

At both Orca and Kokinhenic magnetic observations were made, those in the former place on May 27, 28, and 29, and in the latter on June 19, 20, and 21.

The photo-topographic camera was continually used and the necessary developing accessories were carried along, so that the negatives were largely developed in the field. Owing to the general unfavorableness of the weather, no systematic scheme could be carried out, although a large amount of valuable data was obtained. One hundred and eighty views were taken with the topographic camera and 88 with an ordinary view camera. This work was largely executed by Assistant E. B. Latham.

Speaking generally, it may be said that the triangulation was executed chiefly by Aid H. C. Denson, the astronomical and photographic work by Assistant E. B. Latham, and the topography, hydrography, and magnetic work by the chief of party.

The country in the vicinity of the mouth of the Copper River, as seen when approaching it from the sea, has the appearance of a vast mountain range, whose tops are covered with perpetual snow. Innumerable glaciers move down the mountain sides and fill the deeply-cut canyons. From the head of the delta to the ocean reef is a distance of about 25 miles. The delta is 50 miles wide and the mountains range from 1 000 to 8 000 feet in elevation. The flats at the mouth of the river are cut up into numerous islands by the many tidal sloughs and small streams flowing from the



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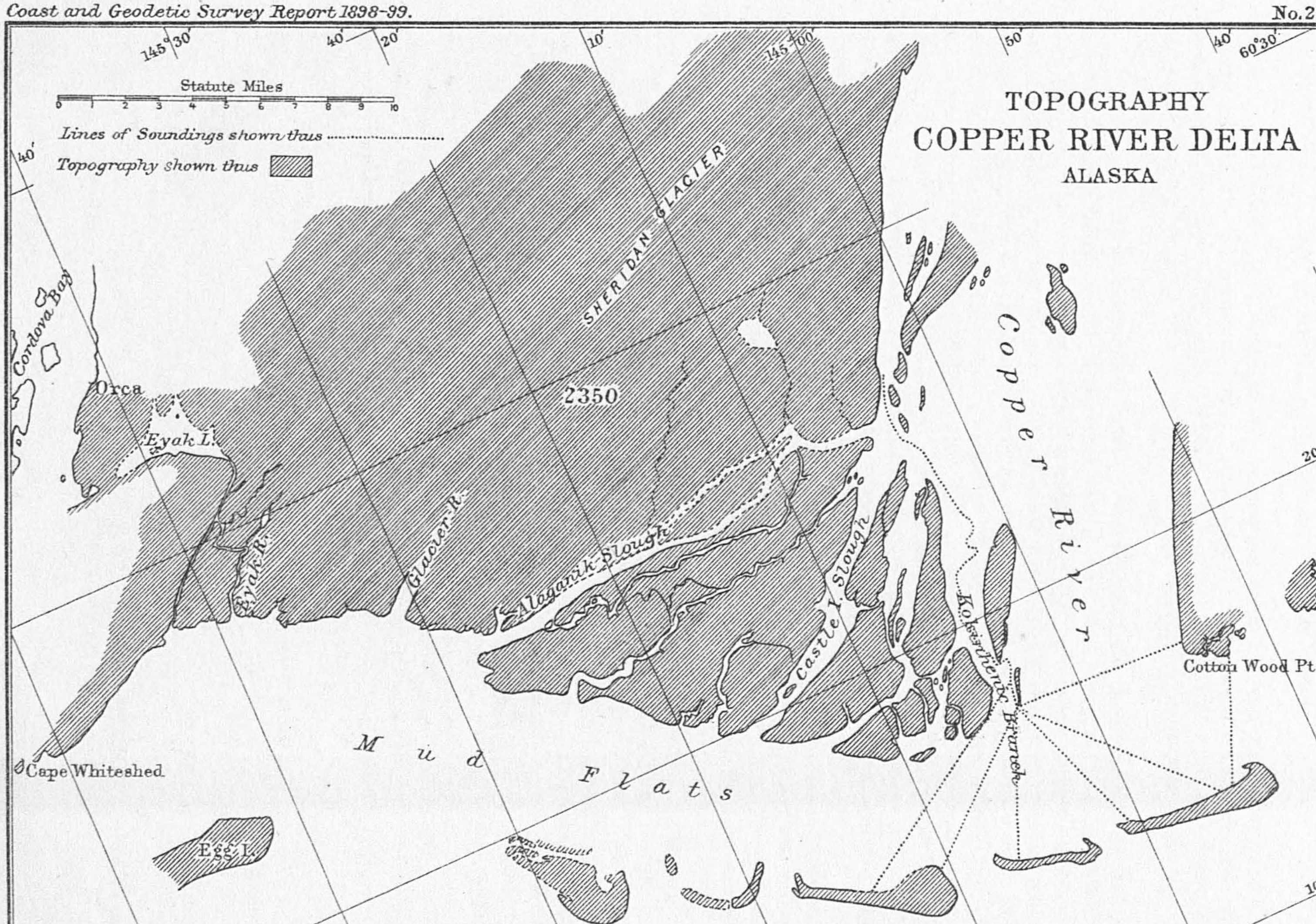

TOPOGRAPHY
COPPER RIVER DELTA
ALASKA
Statute Miles
Lines of Soundings shown thus
Topography shown thus
Cordova Bay
Orca
Eyak L.
Eyak R.
Glacier R.
SHERIDAN GLACIER
2350
Alaganik Slough
Castle I. Slough
Copper River
Kokenhenic Branch
Cotton Wood Pt.
Cape Whiteshed
Mud Flats
Egg I.

glaciers. Many interesting features may be noted in regard to this particular locality, among which may be mentioned the violent winds, which begin during the month of September and last with little intermission through the winter until early spring. They are of such violence that it is impossible for anyone to cross the delta while they prevail.

The body of water intervening between the flats and the ocean reefs is navigable to boats drawing from 3 to 4 feet of water, and is, in places, navigable to these only at high tide. By the receding tide an area of about 250 square miles is completely drained, and the surface presents nothing but one unbroken expanse of mud. The currents during the rising tide are extremely swift, as the ocean reef acts as a barrier until the water rises over it, when it flows in with great rapidity. The average temperature of the delta during the months of June, July, and August was found to be about 50° F. During the month of September it is 10° less, accompanied by freezing weather during the nights. The vegetation is very marked. On the flats are found flowers and marsh grass. On the sand dunes are alders, berry bushes, and cottonwood trees; while on the mountain side hemlock and firs grow in abundance.

From the head of the delta to where the river leaves the marsh and spreads out over the mud flats it flows nearly south, is about 5 miles wide, and consists of numerous changeable channels, varying in depth from 5 to 20 feet. The river breaks through the mountain range about 30 miles from the coast, and is here flanked on the east side by Miles Glacier and on the west by Childs Glacier. In this vicinity are the rapids, which form an insurmountable barrier to all kinds of upstream navigation except in canoes.

The most western branch of the delta is known as the Alaganik Slough, being the most extensively traveled and important branch of the river. Its length is about 15 miles, and it varies in width from one-half to 1 mile, with depths from 5 to 15 feet, depending on the stage of the tide. This branch is a tidal stream. The average tide at the lower end during the stay of Assistant Ritter's party was about 10 feet, while at Alaganik, at the upper end, the tide was from 2 to 3 feet. The navigation of this branch is facilitated by the fact that during flood tide the direction of the current is east, while at ebb tide it is west. This effect is felt as far as Alaganik.

There exist on the Copper River Delta two large canneries—one at Orca and another at Odiak. The fishing season begins about May and ends with July. During this time each cannery turns out about 30 000 cases.

PRATT: ALASKA, Yukon River.

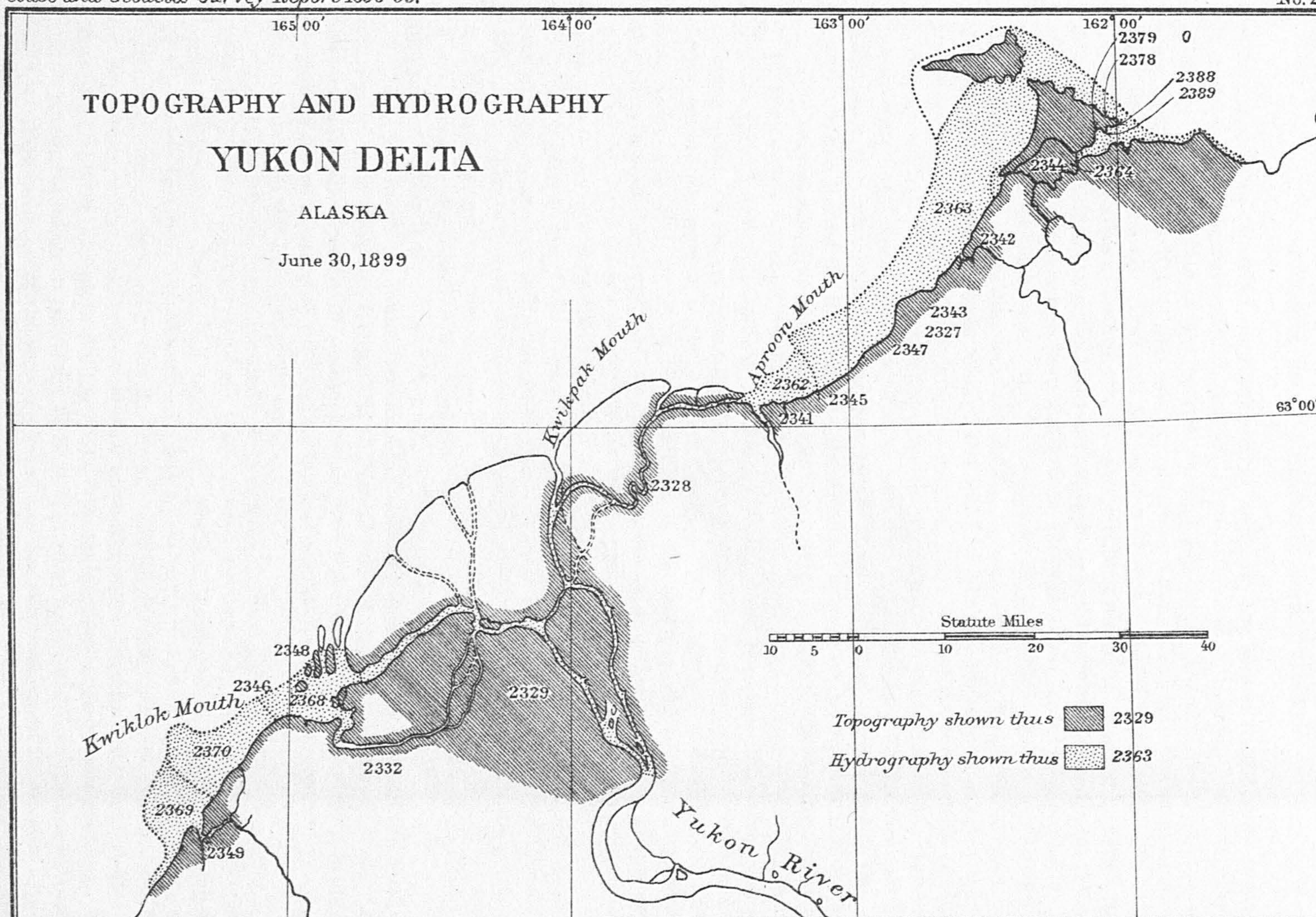
TRIANGULATION.
TOPOGRAPHY.
HYDROGRAPHY.

G. R. PUTNAM, *Assistant.*
F. A. YOUNG, *Assistant.*
A. L. BALDWIN, *Assistant.*
R. L. FARIS, *Assistant.*
R. B. DERICKSON, *Aid.* — July 1 to Sept. 26, 1898.
G. H. PRATT, *Foreman.*
Dr. H. M. W. EDMONDS, *Foreman.*
CRITTENDEN VAN WYCK, *Foreman.*
Dr. G. A. HUNTLY, *Foreman, Tidal Observer;* and 31 petty officers, cooks, and hands.

SUMMARY OF OPERATIONS.

3 025 meters primary base line.
8 427 meters secondary base line.
1 136 square miles triangulation.
54 triangulation stations.
1 station for vertical measures.
81 geographic positions.
11 trigonometric elevations.
3 latitude stations.
4 longitude stations.
2 azimuth stations.
1 pendulum station.
7 magnetic stations.
65 miles coast-line topography.
48 miles creeks and sloughs.
46 miles river shore line.
27 topographic sheets, scale 1:1 000, 1:10 000, 1:20 000.
263 miles river shore-line reconnoissance.

The importance of more complete knowledge of the route to the gold fields of Alaska made it incumbent upon this service to thoroughly explore the mouth of the Yukon. Early in June of the last fiscal year Assistant J. F. Pratt, with a large and well-equipped party, left Seattle for St. Michael, where they arrived on the 29th. The greater part of the party was taken on the U. S. S. *Wheeling*, while several members were left behind to superintend the shipment of freight and supplies. Two small steamers were taken along, one of which was transported in pieces and was put together on the beach after landing at St. Michael. On June 30 the party moved ashore and went into camp. The following day signal lumber was purchased at the



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

rate of $100 per thousand, and the actual work of the season immediately began. It may be stated, parenthetically, that freight for the use of this party was delivered from Seattle at the rate of $12.50 per ton and lumber at $20 per thousand, but as some delay occurred it was necessary to purchase enough lumber on the ground to begin operations at once. Coal cost $17 per ton delivered on the beach at St. Michael.

The steamer *Nelson*, with the stores, material, and outfit, and having on board the steamer *Yukon*, already mentioned as having been shipped in pieces, arrived on the 3d of July. On the 11th enough material was on shore to begin laying the keel. This continued until the 15th, when the *Taku* arrived in a disabled condition. In order that she might begin work as soon as possible, all available force was diverted from the *Yukon* and put upon the *Taku*, and on the 30th she was able to be sent to sea. Work was now resumed on the *Yukon*, and she was launched August 20, forty-one days after laying her keel. Subtracting the time given to the *Taku* and other unavoidable matters, twenty-nine days' work were required to put the *Yukon* together. She was put in commission immediately, and on August 23 stores and equipment were on board, and at 2.15 a. m. she started for the mouth of the Kwiklok by way of the Aproon Mouth.

She was engaged at this point until September 10, being officered by Assistant J. F. Pratt, with Assistant Faris, detached from the *Taku*, and Foreman Van Wyck.

On July 18 Assistant Baldwin, with Aid Derickson and Foreman Pratt, started with camping outfit, on board scow, to take up work from the southern end of St. Michael Island and to continue it to the Aproon Mouth. This work had already been carried from Camp Pritchett, in St. Michael Harbor, to the southern end of the island while the party was still in camp and engaged in outfitting and launching the *Yukon* and preparing the *Taku* for her work. When the party arrived at the Aproon Mouth the scow was taken in tow by the *Yukon* and carried to the mouth of the Kwiklok.

The repairs to the *Taku* were completed on August 1, the stores were placed aboard, and at 2 p. m. she set sail, with Assistants Putnam, Faris, and Young and Foreman Edmonds. The first work consisted in the occupation of Stevens triangulation point on St. Michael Island and the erection of a signal on the highest peak of Stuart Island. Then, going to the mouth of the Kwiklok, the regular work of the season was begun and prosecuted until the 26th of August, when the *Yukon* arrived.

In going south a running reconnoissance of the Aproon was made to the head of the Passes, then down the Kwiklok to the mouth, where the camp was established. On August 26th the *Taku*, with a steam launch, was sent around to the Kripniyuk in order to make a reconnoissance of this locality both as regards hydrography and topography. She returned on the 7th of September.

On the 10th the camping party of Assistant Baldwin, which had been employed near the mouth of the Kwiklok, was taken aboard, and the two vessels, with the scow and steam launch in tow, started back to St. Michael, having on board all the members of the three parties. The same route was followed as in coming south. Nothing of particular interest occurred during the voyage, and St. Michael was reached on the 13th of September. The vessels were hauled out and housed, together with the two steam launches and scow, and eight pulling boats. At midnight on the 26th of September the entire party was taken on board the U. S. S. *Wheeling*, which had been waiting for three days for the conclusion of the season's work, and the start was made for Seattle.

While laying up the vessels considerable work was done in the vicinity of St.

Michael, as there were occasions during which some members of the party would not have been otherwise employed. A base was measured by Assistant Baldwin, Aid Derickson, and Foremen Huntley and Pratt. The improvements of the Alaska Exploration Company were surveyed by Assistant Putnam, and an addition to the topographic work already done was made on the military site, on a scale of 1:1 000, by Assistant Faris and Aid Derickson. The continuation of the hydrography of the military water front, on a scale of 1:1 000, was also carried on by Assistants Young and Baldwin and Foreman Van Wyck. This closed the work of the season, which must be regarded as extremely satisfactory, both as regards amount and quality, when the great disadvantages under which the party labored are taken into account.

The season's work may be classified, as regards its character, under the following heads:

RECONNOISSANCE.

This consisted of an examination of the principal passes of the Yukon River by Assistants Putnam, Young, and Faris, in the steamer *Taku*.

ASTRONOMICAL WORK.

Time observations were made at St. Michael, for use in the determination of gravity and for carrying chronometric longitudes to the stations in the delta. Three points were determined longitudinally—one at the head of the Aproon Pass, one on the lower Kwiklok, and one on the Kripniyuk. These controlled the work effectually as far as its longitude was concerned. The observations were made by Assistant Putnam, and were highly satisfactory.

MAGNETIC.

Four stations were occupied for this class of observations—one at St. Michael, one at the mouth of the Pastoliak, one at the astronomical station on the Kwiklok, and one inside the entrance of the Kripniyuk. At all points the three elements—declination, dip, and intensity—were determined on several days.

BASES.

Wherever a triangulation was developed the measurement of a base line was necessary, and we therefore have these operations on the Kwiklok, on the Kripniyuk, and at St. Michael on the tundra back of Camp Pritchett. This last was measured with great care by Assistant Baldwin, assisted by Aid Derickson and Foremen Pratt and Huntley. The apparatus employed in all the base measurements in Alaska during the season was a steel tape. One of the bases was measured with an ordinary 25-metre steel tape and two were executed with a 50-metre steel tape, No. 205, which was standardized in connection with the Versailles base, in Missouri.

TRIANGULATION.

The triangulation was first begun at St. Michael astronomical station, and carried by Assistants Young and Baldwin to the southern end of the island. This was done, as before stated, while in camp at the landing point. From the southern end of the island to the Aproon entrance the work was carried on by Assistant Baldwin, with Aid Derickson and Foreman Huntley. The entire scheme embraces about 50 miles of triangulation, and, although not of the first order of accuracy, is amply strong for all work which will be based upon it for the next fifty years. None of the Alaska work, in fact, has been pushed to the extreme limit of accuracy, as the object for which it is done can be attained equally as well and more economically without employing the refinements adopted in more thickly settled localities. A rapid triangulation was made at the lower end of the Kwiklok by Assistants Young and Baldwin, and at the entrance of the Kripniyuk by Assistant Young.

TOPOGRAPHY.

The rival claims by commercial companies doing business in Alaska made it necessary to survey the water front at St. Michael. At the request, therefore, of the commanding officer of the United States military reservation this work was taken up and completed as soon as possible. The intervals before the arrival of the *Taku* and at the last of the season, while closing up the affairs of the party, were utilized by making a topographical survey, on a scale of 1: 1 000, by Assistant Faris and Aid Derickson. After the completion of this a tracing of the field sheet was furnished to the commanding officer.

The topography between St. Michael Harbor and the Aproon, including the Aproon entrance and the canal separating St. Michael Island from the mainland, were all executed on a scale of 1:20 000, with the plane table, by Foreman Pratt, while attached to the camping party under Assistant Baldwin. The topography around the Kwiklok entrance was also done, on a scale of 1:20 000, by Assistants Faris and Putnam and Foreman Pratt. At the mouth of the Kripniyuk Assistant Putnam made a topographical survey on a scale of 1:20 000.

TIDAL OBSERVATIONS.

In order to reduce hydrography and make it comparable with a standard datum plane it is necessary to observe the rise and fall of the tides during the period of operations. With this end in view, measurements of the tide were made at Camp Pritchett, St. Michael Bay, from July 15 to August 27 and from September 13 to 24. Near the mouth of the canal to the entrance of the Aproon tide gauges were established and read by Assistant Baldwin's party. On the Kwiklok a self-registering tide gauge was maintained between August 7 and September 10. A staff gauge was also established somewhat nearer the entrance, and finally, at the Kripniyuk, a self-registering gauge was kept in operation for more than a month following August 7.

HYDROGRAPHY.

The operations carried on in this important branch of the season's work were a survey of the St. Michael water front, on a scale of 1: 1 000, for the commandant of the reservation. This was executed by Assistants Young and Faris and Foreman Van Wyck. Two lines of soundings were also run from the pass between Stuart and St. Michael Island to the Aproon entrance. The canal separating St. Michael Island from the mainland was also sounded. The Aproon bar and entrance was developed by the camping party under charge of Mr. Baldwin. During the reconnoissance carried on by the party under Assistant Putnam soundings were made in the channel line through the Aproon to the intersection with the Kwikpak, up the Kwikpak to the head of the passes, down the Kwiklok to the mouth, and also through the cut-off connecting the Kwikpak with the Kwiklok entrance. The bar opposite the Kwiklok mouth was also examined, as well as the Kripniyuk entrance. It was the original intention of Assistant Pratt to make a thorough examination of the bar off the mouth of the Yukon, which is said to extend 40 miles to the southward; but the amount of other work was so great and the progress of the party was so impeded by gales that it was not possible to take up this work until late in the season, and therefore little could be done. Besides, at this time of the year the weather was exceptionally bad and the work was much retarded. No systematic detailed operations were undertaken on this bar, but a general reconnoissance was made.

CONCLUDING STATEMENT.

The season of work during the summer of 1898 at the mouth of the Yukon brought out some very interesting and important facts, which is necessarily the case in all new surveys of an unknown and important region. Contrary to the usually accepted idea, the Kwiklok Channel runs parallel to the shore until about half way to the Kripniyuk, when it turns seaward, and after passing beyond the sight of land it spreads out onto a bar with from 6 to 8 feet on it at low tide. The shores in the vicinity of the Kwiklok mouth appear to be about 25 miles farther to the westward than is indicated on the published charts, making an increase in the area of land in this one locality of about 2 500 square miles.

Assistant Pratt recommends the publication of a chart on a scale of 1:20 000 immediately, and that such chart be sent north with the first party the following year, in order that new buoys may be marked upon it and that it may be distributed for the benefit of commerce.

At low tide there are only two feet of water on the bar of the Aproon Channel, while at the Kwiklok entrance there are 8 feet. This would seem to speak in favor of the latter as the main entrance, but unfortunately the entrance to the channel is so far from the shore that no landmarks are available to guide the pilot, whereas the entrance to the Aproon Channel, although with very much less water than at the Kwiklok, has the inestimable advantage of being close to shore, so that vessels need not lose sight of land in the entire passage from St. Michael to the entrance.

Assistant Pratt also recommends a chart on a scale of 1:200 000, extending from Besboro Island to Cape Dyer, stating that such chart would be of assistance to vessels trying early to get to St. Michael and passing between the Yukon bar or flats and the Bearing Sea ice, which at that time of the year has been swept a considerable distance offshore by the currents from the river.

There seems to be no reasonable doubt that the upriver traffic for many seasons to come will be by deep-water craft to St. Michael and by river steamers from this point, going by way of the Aproon entrance. This necessitates a transfer at St. Michael, which often involves much loss of time, since the arrival of the river steamers is uncertain by several weeks, on account of the varying condition of the water in the river. While the passenger traffic to the Klondike region will remain as at present through the Lynn Canal and over the passes by way of Dyea and Skagway, the freight will go by way of St. Michael and by the Yukon River. From 60 to 70 regular river steamers are now engaged in the carrying business, and notwithstanding this comparatively large number, freight was left behind at the end of the season. It is hoped that the examination of Scammon Bay, near Cape Dyer, will develop conditions that may possibly enable seagoing vessels to discharge at docks in this locality. If this were the case, and if the Kwiklok entrance were artificially marked, the freight transportation to the Klondike would be considerably cheapened.

On leaving St. Michael, Assistant Pratt states that the steamers *Taku* and *Yukon*, with the 2 steam launches, 8 pulling boats, 1 scow, and miscellaneous outfit, were left near the military headquarters, in charge of the commanding officer, and during the past season sufficient coal (300 tons) and lumber were procured and stored for the next season's work. This will enable the following parties to take up the operations more rapidly and accomplish a full season's work. The instruments were brought back to Seattle.

In conclusion it might be stated that, under the most favorable circumstances, the parties operating in this part of Alaska can not expect more than about sixty or seventy working days throughout the season. Assistant Pratt's party landed on the 30th of June, just eighteen days after the ice had left the bay, and departed on the 26th of September, none too soon to close work in this latitude. The time, therefore, between beginning and closing the work was only eighty-nine days. Deducting Sundays and periods of exceptionally bad weather, when no work was possible, the work of the season is reduced to about two months.

From October 16 to April 20, 1899, Assistant Pratt was in charge of the suboffice at Seattle, Wash., during which time he erected and established a self-registering tide gauge at that port, mention of which has been made in the description of tidal operations. On April 21 he proceeded under instructions to San Francisco, and on the 25th took command of the United States Coast and Geodetic Survey steamer *Patterson*. From this date until the 18th of June the time was spent in repairing the ship and launches, shipping a naval crew, and equipping the vessel for a voyage to the northern Bering Sea.

The party left San Francisco on the 19th, and arrived at Seattle on the 26th. The time from this last-mentioned date until the end of the fiscal year was spent in repairing the main boilers, which had been broken down on the trip north, and taking on board coal and lumber, and miscellaneous stores for the Alaskan work.

PUTNAM: ALASKA, Yukon River.

TRIANGULATION.
HYDROGRAPHY.
TOPOGRAPHY.

G. L. FLOWER, *Assistant.*

July 1 to Sept. 26, 1898.
June 20 to June 30, 1899.

SUMMARY OF OPERATIONS.

(See Pratt, Triang., etc., Alaska.)

Assistant G. R. Putnam was attached to the party of Assistant Pratt from July 1, 1898, to February 20, 1899. The period covering field work extended from July 1 to September 26. From August 1 to the end of the season he had charge of a subparty working from the steamer *Taku* at the mouth of the Yukon and Kripniyuk rivers, Alaska.

On March 1, 1899, he reported at the Office in Washington, and until March 27 was engaged in various duties connected with his Alaska work. He was then assigned to the Computing Division, and assisted in the preparation of a new edition of an astronomical manual on the determination of time, latitude, longitude, and azimuth, by Assistant J. F. Hayford.

On May 1 he left Washington, under instructions of April 27, and proceeded to San Francisco. Sailing from Seattle on June 10, his party reached St. Michael on the 20th, and was engaged in preparing vessels and outfit for the work of the season until the close of the fiscal year. In this latter work Assistant Putnam had charge of a separate party, in cooperation with the parties of Assistants Pratt and Faris, and the particular work assigned to him was the locality of Scammon Bay and the mouth of the Yukon River in that vicinity.

On May 8 Assistant G. L. Flower left Baltimore, Md., for Seattle, Wash., to join Assistant Putnam's party, to be engaged in hydrography and topography, in the vicinity of the Yukon River, Alaska. He was still attached to this party at the close of the fiscal year.

FARIS: ALASKA, Yukon Delta.

TRIANGULATION.
HYDROGRAPHY.
TOPOGRAPHY.

H. F. FLYNN, *Assistant.*
G. S. PHELPS, *Aid.*
R. B. DERICKSON, *Aid.*
D. W. EATON, *Topographer.*
J. A. FRENCH, *Foreman.*
G. A. HARRIS, *Foreman.*
J. E. MCGUIRE, *Recorder.*
CARL E. MORFORD, *Recorder.*

July 1 to Oct. 3, 1899.

On the 27th of April, 1899, instructions were issued to Assistant R. L. Faris for the execution of triangulation, topography, and hydrography in Alaska. The work contemplated the delineation of the shore line of St. Michael and Stuart islands and a development of the hydrography sufficient to show the limits of the 3-fathom curve on the north and west side. The passage between the islands was also to be examined and a general survey made of the Kwikpak mouth of the Yukon Delta and other passes, as opportunity offered.

Upon the receipt of these instructions, Assistant Faris, although on duty in the Computing Division, undertook preparatory work at the same time and was able to leave Washington on the 17th of May for Seattle, where the equipment and organization of the party was to be completed. Arriving at the latter place on the 22d of May, organization was immediately begun, in cooperation with Assistant G. R. Putnam, who had arrived at the localtity, having gone from Washington via San Francisco to make preliminary arrangements with Assistant J. F. Pratt concerning the transfer of certain outfit and instruments necessary for the Alaska work.

It was at first assumed that the Coast and Geodetic Survey steamer *Patterson* would be able to transport the parties to the field of operations, but it was later decided to go by commercial steamer, as, otherwise, considerable delay would have been entailed. The two parties therefore—those of Assistant Putnam and Assistant Faris—sailed from Seattle on June 10 on the steamer *Roanoke*, and after a sea voyage of fourteen days arrived at St. Michael on June 24. The parties landed the following day, and preparations were immediately begun for field operations, which began on the 9th of July.

A detailed statement of the work accomplished during the season will appear in the next annual report.

E. SPECIAL DUTY.

SCHOTT: ENGLAND, Bristol.

SPECIAL DUTY.
Representative.

Sept. 7 to Sept. 14, 1898.

Under instructions of July 29, 1898, Assistant C. A. Schott was directed to attend, as representative of the Coast and Geodetic Survey, the International Conference on Terrestrial Magnetism, to be held between September 7 and 14 at Bristol, England.

This conference was held in connection with the meeting of the British Association for the Advancement of Science, which very materially added to its interest and to the practical results attained. The first magnetic conference was held at Cambridge in 1845, but the present one is the first of an international character since that time. A permanent committee for magnetism and atmospheric electricity was appointed at the International Meteorological Conference held in Paris in 1896, and consisted of 8 members, with power to add to their number. The British Association allowed the Magnetic Conference to organize as a branch of Section A—" Mathematics and Physics"—and besides the President, Prof. A. W. Rücker and the English delegates, foreign members were present from Potsdam, Helsingfors, Vienna, Paris, Rome, St. Petersburg, Gotha, and Washington.

Two meetings were held daily—one public, the other devoted exclusively to consultation and discussion. Several questions of interest were taken up for deliberation: First, whether in differential observations simple means shall be given of hourly tabulation or whether they shall be accompanied by means derived from undisturbed values. Second, discussion respecting the desirability of publishing, besides usual values for declination, dip, and intensity, at least for the months of January and July, the components of the magnetic force toward the north and west, and the vertical. Third, discussion respecting the relative value of long and short magnets. Fourth, the principal work of the conference, however, was on the question of magnetic observatories, their present unsatisfactory distribution over the globe, and their inadequacy as regards number. The United States is now in position to render great service in this line by establishing an observatory in the Hawaiian Islands. This position is unique, being central to a vast area unexplored for magnetism and largely unknown. It is well adapted for special study. Fifth, the disturbing effect of electric tramways when passing within a mile, or even within several miles, of observatories, was commented upon. Sixth, attention was given to the greater need for observatories in the southern than in the northern hemisphere.

Many special papers of great value were presented to the conference by foreign and home delegates. The proposition by the delegate of the United States that an observatory should be maintained for a series of years in Hawaii was received with acclamation.

The results of the meeting will be made known in a report to be made to the International Meteorological Conference, and publication of the discussions may be expected in the proceedings of the Bristol meeting.

Too much praise can not be bestowed on the effective manner in which the sessions of the conference were conducted. The generous hospitality extended by the British association and the chamber of commerce at Bristol will long be remembered by all the visitors.

PRESTON: VIRGINIA; GERMANY, Stuttgart.

MAGNETIC.
SPECIAL DUTY.
Representative.

Aug. 10 to Aug. 15, 1898.
Oct. 3 to Oct. 12, 1898.

SUMMARY OF OPERATIONS.

1 magnetic station.

In accordance with instructions from the Superintendent, dated August 8, 1898, magnetic observations were made by Assistant E. D. Preston at Cherrydale, Va., from August 10 to 15, determining declination, dip, and horizontal intensity. The result of the observations indicates that the declination at the station has been increasing since 1896 at the rate of about 2½ minutes annually and that the dip has been decreasing about 1 minute annually.

REPRESENTATIVE DUTY.—STUTTGART MEETING.

Under instructions from the Superintendent, dated July 29, Mr. E. D. Preston, Assistant and Executive Officer, attended as delegate from the United States the meeting of the International Geodetic Association, at Stuttgart, Germany, from October 3 to 12, 1898. He was instructed to examine en route the foreign offices similar to our own in England, France, and Germany.

Leaving Washington on September 19 and New York on the 20th, Bremen was reached on the 29th and Berlin on the same day. Arriving at Stuttgart on the evening of October 2, the meetings of the conference were attended daily until the 12th. Paris was reached on the evening of the date last named. Five days were devoted to the war office, geographic section, and the International Bureau of Weights and Measures, at Sevres. Leaving Paris October 18, Southampton was reached on the same day, and the ordnance survey office was visited on the 19th. Leaving Southampton on the evening of the 19th, New York was reached on the 27th and Washington on the 28th.

A report on this duty was published in the Coast and Geodetic Survey Report for 1897–98, and an abstract of the proceedings of the meeting at Stuttgart will be found attached to the present Report as Appendix No. 3.

HAYFORD, HARRIS: BOSTON, American Association for the Advancement of Science.

SPECIAL DUTY.
Representative.

Aug. 22 to Aug. 27, 1898.

In August, 1898, Assistant J. F. Hayford, Inspector of Geodesy, attended the Boston meeting of the American Association for the Advancement of Science, and of the Second Conference of Astronomers and Astro-Physicists, at Harvard Observatory, as a representative of the Coast and Geodetic Survey. He took part in the discussions of papers read, and presented a paper entitled "The Limitations of the present Solution of the Tidal Problem." Upon his return he presented a short report, consisting of notes upon the various papers read at the two meetings which were of special interest to this Survey.

Dr. R. A. Harris, of the Tidal Division of the Coast and Geodetic Survey Office, was also a delegate on the part of this bureau at the meeting of the American Association for the Advancement of Science. The following papers were presented by Dr. Harris at the meeting:

(1.) "On harmonic functions."
(2.) "A proposed tidal analyzer."
(3.) "A tidal abacus."
(4.) "The harmonic analysis of high and low waters."

The first paper treats of particular solutions of Laplace's equation and those of certain other partial differential equations analogous to it. Some account of this paper is given in the Bulletin of the American Mathematical Society, Vol. V (1898), pp. 96–98.

The object of the second paper is to show the feasibility of constructing a machine such that if into it the hourly heights of the sea be entered once they will be distributed and added in the various ways required in tidal work. This paper appears in the Physical Review, Vol. VIII (1899), pp. 54–60. (See also Coast and Geodetic Survey Report, 1897, pp. 540, 541.)

The third paper describes an apparatus which, once constructed for a given port, enables a person to mechanically determine the height of the tide at any given time. The apparatus exhibited at this meeting was designed for Port Townsend, Wash. The times and heights of the tides were shown to agree reasonably well with those obtained from the tide-predicting machine. A general description of the apparatus is given on pp. 183–185 of the Coast and Geodetic Survey Report for 1894.

The fourth paper aims to give a thorough method for the harmonic analysis of high and low waters. The essential parts of this method are given upon pp. 569–572 of the Coast and Geodetic Survey Report for 1897.

SINCLAIR: CALIFORNIA AND NEVADA BOUNDARY.

SPECIAL DUTY.
TRIANGULATION.
BASE LINES.
TOPOGRAPHY.

W. B. FAIRFIELD, *Assistant.*
H. F. FLYNN, *Aid.* — Oct. 24, 1898, to June 13, 1899.
F. W. EDMONDS, *Clerk.*

SUMMARY OF OPERATIONS.

870 horizontal angles measured.
619 vertical angles measured.
70 triangulation stations.
96 geographic positions.
130 miles triangulation along boundary.
400 miles of boundary line corrected.

Assistant C. H. Sinclair was on leave from the 1st to the 15th of October. From the 16th to the 20th he was organizing a party for the prosecution of the boundary survey between California and Nevada. Leaving San Francisco on the 20th for Carson City, with such members of the party as had been engaged, they reached the latter place next day. Their first occupation was to overhaul the outfit and to send it to Bishop, Cal., where the animals were in pasture and where the wagons had been stored in 1895.

The party reached Bishop on October 24 and were employed until the 30th in the ordinary preparations of a party to be engaged in work of this kind. It must be remembered that a large party was to be transported over 200 miles of country for the most part uninhabited and with but few watering places. The start on this long journey was finally made on October 31.

The party consisted of 11 persons, 2 6-mule wagons, 1 thorough-brace and 2 buckboards, 5 saddle horses and 3 pack mules; a total of 26 animals. There were two additions to the party later, making in all 13 persons. The animals being fresh from pasture, could go but slowly at first; moreover, the distances traveled were to a great extent regulated by the watering places. On one day only 8 miles were traveled, on another it was necessary to make 35 miles, and it was not until the morning of November 12 that the party reached the scene of operations.

The first working camp was at Mound Spring, near the lower end of Ash Meadows and 6 miles north of the last station occupied in 1895, called T 105. This was to be occupied as a ranging station. Arrangements were made to have hay and grain hauled to this spring from Manse, 24 miles southeast. This ranch supplied the party with hay for 100 miles, and without it they would have incurred heavy expense in getting supplies from the railroad and from Fish Lake Valley by team.

The ranging out of the boundary between California and Nevada is a piece of work somewhat unique in its character. Six years before a point was selected near Lake

Tahoe, and from a calculated azimuth it was proposed to range out a line in the direction of a selected point near the Colorado River, more than 400 miles distant. A triangulation was carried on as a check and for the determination of distances, but the entire correction of the line was based on fore and back ranges, and, as the result subsequently proved, showed remarkable accuracy in the work. The random line from Lake Tahoe missed the terminal post at Colorado River by only 150·5 meters, and the discrepancy in the distance between the determination of a line 3 180·3 meters long, from the triangulation from Lake Tahoe and from a base measured at the Needles, was only 0·2 of a meter, giving an uncertainty of $\frac{1}{16\,000}$ part of the line determined. The discrepancy in azimuth, which was carried by angular determinations through the entire distance, was 10·2 seconds, and the discrepancy of latitude between the observed and calculated was 0·38 of a second. The longitude discrepancy, however, was much greater, being 8·60 seconds.

There were two intermediate bases measured. One, north of the White Mountains, on the railroad, was measured twice at night with a steel tape. Its length was 1 080·14 meters. The other was on the Great Amargosa Desert, which was also measured twice with a steel tape at night, and has a length of 1 464·95 meters. A base was also measured at the Needles four times with a steel tape, twice during the day with high temperature and twice at night. This base had a length of 1 709·33 meters. The starting line was derived from the Yolo base and was 3 017·2 meters long, so that the entire boundary line rests for its accuracy on the four base lines enumerated. These lines were not placed at equal distances along the work, as their position was determined from considerations of expediency and accuracy. The White Mountain base was 109 miles from the northern end of the line, the Amargosa base was 154 miles farther to the southward, and the Needles are 152 miles from this last-named base.

Two intermediate azimuths were observed, at the White Mountains and near the Amargosa base, but the entire line, as ranged out, depends on the initial azimuth measured at Lake Tahoe, where the tracing of the line was started.

Without going into the details of the field work, it may be said that the forward division was in charge of Mr. F. W. Edmonds, and the main ranging party under the immediate direction of Assistant Sinclair. Assistant W. B. Fairfield was in charge of the triangulation, and Aid H. F. Flynn made computations and assisted in all parts of the work.

The line passes over altitudes varying from 750 to 13 000 feet. The uncertainty of the azimuth from local deflections is probably 1 minute. This amounts to 600 feet in 400 miles, so that the errors of azimuth due to local deflections must have been largely compensating, since the error discovered at the lower end, after having ranged the line through a distance of 400 miles, was only 150 metres.

A topographical map of the Colorado River from Fort Mojave to the Needles, on a scale of 1:40 000, was made by Assistant Sinclair. The party reached the southern limit of the work on February 17, and immediately began the return over the line, correcting for the discrepancy observed at the termination and setting the final boundary marks.

In the first 70 miles only three stations could be put in by direct measurement of offset. The others were, therefore, lined in. By the end of February the work had reached Manvel. In order to save expense the party was now reduced to 7 men and

14 animals, which saved about $500 per month and reduced the monthly expenditures to $700. Lake Tahoe was reached on the 17th of June, and the stone at the beginning of the line was set in concrete and the work ended.

Stations T 5 and T 6 were under many feet of snow, and the labor of uncovering them would have been so great that they were left untouched. Most points were marked by a post with a cairn 4 to 5 feet high. When few stones were available a single stone with a drill hole was used, with a mound of sand and earth. Granite monuments, 6 feet long and weighing 856 pounds, were used at stations Nos. 1, 2, 11, 12, 13, 14, 24, and 27. The boundary posts were marked with the letters C and N, and were numbered on the northwest side.

The entire work consists of 14 topographic sheets, on a scale of 1:40 000, executed by Assistant Sinclair and Mr. Edmonds. The magnetic observations and photographs were made by Mr. Edmonds. The work of the season comprises 130 miles of triangulation and 400 miles of boundary line corrected. This involved the establishment of 96 geographical positions by the measurement of 870 horizontal angles and 619 vertical ones.

MARINDIN, Schooner *Eagre:* GEORGIA, Brunswick Outer Bar; MISSISSIPPI RIVER.

SPECIAL DUTY.
HYDROGRAPHY.
MISSISSIPPI RIVER COMMISSION.

G. L. FLOWER, *Assistant.*
E. R. FRISBY, *Aid.*
J. A. WHITNEY.
E. W. RITCHIE.

Nov. 19, 1898, to Apr. 12, 1899.

Under instructions from the Superintendent of the Coast and Geodetic Survey, Assistant Marindin reported to the Secretary of War on November 11, and on the 15th received the Secretary's order for a resurvey of the Brunswick Outer Bar. He arrived at the scene of operations on the 19th.

It had been arranged that the schooner *Eagre*, under command of Assistant F. W. Perkins, was to take up the hydrography of the interior waters of St. Simon Sound and Brunswick and adjacent rivers, and that Mr. Marindin's party, when not engaged on the Brunswick Bar work, should continue, under Assistant Perkins, the interior work just mentioned. For the prosecution of the bar work quarters were secured as near as possible to the proposed locality. It was, however, impossible to find suitable accommodations nearer than 12 miles from the bar, so that it was necessary to charter a small tugboat to take the party to and from the work and to make the necessary soundings. The expenses for this work, except the salaries of Assistants Marindin and Flower and Aid Frisby, were defrayed by the War Department.

The work progressed slowly on account of the exposed situation and the necessity of measuring the depths to tenths of a foot. The slightest disturbance in the surface of the water made accurate work well-nigh impossible, so that it was only on very rare occasions, when a perfectly smooth sea existed, that the work could be carried on. On December 22 and February 23 work was suspended for some time, in obedience to telegraphic orders from the Secretary of War, to allow the dredging of shoal spots which the sounding work had developed.

The *Eagre* arrived at Brunswick on December 12, and was employed as continually as possible on the work indicated. (For the details of this work see ante, p. 172.)

From December 1 to 14 Assistant Marindin was unavoidably absent as a member of the Mississippi River Commission, making a tour of inspection at the low-water stage of the river from Cairo to New Orleans. During his absence Assistant Flower was in charge of the Brunswick Bar work, and continued operations in favorable weather.

On January 20 Assistant Marindin received a communication from the Secretary of War, calling his attention to the fact that a report should be submitted, in conformity with the expressed wish of Congress, stating the amount of work done, its cost, and value to the Government. Material for such a report had already been accumulating in Assistant Marindin's hands. It was now taken up and put in shape. This report was transmitted on the 5th of June, accompanied by a comparative tracing showing changes since the beginning of improvements on the bar in 1871.

Among the numerous causes of delay in the prosecution of the work was the destruction of the eastern observing station on the bar, which was demolished by a cyclone. This was rebuilt by Colonel Goodyear, and its geographical position, together with the western station, which also suffered from the same cause, was determined by Assistant Marindin's party. There were two tide stations, one at the easternmost observing station and the other at the pier on St. Simon Island. They were occupied, however, only on days when sounding was executed on the bar. The tidal plane of reference had been obtained from the height of a bench mark on St. Simon Light-House. This plane of reference for heights had been fixed by Congress at average high tide instead of mean low water, as is usually taken. The survey was completed on April 12. Assistant Marindin arrived in Washington on the 17th.

From April 26 to May 5 his services were again required on the Mississippi River Commission, and a tour of inspection was made from Cairo to New Orleans, as in the previous December.

The plotting of the recent survey of the bar at Brunswick was completed on the 1st of June. The results were noted and incorporated in a report to the Secretary of War, which was transmitted through the Superintendent of the Coast and Geodetic Survey on July 8, 1899.

BRADFORD: ATLANTIC AND GULF COASTS.

SPECIAL DUTY.

Inspection of chart agencies.

June 2 to June 30, 1899.

Assistant G. Bradford, in addition to his duties as chief of the Chart Division, was Acting Hydrographic Inspector from July 1 to October 4, and from this latter date to the 1st of November was Hydrographic Inspector. From the last of November until the close of the fiscal year his duties were those of Inspector of Charts, and he had charge of the work which had previously been that of the Hydrographic Division and Chart Division. The business of the chart agencies was also included as a part of the Chart Division work.

In conformity with instructions of May 16, Assistant Bradford made a tour of inspection of the chart agencies along the Southern seaboard. Taking steamer at New York on June 2, he first went to Charleston, and visited afterwards, in succession, the various agencies at Savannah, Brunswick, Jacksonville, Tampa, Tarpon Springs, Braidentown, Pensacola, Mobile, New Orleans, Galveston, and Key West. Besides the inspection of agencies, correspondence and interviews were had with chambers of commerce, boards of trade, pilot commissioners, etc., for general and special information as to the opinions and wants of the maritime public.

OGDEN: ATLANTIC AND GULF COASTS.

SPECIAL DUTY.

Inspection.

July 1, 1898, to June 30, 1899.

On the 1st of July, 1898, Assistant H. G. Ogden was directing the movements of hydrographic and topographic parties in Chesapeake Bay, with headquarters at Baltimore. During the month a series of tide gauges was established throughout the entire length of the bay, reference to which is made in detail in the description of tidal work, on page 166. On November 1 he relieved Assistant Bradford of so much of the latter's duties as hydrographic inspector as related to the care of ships and details of hydrographic work and the direction of the Coast Pilot Party. He continued the supervision of parties in Chesapeake Bay until the close of the season, and, following this, exercised general supervision of the building of the steamer *Pathfinder*.

In April he was directed to proceed to Mobile to determine the course to be pursued in regard to the steamer *Bache*, which was unseaworthy and had been ordered to stop at Mobile on her way to New York, for repairs. An inspection by the United States local inspector of hulls confirmed the report of Assistant P. A. Welker, and in view of her condition she was overhauled sufficiently to make her safe for a trip North.

While this was being done, Assistant Ogden visited New Orleans, and in company with the local inspector of hulls inspected the schooner *Quick* at the entrance of the canal, Lake Pontchartrain, then in command of Assistant O. B. French. The result of this inspection was the practical condemnation of the schooner, and she was laid up at Madisonville in charge of a shipkeeper.

At the end of April Assistant Ogden returned to Washington, and proceeded to Elizabethport to make final arrangements for taking charge of the steamer *Pathfinder*.

On the 10th of June he proceeded to the Pacific coast to inspect parties fitting out for the field at Seattle and San Francisco. This duty was completed toward the end of July, and he returned to Washington on August 3.

HAYFORD: OKLAHOMA, KANSAS, Ninety-eighth Meridian.

SPECIAL DUTY.

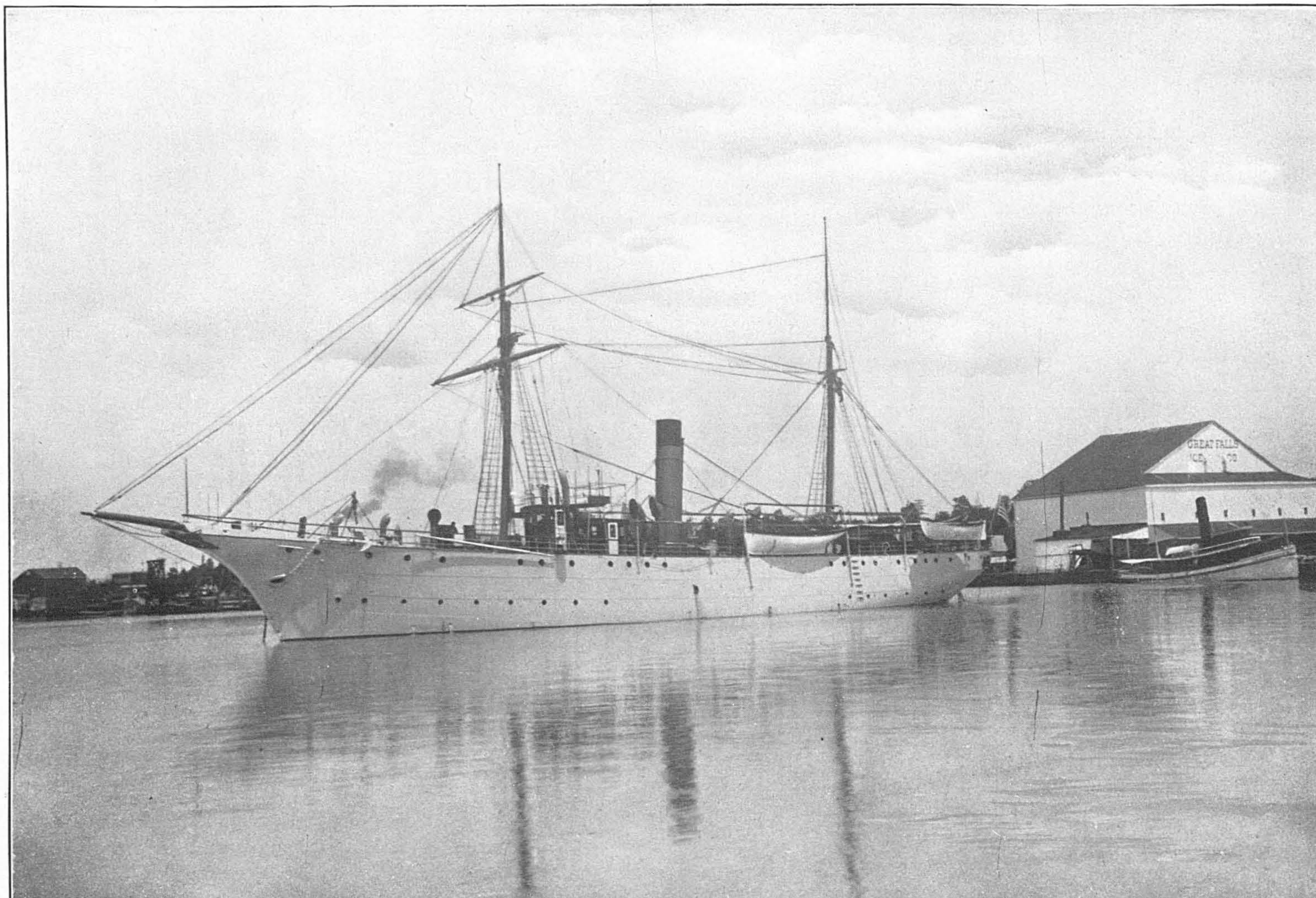
Inspection of reconnoissance, triangulation, and leveling.

June 2 to June 24, 1899.

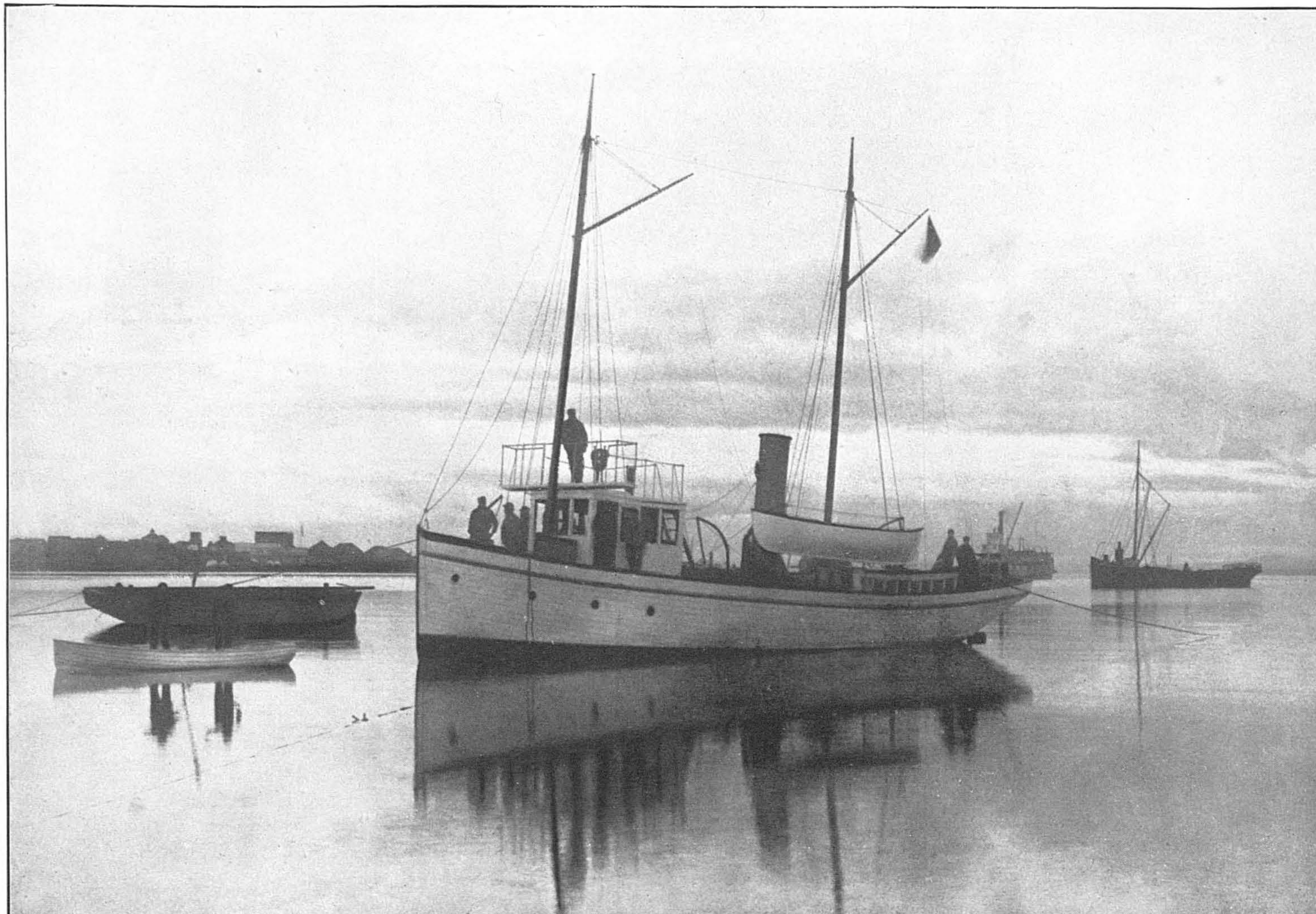
On the 26th of May, 1899, Assistant J. F. Hayford, Inspector of Geodetic Work, was instructed to make a tour among the parties operating in the Mississippi Valley. In compliance with such instructions he left Washington on the 2d of June, and was with Assistant Forney on the 6th, 7th, and 8th, while the party was engaged in the selection of stations Sand Hill, Renfrow, and Miller. On June 14 he had reached Assistant Eimbeck's party, at Sterling, Kans. On the 15th and 16th he was with Assistant Baldwin, doing leveling near Concordia, and on the 19th and 21st with Assistant Granger, at Valley.

The results of the trip were the issuing of instructions to Assistant Forney in regard to base lines and combined longitude and azimuth stations; to Assistant Eimbeck relative to the positions of the circle, and number of measures and observations of horizontal angles, and in regard to abstracts serving as duplicates of the work; to Assistant Granger relative to positions of the circle, and number of measures and observations of horizontal directions, and also recommending the discontinuance of inking in the pencil originals; and to Assistant Winston and Aid Tilton relative to abstracting the precise level results.

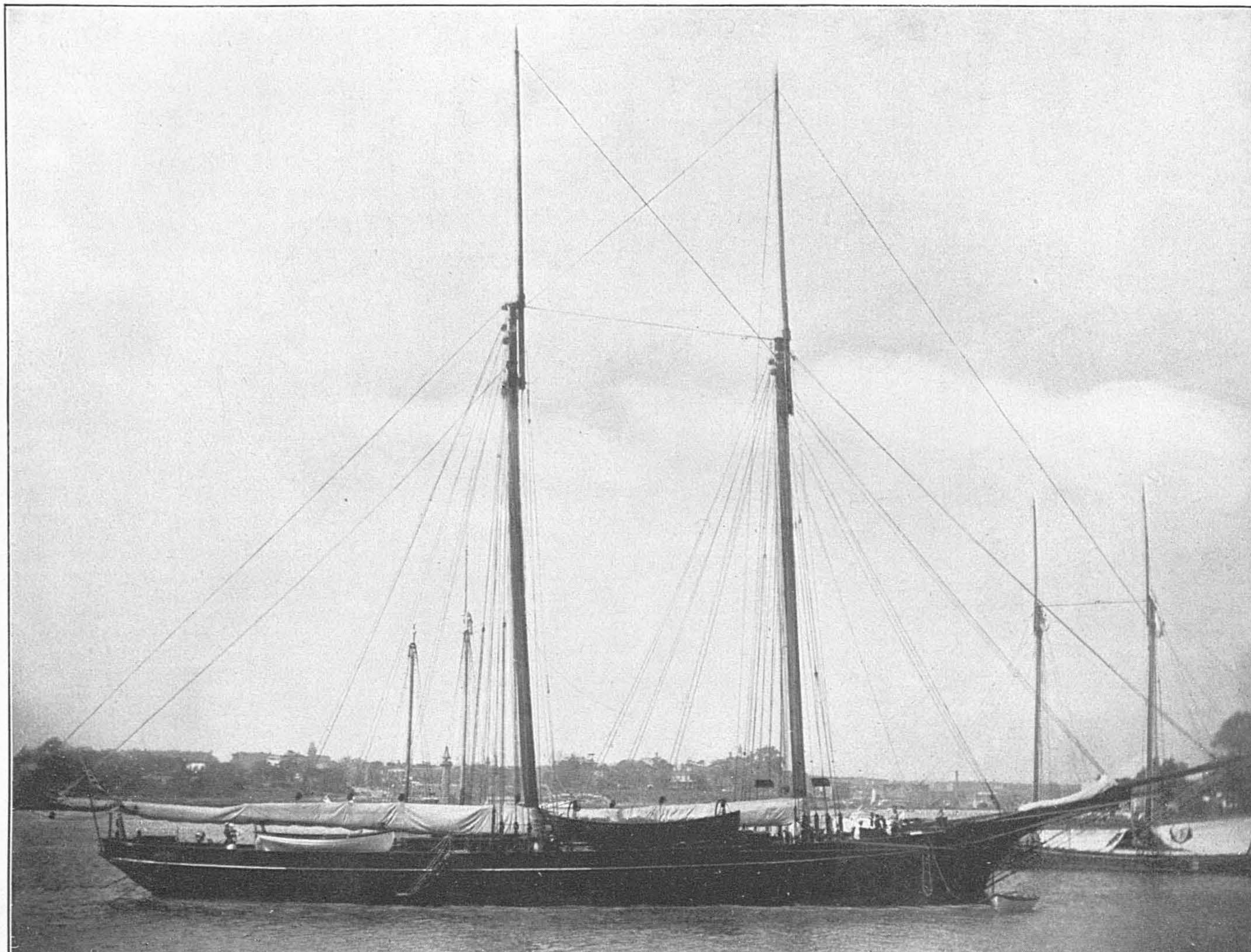
Assistant Hayford makes special commendation of the vigor and economy displayed by Assistant Forney in his work of reconnoissance. New stations were located at the rate of less than two days per station, on the average, and a total progress, in three months, of 174 miles along the ninety-eighth meridian was made, including the selection and marking of two base lines. The leveling party under Assistant Baldwin and Aid Tilton was highly commended for the rapidity of its work, a speed of 1¼ miles per hour being often attained. The use of velocipede cars was carried out in these parties to the fullest extent, and special recognition is given by Assistant Hayford to the way in which the spirit and letter of the instructions of the committee on precise leveling have been followed. The triangulation by Granger has been remarkable for speed and economy, less than two weeks per station, including preparations, moving, etc., being required, and at the same time the monthly expenditures were extremely moderate.



STEAMER PATHFINDER.



STEAMER YUKON.



SCHOONER EAGRE.

F. THE FLEET OF THE UNITED STATES COAST AND GEODETIC SURVEY.

The Coast and Geodetic Survey fleet, in service during the fiscal year 1898–99, consisted of ten steam vessels having an average registered tonnage of 180, and five sailing vessels with an average tonnage of about 72. The largest steamer is the *Pathfinder* (registered tonnage 469), and the smallest the *Cosmos*, with 25 tons register. The largest schooner is the *Eagre* (192 tons), and the smallest the *Spy* (17 tons). The ages of the vessels vary greatly—from the *Matchless*, built in 1859, and the *Endeavor*, in 1862, down to the *Pathfinder*, our most recent and valuable acquisition, which was launched during the fiscal year just closed.

The illustrations given show the types of vessels. No. 27 is the *Pathfinder*, which embodies the latest ideas in marine construction as applied to the necessities of Coast Survey work. No. 28 is the *Yukon*, and shows what can be accomplished in the way of building a vessel, transporting it, in pieces, 6 000 miles by rail and water, and rebuilding it on the beach at the field of operations. The successful accomplishment of this task is due to the energy and ability of Assistant J. F. Pratt. The contract was let on the 9th of April, 1898, to the Gas Engine and Power Company and Charles L. Seabury & Co., Consolidated. The vessel was shipped by rail to Seattle, Wash., and was finally landed at St. Michael, Alaska, on July 3, 1898. A force varying from twenty to twenty-five men, working one month, was required to rebuild and launch her. It is worthy of mention that no essential piece needed in the reconstruction was omitted in the shipment, although the vessel was not completely put together in the shipyards at Morris Heights. Illustration No. 29 shows the *Eagre*, the largest schooner of the fleet.

The ships are generally in good condition, with the exception of the *Bache* and *Quick*, both of which have been condemned as unseaworthy. The *Eagre* was examined and found remarkably sound after twenty-four years' service. It may be stated, in this connection, that she was built as a private yacht and was afterwards sold to the Coast and Geodetic Survey. Her long life and excellent condition after many years of service is a convincing proof that, though seemingly excessive, a generous expenditure of money judiciously applied to the construction of a vessel brings adequate returns as time goes on; and, on the other hand, nothing is eventually gained by the reduction of an appropriation for this purpose to the lowest figure possible in the interest of apparent, but false, economy.

No work was done during the year either with the *Cosmos* or the *Transit*. The former has been laid up at Sitka, Alaska, and the latter at Pensacola, Fla. Of the thirteen remaining vessels seven have been employed on the Atlantic and Gulf coasts and in Porto Rico and five on the Pacific coast and in Alaska. One, the *Pathfinder*, was placed in commission in the spring of 1899, and having sailed from Washington, D. C., in June for San Francisco, was on her voyage during the remainder of the fiscal year.

Classifying the localities one step further, we may note that of the eastern fleet two vessels were engaged exclusively on Chesapeake Bay; two on Lake Maurepas, Louisiana;

one at Portsmouth, N. H., Aransas Pass, Tex., and Charleston, S. C.; one on Chesapeake Bay and afterwards at Brunswick, Ga., and one on the Chesapeake Bay and later on the Hudson River and in Porto Rico.

Of the Pacific fleet one operated in San Francisco Harbor; one in Grays Harbor, Washington, San Diego Harbor, San Pedro Harbor, and San Francisco Harbor, California; two in Alaska, and one, the *Patterson*, was out of commission most of the year, but was prepared for work and sailed for Alaska on June 17.

The following list gives general information as to the construction of the vessels and the localities of their work during the year:

The Coast Survey fleet, fiscal year 1898–99, arranged in order of tonnage.

Vessels.	Where built.	When built.	Registered tonnage.	Length.	Beam.	Draft.	Where stationed.
Screw steamers.				*Ft. in.*	*Ft. in.*	*Ft. in.*	
Pathfinder	Elizabethport, N. J.	1899	469·00	193 0	33 0	11 0	En route New York to San Francisco.
C. P. Patterson	Brooklyn, N. Y.	1883	453·00	175 0	27 3	14 2	Yukon River, Alaska.
G. S. Blake	Baltimore, Md	1874	234·54	148 8	26 6	11 7	Chesapeake Bay, Maryland; Hudson River, New York; Quicks Hole, Massachusetts; Ponce and San Juan, Porto Rico.
A. D. Bache	Wilmington, Del	1871	182·00	147 8	23 5	10 0	Portsmouth, N. H.; Aransas Pass, Tex.; Charleston, S. C.
Gedney	New York, N. Y.	1875	174·37	140 0	23 8	6 9	San Diego, San Pedro, and San Francisco, Cal.; Grays Harbor, Washington, and Alaska.
McArthur	Mare Island, Cal	1876	130·47	115 0	20 0	12 0	San Francisco, Cal.; San Pablo Bay, California.
Endeavor	Norfolk, Va	1862	86·37	111 0	18 5	7 5	Chesapeake Bay, Maryland.
Yukon	New York, N. Y.	1898	30·00	75 0	15 9	4 0	Yukon River, Alaska.
Taku	San Francisco, Cal	1898	25·00	75 0	16 0	4 0	Do.
Cosmos	Mare Island, Cal	1887	25·00	52 5	12 0	4 0	Sitka, Alaska,
Schooners.							
Eagre	Williamsburg, N. Y.	1875	191·71	121 0	30 4	9 0	Chesapeake Bay, Maryland; Brunswick Harbor, Georgia.
Matchless	Key West, Fla	1859	94·50	99 6	24 3	7 0	Chesapeake Bay, Maryland.
Drift	Baltimore, Md	1876	87·00	76 0	19 6	10 8	Transferred to Light-House Board.
Quick	do	1873	38·00	60 0	21 6	4 6	Lake Maurepas, Louisiana.
Transit	Tottenville, N. Y.	1888	21·00	60 0	15 0	1 8	Pensacola, Fla.
Spy	do	1888	17·00	51 6	14 0	1 6	Lake Maurepas, Louisiana.

G. TRIAL TRIP OF THE UNITED STATES COAST AND GEODETIC SURVEY STEAMER PATHFINDER.

On the 20th of June, 1898, a contract was let for the construction of a single-screw steel vessel for service in Alaska and the Aleutian Islands. This contract, made between Lewis Nixon, of Elizabethport, N. J., and the Honorable Lyman J. Gage, Secretary of the Treasury, acting for and in behalf of the United States, stipulated that the vessel should be delivered, complete in all respects, on or before the 1st day of March, 1899. The essential conditions were that the speed developed upon a trial trip, under conditions prescribed by the Secretary of the Treasury, should not be less than an average of 12 knots an hour under natural draft, maintained successfully for four successive hours, and that the vessel should be strong and well built, in conformity with the contract plans and specifications. The price to be paid was $150 000.

The design was prepared by Mr. F. W. Grogan, draftsman in the Bureau of Construction and Repair, Navy Department, and who subsequently superintended her construction; the engine was approved by the Bureau of Steam Engineering, Treasury Department, before acceptance.

On the 6th of February, 1899, a board of inspection was appointed by the Honorable Secretary of the Treasury, consisting of the following-named persons: J. J. Gilbert, Assistant, Coast and Geodetic Survey, president; Thomas H. Barret, United States local inspector of boilers; J. C. Moore, first lieutenant, United States Revenue-Cutter Service; Charles C. Yates, Assistant, United States Coast and Geodetic Survey, recorder, and C. A. McAllister, first assistant engineer, United States Revenue-Cutter Service. This board was charged with the duty of conducting a trial trip of the new steamer and determining whether she responded to the conditions of the contract. Subsequently, on the request of the contractor, the board was directed to inspect and report upon the efficiency of the vessel in all respects.

Notice having been received from Mr. Lewis Nixon that the vessel would be ready about March 15 for her trial trip, a preliminary meeting of the board was held at Washington, D. C., on March 2, at 2 p. m. At this meeting a course for the trial was selected in Long Island Sound, and a list of necessary instruments, projections, blank books, and other requisites made out.

The board met on the evening of March 14 at the Imperial Hotel in New York City. The following day an inspection was made of the vessel, including frames, beams, bulkheads, etc., as she lay at the shipyard at Elizabethport. At this inspection were present the contractor, Mr. Lewis Nixon; the superintendent of construction, Mr. F. W. Grogan; Capt. John Ross; Mr. John L. Goldsborough, the chief engineer, and Mr. H. G. Ogden, inspector of hydrography and topography, Coast and Geodetic Survey. The vessel was not complete in minor details, and the board, therefore, in fairness to the contractor and to the superintendent of construction, confined its report to those parts at that time finished, and made recommendation that when all was completed to the satisfaction of the superintendent of construction and the inspector of hydrography and topography of the Coast and Geodetic Survey the vessel should be accepted.

At 8.16 a. m. on the 17th of March the *Pathfinder* left the Crescent shipyard, bound for the trial course. This course was laid out on Long Island Sound and contemplated a run from Execution Rocks to within a few miles of Stratford Shoal light and return—an adequate distance to secure sufficient data to determine whether the requirements had been met. The vessel drew 8 feet 3 inches forward and 10 feet 5 inches aft, making a mean draft of 9 feet 4 inches. This was somewhat less than the normal draft of 10 feet, but it was understood that the vessel in the trial should sufficiently exceed the required speed of 12 knots an hour to offset any possible advantage from the unavoidably lighter draft.

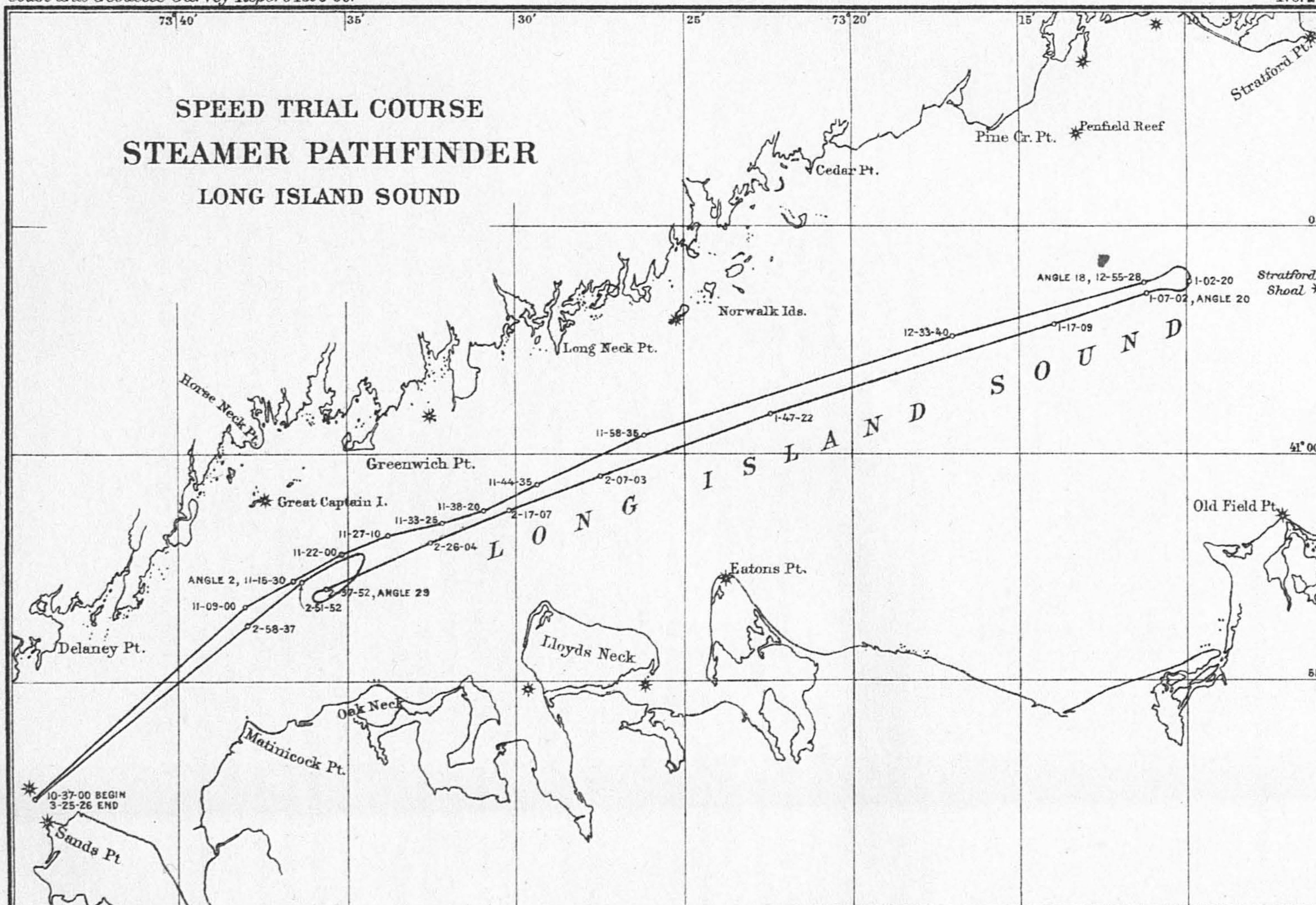
The board met at Pier No. 3, New York City, ran down the bay on a tug, and were transferred to the *Pathfinder* in the upper bay. In the meanwhile the remaining tanks were filled, and the mean draft was after this operation assumed to be 9 feet 6 inches, which assumption was verified after returning to the shipyard immediately following the trial. It must be noted also that considerable coal had been expended, and even under these conditions the draft was found to be 8 feet forward and 10 feet 11 inches aft, giving a mean draft of 9 feet 5½ inches. From the upper bay the vessel continued up the channel, passing Governors Island at 9.18 and Brooklyn Bridge at 9.32, and arriving at Execution Rocks at 10.37. From this point to position noted as angle No. 1 the grates were cleaned and the firemen and engineers took dinner, the number of revolutions in the meantime falling off to about 93. (See illustration No. 26.)

From angle No. 1 the course by compass was a little north of east, which brought the vessel's head a little north of Stratford Shoal light. This course was continued until within about 3 miles of the shoal, or somewhat more than 20 miles from angle No. 2. A broad turn was now made and the vessel headed back over the course just run, and the four hours ended when at angle No. 29, near angles Nos. 1 and 2.

Throughout the course sextant angles were taken at short intervals to fix the position of the vessel, and the time was accurately noted. After completing the four hours' run on natural draft, and while arranging for a short trial under forced draft, the vessel was twice turned, making a circle estimated at about 600 feet. A short run was then made at full speed under forced draft, beginning at angle No. 30 and ending at a point between Execution Rocks and Sands Point light, where the trial began.

The current was against the vessel on its eastward course and with her on the westward, so that the corrections on account of current are practically balanced. There was no appreciable current either way during the run under forced draft.

The result of the trial is given in the following table, where it will be seen that on an average a rate of nearly 12½ knots an hour was attained for the whole time the vessel was under way, while for the time between angles Nos. 2 and 18 and between Nos. 20 and 29, during which the vessel was continuously at a uniform speed, the rate was more than 12½ knots an hour. The forced draft gave nearly 13½.



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

Stretches.	Elapsed time.			Distance run.	Rate per hour.
	h.	m.	s.	Knots.	Knots.
From start to angle No. 2	0	38	30	7·37	11·487
angle No. 2 to angle No. 18	1	39	58	20·45	12·275
Turning around		11	34	2·00	
From angle No. 20 to angle No. 29	1	30	50	19·79	13·072
Sums and average	4	00	52	49·61	12·36
From angle No. 2 to angle No. 18 / angle No. 20 to angle No. 29	3	10	48	40·24	12·65
Under forced draft.					
From angle No. 30 to end		33	34	7·53	13·46

During the trip the steering gear was well tested and found to be in good shape. The hull showed itself to be very staunch, and the working of the engines left nothing to be desired. The *Pathfinder* is able to turn in a remarkably small circle, and can be stopped from full headway in a little more than twice her length. As representative of the engines' average performance under natural draft, it may be stated that for three consecutive hours, 11.15 a. m to 2.15 p. m., the number of revolutions per minute was 115·2, with a steam pressure of 144 pounds at the main engine. The average horsepower developed during this natural draft was 846·8. Under a forced draft there were obtained 120·9 revolutions per minute, 160·6 pounds steam pressure at the main engine, and a total indicated horsepower of 1 173·5. The amount of coal used was 2·08 pounds per indicated horsepower an hour, which is a very fair rate of consumption for machinery of this type.

The report of the board of inspection states that the hull of the vessel is constructed in conformity with the plans and specifications, except where changes were made as approved by the Superintendent of the Coast and Geodetic Survey.

The *Pathfinder* is provided with an electric plant, and this was successfully run for some hours while the board was on the steamer. The windlass was tested after the trial trip by dropping the anchor and hoisting it. The change from steam steering to hand steering can be readily made. The time required to completely turn the vessel around, i. e., 180°, when at full speed was three minutes and one second to starboard and three minutes and twenty-two seconds to port.

In summing up its final report the board states: First, that the vessel, including hull, fittings, machinery, engines, boilers, and appurtenances and equipment, is strong and well built, and in strict conformity with the contract, drawings, and specifications, with duly authorized changes in the same; second, that no defect in the material or construction of machinery was found; third, that no weakness or defect in the vessel was developed during the trial trip; fourth, that the vessel is in all respects complete and ready, in accordance with the requirements of the contract, except in several minor details.

H. DESCRIPTION OF THE COAST AND GEODETIC SURVEY STEAMER PATHFINDER.

By Capt. JOHN ROSS, Nautical Expert, first commander of the vessel.

The steamer *Pathfinder* is the latest vessel built for the Coast and Geodetic Survey, and is specially designed for work in the waters of Alaska and the Bering Sea. Built entirely of steel, and of exceptional strength, she has three decks, seven water-tight transverse bulkheads, and fifteen water-tight compartments, including two trimming tanks, but not including the water tank under the engine and boiler, which forms a water-tight double bottom between the first longitudinals on both sides. Her length on water line is 165 feet; over all, 196 feet; breadth of beam, 33 feet 6 inches; depth of hold, 19 feet 8 inches; gross tonnage, 690, and displacement, on a mean draft of 10 feet, is 875 tons. The rig is brigantine, with a sail area of 4 478 square feet; sufficient to steady her in a heavy sea or to carry steerageway in case of any accident to the machinery.

The engines are vertical triple expansion, 18, 27, and 44 inches, with 28-inch stroke. The horsepower developed on the trial trip under forced draft was 1 173·5. The vessel has a single screw, 10 feet in diameter, with four adjustable blades having a pitch of 13 feet. The number of revolutions per minute is 130.

Two Scotch boilers supply steam to the main engines. They are 11 by 11½ feet, with two furnaces in each. The boilers have a total heating surface of 2 833·84 square feet, and are intended for a working pressure of 160 pounds. One vertical tubular donkey boiler, 10 by 5 feet, with a heating surface of 574 square feet, supplies steam for auxiliary machinery, distilling fresh water, and heating the vessel when there is no steam on the main boilers.

The bunkers have a capacity for 240 tons of coal, sufficient to give an estimated steaming radius of about 5 000 miles. The speed on the trial trip was 13·46 knots under forced draft and 12·65 knots under natural draft.

The auxiliary machinery comprises steam steerer, steam windlass and capstan, steam winch for hoisting boats, two dynamos for electric lighting, and a Sturtevant blower engine for forced draft.

Being intended for surveying work in localities distant from any base of supplies or place where repairs can be made, the fittings and equipment are as complete as possible on a vessel of this size. The quarters for officers and crew are commodious, well lighted and ventilated, thoroughly heated by steam, and fitted with modern sanitary appliances. The regular complement is 14 officers and 65 petty officers and men, but this number can be increased to a total of 100 without crowding.

Holds and storerooms have a capacity for stowing five months' provisions, clothing, and small stores for 100 men and the survey instruments necessary for hydrographic and landing parties. Fresh water is supplied by an evaporator and distiller with a capacity of 1 200 gallons in twenty-four hours. The capacity of the water tanks is

3 000 gallons, but the double bottom under the engine and boilers is utilized to hold 3 500 gallons of fresh water for the boilers.

The electric-lighting plant consists of two directly connected dynamos, 125 incandescent lamps, and one 12-inch search light. These can all be operated by one dynamo, the other being kept as a relief in case of accident. Electric call bells, speaking tubes, and a mechanical telegraph between the pilot house and bridge and the engine room afford means of communication between the different parts of the vessel.

The outfit of boats comprises two 28-foot alco-vapor launches, two 26-foot whale boats (one of them a lifeboat), one 26-foot rowing cutter, and one 18-foot dingey. Provision has been made for carrying additional boats on deck when they are needed. Two tanks, with a capacity for 1 200 gallons, are carried on the lower deck of the vessel for the oil used as fuel in the launches.

I. VOYAGE OF THE PATHFINDER FROM WASHINGTON, D. C., TO SAN FRANCISCO, CAL.

The *Pathfinder* left Washington on June 7, 1899, and arrived at San Francisco on September 18. A short stop was made at Newport News for coal and minor repairs, and the real voyage began on the 16th of June, when she got under way at 9.20 a. m., and headed her course for Santa Lucia, West Indies. Call was made at the following ports en route:

Santa Lucia	June 23 to June 25.
Pernambuco	July 6 to July 11.
Rio	July 16 to July 22.
Montevideo	July 26 to Aug. 4.
Valparaiso	Aug. 20.
Callao	Aug. 25 to Aug. 30.
San Diego	Sept. 14 to Sept. 15.

The total number of knots run was 14 556; the number of tons of coal consumed, 842. The cost of the trip was, in round numbers, $8 000, of which 75 per cent was for coal, the other expenses being pay, subsistence, water, ice, laundry, and miscellaneous.

A detailed account of this very successful trip, written by Capt. F. Walley Perkins, the commander, will appear in the next annual report.

J. STATIONS AT WHICH TIDAL OBSERVATIONS WERE MADE DURING THE FISCAL YEAR 1898-99, INCLUDING A SHORT ACCOUNT OF EARLIER WORK.

Tidal observations in and near New York Harbor have been carried on practically continuously for over fifty-six years by our service. Beginning with 1844, tides were observed on staff gauges until January, 1853, when a self-registering tide gauge was established upon Governors Island, and kept in operation until May, 1879. In October, 1875, an automatic gauge was set up at Sandy Hook, N. J., which was kept running until July, 1893. In December, 1892, an automatic tide gauge was started at Fort Hamilton, on the eastern side of The Narrows, New York, and is still maintained. A tidal indicator was established at Fort Hamilton when the tide gauge was set up, and has been in successful operation ever since. The station is at present in charge of J. G. Spaulding.

At the request of the Maritime Exchange, of Philadelphia, Pa., an automatic tide gauge and a tidal indicator were established at Reedy Island Quarantine Station, Del., in January, 1896, which has been maintained in operation up to the present time. The station is in charge of the Marine Hospital surgeon, with F. C. Fuss as observer.

At the request of the Commissioners of the District of Columbia an automatic tide gauge was set up at the navy yard, Washington, D. C., in July, 1891, and maintained in operation to July, 1899. On account of the silting around the navy yard tide gauge, in June, 1898, a gauge was placed on the wharf of the Norfolk and Washington Steamboat Company, at the foot of Seventh street SW., Washington, D. C., and has been maintained to the present time. The station is under the direction of the Chief of the Tidal Division, with D. S. Bliss as observer.

At the request of the Director of the United States Geological Survey an automatic tide gauge was established at Morehead City, N. C., in April, 1898, and was continued until October 30, 1898. The station was established by Assistant C. C. Yates, and was under the care of Harry V. Webb, as observer.

An automatic tide gauge was established at Fernandina, Fla., in May, 1897, which is still in operation. The station is in charge of B. W. Weeks.

An automatic tide gauge was established in San Juan, Porto Rico, in February, 1899, and maintained until August 6, 1899, when it was wrecked by a hurricane. The station was established by Assistant Superintendent O. H. Tittmann, and was in charge of Ensign W. R. Gherardi, U. S. N.

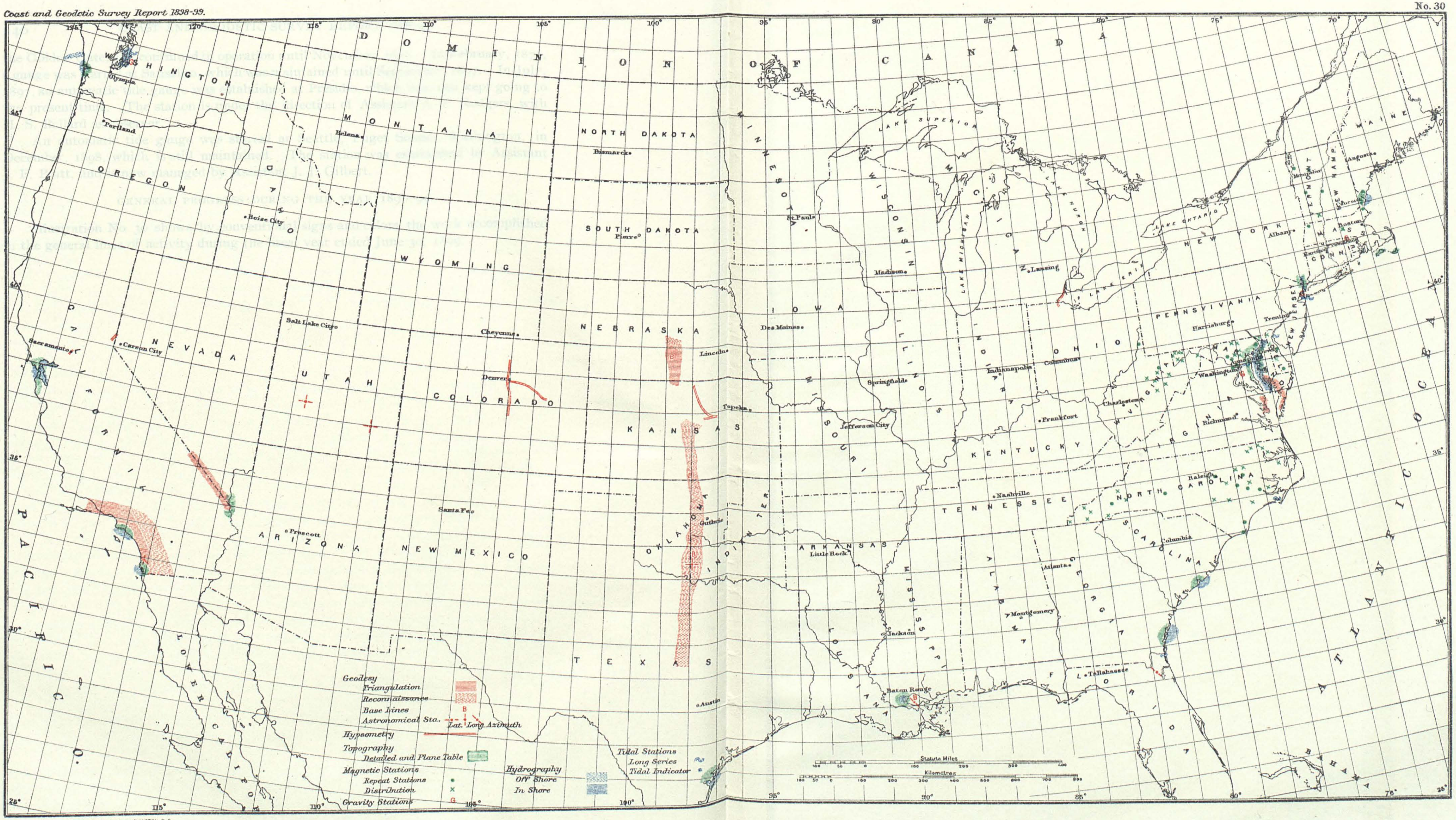
An automatic tide guage was established at Ponce, Porto Rico, in January, 1899, and continued to April 25, 1899. The station was established by Assistant W. C. Hodgkins, with various observers.

Tidal observations near the Golden Gate, San Francisco Bay, California, have been carried on practically continuously for more than forty-five years by this Survey. In June, 1854, a self-registering tide gauge was set up at Fort Point, on the south side of the Golden Gate, and continued in operation until November, 1877. In February, 1877, a gauge was started at Sausalito, which was maintained until September, 1897. In July, 1897, an automatic tide gauge was established at Presidio, which has been kept going to the present time. The station is under the direction of Assistant A. F. Rodgers, with H. S. Ballard as observer.

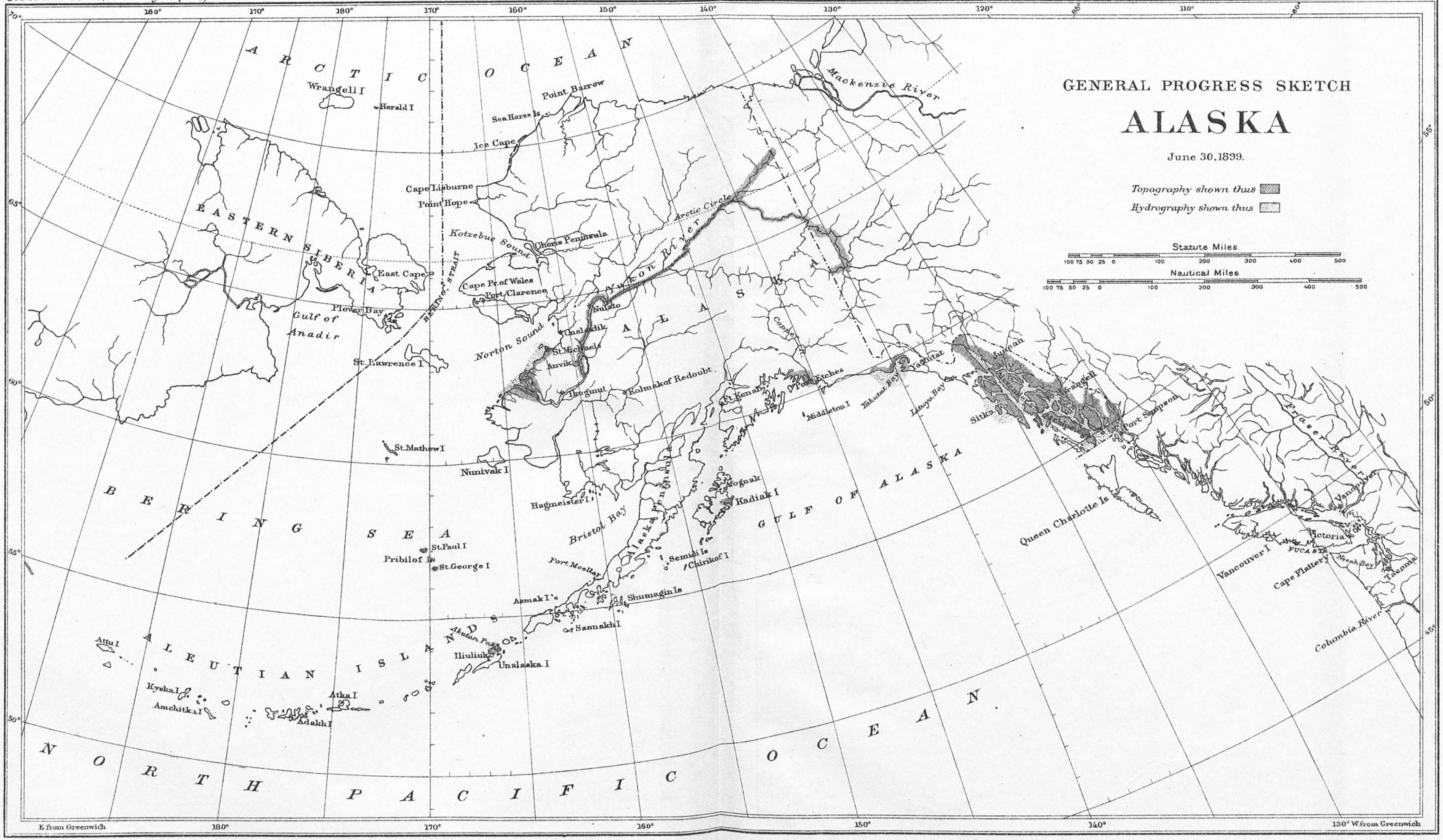
An automatic tide gauge was started at Seattle, Puget Sound, Washington, in December, 1898, which is still maintained. The station was established by Assistant J. F. Pratt, and is now managed by Assistant J. J. Gilbert.

GENERAL PROGRESS DURING THE YEAR 1898–99.

Illustration No. 30 shows, by conventional signs and colors, the work accomplished in the general lines of activity during the fiscal year ended June 30, 1899.



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D.C.



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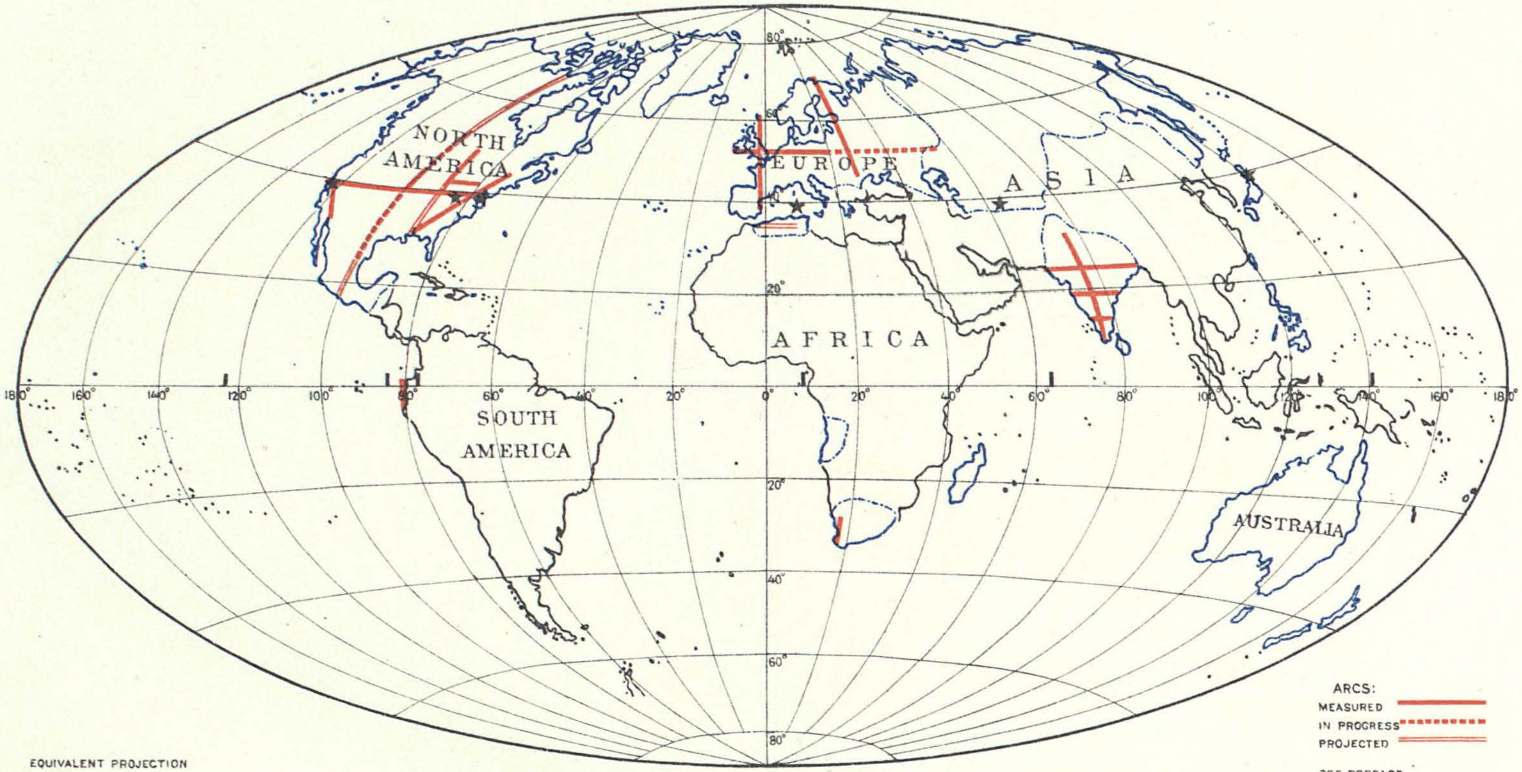

GEODETIC OPERATIONS FOR THE MEASUREMENT OF THE EARTH

Coast and Geodetic Survey Report 1898-99. *Appendix No. 3.* Frontispiece

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

APPENDIX No. 3.

REPORT 1898-1899.

THE INTERNATIONAL GEODETIC ASSOCIATION
FOR THE
MEASUREMENT OF THE EARTH.

By ERASMUS D. PRESTON, Assistant,
Delegate on the part of the United States at the Twelfth General Conference.

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APPENDIX NO. 3. 1898-99.

THE INTERNATIONAL GEODETIC ASSOCIATION FOR THE MEASUREMENT OF THE EARTH.

By ERASMUS D. PRESTON, *Assistant, Coast and Geodetic Survey, Delegate on the part of the United States at the Twelfth General Conference.*

PREFACE.

A. GENERAL STATEMENT.

The great interest now manifested by all civilized nations in the measurement of the earth would seem to warrant the publication of a short account of the origin, development, and present state of the movement. Not only is the size and shape of our planet of universal concern, but a comparative study of the cartographic methods employed by different nations can only be productive of mutual benefit.

With the view of coming to a knowledge of what has been done, as well as to an understanding of the present way of formulating plans of action, it is proposed to give in this paper—

I. A short sketch of the origin and growth of the International Geodetic Association.

II. A translation of the convention under which the organization now exists.

III. A condensed statement of the scientific and administrative activity of the Association during the decade 1887–1896.

IV. A brief summary of the proceedings of the last general conference (Stuttgart, 1898), with a list of the members of the permanent commission and of the delegates present.

B. CONGRESSIONAL ACTION.

The position of the Coast and Geodetic Survey with reference to the meetings of the association is defined by the following joint resolution of Congress:

PUBLIC RESOLUTION—No. 33.

JOINT RESOLUTION authorizing the President to appoint delegates to attend the meetings of the International Geodetic Association.

Whereas the Government of the United States was invited in the year eighteen hundred and eighty-nine by the Imperial German Government to become a party to the International Geodetic Association; and

Whereas this Government duly accepted said invitation by a joint resolution of Congress approved February fifth, eighteen hundred and eighty-nine: Therefore,

Resolved by the Senate and House of Representatives of the United States of America in

Congress assembled, That the President be, and he is hereby, authorized to appoint delegates, who shall be officers of the United States Coast and Geodetic Survey, to attend the meetings of the said International Geodetic Association whenever and wherever the same shall be held; but no extra salary or additional compensation shall be paid to such officers by reason of such attendance.

Approved July 23, 1894.

C. EXPLANATION OF FRONTISPIECE.

In the frontispiece are shown in blue outline those countries now forming part of the International Geodetic Association. The different arcs at present available for the determination of the earth's figure appear in full red lines. Work in progress or projected operations are indicated by dotted or parallel red lines. The positions of the international latitude stations situated on the parallel 39° 8′ N. are designated by an asterisk. Short vertical lines on the equator indicate their longitudes more clearly, which are as follows:

Mizusawa	141·2 E.
Tschardjui	63·6 E.
Carloforte	8·3 E.
Gaithersburg	77·2 W.
Cincinnati	84·4 W.
Ukiah	123·3 W.

The method here employed of representing the earth's surface is a modification of Lambert's equivalent azimuthal projection and originally was proposed by Aitow. The entire spherical surface is shown on an ellipse whose axes are in the ratio of 2 to 1. The meridians and parallels are algebraic curves, the former being of the fourth order. The average angular distortion is considerably reduced in this one over other equivalent projections.

I. ORIGIN AND GROWTH OF THE INTERNATIONAL GEODETIC ASSOCIATION.

A. RUSSIAN AND GERMAN WORK.

The trigonometric connection between the Russian frontier and the astronomical observatory at Königsberg, in East Prussia, marks the beginning of international cooperation for the measurement of the earth. In 1829 the foreign office in St. Petersburg expressed the wish that this work might be carried out. The proposition was favorably entertained by the Germans, partly on account of its immediate utility, but principally because it was a contribution to the determination of the earth's figure. It was even then pointed out by Bessel that the proposed work would make it possible to unite the several existing triangulations, and from such connection to draw conclusions of much greater weight than could be furnished by the actual disconnected geodetic measures. The work was begun in 1831 and finished five years later. It was published in 1838, under the title "Gradmessung in Ostpreussen." The plan was developed and executed by Bessel and Baeyer on the part of Prussia, and the volume bears the imprint of the master mind of the former. The resulting arc coincided neither with a parallel nor with a meridian, but made an angle of about 45 degrees with either. It was, however, recognized that such an arc would completely determine the size and shape of the earth.

With the close of the Gradmessung in 1836, a triangulation was undertaken along the coast. It was executed by the trigonometric division of the army, and was in charge of Col. J. J. Baeyer. This work is described in the Küstenvermessung, published at Berlin in 1849. The details of the geodetic work of Germany during the preceding décade are here exposed, and give evidence of the careful work of Baeyer, the Nestor of German geodesy.

In the meantime other nations were not inactive. England and France on the west and Russia on the east were extending their operations in many directions. During the period from 1850 to 1860 general interest in concerted action grew, and in April of the following year Baeyer (then lieutenant-general) drew up a plan for mutual work by the middle European nations. This was submitted for official action, and in November, 1861, he was empowered to carry out the project and to treat directly with foreign governments.

B. FIRST ORGANIZATION.

The result was that in 1863 an assembly convened in Berlin, at which nineteen States, including many smaller German ones, were represented. The enterprise was now fairly launched, and in 1864 invitations were issued for a general conference, which was held at the same place in October of that year.

Aside from numerous German States, 10 foreign countries participated. Norway and Sweden were jointly represented. The others were Belgium, Denmark, France, Holland, Italy, Austria, Russia, and Switzerland. A central bureau was organized, the permanent commission chosen, and the functions of each were specifically defined. From the date of this meeting until 1886 the history of the association is the history of European geodesy. The contracting parties were limited to continental nations.

In the last-named year a convention, international in a wider sense, was drawn up and adopted for a period of ten years. The new body included representatives from Europe, Asia, and America. In 1895, the old convention having expired by limitation, the last one was adopted, under which the association exists to-day.

In looking back over its career we find that there have been held twelve general conferences, as follows:

C. GENERAL CONFERENCES OF THE ASSOCIATION.

Date.	Locality.	President.	Remarks.
1864	Berlin	Baeyer	General reports on organization and geodetic operations.
1867	Berlin	Baeyer	
1871	Vienna	Baeyer	
1874	Dresden	Baeyer	
1877	Stuttgart	Ibanez	Coast Survey officer present by invitation (Peirce).
1880	Munich	Ibanez	
1883	Rome	Ibanez	Coast and Geodetic Survey officer specially invited (Cutts).
1886	Berlin	Foerster	
1889	Paris	Faye	United States officially represented by Coast and Geodetic Survey officer (Davidson).
1892	Brussels	Hennequin	Results for variation of latitude in Honolulu, first publicly announced.
1895	Berlin	Foerster	United States officially represented by Coast and Geodetic Survey officer (Tittmann).
1898	Stuttgart	Faye	United States officially represented by Coast and Geodetic Survey officer (Preston).

During the intervening years the permanent commission sat at different European cities, generally in Germany.

II. THE NEW INTERNATIONAL GEODETIC CONVENTION.

At the eleventh general conference, held at Berlin in 1895, a new convention was adopted, which was subsequently ratified by the contracting governments. This convention will remain in force until 1906. The following is a translation from the French, with the German text carefully compared:

THE NEW INTERNATIONAL GEODETIC CONVENTION.

ART. 1. The central bureau of the International Geodetic Association retains the attributions originally conferred upon it, and remains attached to the Berlin Geodetic Institute in such manner that the director of the geodetic institute is at the same time director of the central bureau of the International Geodetic Association, and that the resources and scientific means of the institute are placed equally at the service of the association.

ART. 2. The controlling organ of the geodetic association is the general conference of the delegates from the participating governments. This conference convenes at least once every three years. During the interval between the meetings the execution of the decisions of the general conference and the management of the administrative affairs are intrusted to the bureau of the association, composed of the president, vice-president, permanent secretary, and the director of the central bureau.

For administrative affairs in special unforeseen contingencies the bureau of the association shall refer, by correspondence, to a consulting permanent commission composed of delegates named officially by each state for this purpose, each state having one delegate.

The bureau of the association shall fix the date and place of the general conferences, as well as convoke thereto the delegates of the contracting states, at the same time indicating the order of business of the meeting.

ART. 3. The director of the central bureau shall present annually to the bureau of the association a report on the activity of the central bureau and submit a programme of operations for the following year. This report and the programme will be printed and sent to all the delegates.

ART. 4. The publications of the International Geodetic Association, the correspondence with the governments, and the delegates, as well as, in general, the administration of affairs of the association, pertain to the permanent secretary, under the general direction of the president of the association, and in conjunction with the director of the central bureau.

ART. 5. The president, the vice-president, and the permanent secretary of the association are elected by the general conference for the period during which the convention holds.

In case of vacancy, the place will be filled provisionally by the permanent commission, through correspondence, or. if necessary, at a meeting of the commission convoked for the purpose.

ART. 6. The International Geodetic Association shall have an annual endowment, supplied by contributions from all the contracting states. (See Article 9.) This endowment will provide, essentially, for the following expenses:

1. For publication and administration.

2. For salary of the permanent secretary.

3. For remuneration or subsidy of theoretical computing or experimental work of interest to geodesy, authorized by a special vote of the general conference.

4. To carry on international scientific enterprises which are of a nature to facilitate and assure the advancement of geodetic work of a general interest in the different countries.

The distribution of the endowment among the preceding items will be made by the bureau of the association, under the control of the general conference.

ART. 7. The annual endowment is made up of the contributions of the contracting states, determined by Article 9. It is fixed for a period of ten years at a minimum of 60 000 marks (75 000 francs), of which 16 000 marks (20 000 francs) belong to ordinary expenses, and 44 000 marks (55 000 francs) are destined for geodetic work indicated in No. 4 of Article 6, under the direction and responsibility of the central bureau and under the control of the bureau of the association. In order to increase, either permanently or temporarily, the endowment indicated, of 60 000 marks (75 000 francs), a request of the general conference and its ratification by all the interested governments is necessary. The justification of the use of the endowment will be published in the proceedings of the general conferences. Surplus funds may be utilized for the expenses of following years.

ART. 8. The adhering states will pay their contributive parts at the commencement of each year. Payments are made by the diplomatic representatives of the contracting states at the offices of the legations in Berlin. In general, all the communications of the bureau of the association with the governments of the contracting states take place through their representatives at Berlin.

ART. 9. The annual contributions will be made according to the following scale:

(*a*) States whose population does not exceed 5 000 000 pay 800 marks (1 000 francs, about).

(*b*) States whose population is between 5 000 000 and 10 000 000 pay 1 600 marks (2 000 francs, about).

(*c*) States whose population is between 10 000 000 and 20 000 000 pay 3 000 marks (3 750 francs, about).

(*d*) States whose population exceeds 20 000 000 pay 6 000 marks (7 500 francs, about).

Permanent or temporary increase of the endowment will be assessed according to the same scale. The contributions of the states are not modified by the accession of a new state to the convention, which will pay its contribution according to the scale established in this article.

ART. 10. The payments under the different items of the endowment will be made by the director of the central bureau on the order of the president, or, in case he is prevented, on the order of the vice-president of the association.

ART. 11. Balloting in the body of the general conference, either for the nomination of president, vice-president, or permanent secretary of the association, or for decisions on administrative questions, will be made by states, each state of the association having one vote.

States not represented in the conference have the right to delegate their vote to one of the delegates present. However, no delegate can accept more than one of these assignments. The decisions are valid when at least half of the states of the association are directly represented in the conference.

The decisions, by correspondence, of the permanent consulting commission are valid if at least one-third of its members have replied in the time fixed by the bureau of the association.

ART. 12. For the scientific questions there will be instituted during the general conference special consulting commissions, in which each delegate shall have the right to enter. In the balloting of the general conference on scientific questions the absolute majority of the delegates present at the meeting is decisive.

ART. 13. For mixed questions, or if there is doubt as to their scientific or administrative character, balloting must be made by states (see Article 11), providing that this method of balloting is requested by all the delegates of a state.

ART. 14. In case of a tie vote, whether by states or by delegates, the vote of the chairman decides.

ART. 15. The articles of the present convention remain in force until modified by a new agreement between the states.

RESOLUTION.

The present general conference (Berlin, 1895), after having renewed the permanent commission, conformably to the requirements of the convention of 1886, proceeds also to the election of president, vice-president, and permanent secretary of the association. After the ratification of the new convention by the governments the old permanent commission will dissolve and transmit its functions to the bureau of the association. (See Article 2.)

In the name of the Eleventh General Conference of the International Geodetic Association.

FOERSTER, *President.*
HIRSCH, *Secretary.*

III. ADMINISTRATIVE AND SCIENTIFIC ACTIVITY OF THE ASSOCIATION DURING THE DECADE 1887–1896.

A. INTRODUCTORY REMARKS.

The old convention of the International Geodetic Association was in force during the decade 1887–1896, inclusive. On the 31st of December of the last-named year seven of the German states which belonged individually to the old association withdrew, and their place was taken by the German Empire formally entering the association as such.

In the old convention there were twenty-seven contracting states. The retirement of seven of the German states and the substitution therefor of the German Empire reduced the number to twenty-one, which made up the adhering parties on the 1st of January, 1897. Between this date and the date of the Twelfth General Conference, at Stuttgart, in 1898, two of the original states had withdrawn, but these places were filled by the acquisition of Great Britain as a member of the association and by the entrance of Hungary as an independent state, so that at the date of the Stuttgart meeting there were still twenty-one states belonging to the association, of which the following is a list. The order is that given in the official statement of the Stuttgart meeting.

1. Belgium.
2. Denmark.
3. Germany.
4. France.
5. Greece.
6. Great Britain.
7. Italy.
8. Japan.
9. Mexico.
10. Netherlands.
11. Norway.
12. Austria.
13. Portugal.
14. Roumania.
15. Russia.
16. Sweden.
17. Switzerland.
18. Servia.
19. Spain.
20. Hungary.
21. United States.

B. *SUMMARY OF FINANCIAL STATEMENT, DECADE 1887-1896.*

Without going into the details published by the central bureau, it will be of interest to state in general terms and approximate amounts the principal items of expense on account of administration and scientific work:

	Francs.
Total sum received from contributions and from other sources during the period	196 521
Expenses during the period	183 029
Balance on the 1st of January, 1897	13 492

The expenses during this period may be approximately stated as follows:

	Francs.
1. For the study of movements of the earth's axis	46 856
2. Other geodetic and astronomic work	2 080
3. Instruments for the above-mentioned objects	3 845
4. For the permanent secretary of the association	62 500
5. Printing expenses, proceedings and reports	56 776
6. Miscellaneous expenses, transportation, etc	10 971
Total	183 029

To the balance noted above must be added about 18 000 francs on account of back payments. After some adjustment of reimbursements, there appears a total balance for the time stated of about 28 000 francs. This amount is to be applied to the following expenses:

	Francs.
1. For printing proceedings and reports	3 000
2. For liquidation of credits already given the permanent commission, and actually employed in the following scientific work:	
(*a*) For the study of leveling rods	1 000
(*b*) To establish at Breteuil a station for the comparison of pendulum apparatus	5 000
(*c*) For the study of base bars and apparatus	3 000
(*d*) To subsidize studies concerning the measure of the force of gravity on shipboard	8 000
(*e*) To contribute to researches on the deviations of the vertical	8 000

C. *ADMINISTRATIVE ACTIVITY OF THE ASSOCIATION, DECADE 1887–1896.*

1887—Nice.—Meeting of the permanent commission. The definitive adhesion of France, Switzerland, and Servia to the new convention was announced. Correspondence was communicated between the Governments of Great Britain and the United States, on their entrance to the association. The proposition to establish direct correspondence of the bureau with the representatives at Berlin of the contracting states being submitted to the different governments and to Prussia, was tacitly accepted by all parties. A special committee, consisting of Messrs. Ibanez, Hirsch, Foerster, and Helmert, elaborated a project of by-laws for the permanent commission and the central bureau.

1888—Salzburg.—Meeting of the permanent commission. Adhesion of Chile, Mexico, Japan, and Greece to the Convention of 1886 was announced. The first special financial commission was constituted, consisting of Messrs. Faye, Foerster, and von Kalmar.

1889—Paris.—General conference of the association. Definitive adhesion of the United States and the Argentine Republic was announced.

1890—Fribourg i. B.—Meeting of the permanent commission. The permanent commission received the financial report, which showed a balance of 37 000 francs, nearly all the contributions now being paid. The proposition to increase the number of members of the permanent commission from eleven to twelve, submitted to the different Governments, was approved, and led to the nomination of Messrs. Davidson and Hennequin as members of the commission. The question of universal time, taken up in the general conference at Rome in 1883, was discussed, and the commission maintained its recommendation for the meridian of Greenwich as the official meridian, which has been, in fact, chosen as the origin by the conference of Washington.

1891—Florence.—Meeting of the permanent commission. The permanent commission named as president M. Faye, as successor to G. Ibanez.

1892—Brussels.—General conference of the association. Among other matters, the general conference considered the question of an expedition to Honolulu to study the movements of the earth's axis, and gave attention to a report elaborated by M. Marcuse.

1894—Innsbruck.—Meeting of the permanent commission. The commission confirmed the vote taken by correspondence to advance the sum of 3 750 marks for the construction of a photographic zenith telescope, proposed by M. Foerster. In the same meeting there were discussions with representatives of several academies, which offered to cooperate with the permanent commission in the study of the force of gravity, especially in its relation to the geological structure of the earth's crust. The result of this interview was a provisional understanding on the subject. The discussion on the organization of an international latitude service in four stations situated on the same parallel led to the adoption of several decisions on fundamental principles, proposed by General Ferrero. An account was given of preparatory measures taken at Breteuil for the organization of a comparison station for pendulum apparatus, for which the permanent commission voted a subsidy.

1895—Berlin.—General conference of the association. The general conference was essentially occupied with the elaboration of a new geodetic convention, based on a project proposed by the circular of June 15, 1895. The opening discourse, pronounced by M. Foerster, president of the conference, contains an abridged history of the Geodetic Association in its successive phases.

1896.—Lausanne.—Meeting of the permanent commission. The bureau of the association gave an account of the correspondence concerning the ratification of the new convention by the Governments and the transmission of its functions to the new bureau of the association.

D. SCIENTIFIC ACTIVITY OF THE CENTRAL BUREAU.

1887—Nice.—Director Helmert announced that a geodetic bibliography had been prepared by M. Boersch. It appeared in 1889 and was distributed to the Governments. M. Helmert communicated in the same meeting a report on the deviations of the vertical, as well as a report on pendulum measures executed in recent years.

1888—Salzburg.—M. Helmert made a proposition to complete the network of astronomic points of the European triangulation. He also spoke on the determinations of the declination of stars deduced from observations of latitude in the prime vertical.

1889—Paris.—The central bureau gave an account of some preparatory researches on the movement of the terrestrial axis which it had undertaken, and Mr. Albrecht communicated a work on the same subject. The director read, in the same conference, a new report on the deviations of the vertical, as well as a notice on the measures with the pendulum. A communication was also received from M. Boersch on the junction of the measures of the Russian-Scandinavian arc with those of the French-English arc.

1890—Fribourg i. B.—The director of the central bureau continued an account of the calculations of the longitudinal arc of Struve, of which he had already spoken in the previous year at Paris. He submitted a report, by Mr. Albrecht, on the observations of latitude at Berlin, Potsdam, and Prague.

1891—Florence.—The permanent commission having decided to send an expedition to Honolulu, of which the direction was given to Dr. Marcuse, in order to undertake observations of latitude at that point jointly with several European observatories, an account of the preparatory work of this expedition was given. Leaving Berlin on the 1st of April, 1891, the party arrived at Honolulu the 8th of May, after having been joined at Washington by Mr. E. D. Preston, of the Coast and Geodetic Survey, who made similar observations at a neighboring, independent station. Mr. Helmert could, already at this meeting, give some first general results of the expedition. Mr. Helmert presented also a report on the choice of a common zero for altitudes in Europe.

1892—Brussels.—The provisional results of the expedition to Honolulu were given. Confronted with simultaneous observations continued in the observatories of Berlin, Prague, and Strassburg, they showed evidence of the periodic displacement of the axis of the terrestrial globe. The expenses of the expedition amounted to 20 500 marks. On the same subject Mr. Albrecht, of the central bureau, submitted a report, "Results of the observations at Honolulu," and announced a provisional period of 385 days and an amplitude of $0''\cdot53$ for the movement of the earth's axis. In the same conference a new report on the zero of altitude was communicated, which was elaborated by M. Boersch. Another report of the central bureau, on bases and limiting sides of trigonometric network, was due to Mr. Kühnen. The important result was shown that the new equations for the base bars determined by the International Bureau of Weights and Measures at Breteuil showed a very satisfactory accord between nearly all modern bases measured in different countries where, with the old equations of these bars, unexplained discrepancies were found. Mr. Helmert presented two new reports on the measures of the force of gravity and on the deviations of the vertical.. There results from this last, among other things, that on the fifty-sixth degree of latitude the curvature of the parallel agrees better with the ellipsoid of Bessel than with that of Clarke.

1893—Geneva.—Mr. Helmert communicated the first part of his work on the measure of degrees of longitude on the fifty-second parallel. He also gave an account of observations of latitude continued at Potsdam and Strassburg.

1894—Innsbruck.—Mr. Helmert gave still some details on the measures of degrees of longitude on the fifty-second parallel, between Feaghmain and Warsaw, and communicated a table of mean errors in carrying the bases to the first sides of the network of the first order. But the principal subject was the study of the variations of latitude, which Mr. Albrecht treated again in a report, including also the American observations at San Francisco and Honolulu. On the other hand, Mr. Marcuse studied also the movements of the North Pole deduced from observations from 1891 to 1894. Mr. Helmert finally examined the real movement of the North Pole in a notice communicated during the same session.

1895—Berlin.—The central bureau gave an account of the adjustment computation of the arc of longitude on the fifty-second parallel, and presented two synoptic maps, one indicating the actual state of the trigometrical work in Europe, and the other that of the United States, furnished by the Coast and Geodetic Survey. In the first Mr. Helmert called attention to a gap of triangles around the 47½ degree, in Austria-Hungary, which should join the Russian chain with the French and Swiss chain. On the other map he mentioned the transcontinental American chain along the thirty-ninth parallel, an important new element. The interesting question of variations of latitude was the object of a report by Mr. Albrecht, and Mr. Helmert himself presented new reports on the relative me sures of gravity by means of the pendulum, and on the deviatio s of the vertical The director of the central bureau, at the same time, in his report, submitted the account of the financial administration of the association during the triennial period 1893–1895. The same proceedings, of 1895, contain, under the form of appendices, the following documents:

Summary of the propositions received by the central bureau on the subject of the renewal of the convention of October, 1886.

Project of the permanent commission for the renewal of the geodetic convention.

Alternative project for the renewal of the convention.

New international geodetic convention adopted by the eleventh general conference, at Berlin, in October, 1895.

In the last session of the permanent commission, in 1886, at Lausanne, the report of the central bureau makes known important results deduced from a study of the arc of longitude on the fifty-second parallel, and brings out the great continental anomaly of the geoid in this region, where the radius of curvature of the fifty-second parallel is longer by 189 meters than that of the Bessel ellipsoid, and remains less by 486 meters than that of the Clarke ellipsoid. Mr. Helmert made a communication on the relative and absolute measures of the force of gravity. The question of latitudes is the subject of a new report by Professor Albrecht. The same person treats also the choice of international stations for the latitude service. Finally a comparison of the photographic and optic methods for the observation of latitude is studied in the reports of Mr. Albrecht and Messrs. Schnauder and Hecker.

E. SPECIAL REPORTS.

Alongside the scientific activity of the central bureau, it has been the custom since the origin of the Geodetic Association to name special reporters who are willing to present, either in the general conference or in the annual meetings of the permanent commission, a summary of the work executed in the different countries since the last conference. These special periodic reports have the great advantage of giving an account of the total progress made in the different branches, and to specify gaps which should be filled or contradictions which should be explained concerning the different branches of geodetic work. The following reports have been submitted:

1. ON TRIANGULATION.
2. ON THE MEASURE OF BASES.
3. ON LONGITUDES, LATITUDES, AND AZIMUTHS.
4. ON THE LEVELS OF PRECISION AND MARIGRAPHS.
5. MISCELLANEOUS NOTICES AND MEMOIRS ON DIFFERENT QUESTIONS BELONGING TO GEODETIC STUDIES, SUCH AS THE MEASURE OF THE FORCE OF GRAVITY WITH THE PENDULUM, THE DETERMINATION OF THE FIGURE OF THE EARTH, ETC.

Without giving an extensive account of all these reports, it will be useful to note the different reports made under each head during the decade:

1. Reports on triangulation, by—
   - General Ferrero, 1889, Paris;
   - General Ferrero, 1892, Brussels;
   - General Ferrero, 1895, Berlin.
2. Reports on the measure of bases, by—
   - General Perrier, 1887, Nice;
   - Colonel Bassot, 1889, Paris;
   - Colonel Bassot, 1892, Brussels;
   - Colonel Bassot, 1895, Berlin.
3. Reports on longitudes, latitudes, and azimuths, by—
   - Mr. Bakhuyzen, 1887, Nice;
   - Mr. Bakhuyzen, 1889, Paris;
   - Mr. Bakhuyzen, 1892, Brussels;
   - Mr. Bakhuyzen, 1893, Geneva;
   - Mr. Albrecht, 1895, Berlin.
4. Reports on precise leveling and marigraphs, by—
   - Mr. v. Kalmar, 1889, Paris;
   - Mr. v. Kalmar, 1890, Fribourg i. B.;
   - Mr. v. Kalmar, 1892, Brussels;
   - Mr. v. Kalmar, 1893, Geneva;
   - Mr. v. Kalmar, 1895, Berlin.
   - Notice by Mr. Fogler, on leveling rods, 1894, Innsbruck;
   - Report on marigraphs, by General Ibanez, 1889, Paris;
   - Report on the unification of altitudes, by M. Lallemand, 1890, Fribourg i. B.;
   - Report of the commission of international zero of altitudes, by M. Lallemand, 1893, Geneva;
   - Notice on the report of M. Lallemand on altitudes, by M. van Diesen, 1894, Innsbruck.

5. Miscellaneous notices and memoirs—

On the pendulum as an instrument in gravity measures, by Major Defforges:

(*a*) Influence of the pressure of the circumambient fluid on the reversible pendulum.

(*b*) On the law of decrease of the amplitude of the pendulum and on the reduction to an infinitely small arc.

(*c*) On the influence of the slip in the rotation of the knife and the duration of the oscillation of the reversible pendulum.

Memoir on the methods employed for the determination of the ellipticity of the earth, by M. Tisserand, 1889.

Studies on the Bessel toise No. 9, of the Prussian Topographic Bureau, and the toise of Peru, by Dr. Benoit, 1891.

Report of the special commission on the international organization of the latitude service, by M. Foerster, 1894.

Comparison of the latitude observations executed in Honolulu in 1891 and 1892, by Dr. A. Marcuse.

Report on the choice of latitude stations, by Dr. A. Marcuse, 1896.

Notice on the choice of stations of latitude, by M. Kapteyn, 1896.

On the photographic method of determining the latitude, by Dr. A. Marcuse, 1896.

IV. PROCEEDINGS OF THE TWELFTH GENERAL CONFERENCE, STUTTGART, OCTOBER 3-12, 1898.

A. DELEGATES PRESENT.

BELGIUM.

1. Major-General Hennequin, director of the Military-Cartographic Institute in Brussels, member of the permanent commission.

GERMANY.

2. Professor Albrecht, chief of division in the Prussian Royal Geodetic Institute in Potsdam.
3. Professor Börsch, chief of division in the Royal Prussian Geodetic Institute in Potsdam.
4. Dr. W. Foerster, director of the Royal Observatory in Berlin, member of the permanent commission.
5. Dr. Haid, professor at the Technical High School in Karlsruhe.
6. Dr. Hammer, professor at the Technical High School in Stuttgart.
7. Dr. Helmert, professor at the Berlin University, director of the Royal Geodetic Institute and of the central bureau of the International Geodetic Association in Potsdam, member of the Bureau of the International Geodetic Association.
8. Dr. Koch, professor at the Technical High School in Stuttgart.
9. Mr. Nagel, professor at the Technical High School in Dresden.
10. Dr. Nell, professor at the Technical High School in Darmstadt.
11. General Oberhoffer, chief of the Prussian land survey, Berlin.
12. Major-General Von Orff, member of the Academy of Sciences in Munich.
13. Dr. Von Richthofen, professor at the Berlin University.
14. Colonel Von Schmidt, chief of the trigonometric division of the Prussian land survey, Berlin.

15. Dr. Max Schmidt, professor at the university in Munich.

16. Professor Westphal, chief of division in the Prussian Geodetic Institute in Potsdam.

FRANCE.

17. Colonel Bassot, chief of the geographic division of the general staff in Paris, member of the permanent commission.

18. Mr. Bouquet de la Grye, member of the Academy of Sciences in Paris.

19. Major Bourgeois, of the geographic division of the general staff in Paris.

20. Mr. Faye, member of the Academy of Sciences in Paris, president of the International Geodetic Association.

21. Mr. Lallemand, director of the general leveling service of France, Paris.

GREAT BRITAIN.

22. Mr. G. Howard Darwin, professor at Cambridge University, member of the permanent commission.

ITALY.

23. Lieutenant-General Ferrero, imperial senator, member of the permanent commission.

24. Mr. Celoria, vice-president of the geodetic commission of Italy, Milan.

25. Mr. Guarducci, engineer at the Military-Geographic Institute, secretary of the Italian geodetic commission in Florence.

JAPAN.

26. Dr. Kimura, member extraordinary of the geodetic committee in Tokyo.

27. Dr. Tanakadate, professor of physics at the University in Tokyo.

MEXICO.

28. Mr. Angel Anguiano, director of the observatory in Tacubaya, member of the permanent commission.

NETHERLANDS.

29. Mr. Van de Sande-Bakhuyzen, director of the observatory in Leyden, member of the permanent commission.

AUSTRIA.

30. Mr. Tinter, professor at the Technical High School in Vienna, member of the permanent commission.

RUSSIA.

31. General Von Stubendorff, chief of the military-topographic division of the general staff in St. Petersburg, member of the permanent commission.

SWEDEN.

32. Dr. Rosen, professor on the general staff in Stockholm, member of the permanent commission.

SWITZERLAND.

33. Dr. Hirsch, director of the observatory in Neuchatel, permanent secretary of the International Geodetic Association, member of the permanent commission.

34. Prof. Gautier, director of the Geneva Observatory.

SPAIN.

35. Mr. Sagasta, director of the Geographical and Statistical Institute in Madrid.

HUNGARY.

36. Mr. Von Bodola, professor at the Technical High School in Budapest, member of the permanent commission.

UNITED STATES.

37. Mr. E. D. Preston, Executive Officer, Coast and Geodetic Survey, member of the Washington Academy of Sciences.

B. PROCEEDINGS.

I. OPENING SESSION.

At 3·15 p. m. on the 3d of October, 1898, in the aula of the Polytechnic School at Stuttgart, the International Geodetic Association began its twelfth general conference. There were 35 delegates present, of whom 15 came from Germany, 5 from France, 2 from Italy, 2 from Japan, and 1 each from Belgium, Great Britain, Mexico, Netherlands, Austria, Russia, Sweden, Switzerland, Spain, Hungary, and United States. Eighteen invited guests, of whom 12 were from Stuttgart, completed the body.

The session was opened by an address from the minister of public instruction, Dr. Von Sarwey, expressing the interest taken in the proceedings by the King of Württemberg, and calling attention to the fact that since the last reunion in Stuttgart, twenty-one years ago, the association had developed into an international association of much wider character. From a small association, for the measurement of degrees in Europe, founded by the learned Prussian general, Baeyer, it had now become an international body embracing nearly all civilized countries.

He was followed by the director of the Polytechnic School of Stuttgart, Professor Hell, in a well-timed address of welcome; the rector of the University of Tubingen, Dr. Von Brill, speaking in behalf of the institution, made mention of the fact that although geodesy was not one of the avowed departments of the University, they were proud to remember that one of their professors, Bohnenberger, had contributed largely to the development of this branch of science. He paid a well-merited tribute to the memory of Gauss, who developed what might be termed minor geodesy into an important branch of pure science. The director of the Royal Institute of Statistics, Dr. Von Zeller, speaking in its name, called attention to the application of geodesy to the official cartography of their country, and invited the guests to examine their last map, on a scale of 1:25 000, which was shown at the meeting. The president of the association returned thanks to the King for his kindly interest, and to the speakers for their addresses of welcome, full of good feeling and sympathy.

The following vice-presidents were then announced: Professor Hammer, of Stuttgart; General O. de Stubendorff, of St. Petersburg; Prof. G. H. Darwin, of Cambridge, England.

The permanent secretary then read the report on the activity of the bureau of the association. Generally these are given in both French and German, but as nearly all the delegates knew French, and the same could not be said as regards German, the report was read in the former language. It is to appear later, according to custom, in both tongues.

A general statement was made touching the publications that have appeared since the last general conference, in 1895. The old convention remained in force until the end of 1896. With the beginning of the year 1897 a new convention was adopted, and this is to hold until the year 1906. Among the publications that have appeared since the Lausanne meeting, in 1896, is, first, the proceedings of the conference, together with many important additions published as annexes. In accordance with a resolution adopted at Lausanne a report was addressed to the different Governments forming part of the association in April, 1897, on the administrative and scientific works of the period 1887 to 1896, and on the adhesions to the new convention of 1895. This report shows that at the time of its publication fifteen out of the twenty-one States of the old convention had adhered to the new one. The same report contains an account of the financial situation of the association up to the end of 1896. At the end of 1897 an administrative and financial report of the association was made to the different Governments and attention was called to the fact that of the nineteen States which at that time had signified their acceptance of the convention ten had failed to pay their dues. A circular to the different delegates was read, which appeared in April, 1898, and gave reasons for the choice of Stuttgart as the place of meeting and also indicated the order of work at the proposed conference. Besides the reports and financial questions, the following scientific subjects appear: Discussion of the choice of international latitude stations, and the photographic method of determining latitude. Then came special reports on triangulation, measure of bases, precise leveling, marigraphs, astronomical measures, deviation of the vertical, and determinations of gravity.

Attention was called to the fact that Great Britain had now definitely joined the association. This was considered, at the time it was made known, such welcome news that the president of the association issued a special letter making the announcement. In the letter it was stated that the fact that Great Britain had now entered the association was particularly satisfactory in every respect, not only on account of the great geodetic work executed by the Empire, but also because the association now had a completely universal character. The adhesion of Austria-Hungary was also announced and that of the United States.

On the other hand, Chile and the Argentine Republic withdrew, so that the actual number of States adhering to the International Geodetic Association at the present time is twenty-one.

The list of the permanent commission and the invited members was then published, and after the announcement of the death of several persons connected with the association since the last meeting, notably M. Tisserand, the celebrated astronomer at the observatory at Paris, a recess was taken until the following day. The secretary stated that although Tisserand had not made geodesy the principal object of his indefatigable activity, the bonds which unite the two sciences of astronomy and geodesy are so close and numerous that geodesy necessarily feels the disappearance of one of the most glorious workers in the field of modern astronomy. The geodetic association will forever remain proud for having counted Tisserand among the number of its cooperators.

2. SECOND SESSION.

A second meeting was held on October 4, and proceedings began at 3.15. After a few announcements by the secretary in regard to the attendance of certain delegates who were unable to be present, the following order of business was proposed and adopted:

I. Reading of a French translation of the report of Mr. Helmert, on the activity of the central bureau in 1897.

II. Provisional report of Mr. Helmert, on the activity of the central bureau during the year 1898.

III. Report of the central bureau, by Professor Albrecht, on the preparatory work for the international latitude service.

I. The report on the activity of the central bureau in 1897 was divided into three parts, one of which (A) described the scientific, another (B) the administrative results. The financial report o the association was included in the latter part. The third part (C) was devoted to a statement of property. The scientific activity was treated under five heads.

A. SCIENTIFIC:

(1) Systematic deviations of the vertical.
(2) Movement of the terrestrial axis in the interior of the globe, deduced from data furnished by the voluntary cooperation of observatories.
(3) Preparatory work for the international latitude service.
(4) Absolute determinations of gravity by means of the pendulum.
(5) Researches on wooden meridian marks.

B. ADMINISTRATIVE:

(1) A statement as to the employment of the resources of the association since 1896.
(2) A summary of the distribution of publications.

C. INVENTORY OF INSTRUMENTS:

Under this head was given a complete list of the instruments and apparatus belonging to the association and deposited at the central bureau at Potsdam.

II. Report on the activity of the central bureau of the International Geodetic Association in 1898. This, like the previous report, is divided into three parts: The first (A) scientific, presenting a description of the scientific activity; the second (B) administrative, containing a statement of the accounts in the association; and the third (C) relating to property. The scientific operations fall under six heads.

A. SCIENTIFIC:

(1) Continuation of the computations on the deviation of the vertical in Europe.
(2) Deduction of the movement of the terrestrial axis in the interior of the globe, from data furnished by the voluntary cooperation of observatories.
(3) Preparatory work for the international latitude service.
(4) Absolute determinations of the force of gravity by means of the pendulum.
(5) Elaboration of the reports of the general conference of the association at Stuttgart.
(6) Collection and discussion of material for different reports destined for the Stuttgart meeting.

B. ADMINISTRATIVE, COMPRISING—

(1) Financial statement for 1898.
(2) A list of publications distributed.

C. INVENTORY OF INSTRUMENTS:

(As in previous year.)

III. The report of the central bureau on the preparatory work for the international latitude service. Published in Annex A II[a].

At the conclusion of the reading of this report, on the proposition of the central bureau, a commission was constituted to make a report, at a future meeting, on the different propositions of the central bureau, on the subject of the international latitude service. This commission consisted of Messrs. Bakhuyzen, Preston, Bouquet de la Grye, Celoria, and Foerster.

A commission on finances was nominated by the conference, on the proposition of the central bureau, and was composed of Messrs. Bassot, Foerster, Hennequin, Rosen, and Tinter.

3. THIRD SESSION.

The third session was held on October 5, and began at 9.50 a. m. After some preliminary remarks by the president, special reports were read on the following subjects:

1. The measurement of base lines, by Colonel Bassot.
2. The state of the work of the Prussian survey in 1898, by Colonel von Schmidt.
3. The determination of gravity in Baden, by Professor Haid.
4. The work of the Italian Geodetic Commission during the years 1897–98, by M. Celoria.
5. The geodetic operations in France during the years 1896–1898, by Colonel Bassot.
6. The geodetic work executed in Bavaria during 1896–1898, by General von Orff.

Before proceeding further on the national reports the Mexican delegate, Mr. Anguiano, made some remarks on the recent establishment of a geodetic commission in Mexico, whose labors will begin during the next year. He announced also that the Government of the United States had invited the Government of Mexico to take part in a great work which the Coast and Geodetic Survey proposed to execute, and which consists in the measurement of an arc of the meridian situated on the ninety-eighth degree west of Greenwich, and which is ultimately intended to be carried out from the Pacific Ocean to the seventieth degree of north latitude.

Following these remarks, a paper on the trigonometrical operations in the United States was read by Mr. E. D. Preston; M. Sagasta following with a report of the work executed in Spain.

No more national reports being presented at this sitting, the president of the International Committee of Weights and Measures, Mr. Foerster, made an interesting communication on the new alloy of nickel and steel which had just been discovered at Breteuil. In the course of his remarks it was stated, among other things, that the percentage of the component parts of the new alloy was 36 per cent of nickel and 64 of steel. This composition, after being subjected to a special treatment, has at ordinary temperatures, a coefficient of expansion equal to only one-fiftieth of that possessed by either of the components.

At the bureau of weights and measures a meter rule has been kept at a constant length within one one-thousanth of a millimeter for several weeks, the temperature varying a number of degrees. This is a change of only one one-millionth in the length. The new metal has been given the name invar. It has been subjected to immersion in water for some time without the polished surfaces having suffered the least trace of oxidation. It takes an admirable polish and renders possible the tracing of fine lines thereon, for use of measurement. The price of the metal is less than that of platinum-iridium.

After considerable discussion on the subject, in which the fact was brought out that invar is less magnetic than steel, and that the geographic service of the French army had already ordered a base apparatus of 4 meters in length of this material, and that tapes could be made of the material which would replace, advantageously, those used now in the measurement of base lines, the conference adjourned at 12.15.

4. FOURTH SESSION.

The fourth meeting opened at 9.45 on October 7. After some introductory remarks a number of announcements, and further business of a routine nature the regular order was taken up as follows:

M. Guarducci read a paper on the preparatory operations undertaken at the Military Geographical Institute of Florence to make the connection between Malta and Sicily. It was stated that the distance is 180 kilometers and that the line of sight between the two light-houses passed, approximately, 87 meters above the surface of the sea. The author presented a map showing the connecting triangles and distributed copies of a pamphlet entitled "The Faini photo-electric apparatus." Mr. Boersch, in the name of the central bureau, then made a special report on the deviations of the vertical. A printed extract of the report was distributed and some verbal explanations were added.

Following this a special report on longitudes, latitudes, and azimuths was read by M. Albrecht. During the presentation of this report a table was distributed giving the direct and indirect determinations of the difference of longitude between Greenwich and Paris up to the present time. The report expressed the hope that with the cooperation of the International Geodetic Association the interested observatories would cause to disappear as soon as possible the uncertainty now existing in the exact difference of longitude between these two points. At the request of the president the secretary then repeated in French certain parts of this report containing the statement, among other things, that the difference between the direct and indirect determinations amounted to 0·2 of a second of time, equal to 3 seconds of arc. An animated discussion now took place as to the action desirable on the part of the association. At the close of the general remarks the following resolution was offered by M. Foerster:

The association expresses the hope that the uncertainty which still remains in the determination of the difference of longitude between Paris and Greenwich may be removed as soon as possible. With this end in view it is desirable to have published definitely and completely all the observations and results already obtained and to invite the central bureau to study the whole question.

The resolution was adopted unanimously.

Two motions were now made by the American delegate, one relative to the measure of the Peruvian arc, and the other concerning general problems studied by the association. The first of these resolutions was as follows:

An equatorial arc enters into the determination of the earth's figure with great weight. The Peruvian arc, measured in 1736-1739, is still used in combination with modern work, to which it bears no comparison from the point of view of accuracy or extent. Since the work was executed the theory of least squares has been discovered, spherical excess has found application in practical geodesy, and deflections of the plumb line have come to light. Improved methods have been applied to base measures, to triangulation, and to the determination of latitude. By a repetition of Bouguer's work with modern appliances we may expect an increase of accuracy sufficient to materially change the present accepted ellipticity of the earth. The greatest improvements would appear in the astronomic amplitude, and next to that in the horizontal angles. An unexplained discrepancy of several meters now exists between two determinations of a line upon which half the triangulation rests. The temperature was estimated for some of the base measures, and the bars were placed on the ground during measurement. From the method employed in finding the height of the base line there appears an uncertainty of several toises, so that the change in the reduction to sea level would have an appreciable effect on the adopted length of the arc. In view of these facts it is proposed that the International Geodetic Association express itself on the desirability of the measurement of the Peruvian arc, and it is therefore

Moved that, in the opinion of the International Geodetic Association, the Peruvian arc should be remeasured with modern accuracy and extended as far as is practicable in the interest of geodetic science.

After some discussion, on the motion of Mr. Foerster, a commission, composed of Messrs. Bassot, Preston, and Sagasta, was appointed and charged with giving definite form to the matter proposed in the resolution, and invited to submit its propositions to the conference in a later session.

The second motion brought forward by the American delegate was as follows:

In view of the desirability of obtaining more complete information of the present state of the measures of arcs and observations of gravity for the determination of the earth's size and shape, and with the object of utilizing these measures, it is moved that the president of this conference appoint a committee to find out, through the delegate from each country: (1) The present condition of any arc measure; (2) any contemplated extension of the same; and (3) general information bearing upon desirable combinations, or suggestions in any way tending to the furtherance of this prime object of the association; (4) the results of recent pendulum work bearing on the determination of the earth's figure; that the committee discuss the results of these communications and make such recommendations for future operations as may be warranted.

This proposition was discussed at length by Messrs. Helmert and Hirsch, the latter of whom introduced a resolution that the motion should be referred to the central bureau, and that the bureau should be invited to act in accordance with it as much as possible. The resolution proposed by Mr. Hirsch was adopted unanimously.

A special report on the observations of marigraphs, executed in different countries, and on the results that can be deduced therefrom, was then read by Mr. Bouquet de la Grye.

Mr. Darwin then presented a short account of the recent operations executed in England and in India.

The session closed at 12.35.

5. FIFTH SESSION.

The fifth meeting was held on Monday, October 10. Routine business being first disposed of, the president gave the floor to M. Bakhuyzen, president of the latitude commission, who made the statement that the commission had had several sittings and that Mr. Preston had been designated as secretary.

The secretary then read the following report, which was submitted by the Commission:

The latitude commission, composed of Messrs. Bakhuyzen, Bouquet de la Grye, Celoria, Foerster, and Preston, elected Mr. Bakhuyzen president and Mr. Preston secretary.

After careful discussion, in which several other members of the conference took part, the commission has decided unanimously to submit to the conference the following proposition:

First. The conference decides that the international study of the variation of the pole, provided for in paragraph 4, article 6 of the convention of 1896, will be undertaken from the year 1899, under the direction and responsibility of the central bureau, and under the control of the bureau of the association. (See article 7 of the convention.)

Second. With this end in view, the commission adopts the programme presented by the director of the central bureau, which provides for six stations, situated on the same parallel, of which four will be entirely at the expense of the association; and two, the one at Tchardjui, in Russia, and the one at Cincinnati, in the United States, will be subsidized. The commission accepts, with great satisfaction, the aid graciously offered by Russia and the United States for these last two stations.

Third. The expense of this enterprise will be provided for in the amount indicated in paragraph 4 of article 6 of the convention.

Fourth. The conference decides that the observations to be made for this purpose will be continued, first, during a period of five consecutive years. At the end of this period the general conference will pronounce upon the eventual continuation of the observations as well as the modifications which experience shall have suggested in regard to the methods to be employed.

Fifth. During five years the observations will be made according to Talcott's method and in conformity with indications given in the "Report on Preparatory Researches for the Determination of the Variation of the Pole," presented to the conference by Messrs. Helmert and Albrecht.

Sixth. Preliminary researches having indicated that the method of visual observations offers, at present, greater security than the photographic method, and as the last named would entail expenses beyond the available funds, the conference decides that during the first five years of observation the visual method will be employed.

Seventh. As it is very desirable, especially for the determination of the annual periodic variation of the position of the terrestrial axis, to eliminate as much as possible the annual systematic errors, by observations made at a great number of stations, the conference decides that the bureau shall invite observatories which are interested in this enterprise to continue, or commence, determinations of the variation of latitude, leaving them, however, complete liberty in the employment of methods and instruments.

Eighth. The conference decides that the central bureau is authorized to proceed, as soon as possible to the organization of the enterprise. The central bureau is also authorized to arrange the conditions of installation and working of the latitude stations, including the property rights of the apparatus and installations. In cases where it will be necessary to have an understanding with the governments, the bureau of the association will undertake, according to article 4 of the convention, the correspondence and the ratification of agreements.

H. G. VAN DE SANDE-BAKHUYZEN, *President.*
E. D. PRESTON, *Secretary.*

The conference immediately took up the discussion and vote on the different points. The president proposed to vote each proposition separately, and the general secretary of the conference was asked to read each one in French and in German before passing to the vote. Propositions 1, 2, and 3, after discussion, were voted unanimously; 4 and 5, after an exchange of opinions between several members of the conference, were approved without discussion. M. Ferrero proposed the following form for proposition 6, which was adopted by the conference:

In the actual condition of things, and in consideration of the fact that the expense of the photographic method might possibly exceed the funds available for this work, the conference decides that for the first five years the optical method will be exclusively employed.

Proposition 7 was adopted without discussion.

Proposition 8 was adopted by all the representatives, the vote being called for and taken by States.

Communications were then made by Mr. Helmert in reference to the establishment near the latitude station, of a series of marks in the meridian for the sake of studying the eventual variations of the vertical, and by Mr. Tanakadate on the establishment of instruments at the Japanese latitude station, for studying earthquakes.

General Ferrero then had the floor to present a special report on triangulations.

It was moved by Mr. Preston and unanimously carried that on the following day two sessions should be held—one in the morning and one in the afternoon. This would expedite business and make it possible for those delegates who found it necessary to leave Stuttgart on the 12th to do so.

At 12.15 the meeting adjourned, to come together the following day at 9.30.

6. SIXTH SESSION.

The sixth meeting was held on the 11th of October, beginning at 9.45 a. m. The minutes of the previous meeting were read and approved.

Mr. Helmert presented a preliminary report on the relative measures of gravity by means of the pendulum. This was discussed by several members of the association, especially Mr. Lallemand and Mr. Foerster. In view of the discussion which took place, Mr. Helmert offered a motion in the following form:

Resolved, That the bureau of the International Geodetic Association is authorized to grant funds for the purpose of connecting the principal gravity stations.

As this proposition involved a financial question, it was submitted to the conference for a vote by States. It was unanimously adopted by the 15 representatives.

The President then called upon Colonel Bassot to present the report of the special commission charged with the consideration of the Peruvian arc. Colonel Bassot invited Mr. Preston to read this report, which was as follows:

First. The International Geodetic Association expresses the wish that the Peruvian arc be remeasured with the utmost precision and with the most perfect means of the present time; and that the greatest possible extension be given to this arc.

Second. The general conference recommends that as soon as possible the necessary reconnoissance for this enterprise be made.

Third. In order to facilitate this work, the conference decides to allot, in conformity with article 4 of the convention, the sum of 20 000 francs as a contribution to the expenses.

The third proposition was discussed by members of the conference, and after discussion the following amendment was proposed by Mr. Foerster, namely, that instead of section 3 the following be substituted:

The Bureau of the International Geodetic Association is authorized to communicate with the governments and scientific institutions interested and to make the necessary arrangements so that a reconnoissance for a new measure of the Peruvian arc may be taken up as soon as possible.

This amendment was seconded by Mr. Hirsch, and being submitted to the conference, was, together with the first and second propositions, unanimously adopted.

The report of the financial committee was then read, and after being accepted by the conference unanimously, the session closed at 12.10.

7. SEVENTH SESSION.

Tuesday, October 11. The meeting was opened at 3.25 p. m.

The president gave the floor to Mr. Helmert, who submitted to the conference the programme of the work of the central bureau for the two coming years. This report treated in detail the following matters:

First. Continuation of systematic calculations of the deviations of the vertical.

Second. The organization of the international latitude service, and the study of the results which shall be obtained.

Third. Absolute measures of gravity by means of reversible pendulums.

Fourth. A new determination of the constants of Clairaut's formula concerning the variation of gravity with the latitude.

Fifth. Researches on wooden meridian marks and their variations on account of humidity.

After a discussion of some length, the conference adopted unanimously the programme of the work of the central bureau for the two following years.

Mr. Bakhuyzen asked permission to make the following motion:

The conference expresses the desire that a connection of the triangulations of Germany and France on the parallel of the latitude of Paris should be made.

This proposition was adopted unanimously.

A second proposition by Mr. Bakhuyzen was to the effect that national reports on geodetic work executed in the different countries, when deposited at the Bureau, should be considered as read by the authors. After discussion this motion was withdrawn by Mr. Bakhuyzen.

The floor was then given to Mr. Rosen, who read a report on the geodetic work in Sweden. This was discussed by a number of members, and Mr. Rosen later deposited with the Bureau a copy of his memoir on the determination of the intensity of gravity at several stations in Sweden.

Mr. Tinter now communicated the results of the geodetic work in Austria, reading first a report of Admiral von Kalmar on the measures of gravity executed by the officers of the Austro-Hungarian Navy in the years 1895–1898.

Mr. Raoul Gautier then presented a report on the geodetic work executed in Switzerland from 1896–1898.

General de Stubendorff communicated his report on the work done in Russia in the years 1896–1897. Immediately following this he read two obituary notices, one of General Forsch and the other of General Stebnitzky.

Professor Hammer then read a report on the work in Württemberg, after which Professor Koch distributed to the members of the association some copies of his memoir on the relative measures of gravity.

The meeting adjourned at 5.20 p. m.

8. EIGHTH SESSION.

The eighth meeting opened at 10.50, October 12, General de Stubendorff presiding. It was announced that the order of exercises would be the communication of national reports yet remaining to be read, and the floor was given to Mr. de Bodola, who read his report on the work in Hungary.

Mr. Lallemand gave an account of the work executed by the general leveling service in France since the last conference at Lausanne. The result of this work confirmed the equality of the level of the Mediterranean with the English Channel. The speaker presented to the conference a posthumous work by Colonel Gautier, entitled "Studies on the methods and instruments of precise leveling."

General Hennequin now presented his report of the work in Belgium.

This was followed by Mr. van de Sande-Bakhuyzen, who communicated a summary of the work executed in the Netherlands.

After considerable discussion on the movement of the piers during pendulum observations, Mr. Helmert presented a report of the work of the Prussian Geodetic Institute.

Mr. Tanakadate read in English a report on the work of Japan.

Mr. Nell then communicated the results of leveling done in Hesse-Darmstadt.

A discussion was now opened as to the place of meeting for the next general conference. After some discussion M. Hirsch called attention to the fact that according to article 2 of the convention the choice of place belongs to the bureau of the association, consequently the conference could not make a decision; but, according to custom, a discussion on the part of members was in order, and the sentiments expressed would be considered by the bureau at the proper time. Mr. Helmert, in view of the fact that the next general conference might possibly be held three years later, expressed the wish that the national reports be collected and read each year.

The vice-president presiding, General de Stubendorff expressed, on the part of the association, the most profound acknowledgment to the King and to the government of Württemberg for the gracious welcome received by the conference at Stuttgart. Hearty thanks were also expressed on behalf of the members to their colleagues from Württemberg, Messrs. Hammer and Koch, for their indefatigable services and kind attentions during the entire period of the conference. Mr. Helmert thanked the bureau and the permanent secretary for their arduous and impartial labors.

At 12.15 the twelfth general conference of the International Geodetic Association was declared closed.

C. REPORTS AND NOTICES PRESENTED AT THE GENERAL CONFERENCE IN STUTTGART, OCTOBER 3-12, 1898.

1. SPECIAL REPORTS.

Ia. Report on the activity of the central bureau in the year 1897, by Professor Helmert.

Ib. Report on the activity of the central bureau in the year 1898, by Professor Helmert (with 2 plates).

IIa. Report on the preparations for the international latitude service, by Professors Helmert and Albrecht (with 1 plate).

Appendix to IIa. Report on a new series of latitude determinations with the photographic zenith telescope, executed in the year 1897, by B. Wanach (with 1 plate).

IIb. Report on the choice of stations for the international latitude service in Japan, by Professor Tanakadate (with 1 map).

IIc. Report on the determination of the deflections of the vertical, 1898, by Professor Boersch.

III. Report on the measure of bases, by M. Bassot.

IV. Report on the longitude, latitude, and azimuth determinations, submitted by the central bureau, through Professor Albrecht.

V. Report on marigraphs, by M. Bouquet de la Grye.

VI. Report on the relative measures of the force of gravity with pendulum apparatus, by Professor Helmert.

VII. Report on triangulation, by General Ferrero (with 1 map and 4 plates). (Separate volume.)

2. REPORTS OF THE DELEGATES ON THE WORKS IN THEIR COUNTRIES.

I. Prussia. Report of the trigonometrical section of the Imperial Prussian Survey on the condition of the work in 1898, by Colonel von Schmidt (with 1 map).

II. Baden. Report on the pendulum observations executed in the Grand Duchy of Baden, by Professor Haid (with 1 plate).

IIIa. Italy. Report on the works executed by the Italian Geodetic Commission in the years 1897 and 1898, by Professor Celoria (with 3 maps).

IIIb. Italy. Report on the preparatory work for the junction between Malta and Sicily, by M. Guarducci (with 1 plate).
IVa. France. Report on the work executed in France, 1896 to 1898, by Colonel Bassott (with 1 map).
IVb. France. Report on the general leveling work of France in 1897 and 1898, by M. Ch. Lallemand.
V. Bavaria. Report on the geodetic work carried out in the years 1896-1898, by Major-General von Orff.
VI. United States. Report on the geodetic operations in the United States, by Mr. E. D. Preston (with 4 plates).
VII. Spain. Report on the works in Spain, by M. B. M. Sagasta.
VIII. Portugal. Report on the geodetic work executed on the islands St. Michel, Ste Marie, and Terceira, of the Azores Archipelago, by Count d'Avila.
IX. Sweden. Report on the works of the years 1896-1898, by Prof. P. G. Rosen.
Xa. Austria. Report on the gravity measures carried out by the Austro-Hungarian naval officers in the years 1895-1898, by Rear Admiral von Kalmar.
Xb. Austria. Report on the measurement of degrees by the Military Geographical Institute, in the years 1896, 1897, 1898, by Colonel von Sterneck.
XI. Switzerland. Report on the Swiss geodetic work executed in the years 1896-1898, by Prof. R. Gautier.
XII. Russia. Report on the geodetic work executed in 1896-1897, by Gen. O. de Stubendorff (with 1 plate).
XIII. Württemberg. Report on the work in Württemberg, by Professor Hammer (with 1 map).
XIV. Hungary. Report on the work in Hungary, by Mr. L. von Bodola.
XV. Belgium. Report on the work in Belgium, by General Hennequin.
XVI. Netherlands. Report on the work executed in 1897-1898, by M. H. G. van de Sande-Bakhuyzen.
XVII. Prussia. Report on the work executed by the Geodetic Institute in the years 1897-1898, by Professor Helmert.
XVIII. Japan. Report upon the progress of geodetic operations, 1895-1898, by Prof. A. Tanakadate (with 3 maps and 2 plates).
XIX. Hesse-Darmstadt. Report on the work in Hesse, by Dr. Nell.
XX. Denmark. Report on the work executed in 1897-1898, by General Zachariae.
XXI. British Empire. Report, by Prof. G. H. Darwin.

3. NOTICES AND COMMUNICATIONS.

I. Study of the variations of length of leveling rods, from the experiments of Colonel Goulier, by M. Ch. Lallemand (with 8 plates).
II. A proposal for a mercurial level, to be used in zenith telescopes, by Professor Tanakadate.

APPENDIX. Report on the administration and scientific work for the decennial period 1887-1896, and on the adhesions to the new convention of 1895; addressed to the Governments of the International Geodetic Associations by the old permanent commission and the new bureau of the association, jointly.

D. MEMBERS OF THE PERMANENT COMMISSION.

[Arranged according to official list.]

Belgium: M. E. Hennequin, major-general, retired, and director of the Military Cartographic Institute, Brussels.
Denmark: Herr von Zachariæ, major-general and director of trigonometrical work, Copenhagen.
Germany: Dr. W. Foerster, professor in the university and director of the observatory, Berlin.
France: M. L. Bassot, colonel, member of the institute and of the bureau of longitudes, director of the geographical service of the army, Paris.
Great Britain: Mr. G. H. Darwin, F. R. S., professor of astronomy, Cambridge.
Italy: M. A. Ferrero, lieutenant-general, senator of the Kingdom, vice-president of the International Geodetic Association, Allessandre.

Japan: Dr. A. Tanakadate, professor in the Royal University, member of the geodetic committee of Japan, Tokio.

Mexico: M. A. Anguiano, civil engineer and director of the Astronomic Observatory, Tacubaya.

Netherlands: Dr. H. G. van de Sande-Bakhuyzen, member of the Royal Academy of Sciences, professor of astronomy, and director of the observatory, Leyden.

Norway: H. W. Haffner, member of the general staff, and director of the Geographical Institute, Christiania.

Austria: Dr. W. Tinter, professor in the Technical High School, president of the Austrian Geodetic Commission, Vienna.

Portugal: Count D'Avila, peer of the Kingdom, colonel on the general staff, Lisbon.

Russia: H. O. von Stubendorff, general and chief of the military topographical division of the general staff.

Sweden: Dr. P. G. Rosen, professor on the general staff, member of the Imperial Academy of Sciences, Stockholm.

Switzerland: Dr. A. Hirsch, director of the observatory, president of the Swiss Geodetic Commission, permanent secretary of the International Geodetic Association.

Spain: M. F. De P. Arrillaga, ex-director-general of the Geographic and Statistical Institute, member of the Royal Academy of Sciences, Madrid.

Hungary: Herr von Zägon, professor of the Royal Technical High School, Budapest.

United States: Dr. H. S. Pritchett, Superintendent of the United States Coast and Geodetic Survey.

NOTE.—Greece, Roumania, and Servia had not, in October, 1898, appointed members of the permanent commission.

APPENDIX No. 4.

REPORT 1898-1899.

DETERMINATIONS OF GRAVITY AT WORCESTER, MASS., AND NEW YORK CITY.

By EDWIN SMITH, Assistant.

APPENDIX NO. 4, 1898-1899.

DETERMINATIONS OF GRAVITY AT THE POLYTECHNIC INSTITUTE, WORCESTER, MASS., AND AT COLUMBIA UNIVERSITY, NEW YORK CITY, WITH PENDULUM APPARATUS B. 1899.

By EDWIN SMITH, *Assistant.*

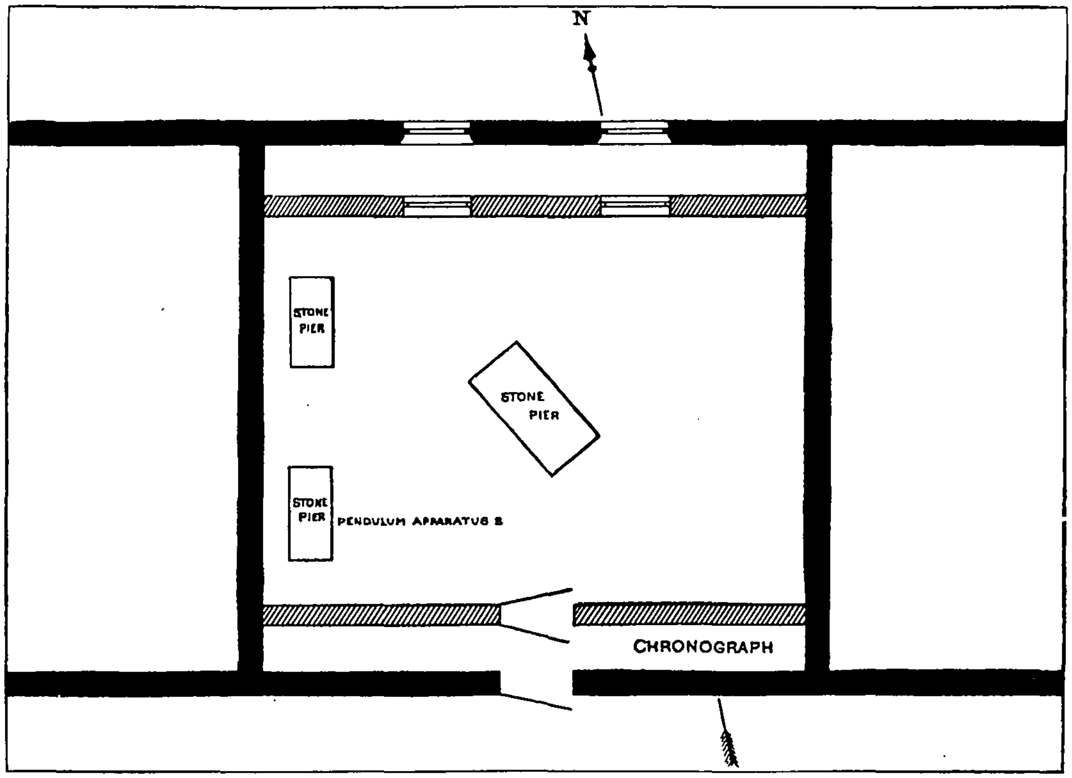
After the construction of the three pendulums, B_4, B_5, B_6, with planes in place of knife edges, the B apparatus was not used in the field till 1898, when it was taken by Prof. J. H. Gore, with the Wellman Arctic expedition of that year. On May 14-16, 1898, before starting on the expedition, Professor Gore made a series of eight-hour swings with the three pendulums at the station in the basement of the Coast and Geodetic Survey Office at Washington, D. C. He then swung them at three stations—Tromsoe, Norway; Danes Island; and Leyden, Holland—and returned to Washington October, 1898. In the following December the Superintendent put the apparatus in charge of Assistant Edwin Smith for the determination of gravity at New York City and Worcester, Mass.

Professor Gore was invited to take part in the swings to be made at the Coast and Geodetic Survey Office before Mr. Smith should start, as these swings would be required in the reduction of his work. Work was begun January 3, 1899, but owing to very bad weather, which prevented the determination of the rates of the chronometers, and to the very leaky condition of the receiver, this series was given up January 6, incomplete. These swings are of so little value that they have not been reduced. After this date it was not convenient for Professor Gore to take part in the work. Two series of eight-hour swings with each pendulum were then made, one beginning January 11 and ending January 14 and the other beginning January 23 and ending January 25, time observations having been obtained at the beginning and end of each series.

During the first series centigrade thermometer No. 242, used by Professor Gore, was attached to the dummy pendulum, but as its corrections were not known it was turned over to the Office of Standard Weights and Measures for comparison, and thermometer No. 240 was attached to the dummy pendulum and used in all other work of the season. The corrections to thermometer No. 242, at temperatures at which it was used in series 1, were furnished by the Assistant in Charge of the Office of Standard Weights and Measures in a letter dated February 1, 1899. The corrections to thermometer No. 240 were copied from the files of the Instrument Division. They had been determined by the Office of Standard Weights and Measures April 20, 1897. The zero point of this thermometer was subsequently redetermined. All these corrections will be found later in this paper.

Early in February the B apparatus was taken to Worcester, Mass., where Dr. T. C. Mendenhall placed at the disposal of the observer all the facilities for gravity determinations of the Worcester Polytechnic Institute. The apparatus was mounted on a stone pier in the southwest corner of the constant-temperature room of the physical laboratory. This room is in the basement and about the middle of the north side of the building. The chronometers were also kept here. The chronograph was mounted on a shelf in the south anteroom of the constant-temperature room, and the transit (meridian tele-

No. 1.



Constant temperature room at Worcester Polytechnic Institute.

scope No. 2) was mounted on a brick pier in a small temporary observatory near the northeast corner of the physical laboratory. The geographical position of the constant-temperature room has been determined by connection with the triangulation of the Coast and Geodetic Survey, and as communicated by Dr. T. C. Mendenhall, is as follows:

	°	′	″
Latitude	42	16	29
Longitude	71	48	28

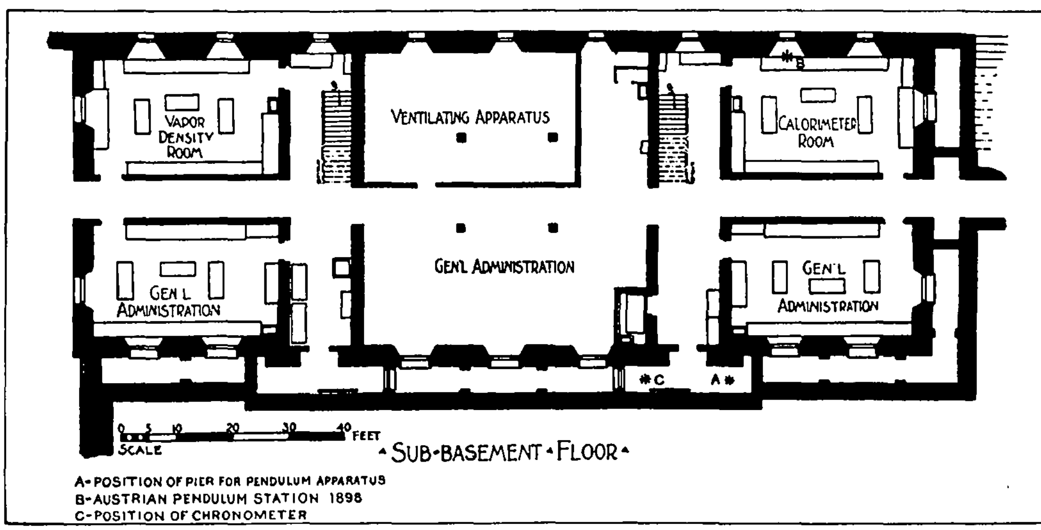
Elevation above mean sea level, 557·9 feet = 170·05 metres.

A series of eight-hour swings with each pendulum was made, beginning February 9 and ending February 11. Time observations were made before beginning, after closing, and also on February 10. A second series of twelve-hour swings was also made—the swings with each pendulum being kept up between time observations. B_4 was swung between February 11 and 14; B_5, February 14 and 15, and B_6 between February 15 and 19.

Owing to the "blizzard" of February 13 it was impracticable to go to the laboratory that night, in consequence of which there is one twenty-four hour swing with B_4, February 13 a. m. to February 14 a. m. At the end of this swing the arc was only 3′, but there was no difficulty in observing the coincidences.

As soon as the swings at Worcester were completed, the apparatus was taken to New York City. The gravity station of 1899 in New York is at the Columbia University, located between One hundred and sixteenth and One hundred and twentieth streets and Amsterdam avenue and the Boulevard. The room in which the pendulums

No. 2.



Subbasement of Physics Building, Columbia University, New York.

were swung is in the subbasement of the physics building. The Austrian station of 1898 was also in this building and on the same level, and the two stations are separated only by the width of the building. A brick and cement pier, with stone cap, was constructed for the pendulum apparatus B and left standing. The chronometers and chronograph were in the same room with the pendulum apparatus. To avoid the delay in constructing a pier for the transit an attempt was made to get special time signals from the Naval Observatory in Washington, but after failures on two nights the transit (meridian telescope No. 2) was mounted on the stone coping at the southwest corner of the physics building. When not in use the telescope was taken into the building and the stand covered with a rubber cloth. At this station a series of eight-hour swings with each pendulum was made, beginning February 25 after time observations, and ending February 27 after time observations. No time was determined on February 26 on account of a storm, during which the stand of the transit was covered with ice.

The latitude and elevation of this station, as communicated by Prof. J. K. Rees, director of the observatory, are as follows:

Latitude	40° 48′ 27″.4
Elevation above mean tide	38.11 metres

The longitude, as determined by the tertiary triangulation of the Coast and Geodetic Survey, is 73° 57′ 43″.

On completion of the swings in New York City the apparatus was taken back to Washington, where an extended series of eight-hour swings with each pendulum was made, beginning March 10 and ending March 16, time observations being made March 10, 11, 12, 15, and 16. The Superintendent's instructions contemplated the determination of gravity at other stations, but as he found it necessary to assign Assistant Smith to other duties the work had to close for the season.

At all the stations coincidences were noted with two sidereal chronometers—Negus Nos. 1823 and 1824. The rate of 1823 was determined from time observations with meridian telescope No. 2, except during the last series at Washington, when transit No. 19 was used. These last time observations, by direction of the Superintendent, were made by Assistant McGrath. The rate of chronometer No. 1824 was determined by comparing it on the chronograph with No. 1823, both before and after time observations. The pressure in the receiver was always kept as nearly as possible to 60^{mm}. The results are reduced to standard conditions—infinitely small arc; temperature, 15° C.; pressure 60^{mm}, mercury at 0° C.; sidereal time, and inflexible support, using the coefficients as determined for the A pendulums, and found on pages 18 and 19 of Appendix No. 1, Report 1894, United States Coast and Geodetic Survey. The A and B pendulums are made of the same alloy (copper 90 per cent and aluminum 10 per cent), and are of the same form and dimensions as nearly as practicable. The temperature coefficient of the B pendulums has been determined by Assistant Putnam, but in the record he states that the temperature conditions were not satisfactory. The result, however, is nearly identical with that obtained for the A pendulums.

On the following pages are given all necessary data and the results of this work:

CORRECTIONS TO THERMOMETERS.

Corrections to thermometer No. 242, attached to the dummy pendulum during swings, January 11-14, as determined at the Office of Standard Weights and Measures, February 1, 1899.

Readings of scale.	Corrections to readings.
°	°
5.0	−0.26
7.5	−0.26
10.0	−0.27

Corrections to thermometer No. 240, attached to dummy pendulum during swings from January 23–25 and thereafter.

Readings of scale.	Corrections Apr. 20, 1897.	Corrected for 0° point, Mar. 21, 1899.
°	°	°
0·0	− 0·15	− 0·05
2·5	− 0·18	− 0·08
5·0	− 0·15	− 0·05
7·5	− 0·20	− 0·10
10·0	− 0·28	− 0·18
12·5	− 0·29	− 0·19
15·0	− 0·27	− 0·17
17·5	− 0·32	− 0·22
20·0	− 0·31	− 0·21
22·5	− 0·31	− 0·21
25·0	− 0·30	− 0·20
27·5	− 0·29	− 0·19
30·0	− 0·28	− 0·18
32·5	− 0·29	− 0·19
35·0	− 0·27	− 0·17
37·5	− 0·22	− 0·12
40·0	− 0·25	− 0·15

Rates of chronometers.

Stations.	Intervals, 1899.	Daily rates. No. 1823.	Daily rates. No. 1824.
		s.	*s.*
Washington	Jan. 11–14	+ 2·002	+ 4·081
Washington	Jan. 23–25	+ 1·166	+ 3·001
Worcester	Feb. 9–10	− 0·030	+ 1·475
Worcester	Feb. 10–11	− 0·082	+ 1·393
Worcester	Feb. 11–14	+ 0·274	+ 1·900
Worcester	Feb. 14–15	− 0·384	+ 1·362
Worcester	Feb. 15–19	− 0·236	+ 1·492
New York.................	Feb. 25–27	+ 0·673	+ 2·258
Washington	Mar. 10–11	+ 1·696	+ 3·115
Washington	Mar. 11–12	+ 0·398	+ 2·194
Washington	Mar. 12–15	+ 0·320	+ 2·100
Washington	Mar. 15–16	+ 0·394	+ 2·286

Pendulum observations and reductions.

WASHINGTON, D. C.

Swing No.	Pendulum.	Position.	Knife-edge.	Date.	Coincidence-intervals chronometers.		Total arc.		Temperature corrected.	Pressure at 0° C.	Period uncorrected. Chronometers.		Corrections (seventh decimal).						Period corrected. Chronometers.		
					1823.	1824.	Initial.	Final.			1823.	1824.	Arc.	Temperature.	Pressure.	Rate chronometers. 1823.	Rate chronometers. 1824.	Flexure.	1823.	1824.	Mean.
				1899.	*s.*	*s.*	′	′	° *C.*	*mm.*	*s.*	*s.*									
1	B_4	D	I	Jan. 11-12	326·54	331·42	56	21	6·74	58	·5007668	·5007555	− 9	+346	+2	+116	+236	−6	·5008117	·5008124	·5008120
2	B_4	R	I	12	324·99	331·32	58	22	6·54	58	7704	7557	−10	+354	+2	+116	+236	−6	8160	8134	8147
3	B_5	D	II	12	364·87	372·12	59	22	6·74	60	·5006861	·5006727	−10	+346	0	+116	+236	−6	·5007307	·5007293	·5007300
4	B_5	R	II	12-13	365·44	372·03	58	22	6·84	57	6850	6729	−10	+342	+3	+116	+236	−6	7295	7294	7294
9	B_5	R	II	14	360·55	366·66	59	22	8·29	58	6943	6828	−10	+281	+2	+116	+236	−6	7326	7331	7328
5	B_6	D	II	13	413·73	421·84	58	22	7·04	57	·5006050	·5005933	−10	+334	+3	+116	+236	−6	·5006487	·5006490	·5006488
6	B_6	R	II	13	411·91	419·89	58	21	7·44	55	6077	5961	−10	+317	+5	+116	+236	−6	6499	6503	6501
7	B_6	R	II	13-14	412·22	418·79	58	21	7·74	58	6072	5978	−10	+304	+2	+116	+236	−6	6478	6504	6491
8	B_6	D	II	14	409·46	417·48	59	22	7·94	56	6113	5995	−10	+296	+4	+116	+236	−6	6513	6515	6514
				Mean..															·5007314	·5007313	·5007314
1	B_4	D	I	Jan. 23-24	317·84	321·21	57	21	10·62	60	·5007878	·5007795	− 9	+184	0	+ 68	+174	−6	·5008115	·5008138	·5008126
2	B_4	R	I	24	316·80	320·84	57	21	10·59	61	7904	7804	− 9	+185	−1	+ 68	+174	−6	8141	8147	8144
3	B_5	D	II	24	352·78	359·30	58	21	10·72	63	·5007097	·5006968	−10	+180	−3	+ 68	+174	−6	·5007326	·5007303	·5007314
4	B_5	R	II	24-25	353·37	358·21	58	22	11·16	56	7085	6989	−10	+161	+4	+ 68	+174	−6	7301	7312	7306
5	B_6	D	II	25	398·00	405·39	58	22	11·22	60	·5006289	·5006175	−10	+159	0	+ 68	+174	−6	·5006500	·5006492	·5006496
6	B_6	R	II	25	397·90	405·88	58	22	11·12	54	6291	6167	−10	+163	+6	+ 68	−174	−6	6512	6494	6502
				Mean..															·5007315	·5007314	·5007315

Pendulum observations and reductions—Continued.

WORCESTER, MASS.

Swing No.	Pendulum.	Position.	Knife-edge.	Date.	Coincidence-intervals chronometers.		Total arc.		Temperature corrected.	Pressure at 0° C.	Period uncorrected.		Corrections (seventh decimal).						Period corrected.		
											Chronometers.					Rate chronometers.			Chronometers.		Mean.
					1823.	1824.	Initial.	Final.			1823.	1824.	Arc.	Temperature.	Pressure.	1823.	1824.	Flexure.	1823.	1824.	
				1899.	*s.*	*s.*	′	′	° *C.*	*mm.*	*s.*	*s.*									
1	B_4	D	I	Feb. 9–10	327·35	331·14	57	21	15·77	54	·5007649	·5007561	− 9	− 32	+6	− 2	+ 85	−10	·5007602	·5007601	·5007602
2	B_4	R	I	10	326·30	330·04	57	22	16·07	55	7673	7586	−10	− 45	+5	− 2	+ 85	−10	7612	7611	7611
3	B_5	D	II	10	363·60	368·02	57	22	17·28	55	·5006885	·5006802	−10	− 95	+5	− 2	+ 85	−10	·5006773	·5006777	·5006775
4	B_5	R	II	10–11	362·17	366·37	57	20	17·83	57	6912	6833	−11	−119	+3	− 5	+ 81	−10	6770	6777	6774
5	B_6	D	II	11	410·10	416·43	57	22	17·78	56	·5006104	·5006011	−10	−116	+5	− 5	+ 81	−10	·5005968	·5005961	·5005964
6	B_6	R	II	11	409·51	415·40	57	22	17·98	57	6112	6026	−10	−125	+3	− 5	+ 81	−10	5965	5965	5965
				Mean..															·5006782	·5006782	·5006782
7	B_6	R	II	Feb. 11–12	413·66	419·31	70	17	17·23	58	·5006051	·5005971	−11	− 93	+2	+16	+110	−10	·5005955	·5005969	·5005962
8	B_6	D	II	12	420·73	426·88	71	16	15·12	59	5949	5863	−11	− 5	+1	+16	+110	−10	5940	5948	5944
9	B_6	D	II	12–13	428·18	434·16	71	17	13·17	52	5845	5765	−11	+ 77	+8	+16	+110	−10	5925	5939	5932
*10	B_6	R	II	13–14	424·29	431·55	70	3	12·96	65	5899	5800	− 5	+ 85	−5	+16	+110	−10	5980	5975	5978
11	B_6	D	II	14	417·07	424·75	71	19	14·98	55	6001	5993	−11	+ 1	+5	+16	+110	−10	6002	5988	5995
				Mean..															·5005964	·5005966	·5005965
12	B_5	D	II	Feb. 14–15	366·47	371·73	70	16	15·32	59	·5006831	·5006734	−11	− 13	+1	−22	+ 79	−10	·5006776	·5006780	·5006778
13	B_5	R	II	15	367·17	372·87	70	17	15·66	60	6818	6714	−11	− 28	0	−22	+ 79	−10	6747	6744	6746
				Mean..															·5006762	·5006762	·5006762
14	B_4	D	I	Feb. 15–16	326·70	330·88	71	17	16·00	53	·5007664	·5007567	−11	− 42	+7	−14	+ 86	−10	·5007594	·5007597	·5007596
15	B_4	R	I	16	326·42	330·28	68	16	16·05	59	7671	7581	−11	− 44	+1	−14	+ 86	−10	7593	7603	7598
16	B_4	R	I	16–17	327·50	331·45	70	16	15·66	56	7645	7554	−11	− 28	+4	−14	+ 86	−10	7586	7595	7591
17	B_4	D	I	17	326·83	331·18	68	16	15·61	57	7661	7560	−11	− 26	+3	−14	+ 86	−10	7603	7602	7602
18	B_4	D	I	17–18	326·23	330·43	68	16	16·01	58	7675	7577	−11	− 42	+2	−14	+ 86	−10	7600	7602	7601
19	B_4	R	I	18	324·60	329·53	70	16	16·50	59	7714	7598	−11	− 63	+1	−14	+ 86	−10	7616	7601	7608
20	B_4	R	I	18–19	324·80	328·78	68	16	16·59	54	7709	7615	−11	− 67	+6	−14	+ 86	−10	7613	7619	7616
21	B_4	D	I	19	325·41	330·28	67	16	16·21	57	7694	7581	−11	− 51	+4	−14	+ 86	−10	7612	7599	7605
				Mean.															·5007602	·5007602	·5007602
				Mean of last 3 groups..															·5006776	·5006777	·5006776

* Swing 10 is a 24-hour swing. It was due to being unable to reach the pendulum room on the night of February 13, on account of the "blizzard." To allow for rate this swing must be given double weight.

Pendulum observations and reductions—Continued.

NEW YORK CITY.

Swing No.	Pendulum.	Position.	Knife-edge.	Date.	Coincidence-intervals chronometers.		Total arc.		Temperature corrected.	Pressure at 0° C.	Period uncorrected.		Corrections (seventh decimal).						Period corrected.		
											Chronometers.		Arc.	Temperature.	Pressure.	Rate chronometers.		Flexure.	Chronometers.		Mean.
					1823.	1824.	Initial.	Final.			1823.	1824.				1823.	1824.		1823.	1824.	
				1899.	*s.*	*s.*	′	′	° *C.*	*mm.*	*s.*	*s.*									
1	B_4	D	I	Feb. 25–26	330.24	333.64	56	18	11.96	57	.5007582	.5007504	− 9	+127	+3	+39	+131	−10	.5007732	.5007746	.5007739
2	B_4	R	I	26	330.71	333.86	57	20	11.67	58	7571	7500	− 9	+140	+2	+39	+131	−10	7733	7754	7744
3	B_5	D	II	26	371.16	376.36	58	22	11.46	55	.5006745	.5006651	−10	+148	+5	+39	+131	−10	.5006917	.5006915	.5006916
4	B_5	R	II	26–27	370.38	375.81	58	21	11.81	55	6759	6661	−10	+134	+5	+39	+131	−10	6917	6911	6914
5	B_6	D	II	27	417.84	425.80	58	22	12.31	56	.5005990	.5005878	−10	+113	+4	+39	+131	−10	.5006126	.5006106	.5006116
6	B_6	R	II	27	416.68	423.94	58	21	12.76	59	6007	5904	−10	+ 94	+1	+39	+131	−10	6121	6110	6116
				Mean.															.5006924	.5006924	.5006924

Pendulum observations and reductions—Continued.

WASHINGTON, D. C.

Swing No.	Pendulum.	Position.	Knife-edge.	Date.	Coincidence-intervals chronometers.		Total arc.		Temperature corrected.	Pressure at 0° C.	Period uncorrected.		Corrections (seventh decimal).						Period corrected.		
											Chronometers.					Rate chronometers.			Chronometers.		Mean.
					1823.	1824.	Initial.	Final.			1823.	1824.	Arc.	Temperature.	Pressure.	1823.	1824.	Flexure.	1823.	1824.	
				1899.	*s.*	*s.*	′	′	° *C.*	*mm.*	*s.*	*s.*									
1	B_4	D	I	Mar. 10–11	320·60	323·80	56	21	9·18	58	·5007810	·5007733	− 9	+244	+2	+98	+181	−6	·5008139	·5008145	·5008142
6	B_4	R	I	12	310·21	314·47	56	21	12·82	58	8072	7962	− 9	+ 91	+2	+23	+127	−6	8173	8167	8170
7	B_4	R	I	12–13	309·30	313·54	57	22	13·57	55	8096	7986	−10	+ 60	+5	+18	+122	−6	8163	8157	8160
12	B_4	D	I	14	310·54	314·32	57	21	13·10	56	8063	7966	− 9	+ 80	+4	+18	+122	−6	8150	8157	8154
13	B_4	D	I	14–15	311·76	316·01	58	21	12·69	56	8032	7924	−10	+ 97	+5	+18	+122	−6	8136	8132	8134
18	B_4	R	I	16	310·79	314·98	58	22	12·81	55	8057	7949	−10	+ 92	+5	+23	+133	−6	8161	8163	8162
2	B_5	D	II	11	356·62	361·15	58	22	9·62	59	·5007020	·5006932	−10	+225	+1	+98	+181	−6	·5007328	·5007323	5007325
5	B_5	R	II	12	349·11	355·06	58	22	11·86	58	7171	7051	−10	+132	+2	+23	+127	−6	7312	7296	7304
8	B_5	R	II	13	344·99	349·70	58	22	14·02	55	7257	7159	−10	+ 41	+5	+18	+122	−6	7305	7311	7308
11	B_5	D	II	14	345·36	351·09	58	21	13·57	58	7249	7131	−10	+ 60	+2	+18	+122	−6	7313	7299	7306
14	B_5	D	II	15	347·68	353·23	58	21	12·53	55	7201	7088	−10	+103	+5	+18	+122	−6	7311	7302	7306
17	B_5	R	II	16	347·12	352·65	58	21	12·71	54	7213	7099	−10	+ 96	+6	+23	+133	−6	7322	7318	7320
3	B_6	D	II	11	400·27	405·82	58	24	10·47	52	·5006254	·5006168	−11	+190	+8	+98	+181	−6	·5006533	·5006530	·5006531
4	B_6	R	II	11–12	398·87	404·39	58	23	11·07	54	6275	6190	−10	+165	+7	+23	+127	−6	6454	6473	6464
9	B_6	R	II	13	388·46	394·13	58	21	13·97	55	6444	6351	−10	+ 43	+5	+18	+122	−6	6494	6505	6500
10	B_6	D	II	13–14	389·27	394·74	58	22	13·87	54	6431	6341	−10	+ 47	+6	+18	+122	−6	6487	6501	6494
15	B_6	D	II	15	391·91	398·65	58	21	12·53	58	6387	6279	−10	+103	+2	+18	+122	−6	6494	6490	6492
16	B_6	R	II	15–16	392·42	399·39	58	21	12·56	56	6379	6267	−10	+102	+4	+23	+133	−6	6492	6490	6491
				Mean.															·5007320	·5007320	·5007320

Summary of corrected periods.

Station.	Date.	Periods.				Difference from mean (seventh decimal).		
		Pendulum B_4, knife edge B I.	Pendulum B_5, knife edge B II.	Pendulum B_6, knife edge B II.	Mean.	B_4.	B_5.	B_6.
	1899.							
Washington	Jan. 11-25	·5008134	·5007308	·5006498	·5007313	+821	− 5	− 815
Worcester	Feb. 9-19	·5007603	·5006768	·5005963	·5006778	+825	− 10	− 815
New York City	Feb. 25-27	·5007742	·5006915	·5006116	·5006924	+818	− 9	− 808
Washington	Mar. 10-16	·5008154	·5007312	·5006497	·5007321	+833	− 9	− 824

Values of g from each pendulum.

Station.	G (in dynes).				Difference from mean in dynes.		
	Pendulum B_4.	Pendulum B_5.	Pendulum B_6.	Mean.	B_4.	B_5.	B_6.
Washington	....	....	....	980·098	....	....	....
Worcester	980·311	980·312	980·308	980·310	+ 001	+ 002	− 002
New York City	980·256	980·254	980·248	980·253	+ 003	+ 001	− 005

APPENDIX No. 5.

REPORT 1898-99.

RESULTING ELEVATIONS FROM SPIRIT LEVELING BETWEEN DENVER, COLO., AND ROCK CREEK, WYO., FROM OBSERVATIONS BY ISAAC WINSTON, ASSISTANT, BETWEEN MAY AND OCTOBER, 1899.

By ISAAC WINSTON, Assistant.

APPENDIX No. 5. 1898-99.

RESULTING ELEVATIONS FROM SPIRIT LEVELING BETWEEN DENVER, COLO., AND ROCK CREEK, WYO., FROM OBSERVATIONS BY ISAAC WINSTON, ASSISTANT, BETWEEN MAY 12 AND OCTOBER 21, 1899.

By ISAAC WINSTON, *Assistant.*

The following results of spirit leveling between Denver, Colo., and Rock Creek, Wyo., are herewith respectfully submitted. This is in continuation of the line of levels starting from bench mark K_3 on the bridge across the Mississippi at St. Louis, Mo., and running westward via Kansas City, Mo., to Denver, Colo. The present extension carries the line 342 kilometres, or 214 statute miles, westward along the Union Pacific Railroad via Cheyenne, Wyo. The line begins at bench marks A_2 and B_2, and the heights of these marks will be found in Appendix No. 8, Report for 1898–99. The heights are relative and refer to the so-called "City Directrix" at St. Louis as the zero or starting level. This level has been transferred to bench mark K_3 at the St. Louis bridge. Should absolute heights be desired, this starting level may be taken as 125·8 metres, or 412 feet, above the Gulf of Mexico; the exact elevation can only be given after the connecting lines are completed and adjusted.*

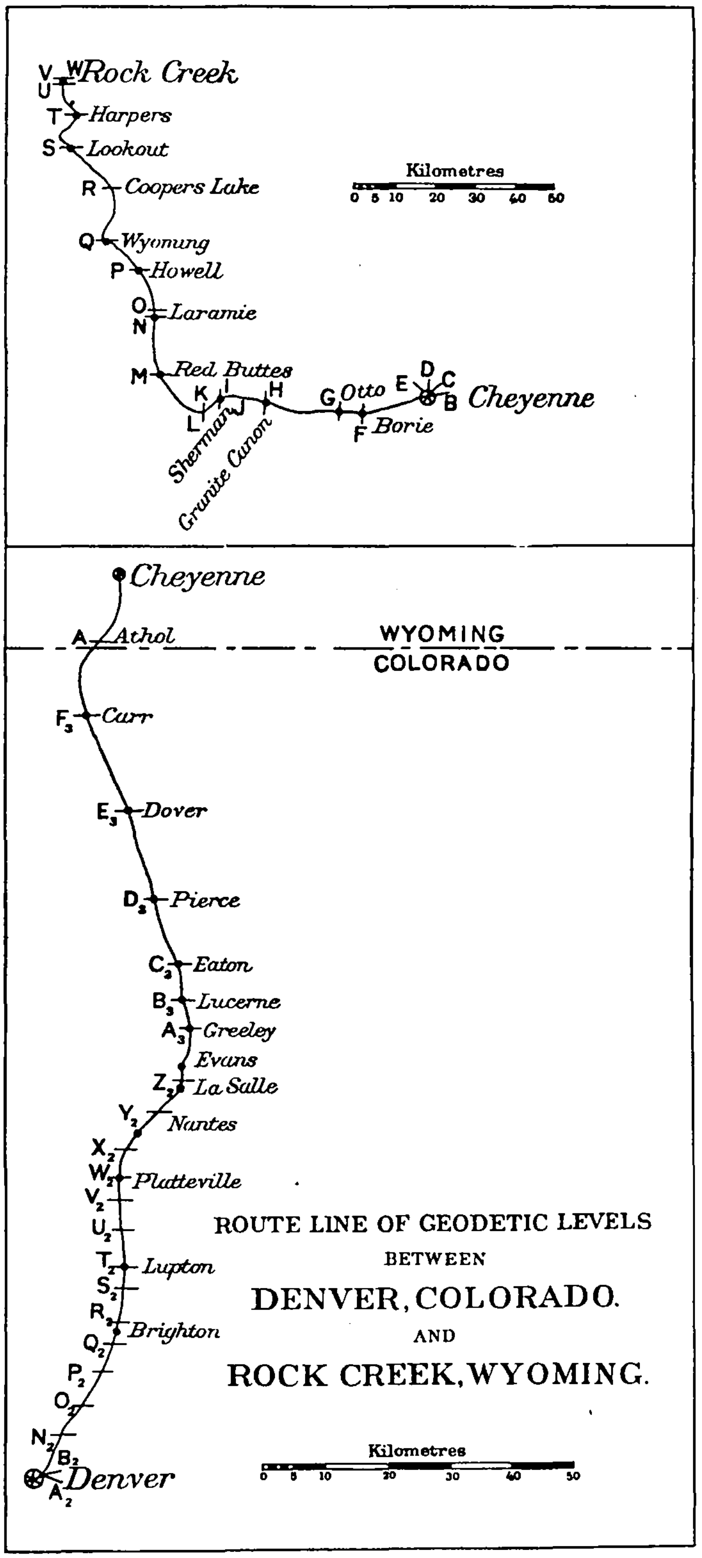
INSTRUMENTS.

Micrometer spirit level No. 5 was used.

This instrument was partially reconstructed in the shop of the Survey in 1899 before being taken to the field, and the following changes made:

The telescope was cast in one tube of nickel-iron, the alloy having a coefficient of expansion of 0·000004 per degree Centigrade. The striding level was mounted on a piece of the same metal and the supporting pieces shortened in order to bring the graduated surface of the level vial as near as possible to the line of collimation of the telescope. An aluminum cover to the vial was provided, with a glass top, and this cover is fastened only at its center to allow expansion in both directions without strain

* The elevations assigned to A_2 and B_2 in the tabulation on page 289 were the best available at the time the computation was made. For the best values now available (April, 1900) see page 479 of Appendix No. 8 of this report. J. F. H.


Rock Creek
Harpers
Lookout
Coopers Lake
Wyoming
Howell
Laramie
Red Buttes
Sherman
Granite Cañon
Otto
Borie
Cheyenne
Kilometres
0 5 10 20 30 40 50
Cheyenne
Athol
WYOMING
COLORADO
Carr
Dover
Pierce
Eaton
Lucerne
Greeley
Evans
La Salle
Nantes
Platteville
Lupton
Brighton
Denver
ROUTE LINE OF GEODETIC LEVELS
BETWEEN
DENVER, COLORADO.
AND
ROCK CREEK, WYOMING.
Kilometres
0 5 10 20 30 40 50

on the metal which carries the level vial. An adjustable mirror was mounted over the striding level.

Prisms were mounted on one side of the instrument in such a way as to enable the observer to set and watch the level bubble without changing his position from the eye end of the telescope.

The constants of this instrument were determined as follows:

Aperture of telescope ....centimetres..	2·9
Focal length of telescope ....do....	34·8
Magnifying power	39
Value of 1 division of level, 2 ^{mm}, as determined October 31, 1896.....seconds..	1·97
Value of turn of micrometer ....do....	212·0
Telemeter threads (extremes) subtend at distance of 1 metre......millimetres..	3
Inequality of collars, May 4, 1899, Tel. E........seconds..	+0·219
Inequality of collars, December 2, 1899, Tel. E........do....	+0·337
Mean used ....do....	+0·278

The wooden metric rods P and Q (for description see Appendix No. 8, Report for 1895) were used.

The targets and chains were removed from these rods and a centimetre graduation, alternately black and white, was painted on the face, to enable the observer to read the rod by using the telescope.

Length of rods between graduations 0^{m}·1 and 3^{m}·0 at 24° C.

Rod P, May, 1899........	2·90177
Rod Q, May, 1899........	2·90142

Coefficient of expansion, 0·000004 per degree centigrade.

Index correction of rods.

Rod P, April, 1899	first 0^{m}·1 of rod = 0^{m}·0997
Rod P, December, 1899........	first 0^{m}·1 of rod = 0^{m}·0994
Mean........	first 0^{m}·1 of rod = 0^{m}·09955
Rod Q, April, 1899	first 0^{m}·1 of rod = 0^{m}·0996
Rod Q, December, 1899........	first 0^{m}·1 of rod = 0^{m}·0995
Mean........	first 0^{m}·1 of rod = 0^{m}·09955

METHOD OF OBSERVING.

Two independent lines, in opposite directions, were run under the following instructions:

1. Except when specific instructions are given to proceed otherwise, all lines are to be leveled independently in both the forward and the backward direction.

2. It is desirable that the backward measurement on each section should be made under different atmospheric conditions from those which occurred on the forward measurement. It is especially desirable to make the backward measurement in the afternoon if the forward measurement was made in the forenoon, and vice versa. The observer is to secure as much difference of conditions between the forward and backward measurements as is possible without materially delaying the work for that purpose.

3. On all sections upon which the forward and backward measures differ by more

than $4^{mm}.0 \sqrt{K}$ (in which K is the distance leveled between adjacent bench marks, in kilometres), both the forward and backward measures are to be repeated until two such measures fall within the limit.

4. The programme of observation at each station is to be as follows:

Set up and level the instrument. Read the three lines of the diaphragm as seen projected against the front (or rear) rod, each reading being taken to the nearest millimetre (estimated) and the bubble being held continuously in the middle of the tube (i. e., both ends reading the same). As soon as possible thereafter read the three lines of the diaphragm as seen projected against the rear (or front) rod, estimating to millimetres as before, and holding the bubble continuously in the middle of the tube. During all observations the telescope is to be erect and the striding level with a particular leg toward the objective—that is, there are to be no reversals of the telescope or striding level.

5. At each rod station the rod thermometer is to be read and the temperature recorded.

6. At stations of odd numbers the backsight is to be taken before the foresight, and at even stations the foresight is to be taken before the backsight.

7. The maximum difference in length between a foresight and the corresponding backsight is to be 10 metres. The actual difference is to be made as small on each pair of sights as is feasible by the use of good judgment without any expenditure of time for this particular purpose.

8. The recorder shall keep a record of the rod intervals subtended by the extreme lines of the diaphragm on each backsight, together with their continuous sum between bench marks. A similar record shall be kept for the foresights. The two continuous sums shall be kept as nearly equal as is feasible without the expenditure of extra time for that purpose by setting the instrument beyond (or short of) the middle point between the back and front rods. The two continuous sums shall not be allowed to differ by more than a quantity corresponding to a distance of 20 metres.

9. The inequality of collars shall be determined at the beginning and end of each season of work.

The collimation error shall be determined once for each day of work, by a set of three readings in the direct position and two in the reverse position of the telescope.

The error of adjustment of the striding level shall be determined at least twice on each day of work by a set of three readings in the ordinary position and two in the reverse position.

10. Notes for future use in studying leveling errors shall be inserted in the record, indicating the time of beginning and ending of the work of each half day; indicating the weather conditions, especially as to cloudiness and wind; indicating whether each portion of the line is run toward or away from the sun; and such other notes as promise to be of value in studying errors.

11. The instrument shall be shaded from the direct rays of the sun both during the observations and the movement from station to station.

12. The maximum length of sight shall be 150 metres, and the maximum is to be attained only under the most favorable circumstances.

COMPUTATIONS.

The field computation was made by the observer, assisted by his recorder. The office computation was made by the observer.

RESULTS.

The resulting heights of the bench marks above the St. Louis standard level K_3 are contained in the tabular exhibit of the operation.

Results of spirit leveling between Denver, Colo., and Rock Creek, Wyo.

[For location of permanent bench marks see sketch, p. 286.]

Bench marks.		Distance between successive B. M's.	Distance from B. M. K_3 at St. Louis.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above B. M. K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	B_2		†1 483·040						1 458·8381
B_2	A_2					−0·0356‡			
B_2	A_2	·078		−0·0367	−0·0355	−0·0361§	+1·2	+1·2	
			1 483·118		Mean	−0·0358			1 458·8023
A_2	0	·748	1 483·866	−4·5685	−4·5664	−4·5675	+2·1	+ 3·3	1 454·2348
0	1	·888	1 484·754	*−2·2176	*−2·2180	−2·2178	−0·4	+ 2·9	1 452·0170
1	2	·921	1 485·675	−3·6365	−3·6365	−3·6365	0·0	+ 2·9	1 448·3805
2	3	·944	1 486·619	−1·3863	−1·3850	−1·3856	+1·3	+ 4·2	1 446·9949
3	4	1·527	1 488·146	*−2·9294	*−2·9310	−2·9302	−1·6	+ 2·6	1 444·0647
4	5	·943	1 489·089	−2·9465	−2·9464	−2·9465	+0·1	+ 2·7	1 441·1182
5	6	·940	1 490·029	−2·1781	−2·1810	−2·1795	−2·9	− 0·2	1 438·9387
6	N_2	·200	1 490·229	−0·1308	−0·1320	−0·1314	−1·2	− 1·4	1 438·8073
N_2	7	·916	1 491·145	−2·8083	−2·8079	−2·8081	+0·4	− 1·0	1 435·9992
7	8	1·002	1 492·147	*+0·3578	*+0·3540	+0·3559	−3·8	− 4·8	1 436·3551
8	9	1·122	1 493·269	−2·5358	−2·5384	−2·5371	−2·6	− 7·4	1 433·8180
9	10	·937	1 494·206	*−0·8391	*−0·8434	−0·8412	−4·3	−11·7	1 432·9768
10	11	·940	1 495·146	*−2·8968	*−2·9001	−2·8984	−3·3	−15·0	1 430·0784
11	O_2	·790	1 495·936	−3·6370	−3·6351	−3·6360	+1·9	−13·1	1 426·4424
O_2	24	·235	1 496·171	−1·7507	−1·7504	−1·7506	+0·3	−12·8	1 424·6918
24	23	1·159	1 497·330	−3·7339	−3·7342	−3·7340	−0·3	−13·1	1 420·9578
23	22	·998	1 498·328	+0·6524	+0·6495	+0·6510	−2·9	−16·0	1 421·6088
22	21	·931	1 499·259	−1·2313	−1·2320	−1·2316	−0·7	−16·7	1 420·3772
21	20	·939	1 500·198	−5·2957	−5·2978	−5·2968	−2·1	−18·8	1 415·0804
20	19	1·295	1 501·493	*−2·7647	*−2·7679	−2·7663	−3·2	−22·0	1 412·3141
19	P_2	1·034	1 502·527	−3·2556	−3·2554	−3·2555	+0·2	−21·8	1 409·0586
P_2	18	·690	1 503·217	−1·8214	−1·8203	−1·8208	+1·1	−20·7	1 407·2378
18	17	1·022	1 504·239	−0·3008	−0·2988	−0·2998	+2·0	−18·7	1 406·9380
17	16	·940	1 505·179	−2·2941	−2·2941	−2·2941	0·0	−18·7	1 404·6439
16	15	·938	1 506·117	*−3·1179	*−3·1115	−3·1147	+6·4	−12·3	1 401·5292
15	Q_2	·921	1 507·038	−1·0213	−1·0242	−1·0228	−2·9	−15·2	1 400·5064
Q_2	14	·717	1 507·755	−2·4761	−2·4800	−2·4780	−3·9	−19·1	1 398·0284
14	13	1·158	1 508·913	−2·2587	−2·2542	−2·2565	+4·5	−14·6	1 395·7719
13	12	1·106	1 510·019	−2·5395	−2·5348	−2·5372	+4·7	− 9·9	1 393·2347
12	R. R. S. (1)			−0·9410		−0·941			1 392·294
12	25	·869	1 510·888	*−1·9991	*−2·0012	−2·0002	−2·1	−12·0	1 391·2345
25	26	1·031	1 511·919	*−2·6049	*−2·6110	−2·6080	−6·1	−18·1	1 388·6265
26	R_2	·038	1 511·957	−0·3392	−0·3389	−0·3390	+0·3	−17·8	1 388·2875

* Mean of two measures. † See Appendix No.8, report for 1898–99, p. 392. ‡ 1898. § 1899.

Results of spirit leveling between Denver, Colo., and Rock Creek, Wyo.—Continued.

Bench marks.		Distance between successive B. M's.	Distance from B. M. K_3 at St. Louis.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above B. M. K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
26	27	1·123	1 513·042	−2·3306	−2·3351	−2·3329	−4·5	−22·6	1 386·2936
27	28	1·179	1 514·221	−2·0324	−2·0342	−2·0333	−1·8	−24·4	1 384·2603
28	29	1·161	1 515·382	−2·1869	−2·1916	−2·1892	−4·7	−29·1	1 382·0711
29	30	1·102	1 516·484	−1·5669	−1·5650	−1·5660	+1·9	−27·2	1 380·5051
30	S_2	·436	1 516·920	−1·3610	−1·3590	−1·3600	+2·0	−25·2	1 379·1451
S_2	31	1·093	1 518·013	−1·2344	−1·2389	−1·2366	−4·5	−29·7	1 377·9085
31	32	·938	1 518·951	−1·8728	−1·8713	−1·8721	+1·5	−28·2	1 376·0364
32	33	·936	1 519·887	−1·3143	−1·3131	−1·3137	+1·2	−27·0	1 374·7227
33	34	·938	1 520·825	−3·2410	−3·2408	−3·2409	+0·2	−26·8	1 371·4818
34	R. R. S. (2)			−1·3399		−1·340			1 370·142
34	T_2	·996	1 521·821	−2·0980	−2·0975	−2·0977	+0·5	−26·3	1 369·3841
T_2	35	1·160	1 522·981	−3·3451	−3·3437	−3·3444	+1·4	−24·9	1 366·0397
35	36	·955	1 523·936	−1·9610	−1·9623	−1·9616	−1·3	−26·2	1 364·0781
36	37	·936	1 524·872	−1·8648	−1·8675	−1·8662	−2·7	−28·9	1 362·2119
37	38	·992	1 525·864	−1·9507	−1·9504	−1·9506	+0·3	−28·6	1 360·2613
38	U_2	·856	1 526·720	−1·5595	−1·5622	−1·5608	−2·7	−31·3	1 358·7005
U_2	39	1·094	1 527·814	−1·9511	−1·9460	−1·9486	+5·1	−26·2	1 356.7519
39	40	·974	1 528·788	−2·2719	−2·2725	−2·2722	−0·6	−26·8	1 354·4797
40	41	1·048	1 529·836	−2·1392	−2·1389	−2·1390	+0·3	−26·5	1 352·3407
41	42	1·064	1 530·900	*−1·9096	*−1·9064	−1·9080	+3·2	−23·3	1 350·4327
42	V_2	·680	1 531·580	−1·5042	−1·5029	−1·5036	+1·3	−22·0	1 348·9291
V_2	43	1·011	1 532·591	−1·8563	−1·8594	−1·8578	−3·1	−25·1	1 347·0713
43	44	·936	1 533·527	−1·1428	−1·1412	−1·1420	+1·6	−23·5	1 345·9293
44	45	·942	1 534·469	−1·5454	−1·5472	−1·5463	−1·8	−25·3	1 344·3830
45	46	·957	1 535·426	−1·2181	−1·2198	−1·2190	−1·7	−27·0	1 343·1640
46	W_2	·152	1 535·578	+0·2825	+0·2825	+0·2825	0·0	−27·0	1 343·4465
W_2	73	·188	1 535·766	−0·5956	−0·5963	−0·5960	−0·7	−27 7	1 342·8505
73	R. R. S. (3)			+0·1121		+0·112			1 342·963
73	72	·914	1 536·680	−1·0416	−1·0456	−1·0436	−4·0	−31·7	1 341·8069
72	71	1·101	1 537·781	−4·9131	−4·9164	−4·9147	−3·3	−35·0	1 336·8922
71	70	1·066	1 538·847	−2·0157	−2·0155	−2·0156	+0·2	−34·8	1 334·8766
70	X_2	·944	1 539·791	*+1·2484	*+1·2516	+1·2500	+3·2	−31·6	1 336·1266
X_2	69	·822	1 540·613	*−3·5360	*−3·5387	−3·5374	−2·7	−34·3	1 332·5892
69	68	·936	1 541·549	−3·6899	−3·6925	−3·6912	−2·6	−36·9	1 328·8980
68	67	·937	1 542·486	*−1·1242	*−1·1220	−1·1231	+2·2	−34·7	1 327·7749
67	66	·938	1 543·424	−3·6290	−3·6264	−3·6277	+2·6	−32·1	1 324·1472
66	65	·930	1 544·354	*−1·2470	*−1·2490	−1·2480	−2.0	−34·1	1 322·8992
65	64	·937	1 545·291	−2.9210	*−2·9215	−2·9213	−0·5	−34·6	1 319·9779
64	R. R. S. (4)			+3·2515		+3·251			1 323·229
64	63	1·049	1 546·340	−2·7083	−2·7092	−2·7087	−0·9	−35·5	1 317·2692
63	62	1·030	1 547·370	−0·3083	−0·3065	−0·3074	+1·8	−33·7	1 316·9618
62	Y_2	·939	1 548·309	−2·4602	−2·4606	−2·4604	−0·4	−34·1	1 314·5014
Y_2	61	·281	1 548·590	−0·6397	−0·6388	−0·6393	+0·9	−33·2	1 313·8621
61	60	·936	1 549·526	−0·8867	−0·8888	−0·8877	−2·1	−35·3	1 312·9744
60	59	·936	1 550·462	−2·0614	−2·0631	−2·0623	−1·7	−37·0	1 310·9121
59	58	·939	1 551·401	−2·4309	−2·4309	−2·4309	0·0	−37·0	1 308·4812
58	57	·938	1 552·339	−2·5193	−2·5154	−2·5173	+3·9	−33·1	1 305·9639
57	56	·975	1 553·314	−2·2117	−2·2151	−2·2134	−3·4	−36·5	1 303·7505
56	55	·972	1 554·286	−2·7938	−2·7977	−2·7958	−3·9	−40·4	1 300·9547
55	54	1·007	1 555·293	−2·4859	−2·4887	−2·4873	−2·8	−43·2	1 298·4674
54	R. R. S. (5)			+0·7610		+0·761			1 299·228
54	53	·969	1 556·262	*−6·7232	*−6·7250	−6·7241	−1·8	−45·0	1 291·7433
53	Z_2	·228	1 556·490	*+0·1991	*+0·2004	+0·1997	−1·3	−46·3	1 291·9430

* Mean of two measures.

Results of spirit leveling between Denver, Colo., and Rock Creek, Wyo.—Continued.

Bench marks.		Distance between successive B. M.'s.	Distance from B. M. K_3 at St. Louis.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above B. M. K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
53	52	·731	1 556·993	*+ 0·6191	*+ 0·6160	+ 0·6176	−3·1	−48·1	1 292·3609
52	51	·940	1 557·933	− 1·3123	− 1·3131	− 1·3127	−0·8	−48·9	1 291·0482
51	R. R. S. (6)			+ 0·8578		+ 0·858			1 291·906
51	50	1·056	1 558·989	+ 2·0891	+ 2·0912	+ 2·0901	+2·1	−46·8	1 293·1383
50	49	1·010	1 559·999	+ 5·9559	+ 5·9590	+ 5·9575	+3·1	−43·7	1 299·0958
49	48	1·085	1 561·084	− 0·8902	− 0·8912	− 0·8907	−1·0	−44·7	1 298·2051
48	47	1·158	1 562·242	− 6·1866	− 6·1823	− 6·1844	+4·3	−40·4	1 292·0207
47	A_3	1·102	1 563·344	*+ 0·2214	*+ 0·2145	+ 0·2179	−6·9	−47·3	1 292·2386
A_3	R. R. S. (7)			− 0·2933		− 0·293			1 291·946
A_3	74	·728	1 564·072	− 1·3683	− 1·3676	− 1·3679	+0·7	−46·6	1 290·8707
74	75	·948	1 565·020	− 0·9236	− 0·9220	− 0·9228	+1·6	−45·0	1 289·9479
75	76	1·074	1 566·094	*+ 8·0296	*+ 8·0318	+ 8·0307	+2·2	−42·8	1 297·9786
76	77	1·102	1 567·196	+10·9648	+10·9628	+10·9638	−2·0	−44·8	1 308·9424
77	78	1·157	1 568·353	+ 6·6659	+ 6·6645	+ 6·6652	−1·4	−46·2	1 315·6076
78	79	1·104	1 569·457	*+ 3·4518	*+ 3·4506	+ 3·4512	−1·2	−47·4	1 319·0588
79	80	·724	1 570·181	+ 2·0035	+ 2·0028	+ 2·0032	−0·7	−48·1	1 321·0620
80	B_3	·143	1 570·324	− 0·0751	− 0·0751	− 0·0751	0·0	−48·1	1 320·9869
80	R. R. S. (8)			+ 1·7100		+ 1·710			1 322·772
80	81	1·104	1 571·285	+ 5·0519	+ 5·0502	+ 5·0510	−1·7	−49·8	1 326·1130
81	82	1·046	1 572·331	+ 5·2878	+ 5·2854	+ 5·2866	−2·4	−52·2	1 331·3996
82	83	·976	1 573·307	+ 3·0968	+ 3·0941	+ 3·0954	−2·7	−54·9	1 334·4950
83	84	·939	1 574·246	*+ 4·8460	*+ 4·8425	+ 4·8442	−3·5	−58·4	1 339·3392
84	85	·915	1 575·161	*+ 4·4308	*+ 4·4309	+ 4·4309	+0·1	−58·3	1 343·7701
85	86	·254	1 575·415	*+ 1·6528	*+ 1·6544	+ 1·6536	+1·6	−56·7	1 345·4237
86	C_3	·038	1 575·453	+ 1·7736	+ 1·7736	+ 1·7736	0·0	−56·7	1 347·1973
86	R. R. S. (9)			+ 0·5507		+ 0·551			1 345·975
86	87	·940	1 576·355	+ 3·2522	+ 3·2562	+ 3·2542	+4·0	−52·7	1 348·6779
87	88	1·069	1 577·421	*+ 5·0965	*+ 5·0949	+ 5·0957	−1·6	−54·3	1 353·7736
88	89	1·160	1 578·581	*+ 3·8567	+ 3·8550	+ 3·8558	−1·7	−56·0	1 357·6294
89	90	1·232	1 579·813	*+ 9·7636	*+ 9·7651	+ 9·7644	+1·5	−54·5	1 367·3938
90	91	1·050	1 580·863	*+ 6·3064	*+ 6·3085	+ 6·3074	+2·1	−52·4	1 373·7012
91	92	1·141	1 582·004	+ 5·6080	+ 5·6096	+ 5·6088	+1·6	−50·8	1 379·3100
92	R.R.S.(10)			+ 0·7030		+ 0·703			1 380·013
92	93	1·102	1 583·106	+ 4·2932	+ 4·2924	+ 4·2928	−0·8	−51·6	1 383·6028
93	94	1·158	1 584·264	+ 7·0351	+ 7·0334	+ 7·0343	−1·7	−53·3	1 390·6371
94	95	1·159	1 585·423	+ 4·1511	+ 4·1495	+ 4·1503	−1·6	−54·9	1 394·7874
95	96	1·030	1 586·453	+ 5·1399	+ 5·1397	+ 5·1398	−0·2	−55·1	1 399·9272
96	97	·953	1 587·406	+ 5·1587	+ 5·1581	+ 5·1584	−0·6	−55·7	1 405·0856
97	D_3	·732	1 588·138	+ 3·6665	+ 3·6669	+ 3·6667	+0·4	−55·3	1 408·7523
D_3	98	·722	1 588·860	+ 3·6197	+ 3·6221	+ 3·6209	+2·4	−52·9	1 412·3732
98	99	·936	1 589·796	*+ 4·5952	*+ 4·5923	+ 4·5938	−2·9	−55·8	1 416·9670
99	100	·938	1 590·734	*+ 5·5862	*+ 5·5826	+ 5·5844	−3·6	−59·4	1 422·5514
100	101	1·034	1 591·768	+ 8·6365	+ 8·6355	+ 8·6360	−1·0	−60·4	1 431·1874
101	102	1·048	1 592·816	+ 4·8406	+ 4·8378	+ 4·8392	−2.8	−63·2	1 436·0266
102	103	1·012	1 593·828	+ 5·0610	+ 5·0578	+ 5.0592	−3·6	−66·8	1 441·0858
103	104	·939	1 594·767	+ 5·3581	+ 5·3551	+ 5·3566	−3·0	−69·8	1 446·4424
104	105	·936	1 595·703	+ 5·8822	+ 5·8790	+ 5·8805	−3·0	−72·8	1 452·3229
105	106	·937	1 596·640	+ 5·7086	+ 5·7097	+ 5·7092	+1·1	−71·7	1 458·0321
106	107	·625	1 597·265	*+ 4·2447	*+ 4·2436	+ 4·2442	−1·1	−72·8	1 462·2763
107	128	·835	1 598·100	*+ 5·0988	*+ 5·0939	+ 5·0964	−4·9	−77·7	1 467·3727
128	127	·992	1 599·092	*+11·6057	*+11·6004	+11·6030	−5·3	−83·0	1 478·9757

* Mean of two measures.

Results of spirit leveling between Denver, Colo., and Rock Creek, Wyo.—Continued.

Bench marks.		Distance between successive B. M's.	Distance from B. M. K_3 at St. Louis.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above B. M. K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
127	126	1·066	1 600·158	*+ 7·1676	*+ 7·1640	+ 7·1658	−3·6	−86·6	1 486·1415
126	125	1·104	1 601·262	+ 9·2363	+ 9·2391	+ 9·2377	+2·8	−83·8	1 495·3792
125	124	1·543	1 602·805	*+10·4504	*+10·4494	+10·4499	−1·0	−84·8	1 505·8291
124	123	1·104	1·603·909	+ 9·2281	+ 9·2282	+ 9·2282	+0·1	−84·7	1 515·0573
123	122	·964	1·604·873	+ 7·1268	+ 7·1244	+ 7·1256	−2·4	−87·1	1 522·1829
122	E_3	·025		+ 0·1881	+ 0·1881	+ 0·1881	0·0	−87·1	1 522·3710
122	121	·311	1 605·184	+ 2·7090	+ 2·7092	+ 2·7091	+0·2	−86·9	1 524·8920
121	120	1·048	1 606·232	+ 8·2042	+ 8·2029	+ 8·2035	−1·3	−88·2	1 533·0955
120	119	1·046	1 607·278	+ 8·5254	+ 8·5260	+ 8·5257	+0·6	−87·6	1 541·6212
119	118	1·048	1 608·326	*+ 8·9214	*+ 8·9186	+ 8·9200	−2·8	−90·4	1 550·5412
118	117	1·159	1 609·485	+ 5·0008	+ 5·0055	+ 5·0032	+4·7	−85·7	1 555·5444
117	116	1·104	1 610·589	+ 9·4304	+ 9·4316	+ 9·4310	+1·2	−84·5	1 564·9754
116	115	1·159	1 611·748	+ 9·1064	+ 9·1038	+ 9·1051	−2·6	−87·1	1 574·0805
115	114	1·158	1 612·906	+ 7·9865	+ 7·9884	+ 7·9874	+1·9	−85·2	1 582·0679
114	113	1·102	1 614·008	+ 8·2131	+ 8·2105	+ 8·2118	−2·6	−87·8	1 590·2797
113	112	·932	1 614·940	− 2·7364	− 2·7332	− 2·7348	+3·2	−84·6	1 587·5449
112	111	·940	1 615·880	+ 6·6834	+ 6·6851	+ 6·6842	+1·7	−82·9	1 594·2291
111	110	·936	1 616·816	+ 5·1876	+ 5·1861	+ 5·1868	−1·5	−84·4	1 599·4159
110	109	1·048	1 617·864	+ 5·5826	+ 5·5792	+ 5·5809	−3·4	−87·8	1 604·9968
109	108	1·062	1·618·926	+ 7·2348	*+ 7·2347	+ 7·2348	−0·1	−87·9	1 612·2316
108	F_3	·416	1 619·342	+ 0·3412	+ 0·3425	+ 0·3418	+1·3	−86·6	1 612·5734
108	R.R.S. (11)			+ 0·446		+ 0·446			1 612·678
108	129	·937	1 619·863	*+ 4·1379	*+ 4·1420	+ 4·1400	+4·1	−83·8	1 616·3716
129	130	1·046	1 620·909	*+10·6290	*+10·6312	+10·6301	+2·2	−81·6	1 627·0017
130	131	1·046	1 621·955	+ 5·0235	+ 5·0204	+ 5·0220	−3·1	−84·7	1 632·0237
131	132	1·037	1 622·992	+10·9513	+10·9541	+10·9527	+2·8	−81·9	1 642·9764
132	133	1·047	1 624·039	+10·0730	+10·0700	+10·0715	−3·0	−84·9	1 653·0479
133	134	1·140	1 625·179	+11·1211	+11·1205	+11·1208	−0·6	−85·5	1 664·1687
134	135	1·046	1 626·225	+11·7849	+11·7818	+11·7834	−3·1	−88·6	1 675·9521
135	136	1·046	1 627·271	+ 9·5453	+ 9·5482	+ 9·5467	+2·9	−85·7	1 685·4988
136	137	1·066	1 628·337	+10·9903	+10·9907	+10·9905	+0·4	−85·3	1 696·4893
137	138	1·048	1 629·385	+12·7979	+12·8017	+12·7998	+3·8	−81·5	1 709·2891
138	139	1·060	1 630·445	*+ 8·2507	*+ 8·2553	+ 8·2530	+4·6	−76·9	1 717·5421
139	140	1·052	1 631.497	*+10·4269	*+10·4312	+10·4290	+4·3	−72·6	1 727·9711
140	141	·954	1 632·451	*+14·0498	*+14·0542	+14·0520	+4·4	−68·2	1 742·0231
141	142	·936	1 633·387	*+14·7890	*+14·7920	+14·7905	+3·0	−65·2	1 756·8136
142	143	·654	1 634·041	*+ 8·5883	*+ 8·5902	+ 8·5892	+1·9	−63·3	1 765·4028
143	144	·974	1 635·015	*+14·8123	*+14·8141	+14·8132	+1·8	−61·5	1 780·2160
144	A	·950	1 635·965	+14·7000	+14·6972	+14·6986	−2·8	−64·3	1 794·9146
A	R.R.S. (12)			+ 2·8273		+ 2·827			1 797·742
A	160	·616	1 636·581	− 1·6591	− 1·6559	− 1·6575	+3·2	−61·1	1 793·2571
160	159	·955	1 637·536	−12·8932	−12·8915	−12·8924	+1·7	−59·4	1 780·3647
159	158	·938	1 638·474	−10·8055	−10·8043	−10·8049	+1·2	−58·2	1 769·5598
158	157	·938	1 639·412	− 6·4869	− 6·4854	− 6·4862	+1·5	−56·7	1 763·0736
157	156	1·009	1 640·421	− 8·4576	− 8·4608	− 8·4592	−3·2	−59·9	1 754·6144
156	155	1·048	1 641·469	+ 3·2913	+ 3·2948	+ 3·2930	+3·5	−56·4	1 757·9074
155	154	1·029	1 642·498	*−10·5072	*−10·5059	−10·5066	+1·3	−55·1	1 747·4008
154	153	·992	1 643·490	−13·5917	−13·5916	−13·5916	+0·1	−55·0	1 733·8092
153	152	·919	1 644·409	−14·0877	−14·0881	−14·0879	−0·4	−55·4	1 719·7213
152	151	·937	1 645·346	− 7·5605	− 7·5633	− 7·5619	−2·8	−58·2	1 712·1594
151	150	·950	1 646·296	− 5·9056	− 5·9052	− 5·9054	+0·4	−57·8	1 706·2540

*Mean of two measures.

Results of spirit leveling between Denver, Colo., and Rock Creek, Wyo.—Continued.

Bench marks. From	Bench marks. To	Distance between successive B. M's.	Distance from B. M. K3 at St. Louis.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B.—F.). Partial.	Discrepancy (B.—F.). Total.	Elevation above B. M. K3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
150	149	·938	1 647·234	— 4·7717	— 4·7701	— 4·7709	+1·6	—56·2	1 701·4831
149	148	·942	1 648·176	— 2·0732	— 2·0743	— 2·0738	—1·1	—57·3	1 699·4093
148	147	1·015	1 649·191	+ 6·0295	+ 6·0270	+ 6·0282	—2·5	—59·8	1 705·4375
147	146	1·151	1 650·342	+ 5·0379	+ 5·0368	+ 5·0374	—1·1	—60·9	1 710·4749
146	145	1·152	1 651·494	+10·0282	+10·0290	+10·0286	+0·8	—60·1	1 720·5035
145	B	1·065	1 852·559	+ 0·9190	+ 0·9180	+ 0·9185	—1·0	—61·1	1 721·4220
B	C	·195	1 652·754	— 0·1886	— 0·1894	— 0·1890	—0·8	—61·9	1 721·2330
C	D	·124	1 652·878	— 0·0380	— 0·0377	— 0·0378	+0·3	—61·6	1 721·1952
B	161	1·047	1 653·606	+ 7·1945	+ 7·1904	+ 7·1924	—4·1	—65·2	1 728·6144
161	E	·078	1 653·684	+ 4·1929	+ 4·1930	+ 4·1930	+0·1	—65·1	1 732·8074
B	R.R.S. (13)			+ 0·0250		+ 0·025			1 721·447
B	162	·909	1 653·468	— 0·0249	— 0·0255	— 0.0252	—0·6	—61·7	1 721·3968
162	163	1·074	1 654·542	+ 6·5220	+ 6·5224	+ 6·5222	+0·4	—61·3	1 727·9190
163	164	1·162	1 655·704	+ 9·5016	+ 9·4987	+ 9·5002	—2·9	—64·2	1 737·4192
164	165	1·310	1 657·014	+ 9·8658	+ 9·8671	+ 9·8664	+1·3	—62·9	1 747·2856
165	166	1·217	1 658·231	+12·5232	+12·5232	+12·5232	0·0	—62·9	1 759·8088
166	167	1·050	1 659·281	*+11·0137	*+11·0175	+11·0156	+3·8	—59·1	1 770·8244
167	168	1·050	1 660·331	+ 9·6372	+ 9·6385	+ 9·6378	+1·3	—57·8	1 780·4622
168	169	1·058	1 661·389	+12·5444	+12·5472	+12·5458	+2·8	—55·0	1 793·0080
169	R.R.S. (14)			+ 3·6224		+ 3·622			1 796·630
169	170	1·056	1 662·445	+ 6·7919	+ 6·7930	+ 6·7924	+1·1	—53·9	1 799·8004
170	171	1·050	1 663·495	+11·9014	+11·9040	+11·9027	+2·6	—51·3	1 811·7031
171	172	1·125	1 664·620	+15·0366	+15·0355	+15·0360	—1·1	—52·4	1 826·7391
172	173	1·052	1 665·672	*+14·3012	*+14·3038	+14·3025	+2·6	—49·8	1 841·0416
173	174	1·401	1 667·073	+18·6140	+18·6123	+18·6132	—1·7	—51·5	1 859·6548
174	175	1·051	1 668·124	+14·6560	+14·6559	+14·6560	—0·1	—51·6	1 874·3108
175	R.R.S. (15)			+14·7458		+14·746			1 889·057
175	176	1·006	1 669·130	+14·8748	+14·8763	+14·8756	+1·5	—50·1	1 889·1864
176	F	·104	1 669·234	— 1·0509	— 1·0516	— 1·0512	—0·7	—50·8	1 888·1352
176	196	·447	1 669·577	+ 6·5700	+ 6·5706	+ 6·5703	+0·6	—49·5	1 895·7567
196	195	·976	1 670·553	+13·3377	+13·3387	+13·3382	+1·0	—48·5	1 909·0949
195	194	·942	1 671·495	+14·7187	+14·7212	+14·7200	+2·5	—46·0	1 923·8149
194	193	·940	1 672·435	+14·2155	+14·2162	+14·2159	+0·7	—45·3	1 938·0308
193	192	·942	1 673·377	+13·7533	+13·7522	+13·7528	—1·1	—46·4	1 951·7836
192	191	·941	1 674·318	+14·4856	+14·4832	+14·4844	—2·4	—48·8	1 966·2680
191	190	·922	1 675·240	+13·2670	+13·2680	+13·2675	+1·0	—47·8	1 979·5355
190	G	·916	1 676·156	*+14·2588	*+14·2570	+14·2579	—1·8	—49·6	1 993·7934
G	R.R.S. (16)			— 2·3803		— 2·380			1 991·413
G	184	·221	1 676·377	+ 2·5143	+ 2·5137	+ 2·5140	—0·6	—50·2	1 996·3074
184	183	·960	1 677·337	+14·4615	+14·4601	+14·4608	—1·4	—51·6	2 010·7682
183	182	·978	1 678·315	*+14·9400	*+14·9418	+14·9409	+1·8	—49·8	2 025·7091
182	181	1·055	1 679·370	*+15·6445	*+15·6480	+15·6462	+3·5	—46·3	2 041·3553
181	180	1·048	1 680·418	+15·5290	+15·5295	+15·5292	+0·5	—45·8	2 056·8845
180	179	·995	1 681·413	*+15·1128	*+15·1087	+15·1108	—4·1	—49·9	2 071·9953
179	178	·958	1 682·371	*+14·3929	*+14·3892	+14·3910	—3·7	—53·6	2 086·3863
178	177	1·325	1 683·696	*+17·1183	+17·1132	+17·1158	—5·1	—58.7	2 103·5021
177	H	·063	1 683·759	— 0·2134	— 0·2131	— 0·2132	+0·3	—58·4	2 103·2889
H	R.R.S. (17)			+ 0·3690		— 0·369			2 103·658

* Mean of two measures.

Results of spirit leveling between Denver, Colo., and Rock Creek, Wyo.—Continued.

Bench marks. From	Bench marks. To	Distance between successive B. M's.	Distance from B. M. K3 at St. Louis.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B.—F.). Partial.	Discrepancy (B.—F.). Total.	Elevation above B. M. K3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
177	185	·924	1 684·620	+ 8·1441	+ 8·1433	+ 8·1437	−0·8	−59·5	2 111·6458
185	186	·940	1 685·560	+13·7953	+13·7966	+13·7960	+1·3	−58·2	2 125·4418
186	187	·894	1 686·454	+13·3453	+13·3454	+13·3454	+0·1	−58·1	2 138·7872
187	188	·942	1 687·396	+13·7791	+13·7763	+13·7777	−2·8	−60·9	2 152·5649
188	189	·950	1 688·346	+14·2224	*+14·2237	+14·2230	+1·3	−59·6	2 166·7879
189	197	·941	1 689·287	+13·9957	+13·9981	+13·9969	+2·4	−57·2	2 180·7848
197	198	·941	1 690.228	+14·0439	+14·0459	+14·0449	+2·0	−55·2	2 194·8297
198	199	·939	1 691·167	+13·1780	+13·1798	+13·1789	+1·8	−53·4	2 208·0086
199	200	1·164	1 692·331	+10·3492	+10·3492	+10·3492	0·0	−53·4	2 218·3578
200	201	·996	1 693·327	+13·5403	+13·5414	+13·5408	+1·1	−52·3	2 231·8986
201	202	·940	1 694·267	+11·2723	+11·2754	+11·2738	+3·1	−49·2	2 243·1724
202	R.R.S.(17½)			+ 1·8527		+ 1·853			2 245·025
202	203	·980	1 195·247	*+11·1164	*+11·1180	+11·1172	+1·6	−47·6	2 254·2896
203	204	1·014	1 696·261	*+14.7717	*+14·7763	+14·7740	+4·6	−43·0	2 269·0636
204	205	1·014	1 697·275	+12·8523	+12·8521	+12·8522	−0·2	−43·2	2 281·9158
205	206	1·052	1 698·327	+13·9369	+13·9336	+13·9352	−3·3	−46·5	2 295·8510
206	207	·952	1 699·279	+13·3882	+13·3879	+13·3880	−0·3	−46·8	2 309·2390
207	223	1·104	1 700·383	*+11·1843	*+11·1876	+11·1860	+3.3	−43·5	2 320·4250
223	222	·941	1 701·324	+14·2455	+14·2431	+14·2443	−2·4	−45·9	2 334·6693
222	221	·940	1 702·264	+14·3139	+14·3116	+14·3128	−2·3	−48·2	2 348·9821
221	220	·958	1 703·222	*+14.1346	*+14·1356	+14·1351	+1·0	−47·2	2 363·1172
220	219	1·042	1 704·264	*+12.5088	*+12·5118	+12·5103	+3·0	−44·2	2 375·6275
219	218	1·135	1 705·399	*+12.6097	*+12·6077	+12·6087	−2·0	−46·2	2 388·2362
218	J	·265	1 705·664	+10·3056	+10·3075	+10·3066	+1·9	−44·3	2 398·5428
218	R.R.S.(18)			+ 0·3293		+ 0·329			2 388·565
218	Sign (19)			+ 0·3363		+ 0·336			2 388·572
218	I	·382	1 705·781	+ 0·7014	+ 0·7020	+ 0·7017	+0·6	−45·6	2 388·9379
I	217	·250	1 706·031	− 2·3532	− 2·3543	− 2·3538	−1·1	−46·7	2 386·5841
217	216	·980	1 707·011	−13·0933	−13·0930	−13·0932	+0·3	−46·4	2 373·4909
216	215	·968	1 707·979	−10·3350	−10·3366	−10·3358	−1·6	−48·0	2 363·1551
215	214	1·013	1 708·992	−12·0923	−12·0897	−12·0910	+2·6	−45·4	2 351·0641
214	213	·942	1 709·934	−13·2463	−13·2447	−13·2455	+1·6	−43·8	2 337·8186
213	212	·938	1 710·872	−14·0311	−14·0312	−14·0312	−0·1	−43·9	2 323·7874
212	K	·984	1 711·856	−10·1377	−10·1406	−10·1392	−2·9	−46·8	2 313·6482
K	L	·094		− 0·9111	− 0·9108	− 0·9110	+0·3	−46·5	2 312·7372
K	211	·645	1 712·501	− 1·0467	− 1·0480	− 1·0474	−1·3	−48·1	2 312·6008
211	210	·860	1 713·361	− 0·6557	− 0·6551	− 0·6554	+0·6	−47·5	2 311·9454
210	209	·921	1 714·282	*−15·2173	*−15·2133	−15·2153	+4·0	−43·5	2 296·7301
209	208	·907	1 715·189	−15·4603	−15·4617	−15·4610	−1·4	−44·9	2 281·2691
208	R.R.S.(20)			+ 0·4813		+ 0·481			2 281·750
208	224	·866	1 716·055	−14·7209	−14·7221	−14·7215	−1·2	−46·1	2 266·5476
224	225	·874	1 716·929	−13·9894	−13·9912	−13·9903	−1·8	−47·9	2 252·5573
225	226	·909	1 717·838	−14·5699	−14·5706	−14·5702	−0·7	−48·6	2 237·9871
226	227	·996	1 718·834	−13·6892	−13·6907	−13·6900	−1·5	−50·1	2 224·2971
227	228	·942	1 719·776	−15·8003	−15·8004	−15·8004	−0·1	−50·2	2 208·4967
228	229	·892	1 720·668	−15·3118	−15·3130	−15·3124	−1·2	−51·4	2 193·1843
229	230	·940	1 721·608	*−15·2565	*−15·2516	−15·2540	+4·9	−46·5	2 177·9303
230	R.R.S.(21)			− 3·9069		− 3·907			2 174·023
230	231	1·067	1 722·675	−12·8664	−12·8681	−12·8672	−1·7	−48·2	2 165·0631
231	232	·980	1 723·655	−12·7538	−12·7547	−12·7542	−0·9	−49·1	2 152·3089

* Mean of two measures.

Results of spirit leveling between Denver, Colo., and Rock Creek, Wyo.—Continued.

Bench marks.		Distance between successive B. M's.	Distance from B. M. K3 at St. Louis.	Difference of elevation.			Discrepancy (B.–F.).		Elevation above B. M. K3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
232	233	1·110	1 724·765	— 8·5117	— 8·5131	— 8·5124	—1·4	—50·5	2 143·7965
233	234	1·108	1 725·873	—13·0944	—13·0916	—13·0930	+2·8	—47·7	2 130·7035
234	235	·977	1 726·850	—14·4499	—14·4487	—14·4493	+1·2	—46·5	2 116·2542
235	236	1·202	1 728·052	—10·0787	—10·0756	—10·0772	+3·1	—43·4	2 106·1770
236	R.R.S.(22)			— 6·9145		— 6·915			2 099·262
236	237	1·268	1 729·320	— 7·1333	— 7·1308	— 7·1320	+2·5	—40·9	2 099·0450
237	M	·193		+ 0·5829	+ 0·5826	+ 0·5828	—0·3	—41·2	2 099·6278
237	250	1·152	1 730·472	— 4·6280	— 4·6263	— 4·6272	+1·7	—39·2	2 094·4178
250	249	1·162	1 731·634	— 9·5999	— 9·6007	— 9·6003	—0·8	—40·0	2 084·8175
249	248	1·069	1 732·703	— 2·1653	— 2·1683	— 2·1668	—3·0	—43·0	2 082·6507
248	247	1·152	1 733·855	— 3·6394	— 3·6397	— 3·6396	—0·3	—43·3	2 079·0111
247	246	1·126	1 734·981	— 5·2242	— 5·2264	— 5·2253	—2·2	—45·5	2 073·7858
246	245	1·102	1 736·083	— 0·7343	— 0·7373	— 0·7358	—3·0	—48·5	2 073·0500
245	R.R.S.(23)			— 2·0597		— 2·060			2 070·990
245	244	1·170	1 737·253	— 3·8830	— 3·8866	— 3·8848	—3·6	—52·1	2 069·1652
244	243	1·139	1 738·392	— 4·7565	— 4·7602	— 4·7584	—3·7	—55·8	2 064·4068
243	242	1·050	1 739·442	— 3·4907	— 3·4863	— 3·4885	+4·4	—51·4	2 060·9183
242	241	·996	1 740·438	— 1·9087	— 1·9067	— 1·9077	+2·0	—49·4	2 059·0106
241	240	·944	1 741·382	— 1·8047	— 1·8083	— 1·8065	—3·6	—53·0	2 057·2041
240	239	1·262	1 742·644	— 5·4881	— 5·4924	— 5·4902	—4·3	—57·3	2 051·7139
239	238	·996	1 743·640	+ 0·7678	+ 0·7679	+ 0·7678	+0·1	—57·2	2 052·4817
238	R.R.S.(24)			+ 0·2096		+ 0·210			2 052·692
238	251	·776	1 744·416	— 0·0730	— 0·0710	— 0·0720	+2·0	—55·2	2 052·4097
251	N	·725	1 745·141	+ 5·2377	+ 5·2375	+ 5·2376	—0·2	—55·4	2 057·6473
251	252	1·083	1 745·499	— 4·4854	— 4·4862	— 4·4858	—0·8	—56·0	2 047·9239
252	253	·996	1 746·495	+ 0·2347	+ 0·2360	+ 0·2354	+1·3	—54·7	2 048·1593
253	O	·346	1 746·841	— 0·7163	— 0·7187	— 0·7175	—2·4	—57·1	2 047·4418
O	254	·940	1 747·781	— 1·4447	— 1·4464	— 1·4456	—1·7	—58·8	2 045·9962
254	255	·942	1 748·723	— 0·2438	— 0·2418	— 0·2428	+2·0	—56·8	2 045·7534
255	256	·940	1 749·663	— 1·6185	— 1·6181	— 1·6183	+0·4	—56·4	2 044·1351
256	257	·941	1 750·604	*+ 4·1755	*+ 4·1748	+ 4·1752	—0·7	—57·1	2 048·3103
257	258	·958	1 751·562	+ 0·1741	+ 0·1731	+ 0·1736	—1·0	—58·1	2 048·4839
258	259	1·048	1 752·610	— 0·2521	— 0·2491	— 0·2506	+3·0	—55·1	2 048·2333
259	260	1·160	1 753·770	— 4·7007	— 4·6980	— 4·6994	+2·7	—52·4	2 043·5339
260	261	1·160	1 754·930	— 0·8040	— 0·8080	— 0·8060	—4·0	—56·4	2 042·7279
261	262	1·106	1 756·036	— 1·5452	— 1·5458	— 1·5455	—0·6	—57·0	2 041·1824
262	263	1·051	1 757·087	— 1·0388	— 1·0409	— 1·0398	—2·1	—59·1	2 040·1426
263	R.R.S.(25)			— 0·0970		— 0·097			2 040·046
263	264	·876	1 757·963	— 0·7574	— 0·7558	— 0·7566	+1·6	—57·5	2 039·3860
264	P	·055	1 758·018	— 0·7664	— 0·7661	— 0·7662	+0·3	—57·2	2 038·6198
264	265	·875	1 758·838	— 1·2450	— 1·2447	— 1·2448	+0·3	—57·2	2 038·1412
265	266	·976	1 759·814	— 1·0733	— 1·0762	— 1·0748	—2·9	—60·1	2 037·0664
266	267	·978	1 760·792	— 0·2799	— 0·2836	— 0·2818	—3·7	—63·8	2 036·7846
267	268	1·142	1 761·934	— 2·1081	— 2·1086	— 2·1084	—0·5	—64·3	2 034·6762
268	269	1·380	1 763·314	— 1·0869	— 1·0888	— 1·0878	—1·9	—66·2	2 033·5884
269	270	·978	1 764·292	— 0·7094	— 0·7095	— 0·7094	—0·1	—66·3	2 032·8790
270	271	1·179	1 765·471	— 0·8041	— 0·8055	— 0·8048	—1·4	—67·7	2 032·0742
271	Q	1·104	1 766·575	— 0·8963	— 0·8934	— 0·8948	+2·9	—64·8	2 031·1794

* Mean of two measures.

Results of spirit leveling between Denver, Colo., and Rock Creek, Wyo.—Continued.

Bench marks. From	Bench marks. To	Distance between successive B. M.'s	Distance from B. M. K3 at St. Louis.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B.—F.). Partial.	Discrepancy (B.—F.). Total.	Elevation above B. M. K3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
Q	272	1·008	1 767·583	*−2·1952	*−2·1968	−2·1960	−1·6	−66·4	2 028·9834
272	273	1·111	1 768·694	*+0·7184	*+0·7138	+0·7161	−4·6	−71·0	2 029·6995
273	274	1·156	1 769·850	*+6·6006	*+6·5983	+6·5994	−2·3	−73·3	2 036·2989
274	275	1·114	1 770·964	+5·0067	+5·0035	+5·0051	−3·2	−76·5	2 041·3040
275	299	·488	1 771·452	−0·1734	−0·1721	−0·1728	+1·3	−75·2	2 041·1312
299	298	·938	1 772·390	+0·2373	+0·2365	+0·2369	−0·8	−76·0	2 041·3681
298	297	·940	1 773·330	−0·6023	−0·6060	−0·6042	−3·7	−79·7	2 040·7639
297	296	·992	1 774·322	+0·2175	+0·2140	+0·2158	−3·5	−83·2	2 040·9797
296	295	1·052	1 775·374	−0·9840	−0·9872	−0·9856	−3·2	−86·4	2 039·9941
295	294	1·048	1 776·422	+3·9628	+3·9643	+3·9636	+1·5	−84·9	2 043·9577
294	R.R.S.(26)			+0·4460		+0·446			2 044·404
294	293	·935	1 777·357	*−0·9901	*−0·9896	−0·9898	+0·5	−84·4	2 042·9679
293	292	·940	1 778·297	−3·0760	−3·0750	−3·0755	+1·0	−83·4	2 039·8924
292	291	·994	1 779·291	−2·0957	−2·0972	−2·0964	−1·5	−84·9	2 037·7960
291	290	1·049	1 780·340	−5·5033	−5·5060	−5·5046	−2·7	−87·6	2 032·2914
290	289	1·054	1 781·394	+0·1134	+0·1173	+0·1154	+3·9	−83·7	2 032·4068
289	288	1·044	1 782·438	−1·4853	−1·4895	−1·4874	−4·2	−87·9	2 030·9194
288	287	1·824	1 784·262	−8·0857	−8·0891	−8·0874	−3·4	−91·3	2 022·8320
287	R	1·064	1 785·326	−2·2305	−2·2278	−2·2292	+2·7	−88·6	2 020·6028
R	286	·686	1 786·012	*−4·0808	*−4·0798	−4·0803	+1·0	−87·6	2 016·5225
286	285	1·052	1 787·064	+1·0529	+1·0526	+1·0528	−0·3	−87·9	2 017·5753
285	284	1·259	1 788·323	+2·6441	+2·6482	+2·6462	+4·1	−83·8	2 020·2215
284	283	1·178	1 789·501	*+4·1108	+4·1092	+4·1100	−1·6	−85·4	2 024·3315
283	282	1·160	1 790·661	+0·2933	+0·2947	+0·2940	+1·4	−84·0	2 024·6255
282	281	1·051	1 791·712	+5·0503	+5·0520	+5·0512	+1·7	−82·3	2 029·6767
281	280	1·029	1 792·741	+7·5693	+7·5688	+7·5690	−0·5	−82·8	2 037·2457
280	279	1·048	1 793·789	+5·4990	+5·4959	+5·4974	−3·1	−85·9	2 042·7431
279	278	1·050	1 794·839	+4·3419	+4·3451	+4·3435	+3·2	−82·7	2 047·0866
278	277	1·095	1 795·934	*+5·3625	*+5·3594	+5·3610	−3·1	−85·8	2 052·4476
277	276	·980	1 796·914	+5·5695	+5·5724	+5·5710	+2·9	−82·9	2 058·0186
276	R.R.S.(27)			+0·4296		+0·430			2 058·449
276	S	·133	1 797·047	+ 1·7650	+ 1·7650	+ 1·7650	0·0	−82·9	2 059·7836
276	300	·906	1 797·820	+4·2412	+4·2447	+4·2430	+3·5	−79·4	2 062·2616
300	301	·944	1 798·764	−5·0766	−5·0788	−5·0777	−2·2	−81·6	2 057·1839
301	302	1·100	1 799·864	−8·4589	−8·4598	−8·4594	−0·9	−82·5	2 048·7245
302	303	1·258	1 801·122	−9·1910	−9·1938	−9·1924	−2·8	−85·3	2 039·5321
303	304	1·281	1 802·403	−9·1903	−9·1896	−9·1900	+0·7	−84·6	2 030·3421
304	305	·897	1 803·300	−6·3303	−6·3275	−6·3289	+2·8	−81·8	2 024·0132
305	306	·954	1 804·254	−3·3433	−3·3417	−3·3425	+1·6	−80·2	2 020·6707
306	307	1·110	1 805·364	−5·8282	−5·8243	−5·8262	+3·9	−76·3	2 014·8445
307	T	1·018	1 806·382	−4·7744	−4·7714	−4·7729	+3·0	−73·3	2 010·0716
T	R.R.S.(28)			−0·0707		−0·071			2 010·001
T	308	·999	1 807·381	−5·2092	−5·2108	−5·2100	−1·6	−74·9	2 004·8616
308	309	·940	1 808·321	*−3·1144	*−3·1122	−3·1133	+2·2	−72·7	2 001·7483
309	310	·626	1 808·947	−3·9291	−3·9307	−3·9299	−1·6	−74·3	1 997·8184
310	326	·698	1 809·645	−5·0148	−5·0141	−5·0144	+0·7	−73·6	1 992·8040
326	325	·910	1 810·555	−6·6764	−6·6780	−6·6772	−1·6	−75·2	1 986·1268
325	324	·900	1 811·455	−7·2589	−7·2568	−7·2578	+2·1	−73·1	1 978·8690
324	323	·882	1 812·337	−5·0024	−5·0036	−5·0030	−1·2	−74·3	1 973·8660
323	322	1·014	1 813·351	*−7·2372	*−7·2350	−7·2361	+2·2	−72·1	1 966·6299
322	321	·952	1 814·303	*−6·0356	*−6·0370	−6·0363	−1·4	−73·5	1 960·5936
321	320	1·062	1 815·365	*−4·5542	*−4·5564	−4·5553	−2·2	−75·7	1 956·0383
320	R.R.S.(29)			−1·5707		−1·571			1 954·467

* Mean of two measures.

Results of spirit leveling between Denver, Colo., and Rock Creek, Wyo.—Continued.

Bench marks.		Distance between successive B. M's.	Distance from B. M. K3 at St. Louis.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above B. M. K3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
320	319	·980	1 816·345	— 6·0437	— 6·0415	— 6·0426	+2·2	—73·5	1 949·9957
319	318	·922	1 817·267	— 6·5248	— 6·5214	— 6·5231	+3·4	—70·1	1 943·4726
318	317	·920	1 818·187	— 3·6930	— 3·6896	— 3·6913	+3·4	—66·7	1 939·7813
317	316	·909	1 819·096	— 3·7728	— 3·7743	— 3·7736	—1·5	—68·2	1 936·0077
316	315	1·069	1 820·165	*— 3·3972	*— 3·4020	— 3·3996	—4·8	—73·0	1 932·6081
315	314	1·034	1 821·199	— 4·3010	— 4·2999	— 4·3004	+1·1	—71·9	1 928·3077
314	313	1·069	1 822·268	— 3·0341	— 3·0345	— 3·0343	—0·4	—72·3	1 925·2734
313	312	1·070	1 823·338	— 5·8394	— 5·8353	— 5·8374	+4·1	—68·2	1 919·4360
312	U	·120		— 2·2532	— 2·2532	—2·2532	0·0	—68·2	1 917·1828
312	311	·994	1 824·332	— 2·7712	— 2·7712	— 2·7712	0·0	—68·2	1 916·6648
311	R.R.S.(30)			+ 0·3817		+ 0·382			1 917·047
311	V	·380	1 824·712	+ 0·3254	+ 0·3258	+ 0·3256	+0·4	—67·8	1 916·9904
311	W	·382	1 824·714	+ 0·3896	+ 0·3902	+ 0·3899	+0·6	—67·6	1 917·0547

* Mean of two measures.

Squaring the numbers in column B–F, which shows the discrepancy between the forward and backward measures (means being used when remeasurement was made), we find the probable error r'' of a double measurement of 1 kilometre,

$$r'' = 0{\cdot}675\sqrt{\frac{[d\,d]}{4(s)}} = 0{\cdot}675\sqrt{\frac{2\ 196}{1\ 367}} = \pm 0{\cdot}86 \text{ millimetres,}$$

and the probable error r of the whole line from bench mark B_2 to W,

$$r = 0{\cdot}675\sqrt{\frac{[d\,d]}{4}} = \pm\ 15{\cdot}8 \text{ millimetres.}$$

For descriptions of permanent bench marks, see pp. 643–647 of Appendix No. 8 of this Report.

The height of the rail in front of the station sign at the following railroad station was also determined; the numbers correspond to those given in the tabulation, pp. 289–297:

(1). Brighton, Colo.
(2). Lupton, Colo.
(3). Platteville, Colo.
(4). Nantes, Colo.
(5). La Salle, Colo.
(6). Evans, Colo.
(7). Greeley, Colo.
(8). Lucerne, Colo.
(9). Eaton, Colo.
(10). Ault, Colo.
(11). Carr, Colo.
(12). Athol, Wyo.
(13). Cheyenne, Wyo.

(14). Corlett, Wyo.
(15). Borie, Wyo.
(16). Otto, Wyo.
(17). Granite Canyon, Wyo.
(17½). Buford, Wyo.
(18). Sherman, Wyo.
(19). Sherman (sign "Top of Rocky Mountains"), Wyo.
(20). Tie Siding, Wyo.
(21). Harney, Wyo.
(22). Red Buttes, Wyo.
(23). Saunders, Wyo.
(24). Laramie (entrance to Thornbrough Hotel), Wyo.
(25). Howell, Wyo.
(26). Hutton, Wyo.
(27). Lookout, Wyo.
(28). Harpers, Wyo.
(29). Miser, Wyo.
(30). Rock Creek, Wyo.

APPENDIX No. 6.

REPORT 1898-1899.

RESULTING ELEVATIONS FROM SPIRIT LEVELING BETWEEN ABILENE, KANS., AND NORFOLK, NEBR., FROM OBSERVATIONS BY A. L. BALDWIN, ASSISTANT, AND B. E. TILTON, AID, BETWEEN MAY 8 AND OCTOBER 17, 1899.

By B. E. TILTON, Aid.

APPENDIX No. 6. 1898-99.

RESULTING ELEVATIONS FROM SPIRIT LEVELING BETWEEN ABILENE, KANS., AND NORFOLK, NEBR., FROM OBSERVATIONS BY A. L. BALDWIN, ASSISTANT, AND B. E. TILTON, AID, BETWEEN MAY 8 AND OCTOBER 17, 1899.

By B. E. TILTON, *Aid.*

The following results of spirit leveling between Abilene, Kans., and Norfolk, Nebr., are herewith respectfully submitted.

The line leaves the transcontinental line of levels, which is now complete from Sandy Hook, N. J., to Rock Creek, Wyo., at bench mark B_1 at Abilene, Kans. To avoid depending wholly upon a single bench mark for this connection, that portion of the transcontinental line, about 14 kilometres, between Abilene and Solomon, Kans. (B. M. C_1), was rerun. The difference of elevation of B_1 and C_1 as given in Appendix No. 4, Report of 1897, is 5·6289 metres. The difference by the lines of this year is 5.6268 metres. The agreement is sufficiently close to indicate that bench mark B_1 has remained stable since it was established in 1895. The elevations here given depend upon the elevation above bench mark K_3 at St. Louis, of B. M. B_1 at Abilene, Kans., as given in Appendix No. 4, Report of 1897, page 278, viz, $226^{m}·7782$. They are therefore relative elevations only. To obtain the constant correction necessary to reduce to absolute elevations above mean sea level, see Appendix No. 8 of this Report.

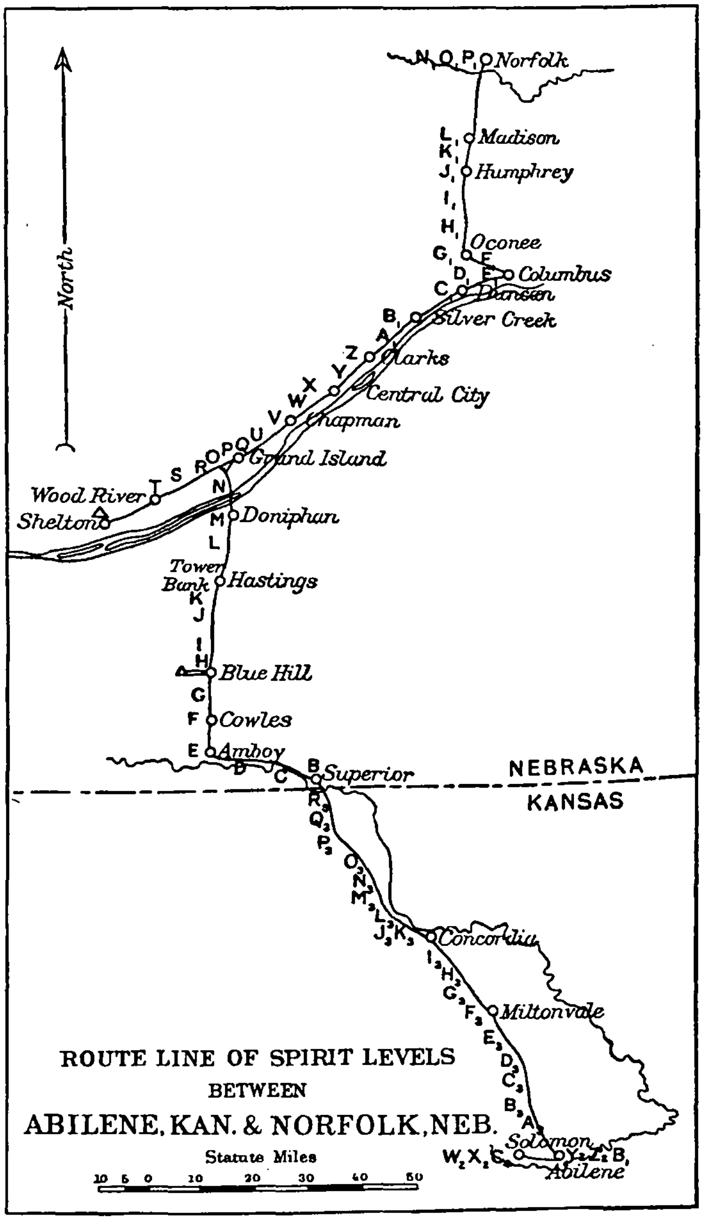
The route is shown in the accompanying sketch. Connections were made with stations Blue Hill and Shelton East Base, of the triangulation along the ninety-eighth meridian, and with bench marks of the United States Geological Survey at Superior, Columbus and Norfolk, Nebr.

The length of the main line is 470 kilometres (292 miles). The lengths of the side lines are as follows:

	Kilometres.
Abilene to Solomon, Kans	14
Main line to triangulation station Blue Hill	5
Grand Island to triangulation station Shelton East Base	38
Various short side lines	10
	67

Total length of line including side lines, 537 kilometres (334 miles).

A continuation of the main line to Sioux City, Iowa, about 76 miles, will develop



ROUTE LINE OF SPIRIT LEVELS
BETWEEN
ABILENE, KAN. & NORFOLK, NEB.

a new loop of the level net, viz, Abilene, Kans.; Sioux City, Iowa; Kansas City, Mo.; Abilene, Kans.

Spirit level No. 6 was used. Before beginning field operations this level was modified by changing the design of the striding level so as to bring the level vial closer to the telescope; by using a nickel-iron alloy, having a small coefficient of expansion, for the metal parts of the telescope and striding level; and by adding a device for reading the level without moving the head away from the eye end of the telescope.

The value of one division of the striding level is $2''\cdot 45$.

The inequality of the collars was determined in May and October, 1899, and gave a value of $+\cdot 39$ of one division of the level, the object end collar being the larger of the two.

The new paraffined wooden metric rods R and S were used from the beginning of the season until September 1. On August 9 rod R was slightly injured and was used in this condition until September 1, on which date rod R_2 was received and replaced rod R during the remainder of the season.

The length of rods between graduations on the metal plugs at $0^m\cdot 1$ and $3^m\cdot 1$ as determined by the Office of Weights and Measures, using a coefficient of expansion of 0·000004 per degree Centigrade and reduced to 0° C., are as follows:

	Metres.	
(1) Rod R, May, 1899	3·00027	
(2) Rod R, September, 1899	3·00140	After accident and before rod was repaired.
(3) Rod R, December, 1899	3·00153	After rod was repaired.
(4) Rod S, May, 1899	3·00064	
(5) Rod S, October, 1899	3·00153	
(6) Rod R_2, August, 1899	3·00068	
(7) Rod R_2, October, 1899	3·00109	

To determine the dates of change of length in the rods, if any appreciable change should occur, measures of the length of the rods were taken with a steel tape at frequent intervals. These measures indicate that the lengths of R and S changed gradually during the first few days of field use and remained of constant length thereafter. Rod R_2 seems to have changed in length soon after arriving in the field. Accordingly the following values were used in the computation:

Mean length of R and S = $3^m\cdot 00096$ at 0° C. between May 8 and June 1.
Mean length of R and S = $3^m\cdot 00146$ at 0° C. between June 1 and September 1.
Mean length of R_2 and S = $3^m\cdot 00131$ at 0° C. between September 1 and October 17.

The first of these values is the mean of (1), (2), (4), and (5) given above, and depends upon the assumption that the rods were gradually changing in length during that time. The second value is the mean of (2) and (5) given above, and depends upon the assumption that the rods remained of constant length from June 1 to September 1, at which time R was replaced by R_2. The third value is the mean of (5) and (7) given above, and depends upon the assumption that R_2 changed length soon after arriving in the field, giving a practically constant length for R_2 and S. The coefficient of expansion used in the computation in fixing the actual lengths of the rods while in use was 0·000004 per Centigrade degree.

The index errors of rods R and R_2 are practically zero. Measures in May and November show the first 0·1 metre to be correct within 0·1 millimetre. Rod S has an index error of − 0·2 millimetre, as shown by measures taken in May and November. This very small index error was neglected in making the computation.

The method of observing is radically different from that used in previous years.

It is sufficiently indicated by the following general instructions issued at the beginning of the field season:

1. Except when specific instructions are given to proceed otherwise, all lines are to be leveled independently in both the forward and the backward direction.

2. It is desirable that the backward measurement on each section should be made under different atmospheric conditions from those which occurred on the forward measurement. It is especially desirable to make the backward measurement in the afternoon if the forward measurement was made in the forenoon, and vice versa. The observer is to secure as much difference of conditions between the forward and backward measurements as is possible without materially delaying the work for that purpose.

3. On all sections upon which the forward and backward measures differ by more than $4^{mm}\cdot0\sqrt{K}$ (in which K is the distance leveled between adjacent bench marks, in kilometres), both the forward and backward measures are to be repeated until two two such measures fall within the limit.

4. The programme of observation at each station is to be as follows:

Set up and level the instrument. Read the three lines of the diaphragm as seen projected against the front (or rear) rod, each reading being taken to the nearest millimetre (estimated) and the bubble being held continuously in the middle of the tube (i. e., both ends being the same). As soon as possible thereafter read the three lines of the diaphragm as seen projected against the rear (or front) rod, estimating to millimetres as before, and holding the bubble continuously in the middle of the tube. During all observations the telescope is to be erect, and the striding level with a particular leg toward the objective; that is, there are to be no reversals of telescope or striding level.

5. At each rod station the rod thermometer is to be read and the temperature recorded.

6. At stations of odd numbers the backsight is to be taken before the foresight, and at even stations the foresight is to be taken before the backsight.

7. The maximum difference in length between a foresight and the corresponding backsight is to be 10 metres. The actual difference is to be made as small on each pair of sights as is feasible by the use of good judgment without any expenditure of time for this particular purpose.

8. The recorder shall keep a record of the rod intervals subtended by the extreme lines of the diaphragm on each backsight, together with their continuous sum between bench marks. A similar record shall be kept for the foresights. The two continuous sums shall be kept as nearly equal as is feasible without the expenditure of extra time for that purpose by setting the instrument beyond (or short of) the middle point between the back and front rods. The two continuous sums shall not be allowed to differ by more than a quantity corresponding to a distance of 20 metres.

9. The inequality of collars shall be determined at the beginning and end of each season of work.

The collimation error shall be determined once for each day of work, by a set of three readings in the direct position and two in the reverse position of the telescope.

The error of adjustment of the striding level shall be determined at least twice on each day of work by a set of three readings in the ordinary position and two in the reverse position.

10. Notes for future use in studying leveling errors shall be inserted in the record indicating the time of beginning and ending of the work of each half day, indicating the weather conditions especially as to cloudiness and wind, indicating whether each portion of the line is run toward or away from the sun, and such other notes as promise to be of value in studying errors.

11. The instrument shall be shaded from the direct rays of the sun both during the observations and the movement from station to station.

12. The maximum length of sight shall be 150 metres, and the maximum is to be attained only under the most favorable circumstances.

In the table of results it will be seen that a few sections show a greater divergence between the forward and backward lines than that which would be allowed by the criterion $4^{mm}\sqrt{K}$. This was caused by mistakes in the field computation which were not discovered until the revision. No measurement was rejected unless it differed from the mean of all measurements by more than 6 millimetres. Eleven such measurements were rejected, all appearing in the table of results. Two rejected measurements do not appear in the table of results, one showing a difference of more than 10 metres between the lengths of corresponding backsight and foresight, and the other showing too large a difference between the upper and lower interval of the wires.

The lettering of the permanent bench marks is carried continuously from A to Z in each State. Where more than one alphabet is required the letters of the succeeding alphabets are denoted by subscripts.

The resulting elevations above K_3, St. Louis, are contained in the succeeding table. The elevations of the rails in front of the railroad stations along the route were taken. They are given in tabular form following the principal table of results.

Sixty-four new permanent bench marks were set, the mean distance between them being 7·9 kilometres. The temporary bench marks were placed at a mean distance of 1 kilometre apart. For descriptions of permanent bench marks see pp. 647–653, Appendix No. 8 of this Report.

The probable error for the mean result for a section, here averaging 1 kilometre in length, is

$$r'' = 0{\cdot}675\sqrt{\frac{[dd]}{4\,[s]}}$$

in which d is the discrepancy between the forward and backward measures, and s is the number of sections. The probable error of the difference of elevation of any two bench marks is

$$r = 0{\cdot}675\sqrt{\frac{[dd]}{4}}$$

The probable errors were computed for several portions of the line as shown below:

Section.	r' Probable error of a single kilometre.	r Probable error of difference of elevation between end bench marks.
Abilene, Kans., to Solomon, Kans.	±0.9	± 3.5
Abilene, Kans., to Concordia, Kans.	±0.9	± 8.6
Concordia, Kans., to Grand Island, Nebr.	±0.8	±11.3
Grand Island, Nebr., to Shelton, Nebr.	±0.8	± 4.6
Grand Island, Nebr., to Columbus, Nebr.	±0.7	± 7.5
Columbus, Nebr., to Norfolk, Nebr.	±0.7	± 6.5
Abilene, Kans., to Norfolk, Nebr.	±0.8	±17.3

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.

[For location of permanent bench marks see sketch, p. 302.]

Bench marks.		Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation.			Discrepancy (B.–F.).		Elevation above bench mark K3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		Beginning of line westward from Abilene to Solomon.							
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	B_1		0.000						226.7782
B_1	Z_2	.852	0.852	+0.0411	−0.0402	+0.0406	−0.9	− 0.9	226.8188
Z_2	Y_2	.767	1.619	−2.3152	+2.3118	−2.3135	+3.4	+ 2.5	224.5053
Y_2	1	1.061	2.680	*−0.4600	+0.4692	−0.4691	+1.4	+ 3.9	224.0362
				−0.4698	+0.4675				
1	2	1.010	3.690	+0.9174	−0.9157	+0.9166	−1.7	+ 2.2	224.9528
2	3	.954	4.644	+1.1408	−1.1329	+1.1372	−3.6	− 1.4	226.0900
				+1.1371	−1.1378				
3	4	1.009	5.653	−0.3277	+0.3305	−0.3291	−2.8	− 4.2	225.7609
4	5	.990	6.643	+0.9083	−0.9047	+0.9065	−3.6	− 7.8	226.6674
5	6	.990	7.633	+3.4199	−3.4121	+3.4141	−4.6	−12.4	230.0815
				+3.4130	−3.4114				
6	7	1.008	8.641	−1.4656	+1.4673	−1.4664	−1.7	−14.1	228.6151
7	8	1.009	9.650	−1.7097	+1.7097	−1.7097	0.0	−14.1	226.9054
8	9	1.008	10.658	+1.3118	−1.3088	+1.3103	−3.0	−17.1	228.2157
9	10	.952	11.610	+1.1172	−1.1154	+1.1163	−1.8	−18.9	229.3320
10	11	.989	12.599	+0.2585	−0.2620	+0.2602	+3.5	−15.4	229.5922
11	12	.961	13.560	+0.0832	−0.0843	+0.0838	+1.1	−14.3	229.6760
12	W_2	.558	14.118	+0.2906	−0.2919	+0.2912	+1.3	−13.0	229.9672
W_2	C_1	.439	14.557	+2.4391	−2.4365	+2.4378	−2.6	−15.6	232.4050
W_2	X_2	.357	14.475	+1.3981	−1.3959	+1.3970	−2.2	−15.2	231.3642
			End of line Abilene to Solomon.						
			Line northward from Abilene						
Y_2	13	1.022	2.641	+3.3904	−3.3924	+3.3914	+2.0	+ 4.5	227.8967
13	14	.918	3.559	+0.9017	−0.8987	+0.9002	−3.0	+ 1.5	228.7969
14	15	1.008	4.567	+1.7782	−1.7751	+1.7766	−3.1	− 1.6	230.5735
15	16	1.010	5.577	*+0.4895	−0.4982	+0.5010	+3.2	+ 1.6	231.0745
				+0.5026	−0.5005				

* Rejected.

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above bench mark K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
16	17	1·063	6·640	+ 3·1648	− 3·1606	+ 3·1627	−4·2	− 2·6	234·2372
17	18	·989	7·629	+ 1·0467	− 1·0481	+ 1·0474	+1·4	− 1·2	235·2846
18	19	1·095	8·724	+ 0·0635	− 0·0660	+ 0·0648	+2·5	+ 1·3	235·3494
19	20	1·018	9·742	+ 0·3501	− 0·3535	+ 0·3518	+3·4	+ 4·7	235·7012
20	21	1·210	10·952	+ 4·9038	− 4·9046	+ 4·9042	+0·8	+ 5·5	240·6054
21	22	·990	11·942	− 0·5067	+ 0·5073	− 0·5070	−0·6	+ 4·9	240·0984
22	23	·824	12·766	+ 5·5144	− 5·5149	+ 5·5146	+0·5	+ 5·4	245·6130
23	24	·963	13·729	− 2·5140	+ 2·5111	− 2·5126	+2·9	+ 8·3	243·1004
24	A_3	·690	14·419	+ 0·1325	− 0·1337	+ 0·1331	+1·2	+ 9·5	243·2335
A_3	25	·961	15·380	+ 1·6711	− 1·6724	+ 1·6718	+1·3	+10·8	244·9053
25	26	1·028	16·408	+ 2·8505	− 2·8542	+ 2·8524	+3·7	+14·5	247·7577
26	27	1·008	17·416	+ 2·3336	− 2·3333	+ 2·3334	−0·3	+14·2	250·0911
27	28	1·027	18·443	+ 0·0883	− 0·0843	+ 0·0863	−4·0	+10·2	250·1774
28	29	1·006	19·449	*+ 2·2592	*− 2·2439	+ 2·2520	−5·6	+ 4·6	252·4294
				+ 2·2504	− 2·2546				
29	30	1·026	20·475	+ 2·1222	− 2·1179	+ 2·1141	−0·9	+ 3·7	254·5435
				+ 2·1069	− 2·1095				
30	31	1·082	21·557	+ 2·7682	− 2·7722	+ 2·7702	+4·0	+ 7·7	257·3137
31	32	1·028	22·585	+ 4·0704	− 4·0733	+ 4·0718	−2·9	+ 4·8	261·3855
32	B_3	1·402	23·987	+ 7·2908	− 7·2856	+ 7·2875	−4·6	+ 0·2	268·6730
				+ 7·2868	− 7·2849				
				+ 7·2917					
B_3	33	1·009	24·996	+ 0·7637	− 0·7628	+ 0·7632	−0·9	− 0·7	269·4362
33	34	1·008	26·004	+ 6·7396	− 6·7388	+ 6·7392	−0·8	− 1·5	276·1754
34	35	·972	26·976	+ 8·4709	− 8·4710	+ 8·4710	+0·1	− 1·4	284·6464
35	36	·917	27·893	+ 7·2032	− 7·2013	+ 7·2021	−4·2	− 5·6	291·8485
				+ 7·2052	− 7·1987				
36	37	1·008	28·901	−10·0559	+10·0581	−10·0570	−2·2	− 7·8	281·7915
37	38	·988	29·889	− 9·1871	+ 9·1896	− 9·1884	−2·5	−10·3	272·6031
38	39	1·024	30·913	− 2·7549	+ 2·7568	− 2·7558	−1·9	−12·2	269·8473
39	40	·914	31·827	+ 2·8749	− 2·8772	+ 2·8760	+2·3	− 9·9	272·7233
40	C_3	·090	31·917	+ 2·0494	− 2·0497	+ 2·0496	+0·3	− 9·6	274·7729
40	41	1·012	32·839	+ 7·7202	− 7·7159	+ 7·7180	−4·3	−14·2	280·4413
41	42	·992	33·831	− 9·0155	+ 9·0170	− 9·0162	−1·5	−15·7	271·4251
42	43	1·008	34·839	− 9·7658	+ 9·7650	− 9·7654	+0·8	−14·9	261·6597
				*− 9·7530	+ 9·7650				
43	44	1·008	35·847	− 3·9644	+ 3·9634	− 3·9639	+1·0	−13·9	257·6958
44	45	1·010	36·857	+ 6·6988	− 6·7020	+ 6·7004	+3·2	−10·7	264·3962
45	46	·992	37·849	+ 9·1073	− 9·1080	+ 9·1077	+0·8	− 9·9	273·5039
46	47	1·011	38·860	− 8·1429	+ 8·1457	− 8·1443	−2·8	−12·7	265·3596
47	48	1·028	39·888	− 1·3712	+ 1·3726	− 1·3719	−1·4	−14·1	263·9877
48	49	·982	40·870	− 6·9583	+ 6·9545	− 6·9551	+1·8	−12·3	257·0326
				− 6·9536	+ 6·9539				
49	D_3	·694	41.564	+ 3·8474	− 3·8391	+ 3·8418	−4·3	−16·6	260·8744
				+ 3·8404	− 3·8400				
D_3	50	1·009	42·573	− 0·1426	+ 0·1376	− 0·1388	−0·9	−17·5	260·7356
				− 0·1343	+ 0·1417				
				− 0·1384	+ 0·1386				
50	51	1·006	43·579	+ 2·7596	− 2·7583	+ 2·7590	−1·3	−18·8	263·4946
51	52	1·026	44·605	+ 1·2409	− 1·2354	+ 1·2398	−3·9	−22·7	264·7344
				+ 1·2427	− 1·2404				

*Rejected.

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B.—F.). Partial.	Discrepancy (B.—F.). Total.	Elevation above bench mark K_3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
52	53	1·006	45·611	+ 1·7228	− 1·7197	+ 1·7212	−3·1	−25·8	266·4556
53	54	1·090	46·701	+ 2·0906	− 2·0892	+ 2·0899	−1·4	−27·2	268·5455
54	55	1·100	47·801	+ 9·1442	− 9·1411	+ 9·1426	−3·1	−30·3	277·6881
55	56	1·118	48·919	+ 0·7283	− 0·7264	+ 0·7274	−1·9	−32·2	278·4155
56	57	·988	49·907	− 2·8556	+ 2·8551	− 2·8554	+0·5	−31·7	275·5601
57	58	·806	50·713	+ 1·3079	− 1·3110	+ 1·3094	+3·1	−28·6	276·8695
58	E_3	·075	50·788	+ 1·9190	− 1·9194	+ 1·9190	+0·7	−27·9	278·7885
				+ 1·9184					
58	59	·896	51·609	+ 3·3772	− 3·3712	+ 3·3742	−6·0	−34·6	280·2437
59	60	·998	52·607	+ 1·6812	− 1·6750	+ 1·6783	−3·0	−37·6	281·9220
				+ 1·6784	− 1·6787				
60	61	·950	53·557	+ 0·9418	− 0·9498	+ 0·9471	+5·8	−31·8	282·8691
				+ 0·9465	− 0·9502				
61	62	·915	54·472	*+ 2·7406	− 2·7300	+ 2·7288	+2·3	−29·5	285·5979
				+ 2·7277	− 2·7300				
62	63	1·062	55·534	+ 3·5201	− 3·5161	+ 3·5181	−4·0	−33·5	289·1160
63	F_3	1·007	56·541	+ 4·4237	− 4·4276	+ 4·4256	+3·9	−29·6	293·5416
F_3	64	·991	57·532	+ 3·3081	− 3·3089	+ 3·3085	+0·8	−28·8	296·8501
64	65	1·022	58·554	+ 5·6334	− 5·6377	+ 5·6342	+4·8	−24·0	302·4843
				+ 5·6303	− 5·6354				
65	66	·805	59·359	+ 4·4683	− 4·4684	+ 4·4678	−1·1	−25·1	306·9521
				*+ 4·4763	− 4·4659				
66	67	1·100	60·459	+11·0162	−11·0121	+11·0142	−4·1	−29·2	317·9663
67	68	·988	61·447	+ 9·9731	− 9·9787	+ 9·9771	+2·2	−27·0	327·9434
				+ 9·9790	− 9·9777				
68	69	·988	62·435	+ 9·3614	− 9·3610	+ 9·3612	−0·4	−27·4	337·3046
69	70	·988	63·423	+ 4·1335	− 4·1289	+ 4·1316	−2·8	−30·2	341·4362
				+ 4·1325	− 4·1314				
70	71	1·044	64·467	+ 7·6297	− 7·6336	+ 7·6316	+3·9	−26·3	349·0678
71	G_3	1·130	65·597	+ 4·5730	− 4·5744	+ 4·5737	+1·4	−24·9	353·6415
G_3	72	1·014	66·611	−10·2926	+10·2931	−10·2928	−0·5	−25·4	343·3487
72	73	·988	67·599	+ 1·1443	− 1·1457	+ 1·1450	+1·4	−24·0	344·4937
73	74	·988	68·587	− 5·6123	+ 5·6113	− 5·6118	+1·0	−23·0	338·8819
74	75	1·100	69·687	− 7·1949	+ 7·1967	− 7·1958	−1·8	−24·8	331·6861
75	76	·890	70·577	− 5·5776	+ 5·5773	− 5·5774	+0·3	−24·5	326·1087
76	H_3	·575	71·152	− 0·4687	+ 0·4700	− 0·4694	−1·3	−25·8	325·6393
H_3	77	·956	72·108	− 0·7871	+ 0·7850	− 0·7850	+0·4	−25·4	324·8543
				− 0·7834	+ 0·7847				
77	78	·988	73·096	− 3·7039	+ 3·7026	− 3·7032	+1·3	−24·1	321·1511
78	79	·962	74·058	− 7·7172	+ 7·7181	− 7·7176	−0·9	−25·0	313·4335
79	80	·948	75·006	− 1·3131	+ 1·3142	− 1·3136	−1·1	−26·1	312·1199
80	81	·946	75·952	+ 4·0304	− 4·0345	+ 4·0324	+4·1	−22·0	316·1523
81	82	·988	76·940	+ 0·0767	− 0·0837	+ 0·0811	+2·9	−19·1	316·2334
				+ 0·0794	− 0·0850				
				+ 0·0830	− 0·0790				
82	83	·984	77·924	+ 6·9393	− 6·9394	+ 6·9394	+0·1	−19·0	323·1728
83	84	·998	78·912	+ 6·1255	− 6·1186	+ 6·1221	−3·4	−22·4	329·2949
				+ 6·1222	− 6·1221				
84	85	·988	79·900	− 7·3690	+ 7·3704	− 7·3697	−1·4	−23·8	321·9252
85	I_3	·642	80·542	− 1·1330	+ 1·1337	− 1·1334	−0·7	−24·5	320·7918
I_3	86	1·088	81·630	− 4·1246	+ 4·1205	− 4·1226	+4·1	−20·4	316·6692
86	87	†{ ·990	82·620	*− 9·4602	*+ 9·4511	− 9·5660	−0·5	−20·9	307·1032
		....	....	− 9·5657	+ 9·5662				

*Rejected.

† See note at end of abstract.

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above bench mark K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
87	88	†{ .994	83.614	*—7.6033	*+7.5975	—7.4954	—1.7	—22.6	299.6078
		......	....	—7.4946	+7.4963				
88	89	1.060	84.674	—6.9959	+6.9895	—6.9932	+1.1	—21.5	292.6146
				—6.9915	+6.9958				
89	90	1.042	85.716	+1.0349	—1.0372	+1.0360	+2.3	—19.2	293.6506
90	91	1.114	86.830	—6.1457	+6.1442	—6.1450	+1.5	—17.7	287.5056
91	92	.952	87.782	—3.2282	+3.2289	—3.2286	—0.7	—18.4	284.2770
92	93	1.027	88.809	+3.3156	—3.3090	+3.3130	—4.8	—23.2	287.5900
				+3.3151	—3.3122				
93	94	.966	89.775	+2.4846	—2.4892	+2.4884	+2.4	—20.8	290.0784
				+2.4898	—2.4901				
94	City	.418	90.193	+3.2749	—3.2728	+3.2738	—2.1	—22.9	293.3522
City	J_8	.292	90.485	+3.0721	—3.0720	+3.0720	—0.1	—23.0	296.4242
94	K_8	.540	90.315	+0.8600	—0.8616	+0.8608	+1.6	—19.2	290.9392
K_8	95	.447	90.762	+0.8742	—0.8751	+0.8746	+0.9	—18.3	291.8138
95	96	1.028	91.790	—0.0899	+0.0883	—0.0891	+1.6	—16.7	291.7247
96	97	.967	92.757	—0.7534	+0.7535	—0.7534	—0.1	—16.8	290.9713
97	98	1.040	93.797	+0.0450	—0.0490	+0.0486	+4.8	—12.0	291.0199
				+0.0473	—0.0530				
98	L_8	.657	94.454	—1.5064	+1.5051	—1.5058	+1.3	—10.7	289.5141
L_8	99	.860	95.314	+1.4618	—1.4669	+1.4644	+2.7	— 8.0	290.9785
				+1.4634	—1.4694				
				+1.4642	—1.4610				
99	100	1.014	96.328	+0.5800	—0.5779	+0.5790	—2.1	—10.1	291.5575
100	101	1.023	97.351	+1.0323	—1.0386	+1.0362	+5.5	— 4.6	292.5937
				+1.0346	—1.0392				
101	102	.952	98.303	+1.0943	—1.0955	+1.0966	+1.2	— 3.4	293.6903
				+1.0976	—1.0989				
102	103	1.024	99.327	+1.1805	—1.1856	+1.1839	+4.6	+ 1.2	294.8742
				+1.1827	—1.1868				
103	104	.850	100.177	—1.5385	+1.5325	—1.5355	+4.8	+ 6.0	293.3387
				—1.5372	+1.5310				
				—1.5365	+1.5319				
				—1.5395	+1.5369				
104	105	.974	101.151	+1.1914	—1.1941	+1.1928	+2.7	+ 8.7	294.5315
105	106	.804	101.955	+4.5623	—4.5601	+4.5612	—2.2	+ 6.5	299.0927
106	107	.806	102.761	—0.0683	+0.0643	—0.0663	+4.0	+10.5	299.0264
107	M_8	.103	102.864	+0.8186	—0.8195	+0.8190	+0.9	+11.4	299.8454
107	108	1.006	103.767	+0.4658	—0.4708	+0.4666	+2.5	+13.0	299.4930
				+0.4648	—0.4648				
108	109	.806	104.573	+0.7475	—0.7488	+0.7482	+1.3	+14.3	300.2412
109	110	1.152	105.725	+9.0083	—9.0099	+9.0091	+1.6	+15.9	309.2503
110	111	1.152	106.877	+4.1040	—4.1082	+4.1061	+4.2	+20.1	313.3564
111	112	1.034	107.911	—1.7821	+1.7782	—1.7811	+3.7	+23.8	311.5753
				—1.7838	+1.7804				
112	113	1.006	108.917	+5.3649	—5.3637	+5.3643	—1.2	+22.6	316.9396
113	114	1.008	109.925	+2.5275	—2.5281	+2.5278	+0.6	+23.2	319.4674
114	115	1.006	110.931	+7.2825	—7.2812	+7.2818	—1.3	+21.9	326.7492
115	116	1.007	111.938	+5.1468	—5.1462	+5.1465	—0.6	+21.3	331.8957
116	N_3	.383	112.321	+3.5141	—3.5194	+3.5176	+3.2	+24.5	335.4133
				+3.5178	—3.5190				

* Rejected.

† See note at end of abstract.

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above bench mark K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
N_3	117	·976	113·297	−2·2698	+2·2682	−2·2690	+1·6	+26·1	333·1443
117	118	·806	114·103	−3·4168	+3·4165	−3·4166	+0·3	+26·4	329·7277
118	119	1·026	115·129	−1·2577	+1·2521	−1·2561	+0·6	+27·0	328·4716
				−1·2551	+1·2594				
119	120	1·008	116·137	−2·7477	+2·7430	−2·7454	+3·1	+30·1	325·7262
				−2·7461	+2·7447				
120	121	1·044	117·181	+2·0807	−2·0894	+2·0838	+5·4	+35·5	327·8100
				+2·0815	−2·0836				
121	122	1·044	118·225	+3·7103	−3·7093	+3·7098	−1·0	+34·5	331·5198
122	123	1·006	119·231	−3·1063	+3·0982	−3·1032	+2·4	+36·9	328·4166
				−3·1026	+3·1058				
123	124	1·009	120·240	−0·4048	+0·4028	−0·4038	+2·0	+38·9	328·0128
124	125	·955	121·195	+1·3905	−1·3888	+1·3896	−1·7	+37·2	329·4024
125	O_3	·918	122·113	+2·0623	−2·0578	+2·0604	−3·5	+33·7	331·4628
				+2·0619	−2·0594				
O_3	126	1·004	123·117	+3·6054	−3·6082	+3·6068	+2·8	+36·5	335·0696
126	127	1·006	124·123	+3·8466	−3·8458	+3·8462	−0·8	+35·7	338·9158
127	128	1·136	125·259	+9·2560	−9·2591	+9·2576	+3·1	+38·8	348·1734
128	129	1·099	126·358	−3·3816	+3·3832	−3·3824	−1·6	+37·2	344·7910
129	130	·914	127·272	+3·1335	−3·1289	+3·1316	−1·2	+36·0	347·9226
				+3·1308	−3·1332				
130	131	1·008	128·280	−2·2420	+2·2474	−2·2431	−1·8	+34·2	345·6795
				−2·2423	+2·2407				
131	132	1·006	129·286	−6·6277	+6·6298	−6·6288	−2·1	+32·1	339·0507
132	133	1·006	130·292	−6·9293	+6·9314	−6·9304	−2·1	+30·0	332·1203
133	134	1·024	131·316	+9·0238	−9·0167	+9·0202	−2·8	+27·2	341·1405
				+9·0193	−9·0209				
134	135	1·004	132·320	+5·5565	−5·5508	+5·5544	−1·9	+25·3	346·6949
				+5·5544	−5·5562				
135	136	1·006	133·326	+0·6498	−0·6501	+0·6500	+0·3	+25·6	347·3449
136	P_3	·928	134·254	−2·3087	+2·3141	−2·3121	−2·9	+22·7	345·0328
				−2·3127	+2·3130				
P_3	137	1·019	135·273	−2·1577	+2·1589	−2·1583	−1·2	+21·5	342·8745
137	138	·988	136·261	+1·2440	−1·2417	+1·2428	−2·3	+19·2	344·1173
138	139	1·008	137·269	+1·5589	−1·5513	+1·5559	−3·9	+15·3	345·6732
				+1·5569	−1·5566				
139	140	·970	138·239	+2·3665	−2·3652	+2·3658	−1·3	+14·0	348·0390
140	141	1·008	139·247	+5·8438	−5·8435	+5·8436	−0·3	+13·7	353·8826
141	142	·980	140·227	+7·9188	−7·9204	+7·9196	+1·6	+15·3	361·8022
142	143	1·008	141·235	+1·0523	−1·0533	+1·0528	+1·0	+16·3	362·8550
143	144	1·028	142·263	+8·8877	−8·8837	+8·8857	−4·0	+12·3	371·7407
144	145	·954	143·217	+8·7359	−8·7349	+8·7354	−1·0	+11·3	380·4761
145	Q_3	·476	143·693	+1·9156	−1·9135	+1·9146	−2·1	+ 9·2	382·3907
Q_3	146	1·016	144·709	+2·8391	−2·8441	+2·8388	+3·3	+12·5	385·2295
				+2·8351	−2·8368				
146	147	·988	145·697	−6·6138	+6·6147	−6·6142	−0·9	+11·6	378·6153
147	148	1·007	146·704	−6·8724	+6·8796	−6·8764	−2·3	+ 9·3	371·7389
				−6·8779	+6·8754				
148	149	·994	147·698	−7·4836	+7·4821	−7·4828	+1·5	+10·8	364·2561
149	150	·986	148·684	−4·1390	+4·1341	−4·1348	+2·7	+13·5	360·1213
				−4·1332	+4·1327				
150	151	·964	149·648	−6·1591	+6·1599	−6·1595	−0·8	+12·7	353·9618
151	R_3	1·189	150·837	−7·3681	+7·3647	−7·3664	+3·4	+16·1	346·5954
R_3	152	1·011	151·848	−0·2338	+0·2357	−0·2348	−1·9	+14·2	346·3606
152	153	1·006	152·854	+4·3294	−4·3272	+4·3283	−2·2	+12·0	350·6889
153	154	1·191	154·045	+3·9972	−3·9955	+3·9964	−1·7	+10·3	354·6853

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above bench mark K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
154	B	·618	154·663	—0·9826	+0·9847	—0·9836	—2·1	+ 8·2	353·7017
B	155	1·004	155·667	—2·1584	+2·1550	—2·1567	+3·4	+11·6	351·5450
155	Geol.	·593	156·260	—1·0262	+1·0242	—1·0252	+2·0	+13·6	350·5198
155	156	1·008	156·675	+0·7655	—0·7698	+0·7681	+1·1	+12·7	352·3131
				+0·7695	—0·7675				
156	157	1·006	157·681	+4·0080	—4·0036	+4·0058	—2·4	+10·3	356·3189
				+4·0061	—4·0055				
157	158	1·005	158·686	+2·4405	—2·4398	+2·4402	—0·7	+ 9·6	358·7591
158	159	1·100	159·786	+2·7242	—2·7233	+2·7238	—0·9	+ 8·7	361·4829
159	160	·988	160·774	—0·4505	+0·4532	—0·4518	—2·7	+ 6·0	361·0311
160	161	1·026	161·800	—2·3771	+2·3785	—2·3778	—1·4	+ 4·6	358·6533
161	162	1·024	162·824	+0·3284	—0·3272	+0·3278	—1·2	+ 3·4	358·9811
162	163	1·026	163·850	+1·6484	—1·6496	+1·6490	+1·2	+ 4·6	360·6301
163	164	·876	164·726	+1·3508	—1·3510	+1·3509	+0·2	+ 4·8	361·9810
164	C	·492	165·218	+0·8876	—0·8882	+0·8879	+0·6	+ 5·4	362·8689
C	165	·978	166·196	+2·4888	—2·4901	+2·4894	+1·3	+ 6·7	365·3583
165	166	·975	167·171	+0·6600	—0·6600	+0·6600	0·0	+ 6·7	366·0183
166	167	1·000	168·171	+3·2806	—3·2783	+3·2794	—2·3	+ 4·4	369·2977
167	168	1·066	169·237	—0·4058	+0·4125	—0·4094	—1·4	+ 3·0	368·8883
				—0·4115	+0·4076				
168	169	1·080	170·317	—3·5975	+3·5970	—3·5972	+0·5	+ 3·5	365·2911
169	170	1·020	171·337	—0·5493	+0·5444	—0·5456	+3·2	+ 6·7	364·7455
				—0·5450	+0·5436				
170	171	1·044	172·381	+1·3167	—1·3171	+1·3169	+0·4	+ 7·1	366·0624
171	172	1·001	173·382	*+2·4095	—2·4182	+2·4184	+1·4	+ 8·5	368·4808
				+2·4177	—2·4200				
172	173	1·006	174·388	*+1·6526	—1·6610	+1·6614	—0·7	+ 7·8	370·1422
				+1·6617	—1·6610				
173	174	1·007	175·395	+1·7625	—1·7692	+1·7671	+3·1	+10·9	371·9093
				+1·7685	—1·7681				
174	175	1·136	176·531	+2·9010	—2·9034	+2·9022	+2·4	+13·3	374·8115
175	176	1·026	177·557	+1·4188	—1·4194	+1·4191	+0·6	+13·9	376·2305
176	D	·748	178·305	+5·1586	—5·1580	+5·1583	—0·6	+13·3	381·3889
176	177	1·006	178·563	+0·6731	—0·6778	+0·6754	+2·8	+16·7	376·9060
				+0·6750	—0·6757				
177	178	1·022	179·585	—0·8042	+0·8027	—0·8034	+1·5	+18·2	376·1026
178	179	1·024	180·609	—0·2181	+0·2108	—0·2132	+4·5	+22·7	375·8894
				—0·2125	+0·2117				
179	180	1·016	181·625	—0·9653	+0·9573	—0·9605	+5·1	+27·8	374·9289
				—0·9609	+0·9586				
180	181	1·002	182·627	+1·4692	—1·4729	+1·4710	+3·7	+31·5	376·3999
181	182	·954	183·581	+1·9246	—1·9256	+1·9251	+1·0	+32·5	378·3250
182	183	1·122	184·703	+1·9143	—1·9179	+1·9161	+3·6	+36·1	380·2411
183	184	1·005	185·708	—0·6427	+0·6384	—0·6388	+2·7	+38·8	379·6023
				—0·6377	+0·6366				
184	185	1·010	186·718	+1·9897	—1·9960	+1·9945	+2·6	+41·4	381·5968
				+1·9966	—1·9956				
185	186	·964	187·682	+6·3280	—6·3316	+6·3298	+3·6	+45·0	387·9266
186	E	·500	188·182	+1·4830	—1·4853	+1·4842	+2·3	+47·3	389·4108
E	187	·964	189·146	—0·0593	+0·0572	—0·0582	+2·1	+49·4	389·3526

* Rejected.

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above bench mark K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
187	188	1.006	190.152	+0.8281	−0.8275	+0.8278	−0.6	+48.8	390.1804
188	189	.988	191.140	+3.5114	−3.5108	+3.5111	−0.6	+48.2	393.6915
189	190	.988	192.128	+3.7628	−3.7629	+3.7628	+0.1	+48.3	397.4543
190	191	1.008	193.136	+3.3244	−3.3258	+3.3251	+1.4	+49.7	400.7794
191	192	1.008	194.144	+4.7492	−4.7500	+4.7496	+0.8	+50.5	405.5290
192	193	1.003	195.147	+3.5244	−3.5252	+3.5248	+0.8	+51.3	409.0538
193	194	1.206	196.353	+6.2283	−6.2287	+6.2285	+0.4	+51.7	415.2823
194	F	1.186	197.539	+5.1656	−5.1655	+5.1656	−0.1	+51.6	420.4479
F	195	1.003	198.542	+2.7510	−2.7468	+2.7489	−4.2	+47.4	423.1968
195	196	.986	199.528	+4.2107	−4.2084	+4.2096	−2.3	+45.1	427.4064
196	197	1.006	200.534	+5.0895	−5.0900	+5.0898	+0.5	+45.6	432.4962
197	198	1.004	201.538	+4.9141	−4.9145	+4.9143	+0.4	+46.0	437.4105
198	199	1.006	202.544	+4.8507	−4.8488	+4.8498	−1.9	+44.1	442.2603
199	200	.986	203.530	+4.9933	−4.9907	+4.9920	−2.6	+41.5	447.2523
200	201	1.006	204.536	* +4.9744	−4.9834	+4.9828	−0.7	+40.8	452.2351
				+4.9831	−4.9814				
201	202	1.004	205.540	+4.9565	−4.9551	+4.9558	−1.4	+39.4	457.1909
202	203	1.004	206.544	+5.1980	−5.2048	+5.2016	+5.1	+44.5	462.3925
				+5.2002	−5.2035				
203	G	1.088	207.632	+5.5408	−5.5391	+5.5400	−1.7	+42.8	467.9325
G	204	1.002	208.634	+5.0492	−5.0458	+5.0475	−3.4	+39.4	472.9800
204	205	1.004	209.638	+5.0812	−5.0794	+5.0803	−1.8	+37.6	478.0603
205	206	1.004	210.642	+4.8192	−4.8196	+4.8194	+0.4	+38.0	482.8797
206	207	.988	211.630	+2.5565	−2.5574	+2.5570	+0.9	+38.9	485.4367
207	208	1.004	212.634	−2.4372	+2.4380	−2.4376	−0.8	+38.1	482.9991
207	208_a	1.152	213.786	−1.9856	+1.9825	−1.9840	+3.1	+41.2	483.4527
208_a	209_a	1.028	214.814	+2.8951	−2.8996	+2.8966	+4.8	+46.0	486.3493
				+2.8933	−2.8984				
209_a	210_a	.970	215.784	+3.5151	−3.5167	+3.5159	+1.6	+47.6	489.8652
210_a	211_a	1.026	216.810	−1.8908	+1.8945	−1.8926	−3.7	+43.9	487.9726
211_a	△ Blue Hill	.774	217.584	+8.0988	−8.0990	+8.0989	+0.2	+44.1	496.0715
208	209	1.171	213.805	−0.1985	+0.1985	−0.1985	0.0	+38.1	482.8006
209	210	.995	214.800	−2.9395	+2.9425	−2.9410	−3.0	+35.1	479.8596
210	H	1.380	216.180	−4.9211	+4.9218	−4.9214	−0.7	+34.4	474.9382
H	211	.958	217.138	−3.4052	+3.4092	−3.4074	−3.6	+30.8	471.5308
				−3.4059	+3.4092				
211	212	.970	218.108	−4.7087	+4.7064	−4.7076	+2.3	+33.1	466.8232
212	213	1.154	219.262	−0.8432	+0.8392	−0.8412	+4.0	+37.1	465.9820
213	214	.984	220.246	+0.5546	−0.5586	+0.5558	+2.4	+39.5	466.5378
				+0.5546	−0.5555				
214	215	1.104	221.350	−4.1160	+4.1132	−4.1146	+2.8	+42.3	462.4232
215	216	1.038	222.388	−3.2180	+3.2146	−3.2163	+3.4	+45.7	459.2069
216	217	.988	223.376	−2.1610	+2.1614	−2.1612	−0.4	+45.3	457.0457
217	218	.987	224.363	−4.6046	+4.6002	−4.6030	+4.3	+49.6	452.4427
				−4.6058	+4.6016				
218	219	1.105	225.468	−5.6636	+5.6635	−5.6636	+0.1	+49.7	446.7791
219	220	.986	226.454	−4.7959	+4.7913	−4.7934	+0.8	+50.5	441.9857
				−4.7917	+4.7947				
220	221	.808	227.262	−4.1004	+4.1005	−4.1004	−0.1	+50.4	437.8853
221	I	.864	228.126	−3.6990	+3.6979	−3.6984	+1.1	+51.5	434.1869
I	222	1.066	229.192	−1.8071	+1.8089	−1.8080	−1.8	+49.7	432.3789
222	223	1.004	230.196	−3.9835	+3.9826	−3.9830	+0.9	+50.6	428.3959
223	224	.990	231.186	−3.2863	+3.2824	−3.2844	+3.9	+54.5	425.1115

* Rejected.

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark H1 at Abilene.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B.—F.). Partial.	Discrepancy (B.—F.). Total.	Elevation above bench mark K3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
224	225	1·012	232·198	+3·2608	−3·2601	+3·2604	−0·7	+ 53·8	428·3719
225	226	1·024	233·222	+2·0917	−2·0945	+2·0931	+2·8	+ 56·6	430·4650
226	J	·860	234·082	+1·1971	−1·2031	+1·2004	+2·9	+ 59·5	431·6654
				+1·2008	−1·2007				
J	227	1·130	235·212	+2·8094	−2·8142	+2·8118	+2·8	+ 62·3	434·4772
				+2·8113	−2·8121				
227	228	1·005	236·217	+3·6545	−3·6601	+3·6562	+6·4	+ 68·7	438·1334
				+3·6510	−3·6583				
228	229	1·008	237·225	+4·6142	−4·6187	+4·6160	+1·2	+ 69·9	442·7494
				+4·6167	−4·6146				
229	230	1·008	238·233	+4·8452	−4·8501	+4·8491	+3·1	+ 73·0	447·5985
				+4·8499	−4·8513				
230	231	1·006	239·239	+4·4153	−4·4175	+4·4164	+2·2	+ 75·2	452·0149
231	232	1·084	240·323	+5·3841	−5·3853	+5·3847	+1·2	+ 76·4	457·3996
232	233	1·184	241·507	−0·4329	+0·4295	−0·4312	+3·4	+ 79·8	456·9684
233	234	·986	242·493	+3·0714	−3·0672	+3·0690	−1·0	+ 78·8	460·0374
				+3·0677	−3·0699				
234	235	1·008	243·501	+2·1677	−2·1659	+2·1668	−1·8	+ 77·0	462·2042
235	236	·990	244·491	+0·2481	−0·2502	+0·2477	+3·8	+ 80·8	462·4519
				+0·2434	−0·2491				
236	237	1·108	245·599	+1·0615	−1·0615	+1·0615	0·0	+ 80·8	463·5134
237	238	1·026	246·625	−1·3062	+1·2989	−1·3034	+3·4	+ 84·2	462·2100
				−1·3039	+1·3044				
238	239	1·100	247·725	−3·4942	+3·4896	−3·4913	+3·4	+ 87·6	458·7187
				−3·4919	*+3·4780				
239	K	·733	248·458	+3·8279	−3·8273	+3·8276	−0·6	+ 87·0	462·5463
K	Bank	·164	248·622	+0·1072	−0·1073	+0·1072	+0·1	+ 87·1	462·6535
239	240	1·000	248·725	−1·0833	+1·0834	−1·0834	−0·1	+ 87·5	457·6353
240	Tower	·696	249·421	+5·3611	−5·3605	+5·3606	−0·7	+ 86·8	462·9959
				+5·3608	−5·3601				
240	241	1·126	249·851	−1·4226	+1·4211	−1·4218	+1·5	+ 89·0	456·2135
241	242	·984	250·835	−3·2976	+3·2997	−3·2986	−2·1	+ 86·9	452·9149
242	243	·981	251·816	+2·5292	−2·5315	+2·5304	+2·3	+ 89·2	455·4453
243	244	·998	252·814	+2·9435	−2·9442	+2·9438	+0·7	+ 89·9	458·3891
244	245	1·020	253·834	+0·5526	−0·5566	+0·5546	+4·0	+ 93·9	458·9437
245	246	·998	254·832	+1·6177	−1·6180	+1·6178	+0·3	+ 94·2	460·5615
246	247	1·160	255·992	+1·2260	−1·2300	+1·2280	+4·0	+ 98·2	461·7895
247	248	1·000	256·992	−1·9029	+1·8995	−1·9012	+3·4	+101·6	459·8883
248	249	·950	257·942	+5·5656	−5·5688	+5·5672	+3·2	+104·8	465·4555
249	250	1·008	258·950	+5·1897	−4·1936	+4·1916	+3·9	+108·7	469·6471
250	L	1·062	260·012	−3·6183	+3·6171	−3·6177	+1·2	+109·9	466·0294
L	251	1·004	261·016	+0·1858	−0·1877	+0·1868	+1·9	+111·8	466·2162
251	252	1·008	262·024	+2·3361	−2·3394	+2·3378	+3·3	+115·1	468·5540
252	253	·974	262·998	−2·5820	+2·5817	−2·5818	+0·3	+115·4	465·9722
253	254	1·018	264·016	+1·2277	−1·2280	+1·2278	+0·3	+115·7	467·2000
254	255	1·028	265·044	+0·8681	−0·8700	+0·8690	+1·9	+117·6	468·0690
255	256	1·008	266·052	−2·7903	+2·7875	−2·7889	+2·8	+120·4	465·2801
256	257	1·010	267·062	−2·2234	+2·2266	−2·2250	−3·2	+117·2	463·0551
257	258	1·018	268·080	+2·7414	−2·7366	+2·7388	−2·0	+115·2	465·7939
				+2·7383	−2·7389				
258	M	·517	268·597	+1·0111	−1·0117	+1·0114	+0·6	+115·8	466·8053

*Rejected.

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation.			Discrepancy (B.–F.).		Elevation above bench mark K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
M	259	1·010	269·607	–2·6030	+2·6060	–2·6038	–2·0	+113·8	464·2015
				–2·6027	+2·6037				
259	260	1·006	270·613	–7·6216	+7·6198	–7·6207	+1·8	+115·6	456·5808
260	261	·998	271·611	–7·5260	+7·5286	–7·5273	–2·6	+113·0	449·0535
261	262	·523	272·134	–0·4380	+0·4405	–0·4392	–2·5	+110·5	448·6143
262	263	·480	272·614	–0·0771	+0.0814	–0·0814	–2·5	+108·0	448·5329
				–0·0821	+0·0849				
				–0·0814	+0·0817				
263	264	1·186	273·800	–0·9631	+0·9633	–0·9632	–0·2	+107·8	447·5697
264	265	·882	274·682	–0·1797	+0·1825	–0·1811	–2·8	+105·0	447·3886
265	266	·509	275·191	–0·8205	+0·8242	–0·8242	–1·1	+103·9	446·5644
				–0·8279	+0·8238				
				–0·8225	+0·8262				
266	267	·402	275·593	–0·4425	+0·4442	–0·4434	–1·7	+102·2	446·1210
267	268	·487	276·080	–0·3719	+0·3709	–0·3720	0·0	+102·2	445·7490
				–0·3728	+0·3725				
				–0·3712	+0·3725				
268	N	·879	276·959	–0·6725	+0·6764	–0·6733	–0·7	+101·5	445·0757
				–0·6734	+0·6710				
N	269	·966	277·925	–1·0553	+1·0576	–1·0564	–2·3	+ 99·2	444·0193
269	270	·998	278·923	–1·1811	+1·1797	–1·1804	+1·4	+100·6	442·8389
270	271	·997	279·920	+0·2158	–0·2168	+0·2163	+1·0	+101·6	443·0552
271	272	1·008	280·928	–0·5168	+0·5173	–0·5170	–0·5	+101·1	442·5382
272	273	·960	281·888	–0·7722	+0·7729	–0·7726	–0·7	+100·4	441·7656
273	274	1·000	282·888	–0·7492	+0·7488	–0·7490	+0·4	+100·8	441·0166
274	275	·800	283·688	+1·0066	–1·0046	+1·0056	–2·0	+ 98·8	442·0222
275	O	·332	284·020	+4·1825	–4·1819	+4·1822	–0·6	+ 98·2	446·2044
				Beginning of branch line to Shelton.					
O	279	·976	284·996	–0·0506	+0·0497	–0.0484	–1·3	+ 96·9	446·1560
				–0·0449	+0·0482				
279	280	1·006	286·002	+1·9786	–1·9807	+1·9796	+2·1	+ 99·0	448·1356
280	281	·996	286·998	+0·4784	–0·4805	+0·4794	+2·1	+101·1	448·6150
281	282	·941	287·939	+0·5587	–0·5597	+0·5592	+1·0	+102·1	449·1742
282	283	1·008	288·947	+1·3495	–1·3495	+1·3495	0·0	+102·1	450·5237
283	284	1·010	289·957		–1·6463	+1·6484	–0·7	+101·4	452·1721
				+1·6487	–1·6497				
284	285	1·007	290·964	+1·1801	–1·1784	+1·1792	–1·7	+ 99·7	453·3513
285	R	·500	291·464	+0·2154	–0·2134	+0·2144	–2·0	+ 97·7	453·5657
R	286	1·152	292·616	+1·7327	–1·7328	+1·7331	–0·6	+ 97·1	455·2988
				+1·7340					
286	287	·965	293·581	+1·2791	–1·2785	+1·2788	–0·6	+ 96·5	456·5776
287	288	·943	294·524	+1·6010	–1·5970	+1·6002	–0·9	+ 95·6	458·1778
				+1·6004	–1·6025				
288	289	1·009	295·533	+1·3769	–1·3762	+1·3766	–0·7	+ 94·9	459·5544
289	290	1.008	296·541	+1·2671	–1·2654	+1·2662	–1·7	+ 93·2	460·8206
290	291	·996	297·537	+1·1950	–1·1925	+1·1938	–2·5	+ 90·7	462·0144
291	292	1·016	298·553	+1·4415	–1·4399	+1·4407	–1·6	+ 89·1	463·4551
292	S	1·200	299·753	+1·4364	–1·4330	+1·4347	–3·4	+ 85·7	464·8898
S	293	1·012	300·765	+0·4366	–0·4382	+0·4374	+1·6	+ 87·3	465·3272
293	294	1·004	301·769	+1·8609	–1·8606	+1·8608	–0·3	+ 87·0	467·1880
294	295	1·009	302·778	+0·7529	–0·7522	+0·7526	–0·7	+ 86·3	467·9406
295	296	1·007	303·785	+0·8155	–0·8215	+0·8198	+3·5	+ 89·8	468·7604
				+0·8205	–0·8215				
296	297	1·008	304·793	+1·5503	–1·5542	+1·5522	+3·9	+ 93·7	470·3126

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B.−F.). Partial.	Discrepancy (B.−F.). Total.	Elevation above bench mark K_3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
297	298	1·008	305·801	+1·1313	−1·1272	+1·1292	−4·1	+ 89·6	471·4418
298	T	·986	306·787	+1·7078	−1·7097	+1·7088	+1·9	+ 91·5	473·1506
T	299	·982	307·769	+0·9624	−0·9651	+0·9638	+2·7	+ 94·2	474·1144
299	300	1·040	308·809	+1·6932	−1·6962	+1·6947	+3·0	+ 97·2	475·8091
300	301	1·014	309·823	+1·1545	−1·1626	+1·1573	+2·8	+100·0	476·9664
				+1·1573	−1·1549				
301	302	1·008	310·831	+1·6973	−1·7023	+1·7005	+4·6	+104·6	478·6669
				+1·6990	−1·7034				
302	303	1·084	311·915	+0.9258	−0·9315	+0·9292	+3·1	+107·7	479·5961
				+0·9295	−0·9299				
303	304	·998	312·913	+1·1604	−1·1630	+1·1617	+2·6	+110·3	480·7578
304	305	1·028	313·941	+1·9555	−1·9584	+1·9570	+2·9	+113·2	482·7148
305	306	1·008	314·949	+0·6728	−0·6731	+0·6730	+0·3	+113·5	483·3878
306	307	1·008	315·957	+0·7268	−0·7264	+0·7266	−0·4	+113·1	484·1144
307	308	1·009	316·966	+1·3688	−1·3695	+1·3692	+0·7	+113·8	485·4836
308	309	1·046	318·012	+2·2860	−2·2856	+2·2858	−0·4	+113·4	487·7694
309	310	·826	318·838	+1·1475	−1·1453	+1·1464	−2·2	+111·2	488·9158
310	△ Shelton E. B.	1·020	319·858	+0·7681	−0·7719	+0·7700	+3·8	+115·0	489·6858
				End of branch line to Shelton.					
O	276	·655	284·675	−1·1251	+1·1226	−1·1238	+2·5	+100·7	445·0806
276	277	·999	285·674	−1·0389	+1·0376	−1·0382	+1·3	+102·0	444·0424
277	278	1·004	286·678	−1·1389	+1·1379	−1·1364	−3·1	+ 98·9	442·9060
				−1·1306					
278	P	·848	287·526	−0·6708	+0·6723	−0·6716	−1·5	+ 97·4	442·2344
P	Q	1·204	288·730	−2·4718	+2·4689	−2·4704	+2·9	+100·3	439·7640
Q	311	·592	289·322	−3·1987	+3·2009	−3·1998	−2·2	+ 98·1	436·5642
311	312	1·008	290·330	−3·2506	+3·2487	−3·2496	+1·9	+100·0	433·3146
312	313	1·008	291·338	−1·3952	+1·3956	−1·3954	−0·4	+ 99·6	431·9192
313	314	1·010	292·348	−1·0970	+1·0951	−1·0960	+1·9	+101·5	430·8232
314	315	1·010	293·358	−1·3319	+1·3306	−1·3312	+1·3	+102·8	429·4920
315	316	1·028	294·386	−1·9398	+1·9416	−1·9407	−1·8	+101·0	427·5513
316	317	1·008	295·394	−0·9643	+0·9640	−0·9642	+0·3	+101·3	426·5871
317	318	1·008	296·402	−1·2960	+1·2947	−1·2954	+1·3	+102·6	425·2917
318	U	1·100	297·502	−1·4482	+1·4476	−1·4479	+0·6	+103·2	423·8438
U	319	1·012	298·514	−1·0410	+1·0426	−1·0423	−2·6	+100·6	422·8015
					+1·0446				
319	320	1·174	299·688	−1·9045	+1·9056	−1·9050	−1·1	+ 99·5	420·8965
320	321	1·008	300·696	−1·1050	+1·1033	−1·1042	+1·7	+101·2	419·7923
321	322	1·010	301·706	−1·3839	+1·3825	−1·3832	+1·4	+102·6	418·4091
322	323	1·010	302·716	−0·2271	+0·2281	−0·2276	−1·0	+101·6	418·1815
323	324	1·028	303·744	−2·3545	+2·3505	−2·3525	+4·0	+105·6	415·8290
324	325	1·008	304·752	−1·5571	+1·5530	−1·5550	+4·1	+109·7	414·2740
325	326	1·010	305·762	−0·5634	+0·5653	−0·5634	−3·9	+105·8	413·7106
				−0·5593					
326	V	1·112	306·874	−0·0070	+0·0120	−0·0089	−1·6	+104·2	413·7017
				−0·0092	+0·0074				
V	327	·972	307·846	−2·1417	+2·1399	−2·1408	+1·8	+106·0	411·5609
327	328	1·008	308·854	−1·8448	+1·8454	−1·8451	−0·6	+105·4	409·7158
328	329	1·028	309·882	−1·1978	+1·1976	−1·1977	+0·2	+105·6	408·5181
329	330	1·066	310·948	−0·5680	+0·5654	−0·5667	+2·6	+108·2	407·9514
330	331	1·010	311·958	−1·6447	+1·6413	−1·6430	+3·4	+111·6	406·3084
331	332	1·010	312·968	−1·5966	+1·5906	−1·5946	+2·8	+114·4	404·7138
				−1·5953	+1·5959				
332	333	1.014	313·982	−0·6447	+0·6397	−0·6437	+5·7	+120·1	404·0701
				−0·6484	+0·6421				

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark B1 at Abilene.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above bench mark K3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
333	334	1.008	314.990	—1.8698 —1.8703	+1.8655 +1.8703	—1.8690	+2.1	+122.2	402.2011
334	335	1.046	316.036	—1.5023 —1.4949	+1.4942 +1.4999	—1.4978	+1.6	+123.8	400.7033
335	336	1.024	317.060	—1.2277	+1.2270	—1.2274	+0.7	+124.5	399.4759
336	W	.593	317.653	—0.6724	+0.6717	—0.6720	+0.7	+125.2	398.8039
W	337	1.012	318.665	—1.1252 —1.1176	+1.1186 +1.1248	—1.1216	—0.3	+124.9	397.6823
337	338	1.018	319.683	—0.6504	+0.6507	—0.6506	—0.3	+124.6	397.0317
338	339	1.012	320.695	—1.3074	+1.3077	—1.3076	—0.3	+124.3	395.7241
339	340	.999	321.694	—1.1296	+1.1286	—1.1291	+1.0	+125.3	394.5950
340	341	1.008	322.702	—2.0566 —2.0535	+2.0518 +2.0555	—2.0544	+1.4	+126.7	392.5406
341	342	.966	323.668	—0.3237 —0.3197	+0.3196 +0.3249	—0.3220	—0.5	+126.2	392.2186
342	X	.680	324.348	+0.5091	—0.5112	+0.5102	+2.1	+128.3	392.7288
342	343	.992	324.660	—1.9205	+1.9197	—1.9201	+0.8	+127.0	390.2985
343	344	1.002	325.662	—1.1579	+1.1538	—1.1558	+4.1	+131.1	389.1427
344	345	1.072	326.734	—1.1570	+1.1537	—1.1554	+3.3	+134.4	387.9873
345	346	1.010	327.744	—1.8233 —1.8220	+1.8187 +1.8220	—1.8215	+2.2	+136.6	386.1658
346	347	1.010	328.754	—1.8946	+1.8953	—1.8950	—0.7	+135.9	384.2708
347	348	1.004	329.758	—0.5694	+0.5714	—0.5704	—2.0	+133.9	383.7004
348	349	1.008	330.766	—1.3494	+1.3494	—1.3494	0.0	+133.9	382.3510
349	350	1.010	331.776	—1.5779	+1.5753	—1.5766	+2.6	+136.5	380.7744
350	Y	1.336	333.112	—1.2352	+1.2360	—1.2356	—0.8	+135.7	379.5388
Y	351	1.588	334.700	—1.0316 —1.0306	+1.0262 +1.0289	—1.0293	+3.5	+139.2	378.5095
351	352	1.612	336.312	—2.9078	+2.9014 +2.9044	—2.9054	+4.9	+144.1	375.6041
352	353	1.616	337.928	—2.1184 —2.1191	+2.1128 +2.1137	—2.1160	+5.6	+149.7	373.4881
353	354	1.596	339.524	—2.1290	+2.1262	—2.1276	+2.8	+152.5	371.3605
354	355	1.564	341.088	—2.3558	+2.3513 +2.3530	—2.3540	+3.6	+156.1	369.0065
355	356	.742	341.830	—0.8311	+0.8308	—0.8310	+0.3	+156.4	368.1755
356	Z	.666	342.496	+1.3964	—1.3963	+1.3964	—0.1	+156.3	369.5719
356	357	1.624	343.454	—2.2512	+2.2495	—2.2504	+1.7	+158.1	365.9251
357	358	1.616	345.070	*—1.6029 —1.5938	+1.5922 +1.5970	—1.5942	—0.8	+157.3	364.3309
358	359	1.616	346.686	—2.5451	+2.5416	—2.5434	+3.5	+160.8	261.7875
359	360	1.604	348.290	—1.5759 —1.5732	+1.5706 +1.5703	—1.5725	+4.2	+165.0	360.2150
360	361	1.008	349.298	—1.2316	+1.2289	—1.2302	+2.7	+167.7	358.9848
361	A_1	1.432	350.730	—2.0218 —2.0154	+2.0191 +2.0167	—2.0182	+0.7	+168.4	356.9666
A_1	362	1.624	352.354	—1.9343 —1.9323	+1.9347 +1.9320	—1.9333	—0.1	+168.3	355.0333
362	363	1.010	353.364	—1.4570	+1.4531	—1.4550	+3.9	+172.2	353.5783
363	364	1.008	354.372	—1.2714 —1.2674	+1.2661 +1.2667	—1.2679	+3.0	+175.2	352.3104

* Rejected.

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above bench mark K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
364	365	1.008	355.380	−1.3114	+1.3085	−1.3100	+2.9	+178.1	351.0004
365	366	1.006	356.386	−1.2240	+1.2243	−1.2242	−0.3	+177.8	349.7762
366	367	1.004	357.390	−0.7808	+0.7814	−0.7811	−0.6	+177.2	348.9951
367	368	1.008	358.398	−1.3317	+1.3335	−1.3326	−1.8	+175.4	347.6625
368	B_1	1.760	360.158	−1.9316	+1.9291	−1.9304	+2.5	+177.9	345.7321
B_1	369	.935	361.093	−0.3892	+0.3835	−0.3880	+3.2	+181.1	345.3441
				−0.3899	+0.3892				
369	370	1.006	362.099	−1.1939	+1.1929	−1.1934	+1.0	+182.1	344.1507
370	371	1.172	363.271	−1.9266	+1.9211	−1.9239	+3.8	+185.9	342.2268
				−1.9250	+1.9228				
371	372	.990	364.261	−1.5396	+1.5339	−1.5380	+2.8	+188.7	340.6888
				−1.5393	+1.5392				
372	373	1.540	365.801	−1.5758	+1.5735	−1.5746	+2.3	+191.0	339.1142
373	374	1.540	367.341	−1.7879	+1.7890	−1.7884	−1.1	+189.9	337.3258
374	375	1.540	368.881	−1.9169	+1.9150	−1.9160	+1.9	+191.8	335.4098
375	376	1.540	370.421	−2.2126	+2.2055	−2.2098	+2.3	+194.1	333.2000
				−2.2092	+2.2117				
376	377	1.008	371.429	−0.5246	+0.5246	−0.5246	0.0	+194.1	332.6754
377	378	1.608	373.037	−0.7014	+0.7004	−0.7043	+1.4	+195.5	331.9711
				−0.7087	+0.7068				
378	379	1.542	374.579	−1.4668	+1.4623	−1.4646	+4.5	+200.0	330.5065
379	380	.955	375.534	−1.4904	+1.4854	−1.4886	+1.6	+201.6	329.0179
				−1.4883	+1.4091				
380	C_1	.955	376.489	−0.0614	+0.0610	−0.0612	+0.4	+202.0	328.9567
C_1	381	.704	377.193	+0.0720	−0.0687	+0.0704	−3.3	+198.7	329.0271
381	382	1.432	378.625	−4.0844	+4.0850	−4.0847	−0.6	+198.1	324.9424
382	383	1.540	380.165	−2.0177	+2.0175	−2.0176	+0.2	+198.3	322.9248
383	384	1.668	381.833	−1.6068	+1.6042	−1.6055	+2.6	+200.9	321.3193
384	385	1.624	383.457	−3.7089	+3.7017	−3.7061	+2.2	+203.1	317.6132
				−3.7055	+3.7083				
385	386	1.596	385.053	+0.9154	*−0.9235	+0.9150	0.0	+203.1	318.5282
				+0.9145	−0.9150				
386	387	.729	385.782	+0.2632	−0.2655	+0.2644	+2.3	+205.4	318.7926
387	Geol. Loup (2)	.140	385.922	−1.5811	+1.5821	−1.5816	−1.0	+204.4	317.2110
387	388	1.420	387.202	−3.9975	+3.9915	−3.9963	+1.8	+207.2	314.7963
				−3.9969	+3.9994				
388	D_1	1.424	388.626	+0.1738	−0.1770	+0.1754	+3.2	+210.4	314.9717
D_1	E_1	1.056	389.682	+0.4375	−0.4369	+0.4372	−0.6	+209.8	315.4089
D_1	388_a	1.030	389.656	−1.0926	+1.0932	−1.0929	−0.6	+209.8	313.8788
388_a	389_a	1.028	390.684	−1.2904	+1.2884	−1.2894	+2.0	+211.8	312.5894
389_a	390_a	1.084	391.768	+0.4736	−0.4665	+0.4699	−2.2	+209.6	313.0593
				+0.4685	−0.4710				
390_a	Geol. Platte (3)	.398	392.166	+0.7879	−0.7840	+0.7856	−1.2	+208.4	313.8449
				+0.7844	−0.7860				
D_1	389	1.236	389.862	+1.2691	−1.2657	+1.2674	−3.4	+207.0	316.2391
389	390	1.082	390.944	+0.4548	−0.4552	+0.4550	+0.4	+207.4	316.6941
390	391	1.007	391.951	+1.5066	−1.5022	+1.5059	−4.6	+202.8	318.2000
				+1.5099	−1.5049				
391	392	1.002	392.953	+0.5914	−0.5891	+0.5894	−0.4	+202.4	318.7894
				+0.5877	−0.5894				

* Rejected.

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B.—F.). Partial.	Discrepancy (B.—F.). Total.	Elevation above bench mark K_3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
392	F_1	1.120	394.073	+ 1.3300	− 1.3337	+ 1.3318	+3.7	+206.1	320.1212
F_1	393	1.026	395.099	+ 0.4372	− 0.4382	+ 0.4377	+1.0	+207.1	320.5589
393	394	.982	396.081	+ 0.9822	− 0.9781	+ 0.9802	−4.1	+203.0	321.5391
394	395	.985	397.066	+ 1.0608	− 1.0633	+ 1.0620	+2.5	+205.5	322.6011
395	396	1.008	398.074	+ 1.0872	− 1.0906	+ 1.0889	+3.4	+208.9	323.6900
396	397	1.009	399.083	+ 1.1426	− 1.1440	+ 1.1433	+1.4	+210.3	324.8333
397	398	1.022	400.105	+ 1.0833	− 1.0854	+ 1.0844	+2.1	+212.4	325.9177
398	399	1.014	401.119	+ 1.4120	− 1.4162	+ 1.4141	+4.2	+216.6	327.3318
399	400	1.188	402.307	+ 0.7150	− 0.7134	+ 0.7142	−1.6	+215.0	328.0460
400	G_1	1.344	403.651	+ 1.0712	− 1.0727	+ 1.0720	+1.5	+216.5	329.1180
G_1	401	1.008	404.659	+ 0.9828	− 0.9855	+ 0.9842	+2.7	+219.2	330.1022
401	402	1.000	405.659	+ 0.6550	− 0.6550	+ 0.6550	0.0	+219.2	330.7572
402	403	1.008	406.667	+ 6.7893	− 6.7850	+ 6.7883	−0.6	+218.6	337.5455
				+ 6.7879	− 6.7909				
403	404	1.001	407.668	+ 1.2309	− 1.2276	+ 1.2292	−3.3	+215.3	338.7747
404	405	.992	408.660	+ 9.4609	− 9.4578	+ 9.4594	−3.1	+212.2	348.2341
405	406	1.000	409.660	− 2.1891	+ 2.1892	− 2.1892	−0.1	+212.1	346.0449
406	407	1.322	410.982	− 5.6847	+ 5.6834	− 5.6840	+1.3	+213.4	340.3609
407	H_1	1.304	412.286	+ 2.3357	− 2.3394	+ 2.3376	+3.7	+217.1	342.6985
H_1	408	.613	412.899	+ 1.0425	− 1.0425	+ 1.0425	0.0	+217.1	343.7410
408	409	.972	413.871	+ 2.7884	− 2.7878	+ 2.7881	−0.6	+216.5	346.5291
409	410	1.082	414.953	+ 3.2626	− 3.2646	+ 3.2636	+2.0	+218.5	349.7927
410	411	1.016	415.969	+ 2.6710	− 2.6747	+ 2.6728	+3.7	+222.2	352.4655
411	412	.982	416.951	+ 2.8647	− 2.8644	+ 2.8646	−0.3	+221.9	355.3301
412	413	1.008	417.959	+ 1.9754	− 1.9767	+ 1.9770	−0.5	+221.4	357.3071
				+ 1.9790					
413	414	.970	418.929	+ 3.7284	− 3.7282	+ 3.7283	−0.2	+221.2	361.0354
414	415	.946	419.875	+ 3.5845	− 3.5856	+ 3.5850	+1.1	+222.3	364.6204
415	I_1	1.176	421.051	+ 4.6029	− 4.6024	+ 4.6026	−0.5	+221.8	369.2230
I_1	416	.976	422.027	+ 1.9962	− 1.9981	+ 1.9972	+1.9	+223.7	371.2202
416	417	1.026	423.053	+ 5.5314	− 5.5324	+ 5.5319	+1.0	+224.7	376.7521
417	418	1.029	424.082	+ 8.5584	− 8.5557	+ 8.5570	−2.7	+222.0	385.3091
418	419	1.018	425.100	+ 4.8245	− 4.8212	+ 4.8224	−4.0	+218.0	390.1315
				+ 4.8244	− 4.8195				
419	420	1.025	426.125	− 3.9275	+ 3.9277	− 3.9276	−0.2	+217.8	386.2039
420	421	1.080	427.205	− 6.2196	+ 6.2176	− 6.2186	+2.0	+219.8	379.9853
421	422	1.200	428.405	− 3.1020	+ 3.1006	− 3.1013	+1.4	+221.2	376.8840
422	423	1.007	429.412	− 0.9345	+ 0.9321	− 0.9333	+2.4	+223.6	375.9507
423	J_1	.574	429.986	+14.1544	−14.1574	+14.1548	+3.1	+226.7	390.1055
				+14.1522	−14.1553				
423	424	.992	430.404	− 2.2462	+ 2.2428	− 2.2445	+3.4	+227.0	373.7062
424	425	.986	431.390	− 0.6717	+ 0.6707	− 0.6712	+1.0	+228.0	373.0350
425	426	1.008	432.398	− 0.8019	+ 0.8044	− 0.8032	−2.5	+225.5	372.2318
426	427	1.022	433.420	+ 9.7004	− 9.7033	+ 9.7018	+2.9	+228.4	381.9336
427	428	.987	434.407	+ 9.7989	− 9.8012	+ 9.8000	+2.3	+230.7	391.7336
428	429	1.002	435.409	− 1.8300	+ 1.8296	− 1.8298	+0.4	+231.1	389.9038
429	430	1.000	436.409	− 2.9501	+ 2.9525	− 2.9513	−2.4	+228.7	386.9525
430	431	.984	437.393	− 8.5100	+ 8.5129	− 8.5114	−2.9	+225.8	378.4411
431	K_1	1.058	438.451	− 9.6201	+ 9.6226	− 9.6214	−2.5	+223.3	368.8197
K_1	432	1.016	439.467	− 3.2091	+ 3.2064	− 3.2078	+2.7	+226.0	365.6119
432	433	1.098	440.565	− 0.1501	+ 0.1511	− 0.1506	−1.0	+225.0	365.4613
433	434	1.008	441.573	− 1.8955	+ 1.8962	− 1.8958	−0.7	+224.3	363.5655
434	435	.998	442.571	− 1.3884	+ 1.3880	− 1.3882	+0.4	+224.7	362.1773
435	436	.994	443.565	− 0.4337	+ 0.4351	− 0.4344	−1.4	+223.3	361.7429

Results of spirit leveling from Abilene, Kans., to Norfolk, Nebr.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark B_1 at Abilene.	Difference of elevation.			Discrepancy (B.—F.).		Elevation above bench mark K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
436	437	1·005	444·570	− 2·5037	+ 2·5023	− 2·5030	+1·4	+224·7	359·2399
437	438	1·004	445·574	− 3·2614	+ 3·2573	− 3·2584	+2·1	+226·8	355·9815
				− 3·2574					
438	L_1	·744	446·318	+ 2·7710	− 2·7718	+ 2·7714	+0·8	+227·6	358·7529
438	439	·998	446·572	− 0·4608	+ 0·4582	− 0·4595	+2·6	+229·4	355·5220
439	440	1·004	447·576	+ 1·7897	− 1·7876	+ 1·7886	−2·1	+227·3	357·3106
440	441	1·202	448·778	+ 3·5964	− 3·6027	+ 3·6016	+2·5	+229·8	360·9122
				+ 3·6044	− 3·6031				
441	442	1·110	449·888	+ 5·7486	− 5·7528	+ 5·7511	+1·8	+231·6	366·6633
				+ 5·7517	− 5·7513				
442	443	1·008	450·896	+ 4·8786	− 4·8814	+ 4·8800	+2·8	+234·4	371·5433
443	444	·988	451·884	+ 7·6895	− 7·6889	+ 7·6892	−0·6	+233·8	379·2325
444	M_1	1·398	453·282	+12·1063	−12·1092	+12·1078	+2·9	+236·7	391·3403
M_1	445	1·018	454·300	− 0·8404	+ 0·8421	− 0·8412	−1·7	+235·0	390·4991
445	446	1·236	455·536	− 6·9380	+ 6·9351	− 6·9366	+2·9	+237·9	383·5625
446	447	·986	456·522	− 5·3079	+ 5·3073	− 5·3076	+0·6	+238·5	378·2549
447	448	1·172	457·694	− 3·0486	+ 3·0474	− 3·0480	+1·2	+239·7	375·2069
448	449	1·008	458·702	− 2·0978	+ 2·0967	− 2·0972	+1·1	+240·8	373·1097
449	450	1·018	459·720	− 2·1509	+ 2·1503	− 2·1506	+0·6	+241·4	370·9591
450	451	1·008	460·728	− 6·1321	+ 6·1322	− 6·1322	−0·1	+241·3	364·8269
451	452	1·046	461·774	− 4·7852	+ 4·7827	− 4·7840	+2·5	+243·8	360·0429
452	453	1·008	462·782	− 3·9671	+ 3·9629	− 3·9664	−0·3	+243·5	356·0765
				− 3·9655	+ 3·9703				
453	454	1·022	463·804	− 4·9698	+ 4·9734	− 4·9716	−3·6	+239·9	351·1049
454	455	·996	464·800	− 8·8345	+ 8·8334	− 8·8340	+1·1	+241·0	342·2709
455	456	1·170	465·970	− 3·4108	+ 3·4112	− 3·4110	−0·4	+240·6	338·8599
456	N_1	1·152	467·122	− 0·9107	+ 0·9064	− 0·9080	+2·1	+242·7	337·9519
				− 0·9075	+ 0·9075				
N_1	457	1·006	468·128	− 0·0290	+ 0·0292	− 0·0291	−0·2	+242·5	337·9228
457	457_a	·940	469·068	− 1·5745	+ 1·5745	− 1·5745	0·0	+242·5	336·3483
457_a	Geol. Elkh'n (3)	·971	470·039	− 0·3310	+ 0·3337	− 0·3324	−2·7	+239·8	336·0159
457	O_1	1·560	469·688	+ 1·1852	− 1·1859	+ 1·1856	+0·7	+243·2	339·1084
O_1	P_1	·807	470·495	− 0·7630	+ 0·7653	− 0·7642	−2·3	+240·9	338·3442

NOTE.—The stake at T. B. M. 87 had evidently been disturbed between the time of the first and second running. The differences of elevation between T. B. M. 86 and T. B. M. 88 are approximately equal from the two sets of measures.

Elevations of top of rail were determined at the following stations:

		Elevation.
		m.
1.	Talmage, Atchison, Topeka and Santa Fe Railroad	243·50
2.	Miltonvale, Atchison, Topeka and Santa Fe Railroad	293·89
3.	Miltonvale, Union Pacific Railroad	293·17
4.	Huscher, Atchison, Topeka and Santa Fe Railroad	320·42
5.	Concordia, Burlington and Missouri River Railroad	290·50
6.	Concordia, Union Pacific	289·51
7.	Concordia, Missouri Pacific	290·21
8.	Hannum, Atchison, Topeka and Santa Fe Railroad	291·29

		Elevation.
		m.
9.	Oneonta, Atchison, Topeka and Santa Fe Railroad	299·77
10.	Courtland, Atchison, Topeka and Santa Fe Railroad	332·20
11.	Lovewell, Atchison, Topeka and Santa Fe Railroad	345·12
12.	Webber, Atchison, Topeka and Santa Fe Railroad	382·59
13.	Superior, Burlington and Missouri River	353·75
14.	Superior, Santa Fe	354·42
15.	Bostwick, Burlington and Missouri River Railroad	362·79
16.	Guide Rock, Burlington and Missouri River Railroad	377·10
17.	Cowles, Burlington and Missouri River Railroad	420·36
18.	Blue Hill, Burlington and Missouri River Railroad	474·62
19.	Hastings, Burlington and Missouri River Railroad. On ballast *	463·92
20.	Hansen, St. Joseph and Grand Island Railroad	467·01
21.	Alda, Union Pacific Railroad	458·06
22.	Chapman. On ballast *	412·42
23.	Central City, Union Pacific Railroad	392·66
24.	Clarks, Union Pacific Railroad	368·54
25.	Havens, Union Pacific Railroad	358·05
26.	Silver Creek, Union Pacific Railroad	346·20
27.	Gardiner, Union Pacific Railroad	336·01
28.	Cayuga, Union Pacific Railroad	322·28
29.	Oconee, Union Pacific Railroad	329·03
30.	Platte Center, Union Pacific Railroad	342·34
31.	Tarnov, Union Pacific Railroad	369·55
32.	Humphrey, Union Pacific Railroad	375·48
33.	Madison, Union Pacific Railroad	356·00
34.	Warnerville, Union Pacific Railroad	362·44
35.	Intersection of Union Pacific and Fremont, Elkhorn and Missouri Valley railroads south of Norfolk	338·12

* Read on ballast instead of top of rail.

APPENDIX No. 7.

REPORT 1898-1899.

RESULTING ELEVATIONS FROM SPIRIT LEVELING BETWEEN GIBRALTAR, MICH., AND CINCINNATI, OHIO, FROM OBSERVATIONS BY O. W. FERGUSON, ASSISTANT, BETWEEN JUNE 3 AND NOVEMBER 28, 1899.

By O. W. FERGUSON, Assistant.

APPENDIX No. 7. 1898-99.

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Report by O. W. FERGUSON, *Assistant.*

The following results of spirit leveling between Gibraltar, Mich., and Cincinnati, Ohio, are herewith respectfully submitted:

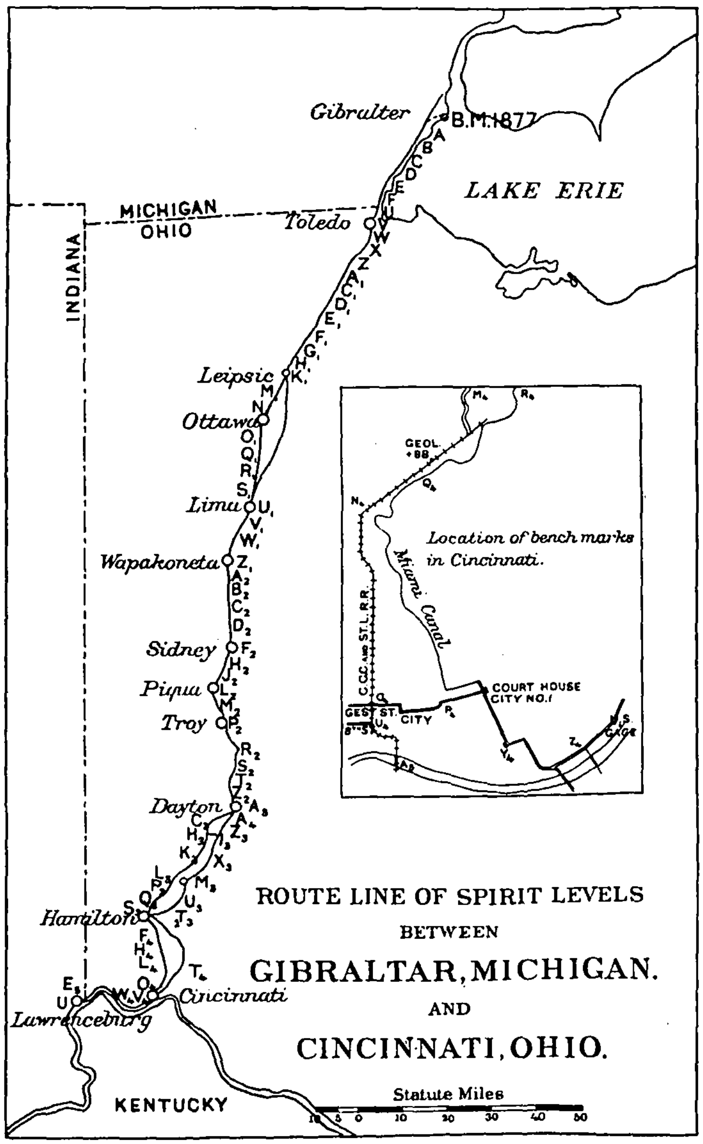
These elevations are carried from "U. S. B. M. Gibraltar 1877," of which the elevation is assumed to be 582·45 feet ($=177^{m}\cdot5292$), as given in Professional Papers of the Corps of Engineers, U. S. A., No. 24, page 616. This line is also connected at Gibraltar, Mich., with B. M. No. 2 of 1875, given in the same report, and with U. S. B. M. No. 1, in the same town, established in 1898, on a line of levels between Lakes Erie and Huron run under the direction of the United States Board of Engineers on Deep Waterways. The difference of elevation found between these three bench marks agreed very closely with former results.

The elevations given in this Report are therefore only relative. To obtain the corrections necessary to reduce them to absolute elevations, see Appendix No. 8 of this Report.

The route, as shown on the sketch, follows the Michigan Central Railroad to Toledo, Ohio, and the Cincinnati, Hamilton and Dayton Railroad thence to Cincinnati, and the Cleveland, Cincinnati, Chicago and St. Louis and the Baltimore and Ohio Southwestern from Cincinnati to Lawrenceburg, Ind. There were a few minor exceptions where the line followed highways, city streets, or canal towpaths.

The main purpose of this line is to connect the levels as carried through the Great Lakes by the United States Lake Survey and other organizations with the transcontinental line of levels run from Sandy Hook westward along the thirty-ninth parallel by the Coast and Geodetic Survey. The connection with the transcontinental line was made at bench mark T (Ohio), also known as Cincinnati City Bench Mark No. 1, and at U (Indiana), at Lawrenceburg. Approximate connections were also made at permanent bench mark LXV and temporary bench marks 119, 118, and 117 of the transcontinental line between Cincinnati and Lawrenceburg. These connections were approximate because in each case either a portion of the stone was broken off or the exact point formerly used as the bench mark could not be identified. Furthermore, it is believed by the "Big Four" civil engineers that the whole river bank in the vicinity of 119, 118, and 117 is very slowly sliding toward the Ohio River, and the elevations obtained in reference to bench mark T in Cincinnati support this belief.

Connections were also made with United States bench marks in Toledo, Ohio, and



Cincinnati, Ohio; with bench marks of the Pennsylvania Railroad at Piqua, Ohio, and with their bench marks Nos. 17, 19, 20, 21, 23, and 24 on the line of their road from Hamilton south to Crescentville, Ohio; with one bench mark of the United States Geological Survey at Winton Place, Ohio, and another at Sedamsville, Ohio; with the bench marks of the Queen and Crescent Railroad on the bridge seat of the south end of the long span (519 feet) of their bridge over the Ohio River at Cincinnati, Ohio, and with one or more city bench marks in each city along the line. The elevation of the top of the railroad rail was determined in front of each station and at each railroad crossing along the line.

The instrument used was the Coast and Geodetic Survey level No. 1 modified as indicated below.* The level vial used was marked "No. 19, 2″·23, K. & E." The value of each 2-mm division of this vial is 1″·94, as determined at the Office, using a level trier. The telescope has a focal length of 36 centimetres (= 14 inches) and a clear aperture of 29 millimetres (= 1⅛ inches). The spider lines in the focus of the eyepiece, which are read against the rod, are placed unusually close together, the interval subtended on the rod being approximately 0·3 metre for a 100-metre sight. The power of the telescope being approximately 38 diameters, the visual angle of the extreme wires is $38 \tan^{-1} 0{\cdot}003 = 6\frac{1}{2}^{\circ}$, whereas it is not unusual in other leveling instruments for this angle to be as great as 20°. This fact that the visual angle is so small makes observing much easier than it otherwise would be, and it insures that only the central portion of the eyepiece field, in which the images are most distinct, shall be used. A further benefit comes from the fact that the lower line of sight traverses air farther away from and therefore less disturbed by the hotter or colder surface of the ground.

Three great improvements were secured by the remodeling of the instrument in the spring of 1899. (1) The distance between the line of collimation and the axis of the level vial was greatly reduced. (2) The material used in the construction is a nickel-iron alloy having a coefficient of expansion of 0·000004 per centigrade degree, about the same as that of wood. (3) An apparatus for reading the position of the bubble without removing the eye from the eyepiece was added to the instrument. The ends of the bubble on the scale are reflected by a mirror and two prisms through a tube located in exact position for the left eye when the right eye is at the eyepiece. The ends of the bubble appear to be only from ¼ to ½ inch apart, making the visual angle between them comfortably small. This device for reading the bubble is superior to the inclined plane mirror often used for that purpose, for it concentrates the vision on the ends of the bubble, shuts out distracting patches of light and images of trees and other objects, which sometimes appear so prominent in the inclined plane mirror that it is hard to see the bubble. It has the further good quality of introducing no parallax between the ends of the bubble and the level scale.

The broad but light wooden tripod head makes the instrument very steady even in a smart breeze. The instrument maintains all its adjustments remarkably well.

The new paraffined rods T and U, graduated to centimetres, were used. The cross section of these rods is symmetrical and in form of a cross.

The methods of observing are the same as those given in Appendix 6 of this Report.

A strong system of permanent bench marks is established along this line. In the towns and cities some bench marks are usually placed off from the railroad on public buildings, as well as on railroad masonry, such as culverts, bridge abutments and piers,

* For a description of this instrument see Appendix No. 11, Coast and Geodetic Survey Report for 1880.

and depot foundations. The number of permanent bench marks in this system of each class is as follows:

New permanent bench marks	121
Old United States Coast and Geodetic Survey bench marks	5
Old United States Engineer bench marks	7
Old United States Geological Survey bench marks	2
Old Pennsylvania Railroad bench marks	10
Old city bench marks	12
Old river gauge bench marks	1
Total	158

This number, 158, corresponds to an average distance of 1·8 miles between permanent bench marks.

Besides these there are 227 temporary or auxiliary bench marks which serve to break the line into short sections.

The length of the main line is 431·8 kilometres; the combined length of the side lines is 27·0 kilometres, making the total length 458·8 kilometres = 285·2 miles.

The average length of a section of the main line is 1·6 kilometre and the average length of a sight on the main line is 60 metres.

Three and one-half per cent of the work did not check within the prescribed limit $4^{mm}\sqrt{K}$ (in which K is the distance between adjacent bench marks in kilometres). Such sections were rerun in opposite directions as before.

The number of working days, making no deduction for stormy weather or for time spent in moving, was 152 days. The average daily rate of progress was therefore 3·0 kilometres of completed line.

Thirty-five per cent of the distance from Gibraltar, Mich., to Cincinnati was comprised in the following three long loops:

Extreme points.	Length of loop.	Error of closure.
	km.	*mm.*
Leipsic, Ohio, to Lima, Ohio	81·6	−4·9
Dayton, Ohio, to Hamilton, Ohio	112·0	+9·0
Hamilton, Ohio, to Cincinnati, Ohio	86·6	+9·3

Each loop was run southward over the Cincinnati, Hamilton and Dayton Railroad. The first was run northward over the Detroit and Lima Northern Railroad, the second over the Cincinnati and Middletown and "Big Four" railroads, and the third northward along the towpath of the Miami and Erie Canal, and along the Pennsylvania Railroad to Hamilton.

The differences of elevation between successive bench marks were recomputed in the Office, introducing various small corrections which had been neglected in the field computation.

The index correction of rods T and U at the beginning of the season was −0·1 millimetre, the zero of the graduation being that distance below the bottom of the rod in each case. At the end of season the index correction was −0·3 millimetre for rod T and −0·4 millimetre for rod U. These index corrections if applied would not change the computed difference of elevation of any two successive bench marks by more than 0·1 millimetre, except in those cases in which direct readings were taken on a bench mark without the use of a rod. Even in such a case the maximum error made by neglecting to apply the index correction is 0·4 millimetre, and even this small error is not carried forward. The index corrections were not applied, being so small and being compensating in their nature.

The corrections due to curvature and refraction are both proportional to the square of the distance. The latter was assumed to be one-eighth of the former and of opposite sign, and the two corrections were applied as one. Instead of applying this correction to each individual sight, it was applied with reference to the difference of corresponding foresights and backsights, using for that purpose a table of which the two arguments are the length of sight and the difference of length of sights. The correction is minus if the backsights are longer. The computation being carried to the nearest 0·1 millimetre only, this correction was appreciable for about 1 per cent of the settings, which could be detected by a mere inspection of the record.

The correction due to inequality of collars of the telescope was applied to each section between bench marks, and was determined from the excess of the sum of lengths of the backsights over the foresights. At the beginning of the season, May 30, the inequality was observed in the pendulum room at the Office. The error was such that the angle between the line of collimation and the surfaces of the collars was $1''\cdot24 = +0\cdot006$ millimetre per metre, the object collar being the larger. Again, after returning from the field it was observed on December 5 in the same place, and found to be $2''\cdot75 = +0\cdot013$ millimetre per metre, the object collar being the larger, as before. The first value was used for the first three months of the field season and the last value for the last three months.

The correction due to the error of the striding level was applied to each section between bench marks and was determined from the excess of the sum of the lengths of backsights over the foresights and from the observed value of the level error on that half day, using a double argument table.

The correction due to the error of collimation was applied to each section between bench marks and was computed in a manner similar to that just stated for the error of the striding level.

Three metres of the graduated portion of each rod is marked off on four metal plugs set in the face of the rod. These lengths were determined by the Office of Standard Weights and Measures on May 27, 1899, just before the field work began, and again on December 22, just after the close of field season. They were also measured at seven other times during the field season by a steel tape, graduated to millimetres, used direct and reversed, under a reading glass, the temperature being noted. These field measurements were rendered comparable by reducing the observed lengths to 9° C., taking into account the coefficient of expansion of both the tape and the rod.

Field measurements of rods.

[Reduced to 9° C.]

Date.	Rod T.	Rod U.
1899.	*Metres.*	*Metres.*
July 21	3·00044	3·00000
Sept. 6	3·00019	3·00011
Oct. 7	3·00051	3·00026
Oct. 25	3·00065	3·00056
Nov. 11	3·00044	3·00034
Nov. 28	3·00058	3·00047
Dec. 4	3·00020	3·00018
Mean	3·00043	3·00027

Measurements of rods, by Weights and Measures Office.

Date.	Rod T.	Rod U.	Temperature.
1899.	*Metres.*	*Metres.*	
May 27	3·000988	3·000674	T = 21·25 C. U = 21·50 C.
Dec. 22	3·001774	3·001545	22·50
THE LENGTHS AT 0°·00.			
May 27	3·000733	3·000416	
Dec. 22	3·001504	3·001275	

Mean length of 1 metre on rods T and U on December 22, 1899, $= 1^{m}·000463$. The field measurements of the rod lengths are relative only, as the correction to the tape was not known. They show that within very small limits the rods remained of the same length from July 21 to December 4. At the end of the season, December 22, they were longer than at beginning of season, May 27, according to the measurements by the Weights and Measures Office. It was therefore concluded that the change of length occurred prior to July 21; that is, soon after they were taken to the field. The same phenomenon has been observed with paraffined rods before on this Survey. Up to July 21 only small differences of elevation had been measured, therefore the mean length found on December 22 was used for the whole computation, viz, 1^{m} on rods $= 1^{m}·000463$ at 0° C. This correction for length of rod will numerically increase the difference of elevation between bench marks in every case.

The mean temperature of the rods given for each section between consecutive bench marks being above 0° C., in every case, the effect of the correction for temperature was to increase numerically the approximate difference of elevation. The amount of the correction is the product of the mean temperature by the coefficient of expansion (0·000004) by the approximate difference of elevation.

The algebraic sum of these corrections being applied to each approximate difference of elevation, gives the corrected difference of elevation between bench marks for that line. The mean of these corrected differences for the forward and backward lines, or any number of lines, between two bench marks gives the mean difference of elevation, but with the consideration that the sign of differences of elevation for all back runs between these bench marks must obviously now be changed in order that their differences may have the same significance as the forward differences.

To find the divergence, or error of closure, between two bench marks, take the sum of the differences of elevation as found by the forward and back lines, or by the mean forward and mean back lines, and change its sign and this quantity will be the divergence or partial discrepancy. A plus sign indicates that the elevation has been carried too low.

Owing to having kept the errors of the striding level and collimation small, and to good pacing on the part of the rodmen, and, lastly, to having taken some care at the closing setting of each run to make sum of lengths of backsights approximately equal to the sum of lengths of foresights, the corrections are quite small. The sum, without regard to sign, of all the corrections due to curvature and refraction for the whole season's work was only 5·9 millimetres; for collar inequality was 1.8 millimetres, and for striding level and collimation was 4·7 millimetres.

A measure of the precision and reliability of the work is furnished by the following considerations. Total number of lines run was 566. One pair of these showed a discrepancy of 100 millimetres. This line was rerun and, moreover, the error was located on the ground between two footplate impressions. If but one line in 283 pairs shows a large discrepancy from its duplicate line, the probability of both lines containing a large error of the same sign and magnitude is very remote.

Eleven other pairs of these 566 lines showed errors of closure greater than the prescribed limit $4^{mm}\sqrt{K}$ (in which K is the distance in kilometres between adjacent bench marks). The first quantity given below is the error of closure, the second is $4^{mm}\sqrt{K}$.

$-6{\cdot}5>-4{\cdot}8$	$-5{\cdot}5>-4{\cdot}8$	$-5{\cdot}5>-4{\cdot}7$	$+6{\cdot}8>+4{\cdot}8$
$+7{\cdot}4>+4{\cdot}5$	$-6{\cdot}2>-4{\cdot}6$	$-7{\cdot}6>-5{\cdot}2$	$-7{\cdot}6>-5{\cdot}7$
$+6{\cdot}5>+5{\cdot}4$	$-6{\cdot}0>-4{\cdot}8$	$-4{\cdot}6>-3{\cdot}8$	

Three of these show closures too low, their sum being $+20{\cdot}7$ millimetres, and eight show closures too high, their sum being $-49{\cdot}5$. I suspect, therefore, that some of these errors were caused by a considerable settling of footplates between foresights and backsights, owing to unfortunate settings thereof.

The following tabulation shows the direct results of the leveling:

Bench mark. From	Bench mark. To	Distance between successive B. M's.	Distance from B. M. Gibraltar 1877.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B—F.) Partial.	Discrepancy (B—F.) Total.	Elevation above sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
Gib. 1877			0·000					0·0	177·5292
Gib. 1877	U. S. E. 1	0·153	0·153	+1·5488	−1·5484	+1·5486	−0·4	− 0·4	179·0778
Gib. 1877	2 of '75	0·125	0·125	+0·7677	−0·7677	+0·7677	0·0	0·0	178·2969
Gib. 1877	1	1·099	1·099	+0·4100	−0·4113	+0·4106	+1·3	+ 1·3	177·9398
1	2	1·672	2·771	−0·6642	+0·6605	−0·6624	+3·7	+ 5·0	177·2774
2	3	1·642	4·413	+1·2201	−1·2200	+1·2200	−0·1	+ 4·9	178·4974
3	4	1·360	5·773	−0·5567	+0·5594	−0·5580	−2·7	+ 2·2	177·9394
4	A	1·994	7·767	+1·0562	−1·0525	+1·0544	−3·7	− 1·5	178·9938
A	5	1·696	9·463	+0·3680	−0·3655	+0·3668	−2·5	− 4·0	179·3606
5	6	1·633	11·096	+2·0856	−2·0851	+2·0854	−0·5	− 4·5	181·4460
6	7	1·297	12·393	−0·4192	+0·4195	−0·4194	−0·3	− 4·8	181·0266
7	8	1·668	14·061	−0·3060	+0·3032	−0·3046	+2·8	− 2·0	180·7220
8	9	1·736	15·797	−0·1199	+0·1194	−0·1196	+0·5	− 1·5	180·6024
9	B	0·413	16·210	−3·7235	+3·7236	−3·7236	−0·1	− 1·6	176·8788
9	10	1·572	17·369	−0·0997	+0·1013	−0·1005	−1·6	− 3·1	180·5019
10	11	1·548	18·917	+1·6502	−1·6464	+1·6483	−3·8	− 6·9	182·1502
11	12	1·360	20·277	−0·7297	+0·7339	−0·7318	−4·2	−11·1	181·4184
12	13	1·329	21·606	−1·3322	+1·3366	−1·3344	−4·4	−15·5	180·0840
13	14	1·198	22·804	+0·5073	−0·5084	+0·5078	+1·1	−14·4	180·5918
14	15	1·171	23·975	−0·3621	+0·3633	−0·3627	−1·2	−15·6	180·2291
15	16	1·248	25·223	+0·7777	−0·7770	+0·7774	−0·7	−16·3	181·0065
16	17	1·150	26·373	−1·2057	+1·2065	−1·2061	−0·8	−17·1	179·8004
17	18	1·154	27·527	−0·3200	+0·3244	−0·3222	−4·4	−21·5	179·4782
18	C	0·031	27·558	−2.3970	+2·3972	−2·3971	−0·2	−21·7	177·0811
18	D	0·780	28·307	+0·5629	−0·5595	+0·5612	−3·4	−24·9	180·0394
18	19	1·130	28·657	−2·9227	+2·9272	−2·9250	−4.5	−26·0	176·5532
19	20	1·456	30·113	+2·5893	−2·5828	+2·5869	−4·2	−30·2	179·1401
				+2·5886	−2·5867				
20	21	1·252	31·365	−1·3139	+1·3065	−1·3102	+3·2	−27·0	177·8299
				−1·3098	+1·3108				
21	22	1·214	32·579	−0·1620	+0·1609	−0·1614	+1·1	−25·9	177·6685
22	23	1·388	33·967	+2·2171	−2·2197	+2·2184	+2·6	−23·3	179·8869
23	24	1·355	35·322	−1·0234	+1·0202	−1·0218	+3·2	−20·1	178·8651
24	25	1·530	36·852	−1·2176	+1·2131	−1·2154	+4·5	−15·6	177·6497
25	26	1·390	38·242	−0.1806	+0·1781	−0·1794	+2·5	−13·1	177·4703
26	E	0·033	38·275	−0·0065	+0·0064	−0·0064	+0·1	−13·0	177·4639
26	27	1·801	40·043	+0·8211	−0·8276	+0·8261	+4·3	− 8·8	178·2964
				+0·8267	−0·8289				
27	28	1·498	41·541	−1·1073	+1·1062	−1·1068	+1·1	− 7·7	177·1896
28	29	2·128	43·669	+2·0116	−2·0117	+2·0116	+0·1	− 7·6	179·2012
29	F	0·151	43·820	+0·2453	−0·2448	+0·2450	−0·5	− 8·1	179·4462
29	30	0·992	44·661	−0·4272	+0·4266	−0·4269	+0·6	− 7·0	178·7743
30	31	1·449	46·110	−1.0633	+1·0688	−1·0644	−2·0	− 9·0	177·7099
				−1·0634	+1·0620				

Bench mark.		Distance between successive B. M's.	Distance from B. M. Gibraltar 1877.	Difference of elevation.			Discrepancy (B—F.)		Elevation above sea level.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
31	32	1·301	47·411	−0·4034	+0·4096	−0·4067	−3·0	−12·0	177·3032
				−0·4069	+0·4069				
32	33	1·334	48·745	+0·4277	−0·4316	+0·4292	+3·9	− 8·1	177·7324
33	34	1·322	50·067	−0·1409	+0·1392	−0·1400	+1·7	− 6·4	177·5924
34	35	1·320	51·387	+2·6036	−2·6035	+2·6036	−0·1	− 6·5	180·1960
35	U	0·798	52·185	−1·7687	+1·7715	−1·7701	−2·8	− 9·3	178·4259
U	36	1·417	53·602	+1·7452	−1·7457	+1·7454	+0·5	− 8·8	180·1713
36	37	1·326	54·928	−0·5035	+0·5013	−0·5024	+2·2	− 6·6	179·6689
37	38	1·358	56·286	+0.4106	−0·4138	+0·4122	+3·2	− 3·4	180·0811
38	39	1.588	57·874	+1·0597	−1·0616	+1·0606	+1·9	− 1·5	181·1417
39	Toledo 165	0·296	58·170		−0·6175	+0·6175			181·7592
39	△ Park	1·380	59·254	+2·0498	−2·0500	+2·0499	+0·2	− 1·3	183·1916
△ Park	40	0·663	59·917	+1·1248	−1·1234	+1·1241	−1·4	− 2·7	184·3157
40	V	1·015	60·932	−4·7833	+4·7813	−4·7823	+2·0	− 0·7	179·5334
V	Power House	1·151	62·083	−1·9538	+1·9559	−1·9548	−2·1	− 2·8	177·5786
Power House	W	0·252	62·335	+6·4571	−6·4567	+6·4569	−0·4	− 3·2	184·0355
W	Post Office	0·066	62·401	−0·4043	+0·4047	−0·4045	−0·4	− 3·6	183·6310
W	Toledo 44	0·150	62·485	−2·2912		−2·2912			181·7443
V	Toledo 296	0·339	61·271	+0·3758	−0·3770	+0·3764	+1·2	+ 0·5	179·9098
296	41	1·269	62·540	+0·7022	−0·7024	+0·7023	+0·2	+ 0·7	180·6121
41	42	1·355	63·895	+6·8271	−6·8257	+6·8264	−1·4	− 0·7	187·4385
42	43	1·056	64·951	−1·4785	+1·4811	−1·4798	−2·6	− 3·3	185·9587
43	44	1·417	66·368	−1·4372	+1·4392	−1·4382	−2·0	− 5·3	184·5205
44	45	1·464	67·832	+3·3190	−3·3204	+3·3197	+1·4	− 3·9	187·8402
45	46	1·136	68·968	+1·2107	−1·2103	+1·2105	−0·4	− 4·3	189·0507
46	47	1·790	70·758	+0·6687	−0·6733	+0·6710	−5·4	− 9·7	189·7217
47	X	0·292	71·050	−5·9174	+5·9182	−5·9178	−0·8	−10·5	183·8039
47	48	1·600	72·358	+1·7075	−1·7078	+1·7076	+0·3	− 9·4	191·4293
48	49	1·484	73·842	−1·5537	+1·5566	−1·5552	−2·9	−12·3	189·8741
49	50	1·393	75·235	+2·4942	−2·4975	+2·4958	+3·3	− 9·0	192·3699
50	51	1·433	76·668	−2·3148	+2·3156	−2·3152	−0·8	− 9·8	190·0547
51	Y	0·027	76·695	−2·4208	+2·4207	−2·4208	+0·1	− 9·7	187·6339
51	52	1·740	78·408	+4·0577	−4·0598	+4·0588	+2·1	− 7·7	194·1135
52	53	0·942	79·350	+0·9479	−0·9504	+0·9492	+2·5	− 5·2	195·0627
53	54	1·894	81·244	+2·0141	−2·0123	+2·0132	−1·8	− 7·0	197·0759
54	Z	0·171	81·415	+0·2804	−0·2802	+0·2803	−0·2	− 7·2	197·3562
54	55	1·126	82·370	+1·1156	−1·1162	+1·1159	+0·6	− 6·4	198·1918
55	56	1·078	83·448	+1·0701	−1·0741	+1·0721	+4·0	− 2·4	199·2639
56	57	1·398	84·846	+0·9841	−0·9781	+0·9800	−2·7	− 5·1	200·2439
				+0·9787	−0·9793				
57	58	1·382	86·228	+1·0965	−1·0910	+1·0942	−3·3	− 8·4	201·3381
				+1·0953	−1·0942				
58	59	1·298	87·526	+0·1341	−0·1295	+0·1318	−4·6	−13·0	201·4699
59	A_1	0·146	87·672	−0·1764	+0·1761	−0·1762	+0·3	−12·7	201·2937

Bench mark.		Distance between successive B. M's.	Distance from B. M. Gibraltar 1877.	Difference of elevation.			Discrepancy (B—F.)		Elevation above sea level.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
59	60	1·159	88·685	+ 0·3659	— 0·3666	+ 0·3662	+0·7	—12·3	201·8361
60	B_1	0·276	88·961	+ 1·6485	— 1.6488	+ 1·6486	+0·3	—12·0	203·4847
60	61	1·342	90·027	+ 0·6096	— 0·6064	+ 0·6080	—3.2	—15·5	202·4441
61	62	1·396	91·423	+ 0·5638	— 0·5654	+ 0·5646	+1·6	—13·9	203·0087
62	63	1·776	93·199	+ 0·0507	— 0·0500	+ 0·0504	—0·7	—14·6	203·0591
63	64	1·060	94·259	+ 0·2431	— 0·2413	+ 0·2422	—1·8	—16·4	203·3013
64	C_1	0·466	94·725	+ 0·7339	— 0·7338	+ 0·7338	—0·1	—16·5	204·0351
64	65	0·682	94·941	+ 0·3019	— 0·3007	+ 0·3013	—1·2	—17·6	203·6026
65	66	1·360	96·301	+ 0·7797	— 0·7759	+ 0·7778	—3·8	—21·4	204·3804
66	67	1·324	97·625	+ 0·7226	— 0·7215	+ 0·7220	—1·1	—22·5	205·1024
67	68	1·388	99·013	+ 1·6451	— 1·6430	+ 1·6440	—2·1	—24·6	206·7464
68	69	1·257	100·270	— 0·4461	+ 0·4437	— 0·4448	+2·4	—22·2	206·3016
69	70	1·389	101·659	+ 1·4235	— 1·4263	+ 1·4249	+2·8	—19·4	207·7265
70	71	1·114	102·773	— 0·8494	+ 0·8484	— 0·8489	+1·0	—18·4	206·8776
71	D_1	1·269	104·042	+ 1·4548	— 1·4548	+ 1·4548	0·0	—18·4	208·3324
D_1	E_1	0·210	104·252	— 0·2756	+ 0·2764	— 0·2760	—0·8	—19·2	208·0564
E_1	Weston	0·024	104·276	— 0·2063	+ 0·2060	— 0·2062	+0·3	—18·9	207·8502
D_1	72	1·568	105·610	+ 0·0197	— 0·0231	+ 0·0214	+3·4	—15·0	208·3538
72	73	1·360	106·970	— 0·2429	+ 0·2464	— 0·2446	—3·5	—18·5	208·1092
73	74	1·396	108·366	+ 0·6288	— 0·6303	+ 0·6296	+1·5	—17·0	208·7388
74	75	1·404	109·770	+ 1·1835	— 1·1808	+ 1·1822	—2·7	—19·7	209·9210
75	F	0·176	109·946	+ 0·3048	— 0·3050	+ 0·3049	+0·2	—19·5	210·2259
75	76	2·089	111·859	+ 1·5686	— 1·5696	+ 1·5691	+1·0	—18·7	211·4901
76	G_1	0·364	112·223	+ 0·8119	— 0·8124	+ 0·8122	+0·5	—18·2	212·3023
76	77	1·300	113·159	+ 0·8499	— 0·8537	+ 0·8518	+3·8	—14·9	212·3419
77	78	1·332	114·491	+ 1·0201	— 1·0162	+ 1·0182	—3·9	—18·8	213·3601
78	79	1·748	116·239	+ 0·7111	— 0·7093	+ 0·7102	—1·8	—20·6	214·0703
79	80	2·112	118·351	+ 0·9683	— 0·9674	+ 0·9678	—0·9	—21·5	215·0381
80	81	2·097	120·448	+ 1·2192	— 1·2197	+ 1·2194	+0·5	—21·0	216·2575
81	82	2·086	122·534	+ 0·6262	— 0·6221	+ 0·6242	—4·1	—25·1	216·8817
82	H_1	1·024	123·558	+ 0·6248	— 0·6264	+ 0·6256	+1·6	—23·5	217·5073
H_1	I_1	0·408	123·966	— 0·1754	+ 0·1757	— 0·1756	—0·3	—23·8	217·3317
82	83	1·364	123·898	+ 1·2434	— 1·2419	+ 1·2426	—1·5	—26·6	218·1243
83	84	1·340	125·238	+ 0·3267	— 0·3310	+ 0·3288	+4·3	—22·3	218·4531
84	85	1·644	126·882	+ 1·9852	— 1·9802	+ 1·9827	—5·0	—27·3	220·4358
85	86	1·790	128·672	+ 3·7683	— 3·7708	+ 3·7696	+2·5	—24·8	224·2054
86	J_1	0·198	128·870	+ 0·3069	— 0·3074	+ 0·3072	+0·5	—24·3	224·5126
86	87	1·092	129·764	— 0·3462	+ 0·3463	— 0·3462	—0·1	—24·9	223·8592
87	88	1·724	131·488	+ 2·1275	— 2·1272	+ 2·1274	—0·3	—25·2	225·9866
88	89	1·484	132·972	+ 2·5979	— 2·5985	+ 2·5982	+0·6	—24·6	228·5848

Bench mark.		Distance between successive B. M's.	Distance from B. M. Gibraltar 1877.	Difference of elevation.			Discrepancy (B—F.)		Elevation above sea level.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
89	90	1·520	134·492	— 0·2846	+ 0·2867	— 0·2856	—2·1	—26·7	228·2992
90	91	1·352	135·844	+ 4·5096	— 4·5084	+ 4·5090	—1·2	—27·9	232·8082
91	K_1	0·092	135·936	+ 0·6136	— 0·6136	+ 0·6136	0·0	—27·9	233·4218
K_1	L_1	0·228	136·164	— 0·6795	+ 0·6788	— 0·6792	+0·7	—27·2	232·7426
91	92	1·612	137·456	+ 2·6085	— 2·6050	+ 2·6068	—3·5	—31·4	235·4150
		Beginning of loop from Leipsic to Lima.							
92	93	1·550	139·006	+ 1·6132		+ 1·6132			237·0282
93	94	1.807	140·813	— 6·1192		— 6·1192			230·9090
94	95	1·252	142·065	— 3·9625		— 3·9625			226·9465
95	M_1	0·427	142·492	— 0·3027		— 0·3027			226·6438
M_1	96	1·622	144·114	— 0·8665		— 0·8665			225·7773
96	97	1·317	145·431	— 2·5837		— 2·5837			223·1936
97	98	0·817	146·248	— 0·8564		— 0·8564			222·3372
98	N_1	0·078	146·326	— 0·0699	+ 0·0695	— 0·0697	+0·4		222·2675
98	99	1·678	147·926	+ 2·0267		+ 2·0267			224.3639
99	100	1·548	149·474	+ 0·8147		+ 0·8147			225·1786
100	101	1·258	150·732	+ 0·7296		+ 0·7296			225·9082
101	O_1	1·568	152·300	+ 1·5724		+ 1·5724			227·4806
O_1	102	1·617	153·917	+ 1·4853		+ 1·4853			228·9659
102	103	1·883	155·800	+ 2·1759		+ 2·1759			231·1418
103	104	1·522	157·322	+ 3·1944		+ 3·1944			234·3362
104	P_1	0·123	157·445	+ 0·6276	— 0·6277	+ 0·6276	+0·1		234·9638
P_1	Q_1	0·036	157·481	+ 1·5010	— 1·5013	+ 1·5012	+0·3		236·4650
104	105	1·477	158·799	+ 2·6613		+ 2·6613			236·9975
105	106	1·862	160·661	+ 0·6185		+ 0·6185			237·6160
106	107	1·587	162·248	+ 2·4874		+ 2·4874			240·1034
107	R_1	1·010	163·258	+ 0·7858		+ 0·7858			240·8892
R_1	108	2·023	165·281	+ 3·5693		+ 3·5693			244·4585
108	109	2·143	167·424	+ 4·1699		+ 4·1699			248·6284
109	S_1	0.214	167·638	— 0·3684	+ 0·3677	— 0·3680	+ 0.7		248·2604
109	110	1·657	169·081	+ 6·1594		+ 6·1594			254·7878
110	111	1·305	170.386	+ 1·8353		+ 1·8353			256.6231
111	T_1	1·899	172·285	— 1·7247		— 1·7247			254·8984
T_1	112	1·783	174·068	+11·6144		+11·6144			266·5128
112	113	1·726	175·794	+ 0·1455		+ 0·1455			266·6583
113	U_1	1·494	177·288	+ 1·2482		+ 1·2482			267·9065
U_1	114	1·350	178·638	— 4·9519		— 4·9519			262·9546
114	115	1·105	179·743	+ 4·5702		+ 4·5702			267·5248
115	117	1·748	181·491	— 2·3098		— 2·3098			265·2150
117	118	1·647	183·138	— 8·3119		— 8·3119			256·9031
118	119	1·975	185·113	— 0·6592		— 0·6592			256·2439
119	120	1·292	186·405	— 4·5480		— 4·5480			251·6959
120	121	1·989	188·394	— 4·3955		— 4·3955			247·3004
121	122	1·906	190·300	— 2·9350		— 2·9350			244·3654
122	R_1	2·052	192·352	— 3·4726		— 3·4726			240·8928

Bench mark. From	Bench mark. To	Distance between successive B. M's.	Distance from B. M. Gibraltar 1877.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B—F.) Partial.	Discrepancy (B—F.) Total.	Elevation above sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
R_1	123	1·186	193·538	— 0·8057		— 0·8057			240·0871
123	124	1·280	194·818	— 2·3920		— 2·3920			237·6931
124	125	2·165	196·983	— 1·6956		— 1·6956			235·9995
125	126	1·326	198·309	— 1·5676		— 1·5676			234·4319
126	127	2·410	200·719	— 3·8465		— 3·8465			230·5854
127	128	1·564	202·283	— 1·6955		— 1·6955			228·8899
128	129	1·646	203·929	— 1·2082		— 1·2082			227·6817
129	130	1·520	205·449	— 1·5803		— 1·5803			226·1014
130	131	1·189	206·638	— 1·0628		— 1·0628			225·0386
131	132	1·663	208·301	— 0·6904		— 0·6904			224·3482
132	133	2·069	210·370	— 0·0432		— 0·0432			224·3050
133	134	1·264	211·634	+ 0·0953		+ 0·0953			224·4003
134	135	2·080	213·714	+ 2·2362		+ 2·2362			226·6365
135	136	1·582	215·296	+ 3·2894		+ 3·2894			229·9259
136	137	1·944	217·240	+ 6·8069		+ 6·8069			236·7328
137	92	1·788	219·028	— 1·3129		— 1·3129			235·4199
	Close of loop from Leipsic to Lima.						—4·9	—36·3	
U_1	V_1	0·818	179·060	— 0·4931	+ 0·4955	— 0·4943	—2·4	—38·7	267·4097
V_1	Lima	0·120	179·180		+ 1·4460	— 1·4460			265·9637
U_1	116	0·844	179·086	— 6·1239	+ 6·1233	— 6·1236	+0·6	—35·7	261·7804
116	138	2·023	181·109	+ 6·8914	— 6·8923	+ 6·8918	+0·9	—34.8	268·6722
138	139	1·745	182·854	+ 1·5882	— 1·5924	+ 1·5903	+4·2	—30·6	270·2625
139	140	1·376	184·230	+ 4·9999	— 4·9985	+ 4·9992	—1·4	—32·0	275·2617
140	141	1·430	185 660	— 8·9290	+ 8·9274	— 8·9282	+1·6	—30·4	266·3335
141	W_1	1·262	186·922	— 1·5156	+ 1·5195	— 1·5176	—3·9	—34·3	264·8159
W_1	142	0·798	187·720	+ 3·1591	— 3·1593	+ 3·1592	+0·2	—34·1	267·9751
142	143	1·304	189·024	+ 3·2354	— 3·2332	+ 3·2343	—2·2	—36·3	271·2094
143	X_1	0·036	189.060	+ 0·7532	— 0·7531	+ 0·7532	—0·1	—36·4	271·9626
143	144	1·274	190·298	+ 0·8432	— 0·8406	+ 0·8419	—2·6	—38·9	272·0513
144	145	1·965	192·263	+ 1·6169	— 1·6147	+ 1·6158	—2·2	—41·1	273·6671
145	146	1·807	194·070	+ 3·4487	— 3·4490	+ 3·4488	+0·3	—40·8	277·1159
146	147	1·674	195·7[illegible]	+ 3·7367	— 3·7291	+ 3·7350	—4·1	—44·9	280·8509
				+ 3·7375	— 3·7369				
147	148	1·478	197·222	— 2·8022	+ 2·8091	— 2·8056	—6·9	—51·8	278·0453
148	Y_1	1·415	198·637	— 7·9961	+ 7·9989	— 7·9975	—2·8	—54·6	270·0478
Y_1	149	0·790	199·427	+ 2·6833	— 2·6851	+ 2·6842	+1·8	—52·8	272·7320
149	Z_1	0·170	199·597	+ 1·0986	— 1·0977	+ 1·0982	—0·9	—53·7	273·8302
149	150	0·912	200·339	+ 1·9202	*— 1·9156	+ 1·9218	+1·1	—51·7	274·6538
				+ 1·9219	— 1·9232				
150	151	1·527	201·866	+ 3·2131	— 3·2102	+ 3·2116	—2·9	—54·6	277·8654
151	A_2	1·588	203·454	+ 1·2643	— 1·2667	+ 1·2655	+2·4	—52·2	279·1309
A_2	152	1·414	204·868	+ 5·8062	— 5·8109	+ 5·8086	+4·7	—47·5	284·9395
152	153	1·330	206·198	+ 6·1240	— 6·1278	+ 6·1259	+3·8	—43·7	291.0654
153	154	2·669	208·867	+14·8439	—14·8421	+14·8430	—1·8	—45·5	305·9084
154	155	1·896	210·763	+ 0·5136	— 0·5142	+ 0·5139	+0·6	—44·9	306·4223
155	B_2	0·432	211·195	— 0·1422	+ 0·1419	— 0·1420	+0·3	—44·6	306·2803

* Rejected—run by an inexperienced observer, the recorder of the party.

Bench mark. From	Bench mark. To	Distance between successive B. M's.	Distance from B. M. Gibraltar 1877.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B—F.) Partial.	Discrepancy (B—F.) Total.	Elevation above sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
155	156	1·600	212·363	− 7·3632	+ 7·3622	− 7·3627	+1·0	−43·9	299·0596
156	157	1·390	213·753	+ 3·4549	− 3·4573	+ 3·4561	+2·4	−41·5	302·5157
157	158	1·391	215·144	+ 4·0287	− 4·0260	+ 4·0274	−2·7	−44·2	306·5431
158	159	2·399	217·543	+ 2·6242	− 2·6232	+ 2·6237	−1·0	−45·2	309·1668
159	160	1·374	218·917	+ 1·6600	− 1·6633	+ 1·6616	+3·3	−41·9	310·8284
160	C_2	0·320	219·237	+ 3·1930	− 3·1952	+ 3·1941	+2·2	−39·7	314·0225
160	161	1·458	220·375	+ 5·5599 + 5·5671	− 5·5667 − 5·5634	+ 5·5642	+1·5	−40·4	316·3926
161	D_2	1·751	222.126	− 7·5947	+ 7·5953	− 7·5950	−0·6	−41·0	308·7976
D_2	162	0·822	222·948	+ 0·4687	− 0·4683	+ 0·4685	−0·4	−41·4	309·2661
162	E_2	2·195	225·143	− 2·6673	+ 2·6676	− 2·6674	−0·3	−41·7	306·5987
E_2	163	0·939	226·082	+ 6·6639	− 6·6625	+ 6·6632	−1·4	−43·1	313·2619
163	164	1·710	227·792	+ 7·7923	− 7·7958	+ 7·7940	+3·5	−39·6	321·0559
164	165	1·630	229·422	− 5·7985	+ 5·8009	− 5·7997	−2·4	−42·0	315·2562
165	F_2	1·872	231·294	−10·2652	+10·2643	−10·2648	+0·9	−41·1	304·9914
F_2	Sidney	0·504	231·798	−13·3205	+13·3197	−13·3201	+0·8	−40·3	291·6713
Sidney	G_2	0·059	231·857	+ 1·7113	− 1·7111	+ 1·7112	−0·2	−40·5	293·3825
F_2	H_2	2·003	233·297	−11·8669	+11·8624	−11·8646	+4·5	−36·6	293·1268
H_2	166	1.937	235·234	− 2·8982 − 2·9054	+ 2·9058 + 2·8991	− 2·9021	−0·6	−37·2	290·2247
166	167	2·340	237·574	+ 4·3312	− 4·3329	+ 4·3320	+1·7	−35·5	294·5567
167	168	2·330	239·904	+ 5·7257	− 5·7248	+ 5·7252	−0·9	−36·4	300·2819
168	I_2	0·238	240·142	+ 0·2375	− 0·2377	+ 0·2376	+0·2	−36·2	300·5195
168	169	1·952	241·856	− 6·9934	+ 6·9937	− 6·9936	−0·3	−36·7	293·2883
169	J_2	2·060	243·916	− 8·5666	+ 8·5698	− 8·5682	−3·2	−39·9	284·7201
J_2	170	1·715	245·631	− 1·4875	+ 1·4888	− 1·4882	−1·3	−41·2	283·2319
170	K_2	1·932	247·563	− 9·2768	+ 9·2725	− 9·2746	+4·3	−36·9	273·9573
K_2	P. R. R.	1·637	249·200	−10·2165	+10·2180	−10·2172	−1·5	−38·4	263·7401
P. R. R.	L_2	0·434	249·634	+ 3·4851	− 3·4869	+ 3·4860	+1·8	−36·6	267·2261
L_2	171	1·667	251·301	− 2·1408	+ 2·1427	− 2·1418	−1·9	−38·5	265·0843
171	172	1·685	252·986	− 0·9447	+ 0·9499	− 0·9473	−5·2	−43·7	264·1370
172	173	0·860	253·846	− 0·8731	+ 0·8767	− 0·8749	−3·6	−47·3	263·2621
173	M_2	0·696	254·542	− 2·6351	+ 2·6369	− 2·6360	−1·8	−49·1	260·6261
M_2	174	1·138	255·680	− 3·1699	+ 3·1712	− 3·1706	−1·3	−50·4	257·4555
174	N_2	2·162	257·842	− 0·0913	+ 0·0858	− 0·0886	+5·5	−44·9	257·3669
N_2	175	1·645	259·487	− 3·1368	+ 3·1365	− 3·1366	+0·3	−44·6	254·2303
175	O_2	2·602	262·089	+ 0·3689	− 0·3682	+ 0·3686	−0·7	−45·3	254·5989
O_2	P_2	0·455	262·544	+ 1·7094	− 1·7095	+ 1·7094	+0·1	−45·2	256·3083
P_2	Troy	0·068	262·612	− 1·0248	+ 1·0251	− 1·0250	−0·3	−45·5	255·2833
O_2	Q_2	1·654	263·743	− 1·3064	+ 1·3112	− 1·3088	−4·8	−50·1	253·2901
Q_2	R_2	1·514	265·257	− 1·1793	+ 1·1791	− 1·1792	+0·2	−49·9	252·1109
R_2	S_2	1·904	267·161	− 4·4019	+ 4·4025	− 4·4022	−0·6	−50·5	247·7087
S_2	176	1·884	269·045	− 1·0074	+ 1·0090	− 1·0082	−1·6	−52·1	246·7005
176	177	1·990	271·035	− 0·7227	+ 0·7250	− 0·7238	−2·3	−54·4	245·9767
177	T_2	1·251	272·286	− 0·0660	+ 0·0695	− 0·0678	−3·5	−57·9	245.9089
T_2	U_2	0·098	272·384	− 1·7440	+ 1·7437	− 1·7438	+0·3	−57·6	244·1651

Bench mark. From	Bench mark. To	Distance between successive B. M's.	Distance from B. M. Gibraltar 1877.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B—F.) Partial.	Discrepancy (B—F.) Total.	Elevation above sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
T_2	178	1·299	273·585	— 2·8209	+ 2·8208	— 2·8208	+0·1	—57·8	243·0881
178	179	1·546	275·131	+ 0·0872	— 0·0827	+ 0·0850	—4·5	—62·3	243·1731
179	V_2	1·131	276·262	— 0·2227	+ 0·2220	— 0·2224	+0·7	—61·6	242·9507
V_2	180	1·038	277·300	— 2·9456	+ 2·9422	— 2·9439	+3·4	—58·2	240·0068
180	W_2	2·442	279·742	+ 1·0535	— 1·0539	+ 1·0537	+0·4	—57·8	241·0605
W_2	181	2·058	281·800	+ 0·5407	— 0·5421	+ 0·5414	+1·4	—56·4	241·6019
181	X_2	1·648	283·448	— 5·9092	+ 5·9112	— 5·9102	—2·0	—58·4	235·6917
X_2	182	1·858	285·306	— 0·2521	+ 0·2509	— 0·2515	+1·2	—57·2	235·4402
182	183	1·676	286·982	+ 0·4477	— 0·4500	+ 0·4488	+2·3	—54·9	235·8890
183	184	1·534	288·516	— 0·2738	+ 0·2755	— 0·2746	—1·7	—56·6	235·6144
184	Y_2	2·526	291·042	— 5·6369	+ 5·6361	— 5·6365	+0·8	—55·8	229·9779
Y_2	Z_2	3·214	294·256	— 3·1257	+ 3·1230	— 3.1244	+2·7	—53·1	226·8535
Z_2	Dayton	2·008	296·264	— 0·2109	+ 0·2093	— 0·2101	+1·6	—51·5	226·6434
Dayton	A_3	0·112	296·376	— 0·0903	+ 0·0900	— 0·0902	+0·3	—51·2	226·5532
Dayton	B_3	0·908	297·172	+ 0·1026	— 0·1030	+ 0·1028	+0·4	—51·1	226·7462
		Beginning of loop from Dayton to Hamilton.							
B_3	185	3·346	300·518	— 3·0623		— 3·0623			223·6839
185	C_3	1·223	301·741	— 1·7217		— 1·7217			221·9622
C_3	186	1·847	303·588	— 0·2356		— 0·2356			221·7266
186	187	1·711	305·299	— 2·4163		— 2·4163			219·3103
187	D_3	2·741	308·040	— 1·6366		— 1·6366			217·6737
D_3	E_3	3·732	311·772	— 4·4452		— 4·4452			213·2285
E_3	F_3	0·571	312·343	— 0·8367		— 0·8367			212·3918
F_3	188	1·830	314·173	+ 0·7158		+ 0·7158			213·1076
188	G_3	1·852	316·025	— 1·7009		— 1 7009			211·4067
G_3	189	3·305	319.330	+ 1·1508		+ 1·1508			212·5575
189	H_3	1·039	320·369	— 1·6624		— 1.6624			210·8951
H_3	I_3	3·791	324·160	— 0·9487		— 0·9487			209·9464
H_3	J_3	3·641	324·010	— 4·2976		— 4·2976			206·5975
J_3	K_3	4·194	328·204	— 6·0046		— 6·0046			200·5929
K_3	190	1·529	329·733	— 2·1613		— 2·1613			198·4316
190	L_3	1·427	331·160	— 2·4885		— 2·4885			195·9431
L_3	M_3	2·357	333·517	+ 7·1512		+ 7·1512			203·0943
L_3	N_3	4·475	335·635	— 3·0569		— 3·0569			192·8862
N_3	191	4·378	340·013	+ 3·0254		+ 3·0254			195·9116
191	O_3	2·030	342·043	— 2·3097		— 2.3097			193·6019
O_3	P_3	4·815	346·858	—11·4925		—11·4925			182·1094
P_3	Q_3	2·058	348·916	— 1·9972		— 1·9972			180·1122
Q_3	192	1·435	350·351	+ 0·2815		+ 0·2815			180·3937
192	Hamilton	0·346	350·697	+ 2·9292	— 2·9286	+ 2·9289	—0·6		183·3226
Hamilton	R_3	0·022	350·719	+ 1·1235	— 1·1235	+ 1·1235	0·0		184·4461
192	S_3	0·563	350·914	+ 1·2129		+ 1·2129		—42·1	181·6066
S_3	193	2·443	353·357	+ 4·4029		+ 4·4029			186·0095
193	194	2·814	356·171	+ 2·1650		+ 2·1650			188·1745
194	195	2·115	358·286	+ 0·7483		+ 0·7483			188·9228
195	T_3	1·495	359·781	— 0·9295		— 0·9295			187·9933
T_3	U_3	3·023	362·804	+ 4·0830		+ 4·0830			192·0763

Bench mark. From	Bench mark. To	Distance between successive B. M.'s.	Distance from B. M. Gibraltar 1877.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B—F.) Partial.	Discrepancy (B—F.) Total.	Elevation above sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
U_3	V_3	1·537	364·341	− 1·6479		− 1·6479			190·4284
V_3	196	3·161	367·502	+ 1·8522		+ 1·8522			192·2806
196	W_3	1·229	368·731	+ 2·2008		+ 2·2008			194·4814
W_3	197	2·366	371·097	+ 2·8179		+ 2·8179			197·2993
197	M_3	2·532	373·629	+ 5·7992		+ 5·7992			203·0985
M_3	198	4·459	378·088	+ 3·4041		+ 3·4041			206·5026
198	X_3	0·255	378·343	− 0·9073		− 0·9073			205·5953
X_3	199	2·144	380·487	− 0·1975		− 0·1975			205·3978
199	Y_3	1·836	382·323	+ 3·1700		+ 3·1700			208·5678
Y_3	I_3	1·046	383·369	+ 1·3757		+ 1·3757			209·9435
I_3	200	2·552	385·921	+ 2·0332		+ 2·0332			211·9767
200	Z_3	1·634	387·555	+ 2·5830		+ 2·5830			214·5597
Z_3	201	1·722	389·277	− 1·1292		− 1·1292			213·4305
201	202	2·128	391·405	+ 0·0215		+ 0·0215			213·4520
202	A_4	1·537	392·942	+ 1·4158		+ 1·4158			214·8678
A_4	B_4	1·168	394.110	+ 0·8083		+ 0·8083			215·6761
B_4	203	1·651	395·761	+ 2·5574		+ 2·5574			218·2335
203	C_4	1·937	397·698	− 1·4452		− 1·4452			216·7883
C_4	204	2·363	400·061	+ 3·3938		+ 3·3938			220·1821
204	D_4	1·022	401·083	− 0.1229		− 0·1229			220·0592
D_4	E_4	4·905	405·988	+ 4·4240		+ 4·4240			224·4832
E_4	205	2·154	408·142	+ 1·2959		+ 1·2959			225·7791
205	B_3	1·024	409.166	+ 0·9581		+ 0·9581			226·7372
		Close of loop from Dayton to Hamilton.					+9·0	−42·1	
		Beginning of loop from Hamilton to Cincinnati.							
S_3	F_4	3·583	356·752	+ 1·9316		+ 1·9316			183·5428
F_4	206	2·150	358·902	+ 3·9974		+ 3·9974			187·5402
206	G_4	2.372	361·274	+ 7·1742		+ 7·1742			194·7144
G_4	207	2·369	363·643	+ 9·3806		+ 9·3806			204·0950
207	H_4	3·566	367·209	− 6·9773		− 6·9773			197·1177
H_4	208	1·732	368·941	− 0·1464		− 0·1464			196·9713
208	I_4	3·099	372·040	−11·9480		−11·9480			185·0233
I_4	J_4	2·433	374·473	−10·3312		−10·3312			174·6921
J_4	K_4	3·129	377·602	−10·4604		−10·4604			164·2317
K_4	209	1·203	378·805	− 2·6900		− 2·6900			161·5417
209	L_4	0·526	379·331	+ 6·4744		+ 6·4744			168·0161
209	M_4	3·184	381·989	− 9·3521		− 9·3521			152·1896
M_4	210	1·658	383·647	− 0·3125		− 0·3125			151·8771
210	Geol.S.498	0·898	384·545	− 0·1491	+0·1480	− 0·1486	+1·1		151·7285
210	N_4	3·168	386·815	+ 0·7626		+ 0·7626			152·6397
N_4	211	2·849	389·664	− 2·3060		− 2·3060			150·3337
211	O_4	2·086	391·750	− 0·5344		− 0·5344			149·7993
O_4	Cin.	1·180	392·930	+ 3·8586		+ 3·8586			153·6579
Cin.	P_4	1·060	393·990	+12·4928	−12·4917	+12·4922	−1·1		166·1501
P_4	*Cin. No. 1	0·912	394·902	+ 0·3768	− 0·3767	+ 0·3768	−0·1	−32·8	166·5269
Cin. 1	Ref. mark	0·000	394·902	+ 1·6376	− 1·6378	+ 1·6377	+0·2		168·1646
Cin. 1	212	1·937	396·839	− 0·8367		− 0·8367			165·6902
212	213	1·139	397·978	+ 0·7370		+ 0·7370			166·4272

* Identical with T of transcontinental line of levels.

Bench mark. From	Bench mark. To	Distance between successive B. M's.	Distance from B. M. Gibraltar 1877.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B—F.) Partial.	Discrepancy (B—F.) Total.	Elevation above sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
213	211	1·225	399·203	−16·0930		−16·0930			150·3342
213	214	1·958	399·936	− 1·2644		− 1·2644			165·1628
214	Q_4	3·580	403·516	− 0·2389		− 0·2389			164·9239
Q_4	Geol. S. 498	0·832	404·348		+13·2009	−13·2009			151·7230
Q_4	215	1·606	405·122	+ 0·8720		+ 0·8720			165·7959
215	R_4	2·031	407·153	+ 1·2810		+ 1·2810			167·0769
R_4	S_4	2·955	410·108	+ 0·8866		+ 0·8866			167·9635
S_4	L_4	0·362	410·470	+ 0·0425		+ 0·0425			168·0060
S_4	T_4	3·950	414·058	+ 6·9564		+ 6·9564			174·9199
T_4	216	2·264	416·322	+ 2·2814		+ 2·2814			177·2013
216	217	2·324	418·646	+ 1·7246		+ 1·7246			178·9259
217	P. R. R. 17	1·690	420·336	− 4·1216		− 4·1216			174·8043
P.R.R. 17	P. R. R. 19	2·044	422·380	+ 1·6639		+ 1·6639			176·4682
P.R.R. 19	P. R. R. 20	2·624	425·004	+ 3·1228		+ 3·1228			179·5910
P.R.R. 20	P. R. R. 21	3·048	428·052	+ 2·0371		+ 2·0371			181·6281
P.R.R. 21	P. R. R. 23	3·380	431·432	+ 2·9139		+ 2·9139			184·5420
P.R.R. 23	P. R. R. 24	3·074	434·506	+ 2·2912		+ 2·2912			186·8332
P.R.R. 24	Pole 745	1·860	436·366	− 0·8859		− 0·8859			185·9473
Pole 745	218	1·655	438·021	− 1·5398		− 1·5398			184·4075
218	S_3	1·738	439·759	− 2·8056		− 2·8056			181·6019
		Close of loop from Hamilton to Cincinnati.					+9·3	−32·8	
Cin. No. 1	Y_4	0·740	397·204	+ 1·9932	− 1·9938	+ 1·9935	+0·6	−32·2	168·5248
Cin. No. 1	Z_4	1·808	398·272	−16·9840	+16·9824	−16·9832	+1·6	−30·6	149·5481
Z_4	Gauge	0·484	398·756	+ 0·2483	− 0·2483	+ 0·2483	0·0	−30·6	149·7964
O_4	U_4	0·387	396·851	+ 0·7104	− 0·7100	+ 0·7102	−0·4	−33·2	150·5138
U_4	A_5	1·076	397·927	+11·9326	−11·9325	+11·9326	−0·1	−33·3	162·4464
U_4	V_4	2·120	398·971	+ 3·1510	− 3·1518	+ 3·1514	+0·8	−32·4	153·6652
V_4	U. S. H.	0·071	399·042	− 1·4446	+ 1·4444	− 1·4445	+0·2	−32·2	152·2207
U. S. H.	Geol. Survey	0·996	400·038	− 2·4118	+ 2·4121	− 2·4120	−0·3	−32·5	149·8087
U. S. H.	219	2·605	401·647	− 2·5899	+ 2·5893	− 2·5896	+0·6	−31·6	149·6311
219	W_4	0·466	402·113	+ 1·0317	− 1·0319	+ 1·0318	+0·2	−31·4	150·6629
219	*266+93.5	1·238	402·885	− 1·6721	+ 1·6742	− 1·6732	−2·1	−33·7	147·9579
*266+93.5	*285+12.0	0·587	403·472	+ 0·0968	− 0·0975	+ 0·0972	+0·7	−33·0	148·0551
*285+12.0	119 ± of 1879	0·306	403·778	+ 0·0004	+ 0·0007	− 0·0002	−1·1	−34·1	148·0549
119 ± of 1879	220	1·680	405·458	+ 0·5021	− 0·5020	+ 0·5020	−0·1	−34·2	148·5569
220	118±of 1879	1·406	406·864	− 0·6134	+ 0·6127	− 0·6130	+0·7	−33·5	147·9439

*Refers to 100-feet stations, from Cincinnati depot, on C., C., C. & St. L. Ry., west end of South Side depot = Sta. 239+10.5.

Bench mark.		Distance between successive B. M's.	Distance from B. M. Gibraltar 1877.	Difference of elevation.			Discrepancy (B—F.)		Elevation above sea level.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
118 ± of 1879	X_4	1·978	408·842	+ 0·1066	− 0·1038	+ 0·1052	−2·8	−36·3	148·0491
X_4	221	1·149	409·991	+ 0·5302	− 0·5318	+ 0·5310	+1·6	−34·7	148·5801
221	117±of 1879	0·016	410·007	− 0·9250	+ 0·9252	− 0·9251	−0·2	−34·9	147·6550
221	LXV ± of 1879	2·218	412·209	+ 0·0187	− 0·0161	+ 0·0174	−2·6	−37·3	148·5975
LXV ± of 1879	222	0·729	412·938	+ 0·3309	− 0·3297	+ 0·3303	−1·2	−38·5	148·9278
222	B_5	2·616	415·554	+ 1·6330	− 1·6290	+ 1·6310	−4·0	−42·5	150·5588
B_5	223	0·370	415·924	− 1·3087	+ 1·3101	− 1·3094	−1·4	−43·9	149·2494
223	224	1·562	417·486	+ 0·4385	− 0·4412	+ 0·4398	+2·7	−41·2	149·6892
224	C_5	2·130	419·616	+ 0·1387	− 0·1391	+ 0·1389	+0·4	−40·8	149·8281
C_5	225	2·009	421·625	− 0·5202	+ 0·5209	− 0·5206	−0·7	−41·5	149·3075
225	226	2·281	423·906	− 0·6605	+ 0·6562	− 0·6584	+4·3	−37·2	148·6491
226	227	2·127	426·033	− 0·9528	+ 0·9573	− 0·9550	−4·5	−41·7	147·6941
227	D_5	1·446	427·479	− 0·6527	+ 0·6521	− 0·6524	+0·6	−41·1	147·0417
D_5	228	1·550	429·029	− 0·4111	+ 0·4089	− 0·4100	+2·2	−38·9	146·6317
228	U	2·225	431·254	+ 1·4155	− 1·4187	+ 1·4171	+3·2	−35·7	148·0488
U	E_5	0·578	431·832	− 0·6095	+ 0·6101	− 0·6098	−0·6	−36·3	147·4390

The three long loops were adjusted for errors of closure. The first loop, between bench marks 92 and U, 81·6 kilometres around, had an error of closure of −4·9 millimetres. It was broken into two loops by the bench mark R_1, which was common to the two sides of the loop. The closures of these separate loops were −1·3 millimetres and −3·6 millimetres. The second loop, 112·0 kilometres around, with an error of closure of +9·0 millimetres, had two cross lines, first from bench mark H_3 to I_3, and second from L_3 to M_3, thus furnishing eight observation equations with five unknown quantities. The third loop, 86·6 kilometres around, with an error of closure of +9·3 millimetres, had three cross lines, the first from bench mark 209 to S_4, the second from 210 to Q_4, and the third from 211 to 213, thus furnishing eleven observation equations with seven unknown quantities. The errors of closure of the small loops into which these two large loops were broken by the cross lines are much smaller than the closure for the whole loop. These last two loops were adjusted by least squares.

The following list shows the elevation of all permanent bench marks after the adjustment of all loops:

Bench mark.	Distance from Gibraltar 1877.	Elevation.	Approximate location.
	km.	*m.*	
Gibraltar 1877	0·0	177·5292	Gibraltar, Mich.
Gibraltar 2, 1875	0·1	178·2969	Do.
U. S. E. No. 1 of 1898	0·2	179·0778	Do.
A, Mich	7·8	178·9938	South Rockwood, Mich.
B, Mich	16·2	176·8788	Newport, Mich.
C, Mich	27·6	177·0811	Raisin River.
D, Mich	28·3	180·0394	Monroe, Mich.
E, Mich	38·3	177·4639	Lasalle Station, Mich.
F, Mich	43·8	179·4462	Vienna Station, or Erie, Mich.
U, Ohio	52·2	178·4259	Alexis, Ohio.
Toledo City 165, Ohio	58·2	181·7592	Toledo, Ohio.
U. S. E. △ Park, Ohio	59·3	183·1916	Do.
V, Ohio	60·9	179·5334	Do.
U. S. E. Power House	62·1	177·5786	Do.
W	62·3	184·0355	Do.
U. S. E. Post Office	62·4	183·6310	Do.
Toledo City 44	62·5	181·7443	Do.
Toledo City 296	61·3	179·9098	Do.
X	71·0	183·8039	Cooks Switch, Ohio.
Y	76·7	187·6339	Perrysburg, Ohio.
Z	81·4	197·3562	Roachton, Ohio.
A_1	87·7	201·2937	Hull Prairie, Ohio.
B_1	89·0	203·4847	Haskins, Ohio.
C_1	94·7	204·0351	Tontogany, Ohio.
D_1	104·0	208·3324	Weston, Ohio.
E_1	104·3	208·0564	Do.
Weston Village	104·3	207·8502	Do.
F_1	109·9	210·2259	Milton Center, Ohio.
G_1	112·2	212·3023	Custar, Ohio.
H_1	123·6	217·5073	Deshler, Ohio.
I_1	124·0	217·3317	Do.
J_1	128·9	224·6126	Belmore, Ohio.
K_1	135·9	233·4218	Leipsic, Ohio.
L_1	136·2	232·7426	Do.
M_1	142·5	226·6437	2½ miles north of Ottawa.
N_1	146·3	222·2673	Ottawa, Ohio.
O_1	152·3	227·4803	4 miles south of Ottawa.
P_1	157·4	234·9633	Columbus Grove, Ohio.
Q_1	157·5	236·4645	Do.
R_1	163·3	240·8886	Sycamore Run (1 mile north of).
S_1	167·6	248·2593	West Cairo, Ohio.
T_1	172·3	254·8966	Booses Viaduct.
U_1	177·3	267·9040	Lima, Ohio.
V_1	179·1	267·4097	Do.
Lima City	179·2	265·9637	Do.
W_1	186·9	264·8159	Little Haw Creek.
X_1	189·1	271·9626	Cridersville, Ohio.
Y_1	198·6	270·0478	Wapakoneta, Ohio.
Z_1	199·6	273·8302	Do.
A_2	203·5	279·1309	Bushada Creek.
B_2	211·2	306·2803	Botkins, Ohio.
C_2	219·2	314·0225	Anna, Ohio.
D_2	222·1	308·7976	Swanders, Ohio.
E_2	225·1	306·5987	Do.
F_2	231·3	304·9914	Sidney, Ohio.
Sidney City	231·8	291·6713	Do.
G_2	231.9	293·3825	Do.

Bench mark.	Distance from Gibraltar 1877.	Elevation.	Approximate location.
	km.	*m.*	
H_2	233.3	293·1268	Sidney, Ohio.
I_2	240·1	300·5195	Kirkwood, Ohio.
J_2	243·9	284·7201	2½ miles south of Kirkwood.
K_2	247·6	273·9573	1 mile above Piqua.
Penn. R. R., Piqua	249·2	263·7401	Piqua, Ohio.
L_2	249·6	267·2261	Do.
M_2	254·5	260·6261	Farrington, Ohio.
N_2	257·8	257·3669	2½ miles north of Troy.
O_2	262·1	254·5989	Troy, Ohio.
P_2	262·5	256·3083	Do.
Troy City	262·6	255·2833	Do.
Q_2	263·7	253·2901	Do.
R_2	265·3	252·1109	1 mile south of Troy.
S_2	267·2	247·7087	Feeder Lock (Canal).
T_2	272·3	245·9089	Tippecanoe City, Ohio.
U_2	272·4	244·1651	Do.
V_2	276·3	242·9507	Picayune Lock (Canal).
W_2	279·7	241·0605	Tadmor, Ohio.
X_2	283·4	235·6917	Poplar Creek.
Y_2	291·0	229·9779	Miami River bridge.
Z_2	294·3	226·8535	Mad River bridge.
Dayton City	296·3	226·6434	Dayton, Ohio.
A_3	296·4	226·5532	Do.
B_3	297·2	226·7462	Miami River bridge.
E_4	300·4	224·4918	2 miles south of Dayton.
C_3	301·7	221.9628	3 miles south of Dayton.
D_4	305·3	220·0671	Dwyers Station, Ohio.
D_3	308·0	217·6752	Whitfield, Ohio.
C_4	308·6	216·7957	Carrollton, Ohio.
B_4	312·0	215·6831	Miamisburg, Ohio.
E_3	312·0	213·2305	Do.
F_3	312·3	212·3938	Do.
A_4	313·4	214·8746	Do.
G_3	316·0	211·4092	2 miles south of Miamisburg.
Z_3	319·0	214·5658	2 miles north of Franklin.
H_3	319·0	210·8982	Carlisle, Ohio.
I_3	323·0	209·9490	Franklin, Ohio.
J_3	324·0	206·6016	Big Twin Creek.
Y_3	324·0	208·5730	Clear Creek.
K_3	328·0	200·5981	Poasttown, Ohio.
X_3	328·0	205·5994	3 miles north of Middletown.
L_3	331·9	195·9493	Heno, Ohio.
M_3	331·9	203·1013	Middletown, Ohio.
W_3	336·6	194·4845	Excello, Ohio.
N_3	336·6	192·8920	1 mile north of Trenton.
V_3	342·0	190·4319	Le Sourdsville, Ohio.
O_3	342·0	193·6070	1 mile south of Busenbark.
U_3	343·5	192·0800	Rockdale.
P_3	347·2	182·1143	Bridge over Miami River.
T_3	347·7	187·9972	Wooddale.
Q_3	350·2	180·1169	Old River, stone arch.
Hamilton City	352·0	183·3272	Hamilton, Ohio.
R_3	352·0	184·4507	Do.
S_3	353·2	181·6112	Do.
Penn. tel. pole 745	356·6	185·9566	1 mile south of Lindenwald.
F_4	356·8	183·5428	Do.
Penn. 24	358·4	186·8425	2 miles north of Flockton.
Penn. 23	361·3	184·5514	Flockton, Ohio.
G_4	361·3	194·7143	Fairsmiths, Ohio.
Penn. 21	364·2	181·6375	Port Union, Ohio.
Penn. 20	367·6	179·6004	Crescentville, Ohio.

Bench mark.	Distance from Gibraltar 1877.	Elevation.	Approximate location.
	km.	*m.*	
H_4	367·6	197·1175	Mulhauser, Ohio.
Penn. 19	370·2	176·4776	Crescentville, Ohio.
Penn. 17	372·2	174·8137	1½ miles south of Crescentville, Ohio.
I_4	372·2	185·0231	Glendale, Ohio.
J_4	374·5	174·6918	Park Place, Ohio.
T_4	378·2	174·9294	Lockland, Ohio.
K_4	378·2	164·2314	Hartwell, Ohio.
L_4	382·1	168·0156	Carthage, Ohio.
S_4	382·1	167·9730	Do.
R_4	383·8	167·0853	St. Bernard, Ohio.
M_4	383·8	152·1906	Ivorydale, Ohio.
Geological Survey 498	385·8	151·7301	Winton Place, Ohio.
Q_4	388·1	164·9309	Near Clifton Springs.
N_4	388·1	152·6427	Cumminsville, Ohio.
O_4	396·5	149·8036	Cincinnati, Ohio.
Cincinnati City	396·5	153·6623	Do.
P_4	396·5	166·1545	Do.
Cincinnati City No. 1 = T	396·5	166·5313	Do.
Reference mark to same	396·5	168·1690	Do.
Y_4	397·2	168·5248	Do.
Z_4	398.3	149·5481	Do.
U. S. Gauge B. M	398·8	149·7964	Do.
U_4	396·9	150·5138	Do.
A_5	397·9	162·4464	Do.
V_4	399·0	153·6652	Do.
U. S. H	399·0	152·2207	Do.
Geological Survey	400·0	149·8087	Sedamsville, Ohio.
W_4	402·1	150·6629	South Side, Ohio.
R. R. Stone Sta. 266 + 93·5	402·9	147·9579	Do.
R. R. Stone Sta. 285 + 12·0	403·5	148·0551	Do.
Old 119 ± of 1879	403·8	148·0549	Tell Cottage, Ohio.
Old 118 ± of 1879	406·9	147·9439	Trautman Sta., Ohio.
X_4	408·8	148·0491	St. Joseph, Ohio.
Old 117 ± of 1879	410·0	147·6550	Crescent, Ohio.
Old LXV ± of 1879	412·2	148·5975	Delhi, Ohio.
B_5	415·6	150·5588	Muddy Creek.
C_5 Ohio	419.6	149·8281	North Bend, Ohio.
D_5 Ohio	427.5	147·0417	Miami River.
U of 1879, Ind	431·3	148·0488	Lawrenceburg, Ind.
E_5 Ind	431·8	147.4390	Do.

The following list shows the elevation of the top of the rail at eighty-five places along the line. The elevation refers to the top of the rail in front of the depot unless otherwise stated.

Location.	Elevation of top of rail.
	Metres.
South Rockwood, Mich., Michigan Central R. R.	178·77
Newport, Mich., Michigan Central R. R.	180·96
Monroe, Mich., Michigan Central R. R.	178·78
La Salle, Mich., Michigan Central R. R.	179·62
Vienna Station, Mich., Michigan Central R. R.	178·31
Vienna Station, Mich., Lake Shore R. R.	178·28
Toledo, Ohio, intersection W. and L. E., and Ann Arbor (Manhattan Junction)	181·66
Toledo, Ohio, draw Pennsylvania R. R. bridge over Maumee	180·19
South of Toledo, intersection C., H. and D. spur and Miami street	188·72
Perrysburg, Ohio, C., H. and D. R. R.	191·35
Roachton, Ohio, C., H. and D. R. R.	196·49
Haskins, Ohio, C., H. and D. R. R.	202·58
Tontogany, Ohio, C., H. and D. R. R.	204·19
Weston, Ohio, C., H. and D. R. R.	208·25
Milton Center, Ohio, C., H. and D. R. R.	210·71
Custar, Ohio, C., H. and D. R. R.	212·05
Deshler, Ohio, crossing B. and O., and C., H. and D. R. R.	217·44
Belmore, Ohio, C., H. and D. R. R.	223·75
Leipsic, Ohio, C., H. and D. R. R.	232·14
Leipsic, Ohio, crossing N. Y., C. and St. L., and C., H. and D. R. R.	230·01
Leipsic, Ohio, crossing C., H. and D , and D. and L. N. R. R.	235·77
Ottawa, Ohio, crossing C., H. and D. R. R. and F., F. W. and W. R. R.	222·44
Ottawa, Ohio, crossing D. and L. N. R. R. and F., F. W. and W. R. R.	224·25
Columbus Grove, Ohio, C., H. and D. R. R.	234·29
Columbus Grove, Ohio, D. and L. N. R. R.	234·58
Columbus Grove, Ohio, crossing C., H. and D. R. R. and N. O. R. R.	235·63
Columbus Grove, Ohio, crossing D. and L. N. R. R. and N. O. R. R.	235·30
West Cairo, Ohio, C., H. and D. R. R.	248·80
Lima, Ohio, crossing D. and L. N. R. R. and L. E. and W. R. R.	267·11
Lima, Ohio, crossing C., H. and D. R. R. and P., F. W. and C. Rwy.	267·52
Lima, Ohio, crossing D. and L. N. R. R. and P., F. W. and C. Rwy.	263·65
Lima, Ohio, crossing C., H. and D. R. R. and C. and E. R. R.	268·03
Cridersville, Ohio, C., H. and D. R. R.	271·16
Wapakoneta, Ohio, C., H. and D. R. R.	272·26
Botkins, Ohio, C., H. and D. R. R.	306·82
Anna, Ohio, C., H. and D. R. R.	310·70
Swanders, Ohio, C., H. and D. R. R.	310·26
Sidney, Ohio, crossing C., H. and D. R. R. and C., C., C. and St. L. R. R.	298·91
Sidney, Ohio, C., H. and D. R. R.	305·56
Kirkwood, Ohio, C., H. and D. R. R.	300·25
Piqua, Ohio (one mile east), crossing Pennsylvania R. R. and C., H. and D. R. R.	275·39
Piqua, Ohio, Pennsylvania R. R.	265·66
Tadmor, Ohio, C., H. and D. R. R.	244·00
Dayton, Ohio, bridge No. 2 over Mad River	227·97
Dayton, Ohio, P., C., C. and St. L. R. R.	227·16
Dayton, Ohio, old Union depot C., H. and D. R. R.	225·43
Dayton, Ohio, new Union depot C., H. and D. R. R.	225·73
Whitfield, Ohio, C., H. and D. R. R.	218·24
Carrolton, Ohio, C., H. and D. R. R.	217·80
Miamisburg, Ohio, C., H. and D. R. R.	214·42
Miamisburg, Ohio, C., C., C. and St. L. R. R.	216·74
Carlisle, Ohio, crossing C., H. and D. R. R. and Cin. N. R. R.	210·67
Franklin, Ohio, C., C., C. and St. L. R. R.	210·56
Poasttown, Ohio, C., H. and D. R. R.	201·95
Middletown, Ohio, C., C., C. and St. L. R. R.	202·25
Middletown, Ohio, C., H. and D. R. R.	202·13
Trenton, Ohio, C., H. and D. R. R.	199·25

Location.	Elevation of top of rail.
	Metres.
Excello Mills, Ohio, C., H. and D. R. R	194·85
Le Sourdsville, Ohio, C., H. and D. R. R	191·81
Busenbark, Ohio, C., H. and D. R. R	196·26
Rockdale, Ohio, C., H. and D. R. R	193·06
Overpeck, Ohio, C., H. and D. R. R	192·24
Hamilton, Ohio, P., C., C. and St. L. R. R	181·52
Hamilton, Ohio, C., H. and D. R. R	181·42
Lindenwald, Ohio, C., H. and D. R. R	183·58
Jones, Ohio, C., H. and D. R. R	203·67
Crescentville, Ohio, Pennsylvania R. R	178·74
Crestvue, Ohio, C., H. and D. R. R	201·84
Glendale, Ohio, C., H. and D. R. R	193·39
Woodlawn, Ohio, C., H. and D. R. R	185·03
Wyoming, Ohio, C., H. and D. R. R	174·58
Hartwell, Ohio, C., H. and D. R. R	167·38
Carthage, Ohio, C., H. and D. R. R	160·24
Ivorydale, Ohio, C., H. and D. R. R	154·24
East Cumminsville, Ohio, C., C., C. and St. L. R. R	150·71
Cumminsville, Ohio, C., C., C. and St. L. R. R	154·85
Brighton, Ohio, C., C., C. and St. L. R. R	150·66
Stoors, Ohio, C., C., C. and St. L. R. R	149·52
Sedamsville, Ohio, C., C., C. and St. L. R. R	148·91
South Side, Ohio, C., C., C. and St. L. R. R	149·22
Tell Cottage, Ohio, C., C., C. and St. L. R. R	149·01
Trautmans, Ohio, C., C., C. and St. L. R. R	148·65
Fernbank, Ohio, C., C., C. and St. L. R. R	148.44
North Bend, Ohio, B. and O. S. W. R. R	149·25
Lawrenceburg, Ind., crossing B. and O. S. W. R. R. and C., C., C. and St. L. R. R	147·03

For descriptions of bench marks see pp. 653–667, Appendix No. 8.

$r'' = 0{\cdot}675\sqrt{\frac{\Sigma d^2}{4s}}$ in which r'' is the probable error of the mean result for a section between two bench marks, d is the discrepancy between the forward and backward measures, and s the number of sections.

$r = 0{\cdot}675\sqrt{\frac{\Sigma d^2}{4}}$ in which r is the probable error of the difference of elevation of end bench marks.

The probable error per kilometre of completed line =

$$r''\sqrt{\frac{1}{\text{average section in kilometres.}}}$$

The following table indicates the accuracy of the leveling:

Portion.	Length.	Number of sections.	Average length of section.	r'' = probable error per section.	Probable error per kilometre.	r = probable error between end B. M's.	Divergence on each portion.	$2r$.	Divergence per kilometre.
	km.		*km.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Gibraltar, Mich., to Leipsic, Ohio	137·456	99	1·39	±0·87	±0·74	± 8·6	−31·4	±17·2	−0·23
Leipsic, Ohio, to Lima, Ohio (loop)	40·786	25	1·63	......	......	......	− 4·9	......	−0·12
Lima, Ohio, to Dayton, Ohio	118·930	73	1·63	±0·86	±0·67	± 7·4	−14·8	±14·8	−0·12
Dayton, Ohio, to Hamilton, Ohio (loop)	55·997	25	2·24	......	......	......	+ 9·0	......	+0·16
Hamilton, Ohio, to Cincinnati, Ohio (loop)	43·295	18	2·34	......	......	......	+ 9·3	......	+0·21
Cincinnati, Ohio, to Lawrenceburg, Ind.	35·368	24	1·47	±0·71	±0·59	± 3·5	− 3·5	± 7·0	−0·10
Gibraltar, Mich., to Cincinnati, Ohio	396·464	240	1·65	±0·83	±0·65	±13·0	−32·8	±26·0	−0·09

In computing the probable error of the portion Gibraltar, Mich., to Cincinnati, Ohio, the probable error per kilometre over the portion covered by the three loops was taken to be the same as the mean over the three portions run in small sections. If it had been computed from the errors of closure of these loops it would have been considerably less.

If the divergence between the forward and backward lines is all due to accidental errors, the divergence on any portion of the line is equally liable to be greater than or less than $2r$. The table indicates that this condition is nearly fulfilled and therefore indicates that the constant errors are very small.

APPENDIX No. 8.

REPORT 1898-99.

PRECISE LEVELING IN THE UNITED STATES.

By JOHN F. HAYFORD, ASSISTANT,
Inspector of Geodetic Work and Chief of the Computing Division.

CONTENTS.

APPENDIX No. 8. 1898-99.

PRECISE LEVELING IN THE UNITED STATES.

By JOHN F. HAYFORD, *Inspector of Geodetic Work and Chief of the Computing Division.*

INTRODUCTION.

The fourfold purpose of this appendix is to bring the publication in detail of the results of precise leveling by the Coast and Geodetic Survey as nearly as possible up to date; to set forth the methods employed in making a general adjustment of the precise-level net covering the eastern half of the United States and involving leveling by other organizations as well as by the Coast and Geodetic Survey; to put into print in convenient form for ready reference a concise compilation of the corrected elevations resulting from this general adjustment; and, finally, to make available in form for general use, examination, and criticism the more important items of information and opinions in regard to precise leveling which have been acquired during the course of a long and careful investigation of the problem of making such an adjustment and of securing the highest degree of accuracy in future precise level observations consistent with a reasonable degree of economy and rapidity.

The greater portion of the precise leveling done by the Coast and Geodetic Survey has already been published in detail in the various annual reports. The results from certain lines which have not yet been published are here shown in detail,* namely, the lines between Vicksburg and Meridian, Miss., 236 kilometres, run in 1896–97; from Little Rock, Ark., to Holliday, Kans., via London, Van Buren, and Chester, Ark., Harrisonville, Mo., and Olathe, Kans., with branch lines to Fort Smith, Ark., and Pleasant Hill, Mo., 795 kilometres, run in 1888, 1889, 1891, 1893, and 1894; from Colorado Springs to Denver, Colo., 119 kilometres, and Limon to Denver, Colo., 146 kilometres, run in 1898; and the line between St. Augustine and Cedar Keys, Fla., 216 kilometres, run in 1892, 1893, and 1894. The results from the three lines run in 1899, namely, Denver, Colo., to Rock Creek, Wyo., 342 kilometres; Solomon and Abilene, Kans., to Norfolk, Nebr., 537 kilometres; Gibraltar, Mich., to Cincinnati, Ohio, and Lawrenceburg, Ind., 459 kilometres, are given in Appendices No. 5, No. 6, and No. 7 of this report. The combined length of the lines thus published for the first time in this report is 2 850 kilometres.

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* See pp. 353–398 of this report.

The first step toward making a general adjustment of the precise level net covering the eastern half of the United States was to collect in convenient form for reference the general results from all the precise leveling which is connected with said net. In doing this all the annual reports of the Coast and Geodetic Survey and of the Chief of Engineers published up to date (March, 1900) were examined carefully in detail. A general examination was also made of a large collection of other miscellaneous literature relating to precise levels, which is found scattered through various publications. The Corps of Engineers of the United States Army, the United States Geological Survey, the United States Board on Deep Waterways were then requested to cooperate by furnishing such unpublished data as to bring the collection as nearly as possible up to date. All these organizations responded with a heartiness and generosity which has increased very materially the value of this publication.* The Pennsylvania Railroad Company also responded to a similar request for cooperation by furnishing a copy of its official list showing the location and elevation of its permanent bench marks. The net proceeds of this compilation and correspondence were a collection of the general results from over 20 000 kilometres (over 12 000 miles) of spirit leveling and of 2 200 kilometres (nearly 1 400 miles) of accurate water levels, all, with the exception of the line across Florida, 216 kilometres (=134 miles), forming links of the precise level net, or spur lines attached to said net.†

These lines were run with a variety of instruments showing radical differences in design. The methods of observation have also differed radically. Unit lengths of these various lines are therefore presumably entitled to various weights according to the actual accuracy attained by the various instruments, methods and observers. Presumably, also, the errors involved in the measured differences of elevation on these various lines do not all belong to the accidental class, and it is therefore desirable to make as careful a search for systematic errors and the laws which they follow as is feasible; to eliminate such errors by applying special corrections if possible; and to pay due respect to the evidence in regard to uneliminated systematic errors in fixing the relation between the assigned weights and the lengths of the lines and in fixing the relative weights assigned to different classes of lines.

The lines along which the investigations of relative weights and of systematic errors have proceeded were suggested largely by the work of a committee of four appointed by the Superintendent on November 29, 1898, to consider the subject of precise levels and in particular to investigate "the accuracy of various methods, their relative freedom from systematic errors, and their relative quickness, cheapness, and facility for the reduction of the observations." ‡ This committee met for three or more hours on nearly every working day from that day until their report was submitted on February 9, 1899. The extensive compilation of facts made by this committee and included in their report has been used freely in the preparation of this appendix. The facts are here grouped in a different way, however, and presented in a more concise form, with a view to bringing out more clearly the relations between them. Much new material has become available since the committee made its report, and considerable time has been spent in

* See page 414 for further details as to these responses to requests for cooperation.

† See pp. 398-414 of this Report.

‡ This committee consisted of John F. Hayford, Expert Computer and Geodesist; Isaac Winston, Assistant; J. J. Gilbert. Assistant, and A. L. Baldwin, Assistant.

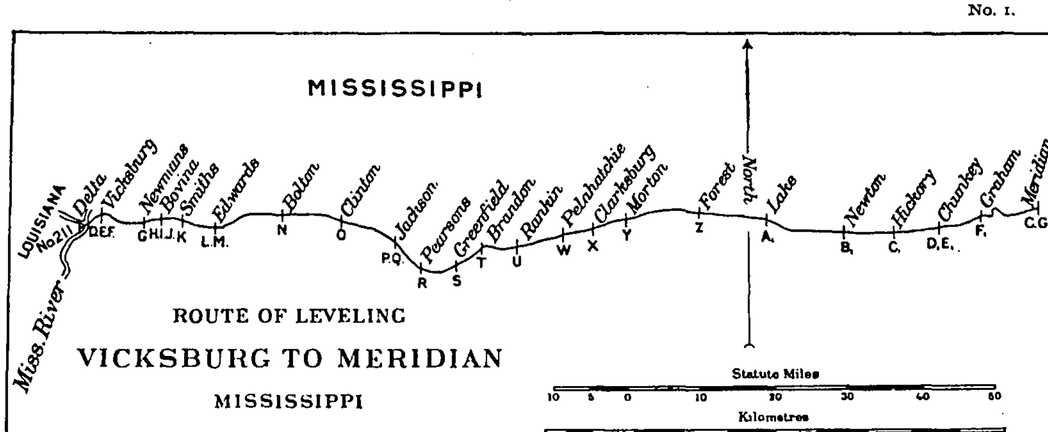
digesting the old material more thoroughly. In the following pages an attempt is made to exhibit clearly to the reader the inductive process which led from the recorded facts to the relative weights assigned in the final adjustment, to the form in which that adjustment was made, and to the changes in methods of observing and instruments made in 1899 and 1900.

The corrected elevations resulting from the general adjustment, of all bench marks of a permanent character connected with the level net, are given on pages 472–548 in the order in which the bench marks occur in passing along certain lines. The order in which the various lines are placed is somewhat arbitrary. Coast and Geodetic Survey lines run previous to 1899 are placed first; then the Coast and Geodetic Survey lines of 1899; lines by the United States engineers, including water levels along the Great Lakes; lines run by or in cooperation with the Deep Waterways Commission; the two lines run by C. H. Van Orden (formerly Assistant on Coast and Geodetic Survey) to Greenbush, N. Y.; the lines by the United States Geological Survey; and, finally, the Pennsylvania Railroad line from Harrisburg to the vicinity of Pittsburg. The corresponding descriptions of bench marks are placed in approximately the same order. The index to corrected elevations and descriptions of bench marks on pages 453–471 is arranged in alphabetic order under each State, the States being also placed in alphabetic order. Nearly all of the descriptions of bench marks established by other organizations than the Coast and Geodetic Survey have already been printed elsewhere, but are here reprinted to make them easily accessible.

VICKSBURG–MERIDIAN LINE.

The line of precise levels between Vicksburg and Meridian, Miss., as run by Isaac Winston, Assistant, between November 7, 1896, and February 5, 1897, using level No. 5* and the paraffined target rods P and Q.† The line began at bench mark 211 on the

No. 1.



Willow Glen Plantation, Madison Parish, La., crossed the Mississippi River to Vicksburg, and was continued eastward along the Alabama and Vicksburg Railroad to Meridian, Miss., as indicated by the accompanying route sketch. The total length of

*See pages 414–415 of this Report. †See page 415 of this Report.

the line is 236 kilometres (= 147 miles). It connects at its western end with the Coast and Geodetic Survey precise level line along the Mississippi River, and with the United States Engineer lines from Vicksburg westward to Shreveport, and from Vicksburg northward to Greenwood and Greenville. At its eastern end it connects with the Coast and Geodetic Survey precise level line between Biloxi, Miss., and Odin, Ill., and with the United States Engineer line from Meridian, Miss., to Demopolis and Birmingham, Ala. A simultaneous double line was run over the whole distance excepting the river crossing, using the programme of observation indicated on page 417. The river crossing, made between bench marks 494 metres apart, was made by taking simultaneous observations from opposite banks, using levels No. 5 and No. 6, on the forenoon of November 7, 1896. The lines of sight were from 3 to 4 metres above the surface of the water. After half the observations had been made the observers changed places, each taking his own instrument with him.

The lengths of the rods were determined at the Office of Standard Weights and Measures on October 30, 1896, just before the beginning of field work, and again on March 24, 1897, soon after the close of the season. The inequality of collars was determined at the beginning and end of the season. The corrections for length and temperature of rods, and for index errors of rods, as well as for the measured angle between the target and the horizon, for the inequality of collars, for curvature and for refraction, were applied in the Office computation.

The direct results of the leveling are shown in the following tabulation. The distances from B. M. F_1 at Biloxi are measured along the level line from Biloxi to Carrollton and New Orleans, and thence up the river to Vicksburg. The elevation of the top of the railroad rail was determined in front of eighteen railroad stations along the line, indicated thus in the tabulation R. R. S. (1), R. R. S. (2), etc. The names of these stations are given in the list following the tabulation, pages 360–361.

RESULTS OF SPIRIT LEVELING FROM VICKSBURG TO MERIDIAN, MISS.

[For approximate location of permanent bench marks see Sketch, p. 353.]

Bench marks.		Distance between successive bench marks.	Distance from bench mark F_1 at Biloxi.	Difference of elevation.			Discrepancy, P—Q.		Elevation above mean gulf level at Biloxi.*
From	To			Rod P.	Rod Q.	Mean of rods.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	211		685·429†						27·6085‡
211	7	·539	685·968	− 1·0999	− 1·1002	− 1·1000	+0·3	+0·3	26·5085
7	6	1·088	687·056	− 0·2420	− 0·2387	− 0·2404	−3·3	−3·0	26·2681
6	S.W.Base	1·009	688·065	+ 0·1908	+ 0·1932	+ 0·1920	−2·4	−5·4	26·4601
S. W. Base	5	·459	688·524	− 0·4133	− 0·4123	− 0·4128	−1·0	−6·4	26·0473
5	4	1·080	689·604	+ 0·8170	+ 0·8130	+ 0·8150	+4·0	−2·4	26·8623
4	N.E.Base	1·581	691·185	+ 0·8307	+ 0·8316	+ 0·8311	−0·9	−3·3	27·6934
N. E. Base	3	·890	692·075	− 6·6189	− 6·6210	− 6·6200	+2·1	−1·2	21·0734
3	a	1·024	693·099	− 4·9185	− 4·9185	− 4·9185	0·0	−1·2	16·1549
a	b	·494	693·593			− 0·3475			15·8074
b	1	·567	694·160	+10·9553	+10·9549	+10·9551	+0·4	−0·8	26·7625
1	B	·250	694·410	+ 3·0197	+ 3·0187	+ 3·0192	+1·0	+0·2	29·7817
B	2	·835	695·245	− 1·0770	− 1·0798	− 1·0784	+2·8	+3·0	28·7033

*See Appendix No. 9, Report for 1887, for discussion of tides at Biloxi, Miss., upon which these values depend.
†See Appendix No. 11, Report for 1888, and No. 9, Report for 1887. ‡See Appendix No. 11, Report for 1888, p. 443.

Results of spirit leveling from Vicksburg to Meridian, Miss.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark F_1 at Biloxi.	Difference of elevation. Rod P.	Difference of elevation. Rod Q.	Difference of elevation. Mean of rods.	Discrepancy, P—Q. Partial.	Discrepancy, P—Q. Total.	Elevation above mean gulf level at Biloxi.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
2	107	·582	695·827	— 2·0720	— 2·0729	— 2·0724	+0·9	+ 3·9	26·6309
2	A	·580	695·825	— 0·3010	— 0·3022	— 0·3016	+1·2	+ 4·2	28·4017
2	8	·776	696·021	+12·4065	+12·4054	+12·4060	+1·1	+ 4·1	41·1093
8	Cistern	1·084	697·105	+17·6650	+17·6670	+17·6660	—2·0	+ 2·1	58·7753
Cistern	9	·691	697·796	+ 1·1662	+ 1·1679	+ 1·1670	—1·7	+ 0·4	59·9423
9	C	·030	697·826	+ 2·5820	+ 2·5816	+ 2·5818	+0·4	+ 0·8	62·5241
9	D	·100	697·896	+ 0·0834	+ 0·0838	+ 0·0836	—0·4	0·0	60·0259
9	R. R. S. (1)	·097	697·893	— 0·1803		— 0·180			59·762
9	10	1·056	698·852	+ 7·3790	+ 7·3799	+ 7·3795	—0·9	— 0·5	67·3218
10	E	·741	699·593	+ 8·3935	+ 8·3926	+ 8·3930	+0·9	+ 0·4	75·7148
10	11	1·137	699·989	+11·2488	+11·2464	+11·2476	+2·4	+ 1·9	78·5694
11	F	·617	700·606	+ 1·3118	+ 1·3096	+ 1·3107	+2·2	+ 4·1	79·8801
11	12	1·169	701·158	— 4·3796	— 4·3837	— 4·3816	+4·1	+ 6·0	74·1878
12	13	1·102	702·260	— 4·5809	— 4·5808	— 4·5809	—0·1	+ 5·9	69·6069
13	14	1·104	703·364	— 7·2506	— 7·2488	— 7·2497	—1·8	+ 4·1	62·3572
14	15	·988	704·352	+10·4093	+10·4066	+10·4080	+2·7	+ 6·8	72·7652
15	R. R. S. (2)	·466	704·818	+ 4·1531		+ 4·1531			76·918
15	16	1·085	705·437	+11·2973	+11·2966	+11·2970	+0·7	+ 7·5	84·0622
16	17	1·184	706·621	+12·5036	+12·5054	+12·5045	—1·8	+ 5·7	96·5667
17	18	1·060	707·681	— 0·8236	— 0·8219	— 0·8228	—1·7	+ 4·0	95·7439
18	19	1·320	709·001	— 2·5806	— 2·5819	— 2·5813	+1·3	+ 5·3	93·1626
19	G	·494	709·495	+ 7·4635	+ 7·4641	+ 7·4638	—0·6	+ 4·7	100·6264
19	20	1·118	710·119	+ 0·2500	+ 0·2515	+ 0·2507	—1·5	+ 3·8	93·4133
20	21	1·196	711·315	— 9·7637	— 9·7656	— 9·7646	+1·9	+ 5·7	83·6487
21	33	1·723	713·038	—10·1866	—10·1904	—10·1885	+3·8	+ 9·5	73·4602
33	H	·073	713·111	+ 1·6099	+ 1·6097	+ 1·6098	+0·2	+ 9·7	75·0700
33	R. R. S. (3)	·121	713·159	+ 0·5995		+ 0·5995			74·0597
33	32	·758	713·796	— 6·6476	— 6·6484	— 6·6480	+0·8	+10·3	66·8122
32	31	1·114	714·910	— 9·0994	— 9·1005	— 9·1000	+1·1	—11·4	57·7122
31	I	1·133	716·043	—11·4980	—11·4962	—11·4971	—1·8	+ 9·6	46·2151
I	30	·076	716·119	+ 1·5729	+ 1·5742	+ 1·5736	—1·3	+ 8·3	47·7887
30	J	·444	716·563	—15·9090	—15·9122	—15·9106	+3·2	+11·5	31·8781
J	29	1·077	717·640	+ 6·3198	+ 6·3161	+ 6·3179	+3·7	+15·2	38·1960
29	28	1·145	718·785	— 0·8430	— 0·8408	— 0·8419	—2·2	+13·0	37·3541
28	K	1·017	719·802	+ 3·4177	+ 3·4173	+ 3·4175	+0·4	+13·4	40·7716
K	R. R. S. (4)	·255	720·057	— 0·5885		— 0·5885			40·183
K	27	·528	720·330	— 0·9748	— 0·9761	— 0·9754	+1·3	+14·7	39·7962
27	26	1·194	721·524	+ 2·9784	+ 2·9772	+ 2·9778	+1·2	+15·9	42·7740
26	25	1·193	722·717	*+1·3641	*+1·3697	+ 1·3669	—5·6	+10·3	44·1409

* Mean of two measures.

Results of spirit leveling from Vicksburg to Meridian, Miss.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark F1 at Biloxi.	Difference of elevation.			Discrepancy, P—Q.		Elevation above mean gulf level at Biloxi.
From	To			Rod P.	Rod Q.	Mean of rods.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
25	24	1·196	723·913	+4·5890	+4·5889	+ 4·5890	+0·1	+10·4	48·7299
24	23	1·194	725·107	+9·6566	+9·6592	+ 9·6579	−2·6	+ 7·8	58·3878
23	22	1·202	726·309	+9·1311	+9·1341	+ 9·1326	−3·0	+ 4·8	67·5204
22	R. R. S. (5)	·153	726·462	+0·4448		+ 0·4448			67·965
22	L	·038	726·347	+1·0907	+1·0911	+ 1·0909	−0·4	+ 4·4	68·6113
22	34	1·294	727·603	−1·7748	−1·7763	− 1·7756	+1·5	+ 6·3	65·7448
34	35	1·139	728·742	−6·2417	−6·2424	− 6·2420	+0·7	+ 7·0	59·5028
35	36	1·128	729·870	−4·2099	−4·2118	− 4·2108	+1·9	+ 8·9	55·2920
36	37	1·242	731·112	−1·6122	−1·6103	− 1·6113	−1·9	+ 7·0	53·6807
37	38	·404	731·516	+0·8874	+0·8880	+ 0·8877	−0·6	+ 6·4	54·5684
38	M	·112	731·628	−2·1297	−2·1298	− 2·1298	+0·1	+ 6·5	52·4386
38	39	1·180	732·696	+3·3161	+3·3123	+ 3·3142	+3·8	+10·2	57·8826
39	40	1·182	733·878	−0·3589	−0·3634	− 0·3612	+4·5	+14·7	57·5214
40	41	1·212	735·090	−1·9600	−1·9579	− 1·9589	−2·1	+12·6	55·5625
41	42	1·088	736·178	*+1·8459	*+1·8413	+ 1·8436	+4·6	+17·2	57·4061
42	43	1·176	737·354	+0·8615	+0·8592	+ 0·8604	+2·3	+19·5	58·2665
43	44	1·020	738·374	+1·3915	+1·3872	+ 1·3893	+4·3	+23·8	59·6558
44	N	·891	739·265	+2·2523	+2·2529	+ 2·2526	−0·6	+23·2	61·9084
N	45	·986	740·251	+2·0521	+2·0512	+ 2·0517	+0·9	+24·1	63·9601
45	R. R. S. (6)	·316		+2·0231		+ 2·0231			65·9832
45	46	1·179	741·430	+3·7492	+3·7454	+ 3·7473	+3·8	+27·9	67·7074
46	47	1·352	742·782	+1·6755	+1·6739	+ 1·6747	+1·6	+29·5	69·3821
47	48	1·162	743·944	+1·5611	+1·5589	+ 1·5600	+2·2	+31·7	70·9421
48	49	1·055	744·999	+2·5882	+2·5890	+ 2·5886	−0·8	+30·9	73·5307
49	50	1·216	746·215	+1·2934	+1·2944	+ 1·2939	−1·0	+29·9	74·8246
50	51	1·175	747·390	+3·2320	+3·2290	+ 3·2305	+3·0	+32·9	78·0551
51	52	1·161	748·551	+2·4129	+2·4137	+ 2·4133	−0·8	+32·1	80·4684
52	53	1·177	749·728	+6·8574	+6·8589	+ 6·8581	−1·5	+30·6	87·3265
53	54	1·005	750·733	+7·8974	+7·8988	+ 7·8981	−1·4	+29·2	95·2246
54	55	1·014	751·747	+2·7319	+2·7294	+ 2·7307	+2·5	+31·7	97·9553
55	56	·703	752·450	+3·0971	+3·0946	+ 3·0958	+2·5	+34·2	101·0511
56	R. R. S. (7)	·764	753·214	−2·2271		− 2·2271			98·8240
56	O	·112	752·562	−0·1102	−0·1098	− 0·1100	−0·4	+33·8	100·9411
56	57	1·158	753·608	−0·7078	−0·7099	− 0·7089	+2·1	+36·3	100·3422
57	58	1·253	754·861	+4·6394	+4·6488	+ 4·6441	−9·4	+26·9	104·9863
58	59	1·142	756·003	−1·0929	−1·0979	− 1·0954	+5·0	+31·9	103·8909
59	60	1·324	757·327	+5·7644	+5·7639	+ 5·7642	+0·5	+32·4	109·6551
60	61	1·179	758·506	+2·5395	+2·5416	+ 2·5405	−2·1	+30·3	112·1956
61	62	1·036	759·542	−3·6791	−3·6794	− 3·6792	+0·3	+30·6	108·5164
62	63	1·280	760·822	−7·4484	−7·4499	− 7·4492	+1·5	+32·1	101·0672
63	64	1·174	761·996	−3·1183	−3·1147	− 3·1165	−3·6	+28·5	97·9507
64	65	1·094	763·090	+4·1031	+4·1059	+ 4·1045	−2·8	+25·7	102·0552
65	66	1·087	764·177	−7·7194	−7·7190	− 7·7192	−0·4	+25·3	94·3360
66	67	1·186	765·363	−4·6199	−4·6249	− 4·6224	+5·0	+30·3	89·7136
67	68	·982	766·345	−1·3116	−1·3100	− 1·3108	−1·6	+28·7	88·4028
68	69	·981	767·326	+0·0428	+0·0393	+ 0·0411	+3·5	+32·2	88·4439

*Mean of two measures.

Results of spirit leveling from Vicksburg to Meridian, Miss.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark F1 at Biloxi.	Difference of elevation.			Discrepancy, P—Q.		Elevation above mean gulf level at Biloxi.
From	To			Rod P.	Rod Q.	Mean of rods.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
69	R. R. X. (8)	.773	768.099	−2.0743		− 2.0743			86.3696
69	70	.826	768.152	−2.8222	−2.8229	− 2.8225	+0.7	+32.9	85.6214
70	71	.705	768.857	−1.4639	−1.4652	− 1.4646	+1.3	+34.2	84.1568
71	P	.534	769.391	+6.2163	+6.2170	+ 6.2166	−0.7	+33.5	90.3734
71	72	1.150	770.007	−1.3489	−1.3520	− 1.3504	+3.1	+37.3	82.8064
72	Q	.040	770.047	+0.8523	+0.8526	+ 0.8524	−0.3	+37.0	83.6588
72	73	.506	770.513	*−1.4830	*−1.4818	− 1.4824	−1.2	+36.1	81.3240
73	74	1.164	771.677	−0.8403	−0.8396	− 0.8400	−0.7	+35.4	80.4840
74	75	1.301	772.978	+0.1125	+0.1089	+ 0.1107	+3.6	+38.1	80.5947
75	76	1.172	774.150	+0.7770	+0.7768	+ 0.7769	+0.2	+38.3	81.3716
76	77	1.196	775.346	+0.7170	+0.7180	+ 0.7175	−1.0	+37.3	82.0891
77	78	1.077	776.423	+4.7726	+4.7749	+ 4.7737	−2.3	+35.0	86.8628
78	R. R. S. (9)	.257	776.680	+0.2770		+ 0.2770			87.1398
78	79	.615	777.038	−2.0917	−2.0912	− 2.0915	−0.5	+34.5	84.7713
79	R	.182	777.220	+0.4200	+0.4204	+ 0.4202	−0.4	+34.1	85.1915
79	80	1.049	778.087	+3.0099	+3.0071	+ 3.0085	+2.8	+37.3	87.7798
80	81	1.150	779.237	−0.0196	−0.0217	− 0.0206	+2.1	+39.4	87.7592
81	82	1.049	780.286	−0.1832	−0.1816	− 0.1824	−1.6	+37.8	87.5768
82	83	1.197	781.483	+1.5464	+1.5447	+ 1.5456	+1.7	+39.5	89.1224
83	84	1.342	782.825	+4.0285	+4.0278	+ 4.0282	+0.7	+40.2	93.1506
84	85	1.154	783.979	−0.4632	−0.4672	− 0.4652	+4.0	+44.2	92.6854
85	86	1.046	785.025	+1.3982	+1.3965	+ 1.3973	+1.7	+45.9	94.0827
86	S	.182	785.207	+0.4035	+0.4026	+ 0.4030	+0.9	+46.8	94.4857
86	87	1.158	786.183	+1.9170	+1.9149	+ 1.9160	+2.1	+48.0	95.9987
87	88	1.328	787.511	+2.9891	+2.9878	+ 2.9884	+1.3	+49.3	98.9871
88	89	1.040	788.551	+1.4096	+1.4084	+ 1.4090	+1.2	+50.5	100.3961
89	90	1.115	789.666	+4.3635	+4.3603	+ 4.3619	+3.2	+53.7	104.7580
90	91	1.070	790.736	+8.8343	+8.8289	+ 8.8316	+5.4	+59.1	113.5896
91	T	1.194	791.930	+7.0495	+7.0480	+ 7.0487	+1.5	+60.6	120.6383
T	R. R. S. (10)	.144	792.074	+0.2491		+ 0.2491			120.8874
T	92	1.230	793.160	+6.2828	+6.2805	+ 6.2816	+2.3	+62.9	126.9199
92	93	1.185	794.345	+3.3522	+3.3500	+ 3.3511	+2.2	+65.1	130.2710
93	94	1.216	795.561	−5.1950	−5.1929	− 5.1939	−2.1	+63.0	125.0771
94	103	1.016	796.577	−7.0333	−7.0338	− 7.0336	+0.5	+63.5	118.0435
103	104	1.073	797.650	+2.2005	+2.1984	+ 2.1994	+2.1	+65.6	120.2429
104	105	1.119	798.769	+8.3823	+8.3834	+ 8.3829	−1.1	+64.5	128.6258
105	[illegible]	1.077	799.846	−0.1564	−0.1609	− 0.1586	+4.5	+69.0	128.4672

* Mean of two measures.

Results of spirit leveling from Vicksburg to Meridian, Miss.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark F_1 at Biloxi.	Difference of elevation. Rod P.	Difference of elevation. Rod Q.	Difference of elevation. Mean of rods.	Discrepancy, P – Q. Partial.	Discrepancy, P – Q. Total.	Elevation above mean gulf level at Biloxi.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
105	106	1·079	799·848	–0·6500	–0·6542	–0·6521	+4·2	+68·7	127·9737
106	107	1·036	800·884	+1·9567	+1·9589	+1·9578	–2·2	+66·5	129·9315
107	108	·945	801·829	–6·7910	–6·7914	–6·7912	+0·4	+66·9	123·1403
108	109	1·250	803·079	–4·3766	–4·3764	–4·3765	–0·2	+66·7	118·7638
109	110	1·144	804·223	–4·2182	–4·2179	–4·2180	–0·3	+66·4	114·5458
110	111	1·158	805·381	–6·0929	–6·0944	–6·0937	+1·5	+67·9	108·4521
111	112	1·272	806·653	–2·1335	–2·1342	–2·1338	+0·7	+68·6	106·3183
112	113	1·174	807·827	+5·3086	+5·3063	+5·3074	+2·3	+70·9	111·6257
113	114	1·117	808·944	–4·3456	–4·3432	–4·3444	–2·4	+68·5	107·2813
114	115	1·159	810·103	–1·9592	–1·9568	–1·9580	–2·4	+66·1	105·3233
115	95	·824	810·927	*+2·2552	*+2·2564	+2·2558	+1·2	+64·9	107·5791
95	W	·028	810·955	+1·4310	+1·4310	+1·4310	0·0	+64·9	109·0101
95	96	1·067	811·994	+4·8711	+4·8728	+4·8720	–1·7	+63·2	112·4511
96	97	1·232	813·226	+2·4228	+2·4225	+2·4226	+0·3	+63·5	114·8737
97	98	1·068	814·294	+2·4294	+2.4281	+2·4288	+1·3	+64·8	117·3025
98	99	1·390	815·684	+2·6533	+2·6558	+2·6545	–2·5	+62·3	119·9570
99	100	1·123	816·807	–7·6032	–7·6024	–7·6028	–0·8	+61·5	112·3542
100	X	·638	817·445	+0·5573	+0·5574	+0·5574	–0·1	+61·4	112·9116
X	R.R.S.(11)	·342	817·787	+2·1361		+2·1361			115·0477
X	101	1·046	818·491	+1·5064	+1·5061	+1·5062	+0·3	+61·7	114·4178
101	102	1·196	819·687	+2·2789	+2·2755	+2·2772	+3·4	+65·1	116·6950
102	116	1·150	820·837	+2·4569	+2·4567	+2·4568	+0·2	+65·3	119·1518
116	117	1·124	821·961	+5·0617	+5·0599	+5·0608	+1·8	+67·1	124·2126
117	118	1·192	823·153	+4·9936	+4·9915	+4·9926	+2·1	+69·2	129·2052
118	119	1·158	824·311	+9·8888	+9·8912	+9·8900	–2·4	+66·8	139·0952
119	Y	·440	824·751	–0·9298	–0·9284	–0·9291	–1·4	+65·4	138·1661
119	R.R.S.(12)	·597	824·908	+2·1960		+2·1960			141·2912
119	120	·991	825·302	+3·8946	+3·8995	+3·8970	–4·9	+61·9	142·9922
120	121	1·114	826·416	–2·6966	–2·6945	–2·6956	–2·1	+59·8	140·2966
121	122	1·212	827·628	–2·5734	–2·5762	–2·5748	+2·8	+62·6	137·7218
122	123	1·181	828·809	–4·1536	–4·1530	–4·1533	–0·6	+62·0	133·5685
123	124	1·260	830·069	+5·9194	+5·9172	+5·9183	+2·2	+64·2	139·4868
124	125	1·229	831·298	–3·1892	–3·1903	–3·1897	+1·1	+65·3	136·2971
125	126	1·209	832·507	+4·4595	+4·4549	+4·4572	+4·6	+69·9	140·7543
126	127	1·130	833·637	+7·2266	+7·2259	+7·2263	+0·7	+70·6	147·9806
127	128	1·464	835·101	+0·0041	+0·0027	+0·0034	+1·4	+72·0	147·9840
128	129	1·205	836·306	–2·0461	–2·0429	–2·0445	–3·2	+68·8	145·9395
129	130	1·415	837·721	–2·7144	–2·7189	–2·7167	+4·5	+73·3	143·2228
130	131	1·178	838·899	–4·2446	–4·2438	–4·2442	–0·8	+72·5	138·9786
131	132	1·171	840·070	+5·7602	+5·7581	+5·7591	+2·1	+74·6	144·7377
132	133	1·502	841·572	+1·5092	+1·5112	+1·5102	–2·0	+72·6	146·2479
133	134	·630	842·202	–3·3702	–3·3675	–3·3688	–2·7	+69·9	142·8791
134	Z	·184	842·386	+3·3945	+3·3922	+3·3934	+2·3	+72·2	146·2725
134	R.R.S.(13)	·113	842·315	+0·9545		+0·9545			143·8336
134	135	1·294	843·496	–5·8021	–5·7973	–5.7997	–4·8	+65·1	137·0794
135	136	1·271	844·767	–2·5273	–2·5302	–2·5288	+2·9	+68·0	134·5506

* Mean of two measures.

Results of spirit leveling from Vicksburg to Meridian, Miss.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark F_1 at Biloxi.	Difference of elevation.			Discrepancy, P—Q.		Elevation above mean gulf level at Biloxi.
From	To			Rod P.	Rod Q.	Mean of rods.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
136	137	1·174	845·941	+ 2·9546	+ 2·9543	+ 2·9544	+0·3	+68·3	137·5050
137	138	1·142	847·083	— 4·6574	— 4·6548	— 4·6562	—2·6	+65·7	132·8488
138	139	1·200	848·283	+ 1·8887	+ 1·8941	+ 1·8914	—5·4	+60·3	134·7402
139	140	·976	849·259	+ 1·2583	+ 1·2577	+ 1·2580	+0·6	+60·9	135·9982
140	141	1·046	850·305	— 5·6788	— 5·6788	— 5·6788	0·0	+60·9	130·3194
141	142	1·110	851·415	+ 7·2917	+ 7·2874	+ 7·2896	+4·3	+65·2	137·6090
142	143	1·284	852·699	— 7·1282	— 7·1303	— 7·1292	+2·1	+67·3	130·4798
143	144	1·169	853·868	*—0·3648	*—0·3670	— 0·3659	+2·2	+69·5	130·1139
144	145	1·046	854·914	— 1·1379	— 1·1394	— 1·1387	+1·5	+71·0	128·9752
145	146	1·176	856·080	+ 5·5606	+ 5·5595	+ 5·5600	+1·1	+72·1	134·5352
146	A_1	·034	856·114	+ 2·7283	+ 2·7281	+ 2·7282	+0·2	+72·3	137·2634
146	R.R.S.(14)	·182	856·262	+ 0·9539		+ 0·9539			135·4891
146	147	1·156	857·236	+ 5·9963	+ 5·9965	+ 5·9964	—0·2	+71·9	140·5316
147	148	1·146	858·382	+ 4·0978	+ 4·0993	+ 4·0986	—1·5	+70·4	144.6302
148	153	1·158	859·540	+ 4·0030	+ 4·0019	+ 4·0024	+1·1	+71·5	148·6326
153	156	1·036	860·576	— 8·1207	— 8·1201	— 8·1204	—0·6	+70·9	140·5122
156	157	1·114	861·690	— 0·3677	— 0·3691	— 0·3684	+1·4	+72·3	140·1438
157	158	1·108	862·798	— 6·9873	— 6·9880	— 6·9876	+0·7	+73·0	133·1562
158	159	1·232	864·030	+ 7·7693	+ 7·7669	+ 7·7681	+2·4	+75·4	140·9243
159	160	1·127	865·157	— 5·4183	— 5·4206	— 5·4195	+2·3	+77·7	135·5048
160	R.R.S.(15)	·232	865·389	+ 1·8864		+ 1·8864			137·3912
160	161	1·114	866·271	— 2·1416	— 2·1410	— 2.1413	—0·6	+77·1	133·3635
161	162	1·164	867·445	— 3·6290	— 3·6340	— 3·6315	+5·0	+82·1	129·7320
162	154	1·683	869·128	—10·1932	—10·1934	—10·1933	+0·2	+82·3	119·5387
154	155	1·235	870·363	+ 1·0958	+ 1·0932	+ 1·0945	+2.6	+84·9	120.6332
155	149	1·639	872·002	+ 4·5117	+ 4·5126	+ 4·5122	—0·9	+84·0	125·1454
149	R.R.S.(16)	·283	872·285	+ 0·5795		+ 0·5795			125·7249
149	B_1	·069	872·071	+ 3·7829	+ 3·7829	+ 3·7829	0·0	+84·0	128·9283
149	150	1·184	873·186	— 7·0870	— 7·0880	— 7·0875	+1.0	+85·0	118·0579
150	151	1·171	874·357	— 4·8952	— 4·8938	— 4·8945	—1·4	+83·6	113·1634
151	152	1·146	875·503	— 7·1971	— 7·1987	— 7·1979	+1·6	+85·2	105·9655
152	163	1·036	876·539	— 1.2010	— 1·1985	— 1·1998	—2·5	+82·7	104·7657
163	164	1·185	877·724	+ 0·0447	+ 0·0423	+ 0·0435	+2·4	+85·1	104·8092
164	165	1·106	878·830	— 3·0334	— 3·0337	— 3·0335	+0·3	+85·4	101·7757
165	168	1·052	879·882	— 1·1110	— 1·1105	— 1·1108	—0·5	+ 84·9	100·6649
168	169	1·248	881·130	— 1·4579	— 1·4571	— 1·4575	—0·8	+ 84·1	99·2074
169	170	1·305	882·435	— 1·0526	— 1·0489	— 1·0507	—3·7	+ 80·4	98·1567
170	171	1·195	883·630	— 0·6848	— 0·6809	— 0·6829	—3·9	+ 76·5	97·4738
171	166	1·393	885·023	+ 0·4281	+ 0·4290	+ 0·4285	—0·9	+ 75·6	97·9023
166	C_1	·059	885·082	+ 1·0205	+ 1·0208	+ 1·0206	—0·3	+ 75·3	98·9229
166	R.R.S.(17)	·213	885·236	+ 0·2110		+ 0·2110			98·1133
166	167	1·132	886·155	— 1·3602	— 1·3563	— 1·3582	—3·9	+ 71·7	96·5441
167	172	1·324	887·479	+ 0·3270	+ 0·3251	+ 0·3261	+1·9	+ 73·6	96·8702
172	173	1·198	888·677	*+0·0082	*+0·0099	+ 0·0090	—1·7	+ 71·9	96·8792
173	174	1·097	889·774	— 3·8123	— 3·8106	— 3·8115	—1·7	+ 70·2	93·0677
174	175	1·072	890·846	— 0·4621	— 0·4644	— 0·4632	+2·3	+ 72·5	92·6045

* Mean of two measures.

Results of spirit leveling from Vicksburg to Meridian, Miss.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark F_1 at Biloxi.	Difference of elevation. Rod P.	Difference of elevation. Rod Q.	Difference of elevation. Mean of rods.	Discrepancy, P—Q. Partial.	Discrepancy, P—Q. Total.	Elevation above mean gulf level at Biloxi.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
175	176	1·164	892·010	−0·5576	−0·5596	−0·5586	+2·0	+ 74·5	92·0459
176	177	1·215	893·225	−1·1787	−1·1814	−1·1801	+2·7	+ 77·2	90·8658
177	R.R.S. (18)	·946	894·171	+4·1429	·	+4·1429			95·0087
177	D_1	·984	894·209	+3·7277	+3·7238	+3·7258	+3·9	+ 81·1	94·5916
D_1	E_1	1·020	895·229	−4·2248	−4·2223	−4·2235	−2·5	+ 78·6	90·3681
E_1	178	1·095	896·324	−2·9250	−2·9239	−2·9245	−1·1	+ 77·5	87·4436
178	179	1·372	897·696	−1·4280	−1·4306	−1·4293	+2·6	+ 80·1	86·0143
179	180	1·180	898·876	−1·0301	−1·0284	−1·0292	−1·7	+ 78·4	84·9851
180	181	1·180	900·056	+0·1455	+0·1430	+0·1442	+2·5	+ 80·9	85·1293
181	182	1·235	901·291	+3·4403	+3·4413	+3·4408	−1·0	+ 79·9	88·5701
182	183	1·128	902·419	+1·7466	+1·7449	+1·7458	+1·7	+ 81·6	90·3159
183	184	1·196	603·615	+2·6562	+2·6551	+2·6556	+1·1	+ 82·7	92·9715
184	F_1	·478	904·093	+0·9035	+0·9036	+0·9036	−0·1	+ 82·6	93·8751
184	185	1·102	904·717	+2·8565	+2·8549	+2·8557	+1·6	+ 84·3	95·8272
185	186	1·274	905·991	+6·6937	+6·6912	+6·6925	+2·5	+ 86·8	102·5197
186	187	1·271	907·262	+9·2055	+9·2022	+9·2038	+3·3	+ 90·1	111·7235
187	G_1	·668	907·930	+6·4832	+6·4822	+ 6·4827	+1·0	+ 91·1	118·2062
187	188	1·005	908·267	+4·0423	+4·0384	+4·0404	+3·9	+ 94·0	115·7639
188	189	1·402	909·669	−9·1514	−9·1491	−9·1502	−2·3	+ 91·7	106·6137
189	190	1·144	910·813	+9·7206	+9·7175	+9·7190	+3·1	+ 94·8	116·3327
190	191	1·230	912·043	−8·7209	−8·7195	−8·7202	−1·4	+ 93·4	107·6125
191	192	1·297	913·340	−9·9773	−9·9805	−9·9789	+3·2	+ 96·6	97·6336
192	193	1·357	914·697	−9·1556	−9·1567	−9·1562	+1·1	+ 97·7	88·4774
193	194	1·288	915·985	+0·9138	+0·9109	+0·9124	+2·9	+100·6	89·3898
194	195	1·162	917·147	+3·3412	+3·3400	+3·3406	+1·2	+101·8	92·7304
195	196	1·158	918·305	+1·6726	+1·6753	+1·6739	−2·7	+ 99·1	94·4043
196	197	1·414	919·719	+1·6517	+1·6497	+1·6507	+2·0	+101·1	96·0550
197	198	·866	920·585	+0·8254	+0·8221	+0·8238	+3·3	+104·4	96·8788
198	C	·852	921·437	+7·4847	+7·4854	+7·4850	−0·7	+103·7	†104·3638

†See Appendix No. 10, Report for 1888, p. 417, for another determination of this elevation via Mobile, Ala.

Key to elevations of top of rail, indicated thus, R. R. S. (1), R. R. S. (2), *etc., in the preceding tabulation.*

[The elevations given in this list refer to the top of the railroad rail in front of the station named, unless otherwise stated.]

(1) Vicksburg (Alabama and Vicksburg passenger depot).
(2) Beachwood.
(3) Bovina.
(4) Smiths.
(5) Edwards.
(6) Bolton.
(7) Clinton.

(8) Jackson (crossing of Alabama and Vicksburg and Illinois Central railroads).
(9) Pearson.
(10) Brandon.
(11) Clarkesburg.
(12) Morton.
(13) Forest.
(14) Lake.
(15) Lawrence.
(16) Newton.
(17) Hickory.
(18) Chunkey.

LITTLE ROCK–HOLLIDAY LINE.

The long line from Little Rock, Ark., to Holliday, Kans., with its branches, was run in several sections in several different years by various observers. The section, 135 kilometres (=84 miles) long, from B. M. West Base near Little Rock westward along the railroad now known as the St. Louis, Iron Mountain and Southern to B. M. XX at London, Ark., was run by Isaac Winston, Subassistant; P. A. Welker, Subassistant, and Gershom Bradford, Assistant, between July 5 and September 30, 1888, using levels No. 2 and No. 3 and rods B, C, and D. The section, 132 kilometres (=82 miles) long, from B. M. XX at London, Ark., westward along the same railroad to B. M. XLII at Fort Smith, Ark., was run by Isaac Winston, Assistant; J. H. Gray, Subassistant, and F. A. Young, recorder, between July 24 and October 22, 1889, using levels No. 5 and No. 6 and rods L, M, N, and O. The remaining portions of this line, Little Rock to Holliday, were run by Isaac Winston, Assistant, using levels No. 5 and No. 6 and rods I and K. The section, 40 kilometres (=25 miles) long, from B. M. XXXVIII at Van Buren, Ark., on the London-Fort Smith line, northward along the St. Louis and San Francisco Railroad to B. M. XLIX at Chester, Ark., was run between October 13 and November 2, 1893. The section, 251 kilometres (=156 miles) long, from B. M. XCVI at Boston, Mo., southward along the Missouri Pacific Railroad to Carthage, Mo., and thence along the St. Louis and San Francisco Railroad to B. M. XLVIII at Chester, Ark., was run between June 22 and October 9, 1894. The section, 143 kilometres (=89 miles) long, from temporary B. M. 43 near Harrisonville, Mo., southward along the Missouri Pacific Railroad to B. M. XCVII at Boston, Mo., was run between July 14 and October 11, 1893. The section, 70 kilometres (=43 miles) long, from B. M. LXV at Olathe, Kans., southeastward along the Kansas City, Fort Scott and Memphis Railroad to Harrisonville, Mo., thence to Pleasant Hill, Mo., over the Missouri Pacific Railroad, was run between June 17 and July 28, 1893. The section, 19 kilometres (=12 miles) long, from B. M. LXIII at Holliday, Kans., southward along the Atchison, Topeka and Santa Fe Railroad to B. M. LXVII at Olathe, Kans., was run between October 5 and October 18, 1891. The programme of observations on all of these sections was substantially that given on page 417. On the sections Little Rock to London, London to Fort Smith, and Holliday to Olathe the line was run independently in the forward and backward directions. On the remaining sections a simultaneous double line was run. These various sections, with an aggregate length of 795 kilometres (=494 miles), connect the line Arkansas City, Ark., to Little Rock, Ark. (see Appendix No. 12 of the report for 1888, pp. 455–464), at Little Rock, with the transcontinental line of levels along the thirty-ninth parallel at Pleasant Hill, Mo., and Holliday, Kans. (See route sketch.)

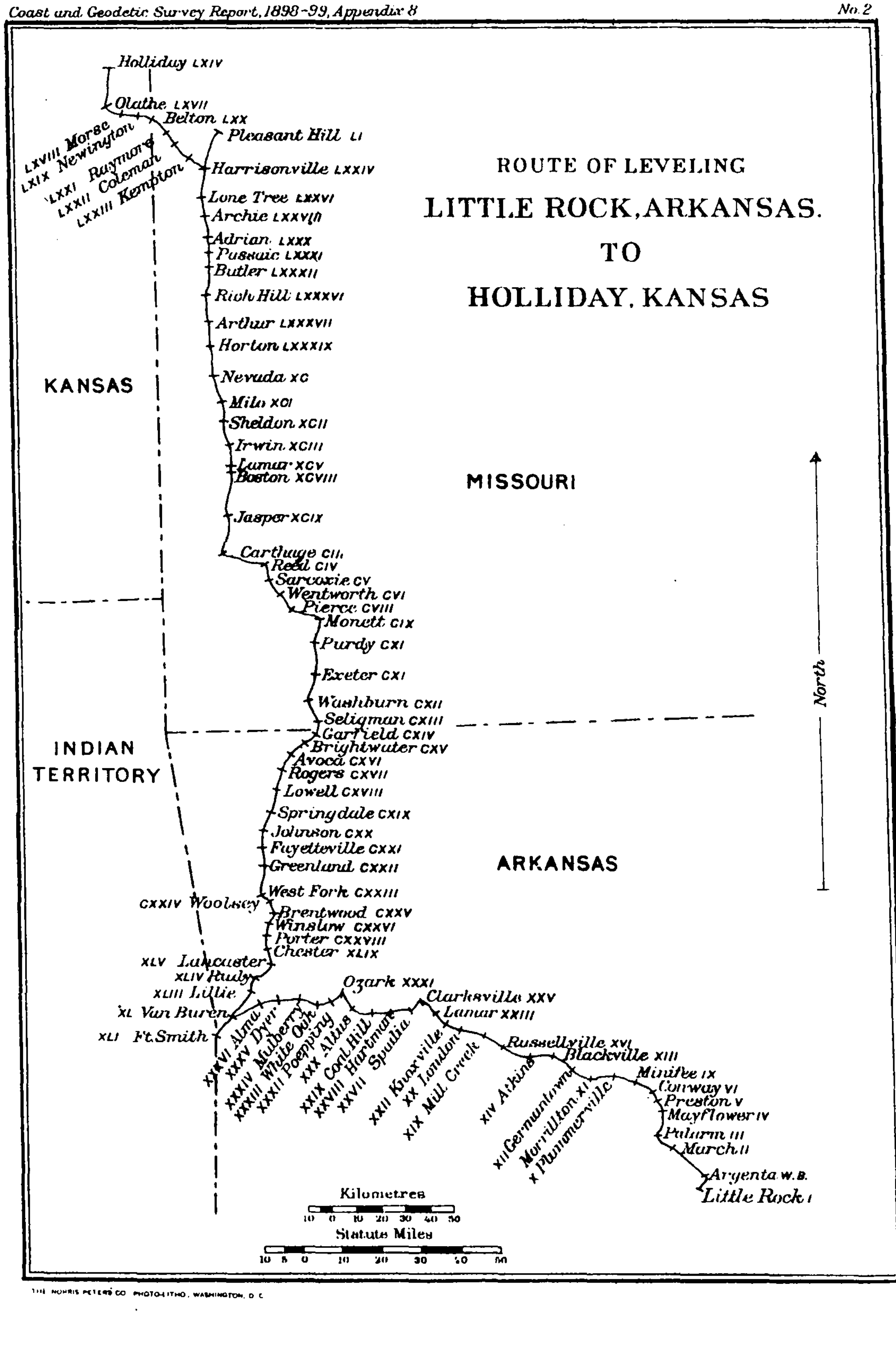
The direct results of the leveling are shown in the following tabulations. The corrections for length and temperature of rods and index error of rods, as well as for the measured angles between the target and the horizon, for the inequality of collars, for curvature, and for refraction, were applied in the Office computation whenever they were of sufficient magnitude to make it necessary to do so.

Results of spirit leveling from Little Rock to London, Ark.

[For approximate location of permanent bench marks, see sketch, opposite.]

Bench marks.		Distance between successive bench marks.	Distance from bench mark West Base.*	Difference of elevation.			Discrepancy (B−F).		Elevation above mean sea level.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	West Base								†77·7426
	1	·885	·885	+1·8542	−1·8562	+1·8552	+2·0	+2·0	79·5978
1	2	·846	1·731	−1·7000	+1·7023	−1·7012	−2·3	−0·3	77·8966
2	3	·986	2·717	+2·6760	−2·6755	+2·6758	−0·5	−0·8	80·5724
3	4	·925	3·642	−0·7718	+0·7711	−0·7714	+0·7	−0·1	79·8010
4	5	·973	4·615	+4·0894	−4·0928	+4·0911	+3·4	+3·3	83·8921
5	6	·976	5·591	−3·0007	+3·0006	−3·0006	+0·1	+3·4	80·8915
6	7	1·453	7·044	+12·2608	−12·2547	+12·2546	−2·7	+0·7	93·1461
				+12·2548	−12·2494				
				+12·2534	‡−12·2447				
				+12·2552	−12·2557				
7	I	·147	7·191	+2·7134	−2·7134	+2·7134	0·0	+0·7	95·8595
I	8	1·026	8·217	−6·9068	+6·9088	−6·9078	−2·0	−1·3	88·9517
8	9	·971	9·188	−9·1803	+9·1795	−9·1799	+0·8	−0·5	79·7718
9	10	·919	10·107	+6·9784	−6·9805	+6·9794	+2·1	+1·6	86·7512
10	11	·997	11·104	+11·5977	−11·5998	+11·5988	+2·1	+3·7	98·3500
11	12	·993	12·097	−4·5465	+4·5438	−4·5452	+2·7	+6·4	93·8048
12	13	·968	13·065	−8·5871	+8·5894	−8·5882	−2·3	+4·1	85·2166
13	14	·966	14·031	−0·5011	+0·5043	−0·5027	−3·2	+0·9	84·7139
14	15	·965	14·996	+5·0187	−5·0223	+5·0205	+3·6	+4·5	89·7344
15	16	1·289	16·285	−8·4581	+8·4632	−8·4618	−7·3	−2·8	81·2726
					+8·4676				
16	II	·069	16·354	+0·2838	−0·2836	+0·2837	−0·2	−3·0	81·5563
16	17	·955	17·240	−3·6825	+3·6850	−3·6838	−2·5	−5·3	77·5888
17	18	·835	18·075	+3·6037	−3·6057	+3·6047	+2·0	−3·3	81·1935
18	19	·854	18·929	−1·1675	+1·1642	−1·1658	+3·3	0·0	80·0277
19	20	·934	19·863	+2·8737	−2·8706	+2·8722	−3·1	−3·1	82·8999
20	21	1·006	20·869	+3·2731	−3·2795	+3·2740	+3·9	+0·8	86·1739
				+3·2709	−3·2723				
21	22	·957	21·826	+7·9349	−7·9374	+7·9362	+2·5	+3·3	94·1101
22	23	·943	22·769	−9·9105	+9·9120	−9·9112	−1·5	+1·8	84·1989
23	24	·895	23·664	−2·6372	+2·6366	−2·6369	+0·6	+2·4	81·5620
24	25	·901	24·565	+10·6659	−10·6677	+10·6668	+1·8	+4·2	92·2288
25	26	·882	25·447	−10·6770	+10·6761	−10·6766	+0·9	+5·1	81·5522
26	27	·920	26·367	−0·1794	+0·1804	−0·1799	−1·0	+4·1	81·3723
27	28	·338	26·705	+0·2711	−0·2725	+0·2718	+1·4	+5·5	81·6441
28	III	·086	26·791	+0·2848	−0·2849	+0·2848	+0·1	+5·6	81·9289

* At Argenta, Ark. † See Coast and Geodetic Survey Report 1888, p. 462. ‡ Rejected.



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Results of spirit leveling from Little Rock to London, Ark.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark West Base	Difference of elevation.			Discrepancy (B–F).		Elevation above mean sea level.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
28	29	1·042	27·747	+ 0·7667	− 0·7701	+ 0·7684	+3·4	+ 8·9	82·4125
29	30	·953	28·700	+12·1175	−12·1199	+12·1187	+2·4	+11·3	94·5312
30	31	·989	29·689	− 4·7729	+ 4·7775	− 4·7752	−4·6	+ 6·7	89·7560
31	32	·992	30·681	+ 0·1660	− 0·1648	+ 0·1654	−1·2	+ 5·5	89·9214
32	33	·952	31·633	− 4·1276	+ 4·1282	− 4·1279	−0·6	+ 4·9	85·7935
33	34	·942	32·575	+ 0·0951	− 0·0928	+ 0·0940	−2·3	+ 2·6	85·8875
34	IV	·368	32·943	+ 1·3145	− 1·3133	+ 1·3139	−1·2	+ 1·4	87·2014
IV	35	·817	33·760	− 3·4656	+ 3·4574	− 3·4619	+3·4	+ 4·8	83·7395
				− 3·4617	+ 3·4631				
35	36	·996	34·756	+ 2·1214	− 2·1229	+ 2·1222	+1·5	+ 6·3	85·8617
36	37	1·010	35·766	− 2·0425	+ 2·0481	− 2·0456	−2·5	+ 3·8	83·8161
				− 2·0461	+ 2·0455				
37	38	1·005	36·771	+ 3·7631	− 3·7642	+ 3·7636	+1·1	+ 4·9	87·5797
38	39	·983	37·754	+ 5·8679	− 5·8643	+ 5·8661	−3·6	+ 1·3	93·4458
39	40	1·017	38·771	− 2·5375	+ 2·5387	− 2·5381	−1·2	+ 0·1	90·9077
40	41	1·002	39·773	− 2·5735	+ 2·5775	− 2·5755	−4·0	− 3·9	88·3322
41	42	·993	40·766	− 5·5078	+ 5·5087	− 5·5082	−0·9	− 4·8	82·8240
42	V	·062	40·828	+ 0·8861	− 0·8863	+ 0·8862	+0·2	− 4·6	83·7102
42	43	·953	41·719	+ 6·8696	− 6·8680	+ 6·8688	−1·6	− 6·4	89·6928
43	44	·944	42·663	− 2·6209	+ 2·6231	− 2·6220	−2·2	− 8·6	87·0708
44	45	1·204	43·867	− 5·2780	+ 5·2830	− 5·2805	−5·0	−13·6	81·7903
45	46	1·097	44·964	+ 5·4529	− 5·4563	+ 5·4546	+3·4	−10·2	87·2449
46	47	·960	45·924	+ 1·6730	− 1·6727	+ 1·6728	−0·3	−10·5	88·9177
47	48	·975	46·899	+ 3·1997	− 3·1981	+ 3·1989	−1·6	−12·1	92·1166
48	49	·952	47·851	+ 0·7798	− 0·7756	+ 0·7777	−4·2	−16·3	92·8943
49	VI	·613	48·464	+ 4·4338	− 4·4349	+ 4·4344	+1·1	−15·2	97·3287
VI	50	·965	49·429	+ 0·2615	− 0·2589	+ 0·2602	−2·6	−17·8	97·5889
50	51	1·042	50·471	+ 6·7055	− 6·7043	+ 6·7049	−1·2	−19·0	104·2938
51	52	1·083	51·554	+12·1477	−12·1511	+12·1494	+3·4	−15·6	116·4432
52	53	1·012	52·566	+14·0307	−14·0343	+14·0346	+3·1	−12·5	130·4778
				+14·0354	−14·0379				
53	54	·989	53·555	− 3·3641	+ 3·3659	− 3·3650	−1·8	−14·3	127·1128
54	55	·905	54·460	− 5·8646	+ 5·8592	− 5·8619	+5·4	− 8·9	121·2509
55	56	·955	55·415	− 7·8650	+ 7·8698	− 7·8678	−2·5	−11·4	113·3831
				− 7·8680	+ 7·8681				
56	57	1·078	56·493	− 8·3846	+ 8·3811	− 8·3828	+3·5	− 7·9	105·0003
57	VII	·750	57·243	− 4·5839	+ 4·5883	− 4·5860	−1·9	− 9·8	100·4143
				− 4·5863	+ 4·5858				
VII	58	·915	58·158	− 8·1619	+ 8·1635	− 8·1627	−1·6	−11·4	92·2516
58	VIII	·789	58·947	− 6·1200	+ 6·1196	− 6·1198	+0·4	−11·0	86·1318
VIII	59	1·078	60·025	− 0·3448	+ 0·3481	− 0·3464	−3·3	−14·3	85·7854
59	60	·911	60·936	+ 3·6404	− 3·6413	+ 3·6408	+0·9	−13·4	89·4262
60	61	1·127	62·063	− 3·0665	+ 3·0629	− 3·0647	+3·6	− 9·8	86·3615
61	IX	·904	62·967	+ 0·5431	− 0·5400	+ 0·5416	−3·1	−12·9	86·9031
IX	62	·990	63·957	− 0·0394	+ 0·0355	− 0·0374	+3·9	− 9·0	86·8657
62	63	1·017	64·974	+ 0·1788	− 0·1737	+ 0·1752	−1·2	−10·2	87·0409
				+ 0·1728	− 0·1755				
63	64	·982	65·956	− 0·5279	+ 0·5269	− 0·5274	+1·0	− 9·2	86·5135
64	65	1·002	66·958	+ 1·0428	− 1·0392	+ 1·0410	−3·6	−12·8	87·5545
65	66	1·224	68·182	+ 0·3266	− 0·3302	+ 0·3284	+3·6	− 9·2	87·8829
66	67	1·165	69·347	− 0·7084	+ 0·7084	− 0·7084	0·0	− 9·2	87·1745
67	68	·997	70·344	− 0·4175	+ 0·4240	− 0·4200	−3·0	−12·2	86·7545
				− 0·4195	+ 0·4190				
68	69	1·014	71·358	+ 0·3530	− 0·3530	+ 0·3530	0·0	−12·2	87·1075

Results of spirit leveling from Little Rock to London, Ark.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark West Base.	Difference of elevation.			Discrepancy (B—F).		Elevation above mean sea level.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
69	X	·350	71·708	+ 1·7390	− 1·7374	+ 1·7382	−1·6	−13·8	88·8457
X	70	1·057	72·765	+ 1·4515	− 1·4532	+ 1·4524	+1·7	−12·1	90·2981
70	71	1·037	73·802	+ 7·9233	− 7·9262	+ 7·9248	+2·9	− 9·2	98·2229
71	72	·992	74·794	+ 9·1483	− 9·1451	+ 9·1467	−3·2	−12·4	107·3696
72	73	1·048	75·842	+ 7·6053	− 7·6011	+ 7·6032	−4·2	−16·6	114·9228
73	74	1·297	77·139	− 7·1062	+ 7·1054	− 7·1058	+0·8	−15·8	107·8670
74	75	1·519	78·658	+ 6·1811	− 6·1805	+ 6·1808	−0·6	−16·4	114·0478
75	76	1·095	79·753	+ 2·4764	− 2·4756	+ 2·4760	−0·8	−17·2	116·5238
76	77	1·054	80·807	− 3·0946	+ 3·0961	− 3·0954	−1·5	−18·7	113·4284
77	XI	·472	81·279	+ 4·5966	− 4·5910	+ 4·5920	−2·8	−21·5	118·0204
				+ 4·5903	− 4·5901				
XI	78	1·035	82·314	−10·8053	+10·8004	−10·8024	+4·8	−16·7	107·2180
				−10·8043	+10·7996				
78	79	1·201	83·515	− 2·9860	+ 2·9869	− 2·9864	−0·9	−17·6	104·2316
79	80	1·077	84·592	− 9·6039	+ 9·6042	− 9·6040	−0·3	−17·9	94·6276
80	81	1·351	85·943	+ 1·2050	− 1·2051	+ 1·2050	+0·1	−17·8	95·8326
81	82	2·497	88·440	− 5·1741	+ 5·1790	− 5·1766	−4·9	−22·7	90·6560
82	XII	1·166	89·606	+ 2·5679	− 2·5718	+ 2·5698	+3·9	−18·8	93·2258
XII	83	1·147	90·753	+ 0·7070	− 0·7023	+ 0·7046	−4·7	−23·5	93·9304
83	84	1·206	91·959	+ 4·9573	− 4·9593	+ 4·9583	+2·0	−21·5	98·8887
84	XIII	1·490	93·449	+ 0·1216	− 0·1230	+ 0·1223	+1·4	−20·1	99·0110
XIII	85	·996	94·445	+ 0·5320	− 0·5277	+ 0·5298	−4·3	−24·4	99·5408
85	86	·988	95·433	+ 0·1682	− 0·1669	+ 0·1676	−1·3	−25·7	99·7084
86	87	1·059	96·492	+ 0·2411	− 0·2387	+ 0·2399	−2·4	−28·1	99·9483
87	88	1·135	97·627	− 0·2206	+ 0·2177	− 0·2192	+2·9	−25·2	99·7291
88	89	1·076	98·703	+ 0·7001	− 0·7016	+ 0·7008	+1·5	−23·7	100·4299
89	90	·973	99·676	+ 1·0406	− 1·0445	+ 1·0426	+3·9	−19·8	101·4725
90	91	·968	100·644	− 1·6212	+ 1·6208	− 1·6210	+0·4	−19·4	99·8515
91	92	·954	101·598	+ 0·9963	− 0·9983	+ 0·9973	+2·0	−17·4	100.8488
92	XIV	1·208	102·806	+ 7·4589	*− 7·4477	+ 7·4590	0·0	−17·4	108·3078
				+ 7·4626	− 7·4583				
				+ 7·4556	− 7·4598				
XIV	93	1·050	103·856	+ 4·1580	− 4·1535	+ 4·1558	−4·5	−21·9	112·4636
93	94	1·183	105·039	+ 8·0449	− 8·0484	+ 8·0466	+3·5	−18·4	120·5102
94	95	1·130	106·169	+ 8·8455	− 8·8490	+ 8·8472	+3·5	−14·9	129·3574
95	96	1·090	107·259	− 4·3262	+ 4·3248	− 4·3255	+1·4	−13·5	125·0319
96	97	·986	108·245	− 5·4941	+ 5·4885	− 5·4913	+5·6	− 7·9	119·5406
97	98	1·005	109·250	+ 1·7858	− 1·7897	+ 1·7878	+3·9	− 4·0	121·3284
98	99	1·246	110·496	− 2·0636	+ 2·0621	− 2·0628	+1·5	− 2·5	119·2656
99	100	1·192	111·688	− 6·3964	+ 6·3974	− 6·3969	−1·0	− 3·5	112·8687
100	XV	1·344	113·032	+ 0·1260	− 0·1246	+ 0·1253	−1·4	− 4·9	112·9940
XV	101	·814	113·846	+ 0·9263	− 0·9288	+ 0·9276	+2·5	− 2·4	113·9216
101	102	1·024	114·870	+10·5604	−10·5689	+10·5631	+3·4	+ 1·0	124·4847
				+10·5604	−10·5625				
				+10·5634	−10·5631				
102	103	1·138	116·008	+12·5167	−12·5177	+12·5172	+1·0	+ 2·0	137·0019
103	104	1·240	117·248	− 6·6572	+ 6·6546	− 6·6559	+2·6	+ 4·6	130·3460
104	105	1·275	118·523	− 8·0744	+ 8·0727	− 8·0736	+1·7	+ 6·3	122·2724
105	106	1·094	119·617	− 6·5804	+ 6·5831	− 6·5818	−2·7	+ 3·6	115·6906
106	107	·978	120·595	− 0·7962	+ 0·7972	− 0·7967	−1·0	+ 2·6	114·8939
107	108	·982	121·577	− 7·7623	+ 7·7655	− 7·7639	−3·2	− 0·6	107·1300
108	XVI	·814	122·391	− 0·5322	+ 0·5364	− 0·5343	−4·2	− 4·8	106·5957
XVI	109	1·374	123·765	− 2·7640	+ 2·7638	− 2·7639	+0·2	− 4·6	103·8318
109	110	1·099	124·864	− 1·2832	+ 1·2816	− 1·2824	+1·6	− 3·0	102·5494
110	111	1·240	126·104	+ 1·4609	− 1·4590	+ 1·4600	−1·9	− 4·9	104·0094
111	XVII	1·034	127·138	+ 4·2889	− 4·2834	+ 4·2862	−5·5	−10·4	108·2956

*Rejected.

Results of spirit leveling from Little Rock to London, Ark.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark West Base.	Difference of elevation.			Discrepancy (B—F).		Elevation above mean sea level.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
XVII	112	1·160	128·298	− 9·0636	+ 9·0660	− 9·0648	−2·4	−12·8	99·2308
112	XVIII	·923	129·221	+ 0·4548	− 0·4532	+ 0·4540	−1·6	−14·4	99·6848
XVIII	113	1·228	130·449	+ 0·7463	− 0·7505	+ 0·7484	+4·2	−10·2	100·4332
113	XIX	·533	130·982	− 1·3297	+ 1·3324	− 1·3314	−0·5	−10·7	99·1018
				− 1·3325	+ 1·3309				
					*+1·3424				
XIX	114	·977	131·959	+ 7·7073	− 7·7057	+ 7·7065	−1·6	−12·3	106·8083
114	115	1·085	133·044	+10·0457	−10·0461	+10·0459	+0·4	−11·9	116·8542
115	116	1·037	134·081	+ 1·2864	− 1·2940	+ 1·2895	+3·2	− 8·7	118·1437
				+ 1·2887	− 1·2929				
				+ 1·2886	− 1·2863				
116	XX	1·254	135·335	− 2·5269	+ 2·5218	− 2·5244	+5·1	− 3·6	115·6193

*Rejected.

Results of spirit leveling from London to Fort Smith, Ark.

[For approximate location of permanent bench marks see sketch p. 362.]

Bench marks.		Distance between successive bench marks.	Distance from bench mark West Base.*	Difference of elevation.			Discrepancy (B—F).		Elevation above mean sea level.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.**	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	XX		135·335					− 3·6	115·6193
XX	1	·879	136·214	−10·6557†	+10·6281	−10·6236	− 5·5	− 9·1	104·9957
				−10·6378†	+10·6270				
				−10·6209	+10·6241				
1	2	1·080	137·294	− 3·5131	+ 3·5114	− 3·5122	+ 1·7	− 7·4	101·4835
2	3	1·070	138·364	+ 7·0312	− 7·0286	+ 7·0299	− 2·6	−10·0	108·5134
3	4	1·072	139·436	+ 8·9114	− 8·9057	+ 8·9086	− 5·7	−15·7	117·4220
4	5	1·076	140·512	− 3·8192	+ 3·8075	− 3·8111	+ 6·2	− 9·5	113·6109
				− 3·8179	+ 3·8122				
				− 3·7937†	+ 3·8044				
				− 3·8055	+ 3·7884†				
5	6	1·030	141·542	+ 3·4221	− 3·4180	+ 3·4200	− 4·1	−13·6	117·0309
6	7	1·060	142·602	− 9·9447	+ 9·9470	− 9·9458	− 2·3	−15·9	107·0851
					+ 9·9740†				
7	XXI	·448	143·050	− 4·1924	+ 4·1931	− 4·1928	− 0·7	−16·6	102·8923
XXI	8	1·221	144·271	+ 0·9134	− 0·9150	+ 0·9142	+ 1·6	−15·0	103·8065
8	9	1·364	145·635	− 0·5621	+ 0·5595	− 0·5599	− 2·2	−17·2	103·2466
				− 0·5866†	+ 0·5548				
				− 0·5555	+ 0·5575				
				− 0·5945†	+ 0·5722				
9	10	2·143	147·778	+ 9·5780	− 9·5829	+ 9·5804	+ 4·9	−12·3	112·8270
10	XXII	·827	148·605	+ 7·5419	− 7·5336	+ 7·5382	− 3·2	−15·5	120·3652
				+ 7·5376	− 7·5397				
XXII	11	1·129	149·734	+ 3·9923	− 3·9883	+ 3·9903	− 4·0	−19·5	124·3555
11	12	1·212	150·946	+ 2·5396	− 2·5408	+ 2·5402	+ 1·2	−18·3	126·8957
12	13	1·175	152·121	−10·5176	+10·5136	−10·5156	+ 4·0	−14·3	116·3801

* At Argenta, Ark.
** Total accumulated discrepancy in leveling from bench mark West Base, at Argenta.
† Rejected.

Results of spirit leveling from London to Fort Smith, Ark.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark West Base.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B—F). Partial	Discrepancy (B—F). Total.	Elevation above mean sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
13	14	1·377	153·498	−13·3043	+13·2949	−13·3030	+ 3·2	−11·1	103·0771
				−13·3121	+13·2936				
				−13·2994	+13·3035				
				−13·3027	+13·3137				
14	15	1·123	154·621	+ 3·0420	− 3·0387	+ 3·0404	− 3·3	−14·4	106·1175
15	16	1·321	155·942	+11·5194	−11·5071	+11·5150	−10·5	− 24·9	117·6325
				+11·5226	−11·5101				
				+11·5185	−11·5118				
16	17	·760	156·702	+ 4·5295	− 4·5347	+ 4·5285	+ 1·4	−23·5	122·1610
				+ 4·5260	− 4·5238				
17	XXIII	·088	156·790	+ 2·8835	− 2·8829	+ 2·8832	− 0·6	−24·1	125·0442
17	18	3·252	159·954	+12·9730	−12·9695	+12·9712	− 3·5	−27·0	135·1322
18	19	·895	160·849	+ 3·2569	− 3·2553	+ 3·2561	− 1·6	−28·6	138·3883
19	20	1·109	161·958	− 7·8771	+ 7·8763	− 7·8767	+ 0·8	−27·8	130·5116
20	21	1·088	163·046	− 4·9048	+ 4·8997	− 4·9012	+ 1·3	−26·5	125·6104
				− 4·8990	+ 4·9016				
21	XXIV	1·217	164·263	−11·2097	+11·2125	−11·2111	− 2·8	−29·3	114·3993
XXIV	22	1·133	165·396	− 1·4270	+ 1·4305	− 1·4288	− 3·5	−32·8	112·9705
22	XXV	·484	165·880	− 0·5061	+ 0·5055	− 0·5058	+ 0·6	−32·2	112·4647
XXV	XXVI	·049	165·929	− 0·3812	+ 0·3809	− 0·3810	+ 0·3	−31·9	112·0837
22	23	1·056	166·452	− 5·0512	+ 5·0476	− 5·0494	+ 3·6	−29·2	107·9211
23	24	1·166	167·618	− 2·8067	+ 2·8074	− 2·8070	− 0·7	−29·9	105·1141
24	25	1·115	168·733	− 0·2953	+ 0·2846	− 0·2932	+ 1·1	−28·8	104·8209
				− 0·2921	+ 0·3005				
25	26	1·093	169.826	− 0·0538	+*0·0463	− 0·0634	− 1·3	−30·1	104·7575
				− 0·0676	+ 0·0635				
				− 0·0667	+ 0·0646				
26	27	1·099	170·925	+*2·0070	− 2·0184	+ 2·0222	− 4·4	−34·5	106·7797
				+ 2·0244	− 2·0215				
27	28	2·264	173·189	+ 8·3845	− 8·3894	+ 8·3870	+ 4.9	−29·6	115·1667
28	XXVII	·140	173·329	− 0·1546	+ 0·1556	− 0·1551	− 0·8	−30·4	115·0116
28	29	2·179	175·368	+ 3·5858	− 3·5822	+ 3·5865	+ 1·4	−28·2	118·7532
29	30	1·073	176·441	+ 0·7985	− 0·7947	+ 0·7966	− 3·8	−32·0	119·5498
30	31	·880	177·321	− 0·2902	+ 0·2987	− 0·2970	− 1·1	−33·1	119·2528
				− 0·3027	+ 0·2963				
31	32	1·055	178·376	−*2·7078	+ 2·7193	− 2·7230	+ 3·3	−29·8	116·5298
				− 2·7247	+ 2·7235				
32	33	1·065	179·441	−*8·3710	+ 8·3809	− 8·3808	− 6·4	−36·2	108·1490
				− 8·3776	+ 8·3828				
				−*8·3951	+ 8·3884				
33	34	1·039	180·480	+ 0·4241	− 0·4121	+ 0·4194	− 6·1	−42·3	108·5684
				+ 0·4209	− 0·4206				
34	35	1·113	181·593	− 1·4684	+ 1·4726	− 1·4705	− 4·2	−46·5	107·0979
35	36	1·097	182·690	+ 1·6277	− 1·6259	+ 1·6268	− 1·8	−48·3	108·7247
36	37	·807	183·497	+ 8·5789	− 8·5790	+ 8·5790	+ 0·1	−48·2	117·3037
37	XXVIII	·151	183·648	+ 6·4073	− 6·4067	+ 6·4070	− 0·6	−48·8	123·7107
37	38	1·254	184·751	+ 7·4782	− 7·4769	+ 7·4776	− 1·3	−49·5	124·7813
38	39	1·235	185·986	+ 5·2086	− 5·2097	+ 5·2092	+ 1·1	−48·4	129·9905
39	40	1·081	187·077	+ 9·2105	− 9·2140	+ 9·2122	+ 3·5	−44·9	139·2027
40	XXIX	1·134	188·201	+ 5·2140	− 5·2236	+ 5·2169	+ 2·2	−42·7	144·4196
				+ 5·2177	− 5·2123				

* Rejected.

Results of spirit leveling from London to Fort Smith, Ark.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark, West Base.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B—F). Partial.	Discrepancy (B—F). Total.	Elevation above mean sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
XXIX	41	·709	188·910	+ 0·9953	− 0·9938	+ 0·9946	−1·5	−44·2	145·4142
41	43	2·237	191·147	+ 4·8615	− 4·8570	+ 4·8592	−4·5	−48·7	150·2734
43	44	1·084	192·231	+ 5·8328	− 5·8273	+ 5·8288	−3·9	−52·6	156·1022
				+ 5·8286	− 5·8262				
44	45	1·279	193·510	+ 0·4324	− 0·4365	+ 0·4344	+4·1	−48·5	156·5366
45	46	1·074	194·584	+ 6·1277	− 6·1354	+ 6·1341	+4·7	−43·8	162·6707
				+ 6·1358	− 6·1376				
46	47	1·072	195·656	− 1·6229	+ 1·6231	− 1·6230	−0·2	−44·0	161·0477
47	48	1·072	196·728	− 0·5877	+ 0·5914	− 0·5896	−3·7	−47·7	160·4581
48	XXX	·442	197·170	+ 4·8229	− 4·8207	+ 4·8218	−2·2	−49·9	165·2799
XXX	49	1·101	198·271	− 6·2778	+ 6·2805	− 6·2792	−2·7	−52·0	159·0007
49	50	1·100	199·371	− 6·3390	+ 6·3464	− 6·3427	−7·4	−66·9	152·6580
50	51	1·000	200·371	−13·7796	+13·7899	−13·7842	−9·2	−60·2	138·8738
				−13·7797	+13·7866				
					+13·7900				
51	52	1·351	201·722	− 9·9678	+ 9·9723	− 9·9672	−7·6	−76·8	128·9066
				− 9·9589	+ 9·9623				
					+ 9·9784				
52	53	1·082	202·804	− 8·8408	+ 8·8442	− 8·8425	−3·4	−80·2	120·0641
53	54	1·089	203·893	− 6·1199	*+6·1353	− 6·1230	−1·2	−81·4	113·9411
				− 6·1249	+ 6·1213				
					+ 6·1259				
54	55	·809	204·702	+ 1·2843	− 1·2839	+ 1·2841	−0·4	−81·8	115·2252
55	XXXI	·260	204·962	+ 6·5628	− 6·5639	+ 6·5634	+1·1	−80·7	121·7886
55	56	1·152	205·854	− 0·5815	+ 0·5734	− 0·5775	+5·0	−76·8	114·6477
				− 0·5785	+ 0·5765				
56	57	1·071	206·925	+ 1·2118	− 1·2089	+ 1·2078	+7·3	−69·5	115·8555
				+ 1·2020	− 1·2139				
				+ 1·1984					
57	58	1·071	207·996	+ 0·7972	− 0·8008	+ 0·7990	+3·6	−65·9	116·6545
58	59	1·070	209·066	− 0·2864	+ 0·2961	− 0·2922	−0·3	−66·2	116·3623
				− 0·2978	+ 0·2888				
59	60	1·114	210·180	− 1·2859	+ 1·2901	− 1·2880	−4·2	−70·4	115·0743
60	61	1·081	211·261	+ 0·6424	− 0·6470	+ 0·6447	+4·6	−65·8	115·7190
61	62	1·175	212·436	+ 0·3062	− 0·3010	+ 0·3036	−5·2	−71·0	116·0226
62	XXXII	·894	213·330	+ 0·6399	− 0·6398	+ 0·6398	−0·1	−71·1	116·6624
XXXII	63	2·115	215·445	+ 0·4523	− 0·4538	+ 0·4530	+1·5	−69·6	117·1154
63	64	1·086	216·531	− 0·4150	+ 0·4192	− 0·4171	−4·2	−73·8	116·6983
64	65	1·222	217·753	+ 0·4789	− 0·4752	+ 0·4770	−3·7	−77·5	117·1753
65	66	1·053	218·806	− 1·3761	+ 1·3715	− 1·3738	+4·6	−72·9	115·8015
66	67	1·104	219·910	+ 0·7036	− 0·6988	+ 0·7012	−4·8	−77·7	116·5027
67	68	1·171	221·081	+ 0·1672	− 0·1591	+ 0·1652	−7·8	−85·5	116·6679
				+ 0·1714	− 0·1627				
				+ 0·1686	− 0·1622				
68	XXXIII	·393	221·474	+ 4·0539	− 4·0564	+ 4·0552	+2·5	−83·0	120·7231
XXXIII	69	·918	222·392	+ 4·4413	− 4·4360	+ 4·4386	−5·3	−88·3	125·1617
69	70	1·053	223·445	− 7·7083	+ 7·7122	− 7·7102	−3·9	−92·2	117·4515
70	71	1·060	224·505	+ 9·7163	− 9·7224	+ 9·7167	+3·4	−88·8	127·1682
				+ 9·7137	− 9·7145				
71	72	1·055	225·560	− 6·5921	+ 6·5914	− 6·5918	+0·7	−88·1	120·5764
72	73	1·047	226·607	+ 4·1469	− 4·1444	+ 4·1456	−2·5	−90·6	124·7220
73	74	1·076	227·683	− 7·5263	+ 7·5171	− 7·5170	+1·0	−89·6	117·2050
				− 7·5087	+ 7·5159				
74	75	1·050	228·733	+ 0·2870	− 0·2889	+ 0·2880	+1·9	−87·7	117·4930

* Rejected.

Results of spirit leveling from London to Fort Smith, Ark.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark West Base.	Difference of elevation. Forward line.	Difference of elevation. Backward line.	Difference of elevation. Mean.	Discrepancy (B−F). Partial.	Discrepancy (B−F). Total.	Elevation above mean sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
75	XXXIV	1·050	229·783	− 0·3340	+ 0·3398	− 0·3369	−5·8	− 93·5	117·1561
XXXIV	76	1·061	230·844	+ 8·9576	− 8·9547	+ 8·9562	−2·9	− 96·4	126·1123
76	77	1·084	231·928	− 5·4247	+ 5·4220	− 5·4234	+2·7	− 93·7	120·6889
77	78	1·043	232·971	+ 3·6313	− 3·6234	+ 3·6274	−7·9	−101·6	124·3163
78	79	1·197	234·168	+ 2·9708	− 2·9737	+ 2·9722	+2·9	− 98·7	127·2885
79	80	1·187	235·355	− 7·3339	+ 7·3442	− 7·3367	−2·0	−100·7	119·9518
				− 7·3375	+ 7·3312				
80	81	1·106	236·461	+ 4·0907	− 4·0962	+ 4·0934	+5·5	− 95·2	124·0452
81	XXXV	·902	237·363	+ 6·6980	− 6·6936	+ 6·6958	−4·4	− 99·6	130·7410
XXXV	82	1·060	238·423	− 2·8863	+ 2·8892	− 2·8878	−2·9	−102·5	127·8532
82	83	1·047	239·470	+ 5·8838	− 5·8867	+ 5·8852	+2·9	− 99·6	133·7384
83	84	1·185	240·655	− 3·1610	+ 3·1575	− 3·1592	+3·5	− 96·1	130·5792
84	85	1·113	241·768	− 0·9878	+ 0·9863	− 0·9870	+1·5	− 94·6	129·5922
85	86	1·119	242·887	− 1·2396	+ 1·2376	− 1·2386	+2·0	− 92·6	128·3536
86	87	1·129	244·016	− 1·8030	+ 1·8016	− 1·8023	+1·4	− 91·2	126·5513
87	88	1·082	245·098	+ 4·1195	− 4·1183	+ 4·1189	−1·2	− 92·4	130·6702
88	XXXVI	·163	245·261	+ 1·8691	− 1·8678	+ 1·8684	−1·3	− 93·7	132·5386
88	89	1·078	246·176	− 2·7461	+ 2·7476	− 2·7468	−1·5	− 93·9	127·9234
89	90	1·262	247·438	+ 1·5887	− 1·5930	+ 1·5908	+4·3	− 89·6	129·5142
90	91	1·161	248·599	+14·0393	−14·0362	+14·0378	−3·1	− 92·7	143·5520
91	92	1·025	249·624	+ 4·5624	− 4·5681	+ 4·5655	−0·2	− 92·9	148·1175
				+ 4·5689	− 4·5628				
92	93	1·160	250·784	+ 1·1959	− 1·2039		−0·2	− 93·1	149·3192
				+ 1·2076	− 1·1994	+ 1·2017			
93	94	1·102	251·886	− 4·4991	+ 4·4897	− 4·4920	+0·4	− 92·7	144·8272
				− 4·4854	+ 4·4939				
94	95	1·231	253·117	− 5·8025	+ 5·7983	− 5·8004	+4·2	− 88·5	139·0268
95	96	·827	253·944	− 6·5987	+ 6·6006	− 6·5996	−1·9	− 90·4	132·4272
96	97	1·255	255·199	− 5·8085	+ 5·8073	− 5·8079	+1·2	− 89·2	126·6193
97	98	1·068	256·267	− 2·2351	+ 2·2329	− 2·2340	+2·2	− 87·0	124·3853
98	99	1·104	257·371	− 0·5025	+ 0·4994	− 0·5010	+3·1	− 83·9	123·8843
99	100	1·093	258·464	− 0·3058	+ 0·3038	− 0·3048	+2·0	− 81·9	123·5795
100	101	·919	259·383	− 0·4437	+ 0·4364	− 0·4387	+4·2	− 77·7	123·1408
				− 0·4378	+ 0·4369				
101	XXXVII	·054	259·433	+ 2·0382	− 2·0383	+ 2·0382	+0·1	− 77·6	125·1790
XXXVII	XXXVIII	·034	259·471	+ 1·0570	− 1·0569	+ 1·0570	−0·1	− 77·7	126·2360
101	XXXIX	·645	260·028	+ 3·0845	− 3·0907	+ 3·0884	+2·4	− 75·3	126·2292
				+ 3·0898	− 3·0885				
XXXIX	XL	·552	260·580	− 0·0443	+ 0·0424	− 0·0434	+1·9	− 73·4	126·1858
XL	102	1·031	261·611	+ 5·9239	− 5·9318	+ 5·9252	+7·1	− 66·3	132·1110
				+ 5·9194	− 5·9256				
102	103	1·064	262·675	+ 1·1903	*− 1·2046	+ 1·1906	+1·9	− 64·4	133·3016
				+ 1·1891	− 1·1894				
					− 1·1939				
103	104	1·064	263·739	+ 6·6572	− 6·6596	+ 6·6584	+2·4	− 62·0	139·9600
104	105	1·179	264·918	− 4·5118	+ 4·5067	− 4·5092	+5·1	− 56·9	135·4508
105	106	1·049	265·967	− 8·4281	+ 8·4216	− 8·4222	+2·2	− 54·7	127·0286
				− 8·4185	+ 8·4206				
106	107	1·086	267·053	− 0·9870	+ 0·9836	− 0·9853	+3·4	− 51·3	126·0433
107	108	1·274	268·327	+ 3·5636	− 3·5677	+ 3·5656	+4·1	− 47·2	129·6089
108	XLI	·292	268·619	+ 6·7787	− 6·7746	+ 6·7766	−4·1	− 51·3	136·3855
108	XLII	·106	268·433	+ 0·9854	− 0·9849	+ 0·9852	−0·5	− 47·7	130·5941

*Rejected.

Results of spirit leveling from Van Buren to Chester, Ark.

[For approximate location of permanent bench marks see sketch, p. 362.]

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark near Van Buren, Ark.	Difference of elevation. Rod I.	Difference of elevation. Rod K.	Difference of elevation. Mean.	Discrepancy (I—K). Partial.	Discrepancy (I—K). Total.	Elevation above mean sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	XXXVIII								*126·2360
XXXVIII	I	·298	·298	+ 0·4839	+ 0·4847	+ 0·4843	—0·8	— 0·8	126·7203
I	XXXIX	·294	·592	— 0·4917	— 0·4922	— 0·4920	+0·5	— 0·3	*126·2283
I	2	1·113	1·411	+ 8·2517	+ 8·2573	+ 8·2545	—5·6	— 6·4	134·9748
2	3	1·394	2·805	+ 5·1526	+ 5·1543	+ 5·1534	—1·7	— 8·1	140·1282
3	4	1·039	3·844	+ 5·2972	+ 5·2957	+ 5·2964	+1·5	— 6·6	145·4246
4	5	1·282	5·126	+ 0·1086	+ 0·1093	+ 0·1090	—0·7	— 7·3	145·5336
5	6	1·237	6·363	+ 8·4482	+ 8·4430	+ 8·4456	+5·2	— 2·1	153·9792
6	7	1·098	7·461	+ 6·0002	+ 5·9979	+ 5·9990	+2·3	+ 0·2	159·9782
7	8	1·430	8·891	—11·6331	—11·6319	—11·6325	—1·2	— 1·0	148·3457
8	9	1·723	10·614	— 5·9111	— 5·9083	— 5·9097	—2·8	— 3·8	142·4360
9	XLIII	·172	10·786	— 1·4726	— 1·4719	— 1·4722	—0·7	— 4·5	140·9638
XLIII	10	1·188	11·974	— 1·3057	— 1·3019	— 1·3038	—3·8	— 8·3	139·6600
10	11	1·438	13·412	+ 8·4797	+ 8·4844	+ 8·4820	—4·7	—13·0	148·1420
11	12	1·096	14·508	— 0·0982	— 0·0983	— 0·0982	+0·1	—12·9	148·0438
12	13	1·339	15·807	+ 3·2641	+ 3·2671	+ 3·2656	—3·0	—15·9	151·3094
13	14	1·335	17·182	+ 6·5094	+ 6·5090	+ 6·5092	+0·4	—15·5	157·8186
14	15	1·223	18·405	+ 8·9223	+ 8·9227	+ 8·9225	—0·4	—15·9	166·7411
15	XLIV	·405	18·810	— 3·2893	— 3·2881	— 3·2887	—1·2	—17·1	163·4524
XLIV	16	1·233	20·043	+ 7·3123	+ 7·3101	+ 7·3112	+2·2	—14·9	170·7636
16	17	1·323	21·366	+ 5·6188	+ 5·6178	+ 5·6183	+1·0	—13·9	176·3819
17	18	1·297	22·663	+ 7·9515	+ 7·9549	+ 7·9532	—3·4	—17·3	184·3351
18	XLV	·545	23·208	+ 0·9750	+ 0·9765	+ 0·9758	—1·5	—18·8	185·3109
XLV	19	1·145	24·353	+ 4·1393	+ 4·1364	+ 4·1378	+2·9	—15·9	189·4487
19	20	1·241	25·594	+ 3·6107	+ 3·6106	+ 3·6106	+0·1	—15·8	193·0593
20	21	1·322	26·916	+ 5·0953	+ 5·0924	+ 5·0938	+2·9	—12·9	198·1531
21	22	1·394	28·310	+ 4·1340	+ 4·1360	+ 4·1350	—2·0	—14·9	202·2881
22	23	1·056	29·366	+ 1·0480	+ 1·0516	+ 1·0498	—3·6	—18·5	203·3379
23	24	1·273	30·639	+ 8·0096	+ 8·0098	+ 8·0097	—0·2	—18·7	211·3476
24	XLVI	1·236	31·875	+ 0·1562	+ 0·1605	+ 0·1584	—4·3	—23·0	211·5060
XLVI	25	1·114	32·989	+ 4·0458	+ 4·0492	+ 4·0475	—3·4	—26·4	215·5535
25	26	1·587	34·576	+ 6·8208	+ 6·8240	+ 6·8224	—3·2	—29·6	222·3759
26	27	1·160	35·736	+ 2·8106	+ 2·8110	+ 2·8108	—0·4	—30·0	225·1867
27	28	1·168	36·904	+ 8·4748	+ 8·4769	+ 8·4758	—2·1	—32·1	233·6625
28	29	·911	37·815	+10·2572	+10·2561	+10·2566	+1·1	—31·0	243·9191
29	30	·863	38·678	+ 6·8840	+ 6·8867	+ 6·8854	—2·7	—33·7	250·8045
30	31	1·369	40·047	+ 5·9689	+ 5·9677	+ 5·9683	+1·2	—32·5	256·7728
31	XLVIII	·066	40·113	+ 0·6853	+ 0·6856	+ 0·6854	—0·3	—32·8	†257·4582
31	32	1·167	41·214	+ 9·1434	+ 9.1406	+ 9·1420	+2·8	—29·7	265·9148
30	XLVII	·135	38·813	— 1·1161	— 1·1159	— 1·1160	—0·2	—33·9	249·6885
XLVIII	XLIX	·049	40·162	— 1·1362	— 1·1361	— 1·1362	—0·1	—32·9	†256·3220

*Compare with elevations given for these bench marks on p. 368 of this Report.
†Compare with elevations given for these bench marks on p. 382 of this Report.

Results of spirit leveling from Holliday to Olathe, Kans.

[For approximate location of permanent bench marks see sketch, p. 362.]

Bench marks.		Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation.			Discrepancy (B—F).		Elevation above bench mark K_3 at St. Louis.
From	To			Forward line.	Backward line.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	LXII		481·460						*106·6442
LXII	LXIV	1·214	482·674	+4·8366	+4·8373	+4·8370	−0·7	−44·3	111·4812
LXIV	260	0·966	483·640	+0·2911	+0·2883	+0·2897	+2·8	−41·5	111·7709
260	261	0·896	484·536	+0·0521	+0·0504	+0·0512	+1·7	−39·8	111·8221
261	262	1·027	485·563	+4·4217	+4·4249	+4·4233	−3·2	−43·0	116·2454
262	263	1·214	486·777	+1·6253	+1·6187	+1·6220	+6·6	−36·4	117·8674
263	264	0·940	487·717	+1.3008	+1·3041	+1·3024	−3·3	−39·7	119·1698
264	265	0·751	488·468	+2·7835	+2·7790	+2·7812	+4·5	−35·2	121·9510
265	266	0·910	489·378	+4·5400	+4·5428	+4·5414	−2·8	−38·0	126·4924
266	267	1·016	490·394	+3·4310	+3·4294	+3·4302	+1·6	−36·4	129·9226
267	268	1·064	491·458	+4·8930	+4·8918	+4·8924	+1·2	−35·2	134·8150
268	269	1·048	492·506	+5·3593	+5·3600	+5·3596	−0·7	−35·9	140·1746
269	270	1·082	493·588	+5·3998	+5·3982	+5·3990	+1·6	−34·3	145·5736
270	271	1·154	494·742	+6·1169	+6·1189	+6·1179	−2·0	−36·3	151·6915
271	272	0·922	495·664	+4·7577	+4·7562	+4·7570	+1·5	−34·8	156·4485
272	273	1·188	496·852	+6·2921	+6·2972	+6·2946	−5·1	−39·9	162.7431
273	274	1·022	497·874	+5·0235	+5·0276	+5·0256	−4·1	−44·0	167·7687
274	275	0·948	498·822	+5·3658	+5·3629	+5·3644	+2·9	−41·1	173·1331
275	276	0·918	499·740	+4·4168	+4·4180	+4·4174	−1·2	−42·3	177·5505
276	277	1·010	500·750	+5·1640	+5·1564	+5·1602	+7·6	−34·7	182·7107
277	†Sta. Olathe	0·609	501·359	+3·7619		+3·7619			186·4826
277	278	0·653	501·403	+4·0399	+4·0370	+4·0384	+2·9	−31·8	186·7491
278	‡LXV	0·336	501·739	+1·0085	+1·0094	+1·0090	−0·9	−32·7	187·7581
‡LXV	LXVI	0·053	501·792	+1·6680	+1·6686	+1·6683	−0·6	−33·3	189·4264
‡LXV	LXVII	0.069	501·808	+1·5418	+1·5422	+1·5420	−0·4	−33·1	189·3001

* See C. & G. S. Report, 1896, p. 275.
† Top of rail in front of station at Olathe.
‡ This bench mark was abandoned in 1893, as it was found to be loose in the ground.

Results of spirit leveling from Olathe, Kans., to Pleasant Hill, Mo.

[For approximate location of permanent bench marks see sketch, p. 362.]

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation. Rod I.	Difference of elevation. Rod K.	Difference of elevation. Mean.	Discrepancy (I-K). Partial.	Discrepancy (I-K). Total.	Elevation above bench mark K_3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
*LXV			501·739	Leveling of 1891. See p. 370.					187·7581
*LXV	LXVI	0·053	501·792			+ 1·6683			189·4264
*LXV	LXVII	·069	501·808			+ 1·5420			189·3001
*LXV	LXVII	·063	Leveling of 1893.	+ 1·4993	+ 1·5000	+ 1·4996	−0.7		
LXVII	LXVI	·108		+ 0·1233	+ 0·1231	+ 0·1232	+0·2		
LXVI	*LXV	·057		− 1·6214	− 1·6222	− 1·6218	+0·8		
LXVI		Adjusted values from leveling of 1891 and 1893.							189·4248
LXVI	LXVII					− 0·1235			189·3013
LXVI	*LXV					− 1·6225			187·8023
*LXV	1	·941	502·680	− 3·8057	− 3·8059	− 3·8058	+0·2	+ 0·2	183·9965
1	2	·994	503·674	+10·9217	+10·9211	+10·9214	+0·6	+ 0·8	194·9179
2	3	1·166	504·840	− 1·1064	− 1·1068	− 1·1066	+0·4	+ 1·2	193·8113
3	4	1·424	506·264	− 7·2051	− 7·2103	− 7·2077	+5·2	+ 6·4	186·6036
4	5	1·204	507·468	+ 8·1901	+ 8·1878	+ 8·1890	+2·3	+ 8·7	194·7926
5	6	1·314	508·782	+ 5·6106	+ 5·6038	+ 5·6072	+6·8	+15·5	200·3998
6	7	1·406	510·188	+ 4·8192	+ 4·8186	+ 4·8189	+0·6	+16·1	205·2187
7	8	1·261	511·449	− 0·8693	− 0·8694	− 0·8694	+0·1	+16·2	204·3493
8	9	·869	512·318	+ 1·6400	+ 1·6371	+ 1·6386	+2·9	+19·1	205·9879
9	LXVIII	·041	512·359	+ 1·2067	+ 1·2072	+ 1·2070	−0·5	+18·6	207·1949
9	Morse Sta.	·135	512·453	+ 0·0727		+ 0·0727			206·0606
9	10	1·462	513·780	− 3·9575	− 3·9633	− 3·9604	+5·8	+24·9	202·0275
10	11	1·458	515·238	− 8·6925	− 8·6909	− 8·6917	−1·6	+23·3	193·3358
12	Stanley Sta.	·907	517·501		− 8·7126	− 8·7126			171·4463
11	12	1·356	516·594	−13·1758	−13·1780	−13·1769	+2·2	+25·5	180·1589
12	13	1·334	517·928	−12·7668	−12·7631	−12·7650	−3·7	+21·8	167·3939
13	14	·897	518·825	− 7·3685	− 7·3685	− 7·3685	0·0	+21·8	160·0254
14	15	1·258	520·083	−10·2698	−10·2718	−10·2708	+2·0	+23·8	149·7546
15	16	1·148	521·231	− 4·3307	− 4·3332	− 4·3320	+2·5	+26·3	145·4226
16	17	1·408	522·639	− 5·8433	− 5·8427	− 5·8430	−0·6	+25·7	139·5796
17	LXIX	·355	522·994	− 0·6501	− 0·6494	− 0·6498	−0·7	+25·0	138·9298
17	Newington Sta.	·143	522·782	+ 0·1870		+ 0·1870			139·7666
LXIX	18	1·214	524·208	+10·5249	+10·5219	+10·5234	+3·0	+28·0	149·4532
18	19	1·276	525·484	+11·8814	+11·8779	+11·8796	+3·5	+31·5	161·3328
19	20	1·296	526·780	+16·1759	+16·1712	+16·1736	+4·7	+36·2	177·5064
20	21	1·294	528·074	+16·0141	+16·0147	+16·0144	−0·6	+35·6	193·5208
21	22	1·332	529·406	+17·1251	+17·1215	+17·1233	+3·6	+39·2	210·6441
22	23	1·260	530·666	− 1·4123	− 1·4126	− 1·4124	+0·3	+39·5	209·2317
23	24	1·324	531·990	+ 0·6222	+ 0·6191	+ 0·6206	+3·1	+42·6	209·8523
24	25	1·268	533·258	− 0·4505	− 0·4489	− 0·4497	−1·6	+41·0	209·4026

* Abandoned; height changed between 1891 and 1893.

Results of spirit leveling from Olathe, Kans., to Pleasant Hill, Mo.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation.			Discrepancy (I-K).		Elevation above bench mark K_3 at St. Louis.
From	To			Rod I.	Rod K.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
24	LXX	.040	532.030	+ 1.0951	+ 1.0949	+ 1.0950	+0.2	+41.2	210.9473
24	Belton Sta.	.145	532.135		− 0.0468	− 0.0468			209.8055
25	26	1.316	534.574	− 0.8500	− 0.8462	− 0.8481	−3.8	+37.2	208.5545
26	27	1.176	535.750	+ 3.1832	+ 3.1782	+ 3.1807	+5.0	+42.2	211.7352
27	28	1.152	526.902	− 3.6219	− 3.6237	− 3.6228	+1.8	+44.0	208.1124
28	29	1.098	538.000	+ 1.9761	+ 1.9757	+ 1.9759	+0.4	+44.4	210.0883
29	30	1.466	539.466	− 1.4439	− 1.4429	− 1.4434	−1.0	+43.4	208.6449
30	Raymore Sta.	.350	539.816	+ 0.6581		+ 0.6581			209.3030
30	LXXI	.174	539.640	+ 1.8440	+ 1.8438	+ 1.8439	+0.2	+43.6	210.4888
30	31	1.240	540.706	+ 0.3804	+ 0.3811	+ 0.3808	−0.7	+42.7	209.0257
31	32	1.518	542.224	−12.8004	−12.7964	−12.7984	−4.0	+38.7	196.2273
32	33	1.261	543.485	+ 0.2652	+ 0.2679	+ 0.2666	−2.7	+36.0	196.4939
33	34	1.572	545.057	− 6.4247	− 6.4241	− 6.4244	−0.6	+35.4	190.0695
34	35	1.334	546.391	− 3.3193	− 3.3166	− 3.3180	−2.7	+32.7	186.7515
35	36	1.022	547.413	− 4.2089	− 4.2089	− 4.2089	0.0	+32.7	182.5426
36	LXXII	.136	547.549	+ 1.3609	+ 1.3611	+ 1.3610	−0.2	+32.5	183.9036
36	Sta. Coleman	.392	547.805		+ 0.6040	+ 0.6040			183.1466
36	37	1.352	548.765	− 1.8091	− 1.8122	− 1.8106	+3.1	+35.8	180.7320
37	38	1.392	550.157	− 0.4814	− 0.4851	− 0.4832	+3.7	+39.5	180.2488
38	39	1.169	551.326	− 1.5968	− 1.5950	− 1.5959	−1.8	+37.7	178.6529
39	40	1.318	552.644	+ 2.2230	+ 2.2200	+ 2.2215	+3.0	+40.7	180.8744
40	LXXIII	1.202	553.846	+ 1.7448	+ 1.7454	+ 1.7451	−0.6	+40.1	182.6195
LXXIII	41	1.120	554.966	− 3.2726	− 3.2703	− 3.2714	−2.3	+37.8	179.3481
41	42	.898	555.864	+ 2.1750	+ 2.1759	+ 2.1754	−0.9	+36.9	181.5235
42	43	.850	556.714	+ 1.5777	+ 1.5753	+ 1.5765	+2.4	+39.3	183.1000
43	a	1.006	557.722	− 3.3212	− 3.3141	− 3.3169	−4.2	+35.1	179.7831
		1.010		− 3.3167	− 3.3156				
a	b	1.484	559.206	− 8.9469	− 8.9511	− 8.9490	+4.2	+39.3	170.8341
b	c	1.188	560.394	+ 3.3744	+ 3.3706	+ 3.3725	+3.8	+43.1	174.2066
c	d	.908	561.302	− 4.5778	− 4.5732	− 4.5755	−4.6	+38.5	169.6311
d	e	1.439	562.741	− 0.7562	− 0.7562	− 0.7562	0.0	+38.5	168.8749
e	f	1.220	563.961	−14.9036	−14.9064	−14.9050	+2.8	+41.3	153.9699
f	g	.731	564.692	− 8.6807	− 8.6814	− 8.6810	+0.7	+42.0	145.2889
g	Big Creek	1.240	565.932	−11.5005	−11.5014	−11.5010	+0.9	+42.9	133.7879
Big Creek	h	1.175	567.107	− 0.6473	− 0.6483	− 0.6478	+1.0	+43.9	133.1401
h	i	1.325	568.432	− 0.8709	− 0.8708	− 0.8708	−0.1	+43.8	132.2693
i	j	1.231	569.663	+ 0.3550	+ 0.3592	+ 0.3571	−4.2	+39.6	132.6264
j	LI	.518	570.181	+ 2.1422	+ 2.1463	+ 2.1442	−4.1	+35.5	*134.7706
LI	LII	1.156	571.337	− 1.2176	− 1.2214	− 1.2195	+3.8	+39.3	*133.5511

*Compare these elevations for LI and LII with those given in Coast and Geodetic Survey Report, 1896, p. 273.

Results of spirit leveling from B. M. 43, Harrisonville, Mo., to Boston, Mo.

[For approximate location of permanent bench marks see sketch, p. 362.]

Bench marks.		Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation.			Discrepancy (I-K).		Elevation above bench mark K_3 at St. Louis.
From	To			Rod I.	Rod K.	Mean.	Partial.	Total.*	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	43		556·714					+39·3	†183·2669
43	44	0·988	557·702	− 9·3907	− 9·3922	− 9·3914	+1·5	+40·8	173·8755
44	45	1·316	559·018	−13·4461	−13·4448	−13·4454	−1·3	+39·5	160·4301
45	46	·888	559·906	− 7·4825	− 7·4807	− 7·4816	−1·8	+37·7	152·9485
46	LXXIV	·402	560·308	+ 0·8967	+ 0·8982	+ 0·8974	−1·5	+36·2	153·8459
46	LXXV	·198	560·104	− 3·7192	− 3·7206	− 3·7199	+1·4	+39·1	149·2286
LXXV	47	1·040	561·144	− 6·4974	− 6·4963	− 6·4968	−1·1	+38·0	142·7318
47	48	1·146	562·290	− 2·3388	− 2·3421	− 2·3404	+3·3	+41·3	140·3914
48	49	1·255	563·545	+ 6·4454	+ 6·4466	+ 6·4460	−1·2	+40·1	146·8374
49	50	1·390	564·935	+ 6·6247	+ 6·6247	+ 6·6247	0·0	+40·1	153·4621
50	51	1·386	566·321	− 6·7141	− 6·7139	− 6·7140	−0·2	+39·9	146·7481
51	52	1·140	567·461	−11·7656	−11.7696	−11·7676	+4·0	+43·9	134·9805
52	53	1·482	568·943	− 4·0022	− 4·0028	− 4·0025	+0·6	+44·5	130·9780
53	54	1·394	570·337	+ 9·6430	+ 9·6391	+ 9·6410	+3·9	+48·4	140·6190
54	Sta. Lone Tree	·132	570·469		− 0·1642	− 0·1642			140·4548
54	55	1·288	571·625	− 8·9324	− 8·9269	− 8·9296	−5·5	+42·9	131·6894
55	56	1·097	572·722	− 7·4027	− 7·4043	− 7·4035	+1·6	+44·5	124·2859
54	LXXVI	·096	570·433	+ 1·1687	+ 1·1677	+ 1·1682	+1·0	+49·4	141·7872
56	57	1·166	573·888	− 2·6070	− 2·6081	− 2·6076	+1·1	+45·6	121·6783
57	58	1·066	574·954	+ 2·0968	+ 2·0956	+ 2·0962	+1·2	+46·8	123·7745
58	59	1·162	576·116	− 6·1417	− 6·1426	− 6·1376	−2·7	+44·1	117·6369
		1·162		− 6·1361	− 6·1298				
59	60	1·143	577·259	− 0·3978	− 0·3984	− 0·3981	+0·6	+44·7	117·2388
60	LXXVII	·298	577·557	+ 0·1974	+ 0·1980	+ 0·1977	−0·6	+44·1	117·4365
LXXVII	61	1·242	578·799	− 0·4179	− 0·4178	− 0·4178	−0·1	+44·0	117·0187
61	62	1·108	579·907	+ 6·2787	+ 6·2749	+ 6·2768	+3·8	+47·8	123·2955
62	63	·673	580·581	+ 3·4358	+ 3·4330	+ 3·4338	+1·5	+49·3	126·7293
		·676		+ 3·4333	+ 3·4332				
63	Sta. Archie	·139	580·720	+ 0·3296		+ 0·3296			127·0589
63	LXXVIII	·039	580·620	+ 2·2369	+ 2·2362	+ 2·2366	+0·7	+50·0	128·9659
63	64	1·165	581·746	+ 1·9724	+ 1·9736	+ 1·9730	−1·2	+48·1	128·7023
64	65	1·544	583·290	− 4·2690	− 4·2686	− 4·2688	−0·4	+47·7	124·4335
65	LXXIX	1·242	584·532	− 7·7537	− 7·7493	− 7·7515	−4·4	+43·3	116·6820
LXXIX	66	·748	585·280	+ 7·8337	+ 7·8293	+ 7·8315	+4·4	+47·7	124·5135
66	67	1·400	586·680	+12·7560	+12·7555	+12·7558	+0·5	+48·2	137·2693
67	68	·971	587·651	− 1·2421	− 1·2409	− 1·2415	−1·2	+47·0	136·0278
68	69	·892	588·543	− 7·0208	− 7·0231	− 7·0220	+2·3	+49·3	129·0058
69	70	1·426	589·969	+10·1797	+10·1753	+10·1775	+4·4	+53·7	139·1833
70	Sta. Adrian	·135	590·104	+ 0·2109		+ 0·2109			139·3942

*Total accumulated discrepancy from B. M. LXV at Olathe, see p. 372 of this Report.

†This elevation results from an approximate adjustment of the loop Pleasant Hill–Kansas City–Holliday–Olathe–Harrisonville–Pleasant Hill.

Results of spirit leveling from B. M. 43, Harrisonville, Mo., to Boston, Mo.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation. Rod I.	Difference of elevation. Rod K.	Difference of elevation. Mean.	Discrepancy (I-K). Partial.	Discrepancy (I-K). Total.	Elevation above bench mark K_3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
70	LXXX	·144	590·113	− 0·8985	− 0·8981	− 0·8983	−0·4	+53·4	138·2850
70	71	·981	590·950	− 6·7847	− 6·7827	− 6·7837	−2·0	+51·7	132·3996
71	72	1·147	592·097	+ 8·4211	+ 8·4183	+ 8·4197	+2·8	+54·5	140·8193
72	73	1·271	593·368	+ 3·4782	+ 3·4795	+ 3·4788	−1·3	+53·2	144·2981
73	74	1·332	594·700	− 5·5099	− 5·5105	− 5·5102	+0·6	+53·8	138·7879
74	75	1·135	595·835	− 4·7946	− 4·7940	− 4·7943	−0·6	+53·2	133·9936
75	76	1·368	597·203	− 3·8873	− 3·8893	− 3·8883	+2·0	+55·2	130·1053
76	77	1·146	598·349	+ 6·9516	+ 6·9514	+ 6·9515	+0·2	+55·4	137·0568
77	LXXXI	·078	598·427	+ 0·4474	+ 0·4477	+ 0·4476	−0·3	+55·1	137·5044
77	Sta. Passaic	·156	598·505	+ 0·2529		+ 0·2529			137·3097
77	78	1·028	599·377	+ 0·1338	+ 0·1334	+ 0·1336	+0·4	+55·8	137·1904
78	79	1·149	600·526	+ 0·1953	+ 0·1968	+ 0·1960	−1·5	+54·3	137·3864
79	80	1·149	601·675	+ 0·1590	+ 0·1582	+ 0·1586	+0·8	+55·1	137·5450
80	81	1·234	602·909	+10·7542	+10·7505	+10·7524	+3·7	+58·8	148·2974
81	82	1·140	604·049	− 4·6397	− 4·6424	− 4·6410	+2·7	+61·5	143·6564
82	Sta. Butler	1·348	605·397	−10·4881		−10·4881			133·1683
82	83	1·376	605·425	−11·5357	−11·5353	−11·5355	−0·4	+61·1	132·1209
83	LXXXII	·450	605·875	+ 5·5067	+ 5·5044	+ 5·5056	+2·3	+63·4	137·6265
83	84	1·166	606·591	− 7·0320	− 7·0318	− 7·0319	−0·2	+60·9	125·0890
84	85	1·458	608·049	+ 0·4014	+ 0·4022	+ 0·4018	−0·8	+60·1	125·4908
85	86	1·210	609·259	− 2·4677	− 2·4671	− 2·4674	−0·6	+59·5	123·0234
86	87	1·370	610·629	−13·5114	−13·5109	−13·5112	−0·5	+59·0	109·5122
87	88	1·319	611·948	− 4·4027	− 4·4056	− 4·4042	+2·9	+61·9	105·1080
88	LXXXIII	·490	612·438	+ 0·1386	+ 0·1376	+ 0·1381	+1·0	+62·9	105·2461
LXXXIII	89	1·304	613·742	+ 0·2155	+ 0·2129	+ 0·2142	+2·6	+65·5	105·4603
89	90	1·446	615·188	− 1·0695	− 1·0707	− 1·0701	+1·2	+66·7	104·3902
90	Sta. Athol	·742	615·930	+ 2·8406		+ 2·8406			107·2308
90	91	1·297	616·485	+ 0·9716	+ 0·9698	+ 0·9707	+1·8	+68·5	105·3609
91	LXXXIV	·543	617·028	+ 0·0470	+ 0·0492	+ 0·0481	−2·2	+66·3	105·4090
LXXXIV	92	1·457	618·485	− 1·2613	− 1·2663	− 1·2638	+5·0	+71·3	104·1452
92	93	1·149	619·634	+ 0·0024	+ 0·0040	+ 0·0032	−1·6	+69·7	104·1484
93	94	1·034	620·668	+ 4·2166	+ 4·2164	+ 4·2165	+0·2	+69·9	108·3649
94	95	1·199	621·867	+ 4·4084	+ 4·4121	+ 4·4102	−3·7	+66·2	112·7751
95	96	1·168	623·035	− 6·1742	− 6·1739	− 6·1740	−0·3	+65·9	106·6011
96	97	1·336	624·371	+10·0027	+10·0061	+10·0044	−3·4	+62·5	116·6055
97	LXXXV	·188	624·559	+ 2·6611	+ 2·6611	+ 2·6611	0·0	+62·5	119·2666
97	LXXXVI	·186	624·557	+ 2·6670	+ 2·6675	+ 2·6672	−0·5	+62·0	119·2727
97	Sta. Rich Hill	·110	624·481	− 0·0212		− 0·0212			116·5843
97	R. R. X	·458	624·829	− 1·3626		− 1·3626			115·2429

Results of spirit leveling from B. M. 43, Harrisonville, Mo., to Boston, Mo.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation.			Discrepancy (I-K).		Elevation above bench mark K_3 at St. Louis.
From	To			Rod I.	Rod K.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
97	98	1·091	625·462	− 1·1774	− 1·1770	− 1·1772	−0·4	+62·1	115·4283
98	99	1·317	626·779	+ 0·7187	+ 0·7177	+ 0·7182	+1·0	+63·1	116·1465
99	100	1·100	627·879	− 4·7516	− 4·7505	− 4·7510	−1·1	+62·0	111·3955
100	101	1·518	629·397	+ 7·3270	+ 7·3249	+ 7·3260	+2·1	+64·1	118·7215
101	C. R. X	·598	629·995		− 4·1837	− 4·1837			114·5378
101	102	1·295	630·692	− 1·6515	− 1·6557	− 1·6536	+4·2	+68·3	117·0679
102	103	1·116	631·808	− 1·3533	− 1·3504	− 1·3518	−2·9	+65·4	115·7161
103	104	1·430	633·238	−11·5599	−11·5594	−11·5596	−0·5	+64·9	104·1565
104	105	·822	634·060	+ 3·4942	+ 3·4903	+ 3·4922	+3·9	+68·8	107·6487
105	Sta. Arthur	·166	634·226	+ 0·2243		+ 0·2243			107·8730
105	106	1·290	635·350	− 2·6593	− 2·6582	− 2·6588	−1·1	+67·7	104·9899
106	LXXXVII	·690	636·040	− 2·5459	− 2·5445	− 2·5452	−1·4	+66·3	102·4447
LXXXVII	107	1·199	637·239	+ 4·6019	+ 4·6014	+ 4·6016	+0·5	+66·8	107·0463
107	LXXXVIII	·781	638·020	+ 3·2659	+ 3·2705	+ 3·2682	−4·6	+62·2	110·3145
LXXXVIII	108	1·270	639·290	− 5·5494	− 5·5499	− 5·5496	+0·5	+62·7	104·7649
108	109	1·171	640·461	+ 2·4976	+ 2·4978	+ 2·4977	−0·2	+62·5	107·2626
109	LXXXIX	1·164	641·625	− 5·5071	− 5·5052	− 5·5062	−1·9	+60·6	101·7564
LXXXIX	110	1·226	642·851	+ 1·7578	+ 1·7560	+ 1·7569	+1·8	+62·4	103·5133
110	111	1·534	644·385	+ 7·6779	+ 7·6782	+ 7·6780	−0·3	+62·1	111·1913
111	112	1·334	645·719	+10·0116	+10·0086	+10·0101	+3·0	+65·1	121·2014
112	113	1·440	647·159	+ 2·7450	+ 2·7451	+ 2·7450	−0·1	+65·0	123·9464
113	114	1·114	648·273	+ 5·3846	+ 5·3825	+ 5·3836	+2·1	+67·1	129·3300
114	115	1·194	649·467	+ 1·8319	+ 1·8313	+ 1·8316	+0·6	+67·7	131·1616
115	116	1·172	650·639	− 6·7359	− 6·7321	− 6·7340	−3·8	+63·9	124·4276
116	117	1·114	651·753	+12·9338	+12·9295	+12·9316	+4·3	+68·2	137·3592
117	118	1·294	653·047	− 6·2421	− 6·2424	− 6·2422	+0·3	+68·5	131·1170
118	XC	1·294	654·341	+ 5·3567	+ 5·3565	+ 5·3566	+0·2	+68·7	136·4736
XC	119	·716	655·057	− 6·1423	− 6·1410	− 6·1416	−1·3	+67·4	130·3320
119	120	1·208	656·265	+ 9·3653	+ 9·3694	+ 9·3674	−4·1	+63·3	139·6994
120	121	1·193	657·458	+ 2·2529	+ 2·2522	+ 2·2526	+0·7	+64·0	141·9520
121	Sta. Nassau	·128	657·586		+ 0·0347	+ 0·0347			141·9867
121	122	1·114	658·572	+ 3·3619	+ 3·3655	+ 3·3637	−3·6	+60·4	145·3157
122	123	1·302	659·874	− 1·4586	− 1·4584	− 1·4539	+3·0	+63·4	143·8618
		1·302		− 1·4462	− 1·4524				
123	124	1·098	660·972	− 1·9906	− 1·9899	− 1·9902	−0·7	+62·7	141·8716
124	125	1·214	662·186	+ 2·2391	+ 2·2406	+ 2·2398	−1·5	+61·2	144·1114
125	126	1·298	663·484	− 5·6380	− 5·6344	− 5·6362	−3·6	+57·6	138·4752
126	127	·880	664·364	+ 1·3474	+ 1·3486	+ 1·3480	−1·2	+56·4	139·8232
127	XCI	·710	665·074	+ 1·8454	+ 1·8486	+ 1·8470	−3·2	+53·2	141·6702
XCI	128	1·058	666·132	− 3·2306	− 3·2320	− 3·2313	+1·4	+54·6	138·4389
XCI	Sta. Milo	·084	666·216		+ 0·8201	+ 0·8201			139·2590
128	129	1·040	667·172	+ 5·0447	+ 5·0467	+ 5·0457	−2·0	+52·6	143·4846
129	130	1·264	668·436	+ 7·3612	+ 7·3601	+ 7·3606	+1·1	+53·7	150·8452
130	131	1·226	669·662	+ 1·7029	+ 1·6997	+ 1·7013	+3·2	+56·9	152·5465
131	132	1·043	670·705	+ 0·4354	+ 0·4370	+ 0·4362	−1·6	+55·3	152·9827
132	133	1·356	672·061	+ 0·3636	+ 0·3589	+ 0·3612	+4·7	+60·0	153·3439
133	134	1·064	673·125	− 2·9136	− 2·9117	− 2·9126	−1·9	+58·1	150·4313

Results of spirit leveling from B. M. 43, Harrisonville, Mo., to Boston, Mo.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation. Rod I.	Difference of elevation. Rod K.	Difference of elevation. Mean.	Discrepancy (I–K). Partial.	Discrepancy (I–K). Total.	Elevation above bench mark K_3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
134	135	1·190	674·315	−0·1275	−0·1292	−0·1284	+1·7	+59·8	150·3029
135	136	1·654	675·969	+2·6186	+2·6177	+2·6182	+0·9	+60·7	152·9211
136	XCII	·216	676·185	+2·5620	+2·5626	+2·5623	−0·6	+60·1	155·4834
136	Sta. Sheldon	·152	676·121	+0·4768		+0·4768			153·3979
136	137	1·121	677·090	+4·4736	+4·4693	+4·4714	+4·3	+65·0	157·3925
137	138	1·134	678·224	+0·3624	+0·3619	+0·3622	+0·5	+65·5	157·7547
138	139	1·534	679·758	+0·7717	+0·7734	+0·7726	−1·7	+63·8	158·5273
139	140	1·335	681·093	+5·0804	+5·0813	+5·0808	−0·9	+62·9	163·6081
140	141	1·462	682·555	+4·7804	+4·7817	+4·7810	−1·3	+61·6	168·3891
141	XCIII	1·230	683·785	+2·1125	+2·1133	+2·1129	−0·8	+60·8	170·5020
XCIII	Sta. Irwin	·136	683·921	+0·1584		+ 0·1584			170·6604
XCIII	142	1·176	684·961	−1·7249	−1·7258	−1·7254	+0·9	+61·7	168·7766
142	143	1·466	686·427	+0·3318	+0·3322	+0·3320	−0·4	+61·3	169·1086
143	144	1·098	687·525	−1·9150	−1·9156	−1·9153	+0·6	+61·9	167·1933
144	145	1·099	688·624	+1·2980	+1·2981	+1·2980	−0·1	+61·8	168·4913
145	146	1·116	689·740	−1·4477	−1·4485	−1·4481	+0·8	+62·6	167·0432
146	XCIV	·885	690·625	−5·1450	−5·1446	−5·1448	−0·4	+62·2	161·8984
XCIV	147	1·142	691·767	+1·7693	+1·7707	+1·7700	−1·4	+60·8	163·6684
147	148	1·044	692·811	+3·4851	+3·4840	+3·4846	+1·1	+61·9	167·1530
148	149	·748	693·559	+2·3650	+2·3654	+2·3652	−0·4	+61·5	169·5182
149	Sta. Lamar	·796	694·355		−1·3803	−1·3803			168·1379
149	XCV	·192	693·751	+2·7906	+2·7903	+2·7904	+0.3	+61·8	172·3086
149	150	1·354	694·913	−4·6888	−4·6901	−4·6894	+1·3	+62·8	164·8288
150	R. R. X	·656	695·569	+0·1264		+0·1264			164·9552
150	151	1·354	696·267	−6·0380	−6·0369	−6·0374	−1·1	+61·7	158·7914
151	152	1·262	697·529	+1·0123	+1·0113	+1·0118	+1·0	+62·7	159·8032
152	153	1·107	698·636	−1·6246	−1·6244	−1·6245	−0·2	+62·5	158·1787
153	154	1·264	699·900	+4·8963	+4·8956	+4·8960	+0·7	+63·2	163·0747
154	155	1·062	700·962	−4·5495	−4·5501	−4·5498	+0·6	+63·8	158·5249
155	XCVI	·355	701·317	−1·1084	−1·1062	−1·1073	−2·2	+61·6	157·4176
XCVI	XCVII	·017	701·334	+0·0011	+0·0010	+0·0010	+0·1	+61·7	157·4186

Results of spirit leveling from Boston, Mo., to Chester, Ark.

[For approximate location of permanent bench marks see sketch, p. 362.]

Bench marks.		Distance between successive bench marks.	Distance from bench mark XCVI near Boston, Mo.	Difference of elevation.			Discrepancy (I—K).		Elevation above mean sea level.
From	To			Rod I.	Rod K.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	XCVI								*283·2180
XCVI	XCVII	0·146	0·146	+ 0·0009	+ 0·0005	+ 0·0007	+0·4	+ 0·4	283·2187
XCVII	1	·888	1·034	+ 0·1687	+ 0·1649	+ 0·1668	+3·8	+ 4·2	283·3855
1	XCVIII	1·288	2·322	+ 3·7800	+ 3·7838	+ 3·7819	−3·8	+ 0·4	287·1674
XCVIII	2	1·176	3·498	+ 0·2523	+ 0·2519	+ 0·2521	+0·4	+ 0·8	287·4195
2	3	1·259	4·757	− 1·1934	− 1·1906	− 1·1920	−2·8	− 2·0	286·2275
3	4	1·262	6·019	+ 2·0211	+ 2·0216	+ 2·0214	−0·5	− 2·5	288·2489
4	5	1·228	7·247	+ 0·4527	+ 0·4539	+ 0·4533	−1·2	− 3·7	288·7022
5	6	1·226	8·473	− 5·4892	− 5·4912	− 5·4902	+2·0	− 1·7	283·2120
6	7	1·226	9·699	− 3·7596	− 3·7535	− 3·7566	−6·1	− 7·8	279·4554
7	8	1·180	10·879	+ 9·8953	+ 9·8977	+ 9·8965	−2·4	−10·2	289·3519
8	9	·611	11·490	− 0·6736	− 0·6748	− 0·6742	+1·2	− 9·0	288·6777
9	XCIX	·036	11·526	− 0·1159	− 0·1151	− 0·1155	− 0·8	− 9·8	288·5622
9	10	1·176	12·666	− 3·6922	− 3·6904	− 3·6913	−1·8	−10·8	284·9864
10	11	1·393	14·059	+ 9·5224	+ 9·5192	+ 9·5208	+3·2	− 7·6	294·5072
11	12	1·432	15·491	− 1·3189	− 1·3142	− 1·3166	−4·7	−12·3	293·1906
12	13	1·422	16·913	− 2·5110	− 2·5051	− 2·5080	−5·9	−18·2	290·6826
13	14	1·180	18·093	− 3·7071	− 3·7052	− 3·7062	−1·9	−20·1	286·9764
14	C	·903	18·996	− 6·8187	− 6·8148	− 6·8168	−3·9	−24.0	280·1596
C	15	1·059	20·055	+ 2·1200	+ 2·1205	+ 2·1202	−0·5	−24·5	282·2798
15	16	1·108	21·163	+ 5·1509	+ 5·1517	+ 5·1513	−0·8	−25·3	287·4311
16	17	1·223	22·386	+ 8·3759	+ 8·3732	+ 8·3746	+2·7	−22·6	295·8057
17	CI	1·005	23·391	− 2·1051	− 2·1048	− 2·1050	−0·3	−22·9	293·7007
CI	18	1·190	24·581	+10·6661	+10·6686	+10·6674	−2·5	−25·4	304·3681
18	19	1·210	25·791	+ 4·7952	+ 4·7956	+ 4·7954	−0·4	−25·8	309·1635
19	20	1·128	26·919	−12·2308	−12·2294	−12·2301	−1·4	−27·2	296·9334
20	CII	1·127	28·046	− 8·9787	− 8·9780	− 8·9784	−0·7	−27·9	287·9550
CII	21	1·092	29·138	− 2·4610	− 2·4595	− 2·4602	−1·5	−29·4	285·4948
21	CIII	·350	29·488	+ 0·9403	+ 0·9401	+ 0·9402	+0·2	−29·2	286·4350
CIII	22	·985	30·473	+ 4·0785	+ 4·0841	+ 4.0813	−5·6	−34·8	290·5163
22	23	1·004	31·477	+ 9·5258	+ 9·5227	+ 9·5242	+3·1	−31·7	300·0405
23	24	1·162	32·639	+ 9·1219	+ 9·1262	+ 9·1240	−4·3	−36·0	309·1645
24	25	·999	33·638	+11·1738 +11·1744	+11·1654 +11·1746	+11·1720	+4·1	−31·9	320·3365
25	26	1·108	34·746	+ 0·0406	+ 0·0415	+ 0·0410	−0·9	−32·8	320·3775
26	27	1·453	36·199	+ 7·1064	+ 7·1087	+ 7·1076	−2·3	−35·1	327·4851
27	28	1·097	37·296	+ 2·7780	+ 2·7808	+ 2·7794	−2·8	−37·9	330·2645
28	29	1·075	38·371	− 0·3564	− 0·3532	− 0·3548	−3·2	−41·1	329·9097
29	30	1·093	39·464	− 1·9437	− 1·9433	− 1·9435	−0·4	−41·5	327·9662
30	31	1·040	40·504	+ 3·3047 + 3·2702 + 3·3165	+ 3·2979 + 3·2758 + 3·3121	+ 3·2962	+1·8	−39·7	331·2624
31	32	·999	41·503	+ 4·8885	+ 4·8934	+ 4·8910	−4·9	−44·6	336·1534
32	33	·999	42·502	+ 3·0417	+ 3·0408	+ 3·0412	+0·9	−43·7	339·1946
33	34	1·262	43·764	+ 6·8084	+ 6·8087	+ 6·8086	−0·3	−44·0	346·0032
34	CIV	1·078	44·842	− 2·9073	− 2·9064	− 2·9068	−0·9	−44·9	343·0964
CIV	35	1·045	45·887	+ 0·6267	+ 0·6245	+ 0·6256	+2·2	−42·7	343·7220
35	36	1·038	46·925	+ 2·3759	+ 2·3723	+ 2·3741	+3·6	−39·1	346·0961
36	37	·964	47·889	− 1·1572	− 1·1600	− 1·1586	+2·8	−36·3	344·9375
37	38	1·076	48·965	− 6·9432	− 6·9437	− 6·9434	+0·5	−35·8	337·9941
38	39	1·448	50·413	− 8·9503	− 8·9525	− 8·9514	+2·2	−33·6	329·0427

* This elevation is the result of an approximate adjustment.

Results of spirit leveling from Boston, Mo., to Chester, Ark.— Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark XCVI near Boston, Mo.	Difference of elevation.			Discrepancy, (I−K).		Elevation above mean sea level.
From	To			Rod I.	Rod K.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
39	40	.942	51.355	− 1.9743	− 1.9757	− 1.9750	+1.4	−32.2	327.0677
40	41	1.088	52.443	+ 3.7750	+ 3.7749	+ 3.7750	+0.1	−32.1	330.8427
41	CV	.569	53.012	+ 0.5572	+ 0.5610	+ 0.5591	−3.8	−35.9	331.4018
CV	42	.982	53.994	+ 6.3170	+ 6.3193	+ 6.3182	−2.3	−38.2	337.7200
42	43	1.286	55.280	+10.9275	+10.9278	+10.9276	−0.3	−38.5	348.6476
43	44	1.210	56.490	+ 8.7903	+ 8.7901	+ 8.7902	+0.2	−38.3	357.4378
44	45	1.020	57.510	− 1.6581	− 1.6559	− 1.6570	−2.2	−40.5	355.7808
45	46	1.033	58.543	+ 5.4808	+ 5.4800	+ 5.4804	+0.8	−39.7	361.2612
46	47	1.206	59.749	+13.5678	+13.5683	+13.5680	−0.5	−40.2	374.8292
				*+13.5589	*+13.5417				
47	48	1.165	60.914	− 5.8298	− 5.8321	− 5.8310	+2.3	−37.9	368.9982
48	49	1.468	62.382	+ 2.2301	+ 2.2272	+ 2.2286	+2.9	−35.0	371.2268
49	CVI	.667	63.049	+ 1.7260	+ 1.7247	+ 1.7254	+1.3	−33.7	372.9522
CVI	50	1.091	64.140	+10.5323	+10.5310	+10.5316	+1.3	−32.4	383.4838
50	51	1.395	65.535	+ 9.9874	+ 9.9886	+ 9.9880	−1.2	−33.6	393.4718
51	52	1.324	66.859	+ 7.8113	+ 7.8080	+ 7.8096	+3.3	−30.3	401.2814
52	53	1.128	67.987	− 2.1241	− 2.1255	− 2.1248	+1.4	−28.9	399.1566
53	54	1.075	69.062	− 5.1114	− 5.1123	− 5.1118	+0.9	−28.0	394.0448
54	55	1.016	70.078	− 7.5270	− 7.5248	− 7.5259	−2.2	−30.2	386.5189
55	56	1.130	71.208	−11.0307	*−11.0401	−11.0282	−1.3	−31.5	375.4907
				−11.0270	−11.0275				
56	57	1.142	72.350	−10.5468	−10.5455	−10.5462	−1.3	−32.8	364.9445
57	CVII	.802	73.152	+ 0.8838	+ 0.8822	+ 0.8830	+1.6	−31.2	365.8275
CVII	58	.878	74.030	+ 1.4434	+ 1.4408	+ 1.4421	+2.6	−28.6	367.2696
58	59	1.162	75.192	+ 4.5155	+ 4.5175	+ 4.5165	−2.0	−30.6	371.7861
59	60	1.228	76.420	+ 3.7951	+ 3.7983	+ 3.7967	−3.2	−33.8	375.5828
60	61	1.129	77.549	+ 4.3623	+ 4.3593	+ 4.3608	+3.0	−30.8	379.9436
61	62	1.257	78.806	+ 4.0447	+ 4.0518	+ 4.0470	−3.0	−33.8	383.9906
				+ 4.0463	+ 4.0453				
62	63	1.225	80.031	+ 4.2001	+ 4.2006	+ 4.2004	−0.5	−34.3	388.1910
63	64	.939	80.970	+ 4.4812	+ 4.4800	+ 4.4806	+1.2	−33.1	392.6716
64	CIX	.542	81.512	+ 3.5972	+ 3.5951	+ 3.5962	+2.1	−31.0	396.2678
64	65	.991	81.961	+ 3.8630	+ 3.8583	+ 3.8606	+4.7	−28.4	396.5322
65	66	1.084	83.045	+ 9.1907	+ 9.1859	+ 9.1883	+4.8	−23.6	405.7205
66	67	1.312	84.357	+13.7837	+13.7870	+13.7854	−3.3	−26.9	419.5059
67	68	1.049	85.406	+ 6.1325	+ 6.1267	+ 6.1296	+5.8	−21.1	425.6355
68	69	1.151	86.557	+ 3.6489	+ 3.6531	+ 3.6510	−4.2	−25.3	429.2865
69	70	1.172	87.729	− 4.9004	− 4.9035	− 4.9020	+3.1	−22.2	424.3845
70	71	1.000	88.729	− 4.3574	− 4.3609	− 4.3592	+3.5	−18.7	420.0253
71	72	.997	89.726	+ 3.4059	+ 3.4102	+ 3.4080	−4.3	−23.0	423.4333
72	73	1.135	90.861	+11.8499	+11.8496	+11.8498	+0.3	−22.7	435.2831
73	74	1.075	91.936	+11.3368	+11.3390	+11.3379	−2.2	−24.9	446.6210
74	75	.930	92.866	+ 4.8846	+ 4.8827	+ 4.8836	+1.9	−23.0	451.5046
75	CX	.117	92.983	+ 0.8893	+ 0.8894	+ 0.8894	−0.1	−23.1	452.3940
75	76	1.390	94.256	− 0.2116	− 0.2124	− 0.2120	+0.8	−22.2	451.2926
76	77	1.015	95.271	+ 1.3390	+ 1.3389	+ 1.3390	+0.1	−22.1	452.6316
77	78	.997	96.268	+10.6472	+10.6519	+10.6496	−4.7	−26.8	463.2812
78	79	1.039	97.307	+ 2.9451	+ 2.9455	+ 2.9453	−0.4	−27.2	466.2265
79	80	1.093	98.400	+ 8.8790	+ 8.8806	+ 8.8798	−1.6	−28.8	475.1063
80	81	.976	99.376	− 1.8873	− 1.8840	− 1.8856	−3.3	−32.1	473.2207
81	82	1.030	100.406	− 6.0881	− 6.0845	− 6.0863	−3.6	−35.7	467.1344

* Rejected.

Results of spirit leveling from Boston, Mo., to Chester, Ark.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark XCVI near Boston, Mo.	Difference of elevation.			Discrepancy (I—K).		Elevation above mean sea level.
From	To			Rod I.	Rod K.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
82	83	1·274	101·680	— 0·2869	— 0·2897	— 0·2883	+2·8	—32·9	466·8461
83	84	1·070	102·750	+ 6·7333	+ 6·7323	+ 6·7328	+1·0	—31·9	473·5789
84	85	1·000	103·750	+ 2·3433	+ 2·3417	+ 2·3425	+1·6	—30·3	475·9214
85	86	1·092	104·842	— 3.8077	— 3·8095	— 3·8086	+1·8	—28·5	472·1128
86	87	1·093	105·935	+ 2·1914	+ 2·1955	+ 2·1934	—4·1	—32·6	474·3062
87	88	1·001	106·936	+ 3·9695	+ 3·9709	+ 3·9702	—1·4	—34·0	478·2764
88	89	·996	107·932	— 6·6879	— 6·6904	— 6·6892	+2·5	—31·5	471·5872
89	90	1·077	109·009	+ 5·3877	+ 5·3876	+ 5·3876	+0·1	—31·4	476·9748
90	91	1·040	110·049	— 6·9627	— 6·9666	— 6·9646	+3·9	—27·5	470·0102
91	CXI	·698	110·747	+ 5·0268	+ 5·0231	+ 5·0250	+3·7	—23·8	475·0352
CXI	92	·865	111·612	— 1·8407	— 1·8383	— 1·8395	—2·4	—26·2	473·1957
92	93	1·109	112·721	— 5·7383	— 5·7402	— 5·7392	+1·9	—24·3	467·4565
93	94	1·107	113·828	+ 7·0885	+ 7·0890	+ 7·0888	—0·5	—24·8	474·5453
94	95	1·149	114·977	+ 3·5757	+ 3·5768	+ 3·5762	—1·1	—25·9	478·1215
95	96	1·144	116·121	+ 1·0947	+ 1·0951	+ 1·0949	—0·4	—26·3	479·2164
96	97	1·114	117.235	—12·4099 —12·4142	*—12·4003 —12·4107	—12·4116	—1·3	—27·6	466·8048
97	98	·944	118·179	—10·2136	—10·2141	—10·2138	+0·5	—27·1	456·5910
98	99	1·134	119·313	— 8·9894	— 8·9879	— 8·9886	—1·5	—28·6	447·6024
99	100	·945	120·258	+ 1·1261	+ 1·1265	+ 1·1263	—0·4	—29·0	448·7287
100	101	·890	121·148	— 2·8474	— 2·8466	— 2·8470	—0·8	—29·8	445·8817
101	102	1·145	122·293	+ 8·8047	+ 8·8048	+ 8·8048	—0·1	—29·9	454·6865
101	CXII	·101	121·249	+ 2·9180	+ 2·9181	+ 2·9180	—0·1	—29·9	448·7997
102	103	1·187	123·480	—11·6085	—11·6067	—11·6076	—1·8	—31·7	443·0789
103	104	1·130	124·610	+ 2·8165	+ 2·8167	+ 2·8166	—0·2	—31·9	445·8955
104	105	1·198	125·808	— 0·7595	— 0·7623	— 0·7609	+2·8	—29·1	445·1346
105	106	1·016	126·824	— 0·2943	— 0·2984	— 0·2964	+4·1	—25·0	444·8382
106	107	·981	127·805	+ 8·3739	+ 8·3759	+ 8·3749	—2·0	—27·0	453·2131
107	108	1·076	128·881	+11·3579	+11·3612	+11·3596	—3·3	—30·3	464·5727
108	109	·945	129·826	+ 2·5753	+ 2·5776	+ 2·5764	—2·3	—32·6	467·1491
109	110	·908	130·734	+ 0·4771	+ 0·4741	+ 0·4756	+3·0	—29·6	467·6247
110	111	1·266	132·000	+ 4·5833	+ 4·5838	+ 4·5836	—0·5	—30·1	472·2083
110	CXIII	·061	130·795	+ 1·8585	+ 1·8584	+ 1·8584	+0·1	—29·5	469·4831
111	112	1·018	133·018	— 0·7443	— 0.7399	— 0·7421	—4·4	—34·5	471·4662
112	113	·713	133·731	+ 8·1629 + 8·1659	+ 8·1697 + 8·1676	+ 8·1665	—4.2	—38·7	479·6327
113	114	1·409	135·140	— 3·3170	— 3·3160	— 3·3165	—1·0	—39·7	476·3162
114	115	1·152	136·292	+12·7733	+12·7752	+12·7742	—1·9	—41·6	489·0904
115	116	1·166	137·458	+ 9·0605	+ 9·0599	+ 9·0602	+0·6	—41·0	498·1506
116	117	·983	138·441	— 8.2790	— 8·2821	— 8·2806	+3·1	—37·9	489·8700
117	118	1·077	139·518	—11·8198 —11·8084	—11·8132 —11·8116	—11·8132	—1·7	—39·6	478·0568
118	119	1·166	140·684	—10·6872	—10·6893	—10·6882	+2·1	—37·5	467·3686
119	120	1·070	141·754	— 6·4267	— 6·4260	— 6·4264	—0·7	—38·2	460·9422
120	121	·457	142·211	+ 2·8416	+ 2·8432	+ 2·8424	—1·6	—39·8	463·7846
121	122	1·302	143·513	*—3·2164 — 3·2074	— 3·2072 — 3·2097	— 3·2081	+1·0	—38·8	460·5765
121	CXIV	·022	142·233	— 0·8889	— 0·8890	— 0·8890	+0·1	—39·7	462·8956

* Rejected.

Results of spirit leveling from Boston, Mo., to Chester, Ark.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark XCVI near Boston, Mo.	Difference of elevation.			Discrepancy (I−K).		Elevation above mean sea level.
From	To			Rod I.	Rod K.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
122	123	1·192	144·705	−11·5321	−11·5322	−11·5322	+0·1	−38·7	449·0443
123	124	1·206	145·911	−12·3657	−12·3665	−12·3661	+0·8	−37·9	436·6782
124	125	1·201	147.112	−12·6588	−12·6585	−12·6586	−0·3	−38·2	424·0196
125	126	·953	148·065	−10·6548	−10·6537	−10·6542	−1·1	−39·3	413·3654
126	127	·907	148·972	− 9·4200	− 9·4196	− 9·4198	−0·4	−39·7	403·9456
127	128	·918	149·890	− 9·4042	− 9.4046	− 9·4044	+0·4	−39·3	394·5412
128	CXV	1·104	150·994	− 9·2748	− 9·2778	− 9·2763	+3·0	−36·3	385·2649
CXV	129	·953	151·947	+ 7·5615	+ 7·5585	+ 7·5600	+3·0	−33·3	392·8249
129	130	1·083	153·030	+11·3678	+11·3681	+11·3680	−0·3	−33·6	404·1929
130	CXVI	1·193	154·223	+10·1603	+10·1623	+10·1613	−2·0	−35·6	414·3542
CXVI	131	·869	155·092	− 4·0740	− 4·0786	− 4·0763	+4·6	−31·0	410·2779
131	132	1·077	156·169	+ 1·9010	+ 1·9097	+ 1·9058	−5·8	−36·8	412·1837
				+ 1·9048	+ 1·9097				
132	133	1·058	157·227	− 4·2080	− 4·2103	− 4·2092	+2·3	−34·5	407·9745
133	134	·963	158·190	+ 4·4852	+ 4·4867	+ 4·4860	−1·5	−36·0	412·4605
134	135	1·002	159·192	+ 3·4435	+ 3·4444	+ 3·4440	−0·9	−36·9	415·9045
135	136	1·207	160·399	− 2·3116	− 2·3084	− 2·3100	−3·2	−40·1	413·5945
136	137	1·171	161·570	+ 1·3796	+ 1·3760	+ 1·3778	+3·6	−36·5	414·9723
137	138	1·002	162·572	+ 0·1992	*+0·1911	+ 0·2001	−3·3	−39·8	415·1724
				+ 0·1989	+ 0·2023				
138	139	·578	163·150	+ 4·8572	+ 4·8578	+ 4·8575	−0·6	−40·4	420·0299
139	CXVII	·060	163·210	+ 0·7990	+ 0·7984	+ 0·7987	+0·6	−39·8	420·8286
139	140	1·252	164·402	− 2·5657	− 2·5661	− 2·5659	+0·4	−40·0	417·4640
140	141	1·267	165·669	−10·2655	−10·2677	−10·2666	+2·2	−37·8	407·1974
141	142	1·097	166·766	+ 3·1353	+ 3·1412	+ 3·1398	+0·1	−37·7	410·3372
				+ 3·1445	+ 3·1384				
142	143	1·113	167·879	− 2·3774	− 2·3789	− 2·3782	+1·5	−36·2	407·9590
143	144	1·225	169·104	− 4·9229	− 4·9272	− 4·9250	+4·3	−31·9	403·0340
144	145	1·190	170·294	− 1·7315	− 1·7361	− 1·7338	+4·6	−27·3	401·3002
145	146	1·110	171·404	+ 4·6746	+ 4·6760	+ 4·6753	−1·4	−28·7	405·9755
146	147	·561	171·965	+ 2·6489	+ 2·6501	+ 2·6495	−1·2	−29·9	408·6250
147	148	1·114	173·079	− 4·6330	− 4·6348	− 4·6339	+1·8	−28·1	403·9911
147	CXVIII	·033	171·998	+ 0·1164	+ 0·1159	+ 0·1162	+0·5	−29·4	408·7412
148	149	1·112	174·191	+ 4·5158	+ 4·5187	+ 4·5172	−2·9	−31·0	408·5083
149	150	1·172	175·363	+ 9·8545	+ 9·8559	+ 9·8552	−1·4	−32·4	418·3635
150	151	1·204	176·567	− 2·6380	− 2·6348	− 2·6364	−3·2	−35·6	415·7271
151	152	1·168	177·735	− 4·9538	− 4·9561	− 4·9550	+2·3	−33·3	410·7721
152	153	1·097	178·832	− 3·2786	− 3·2769	− 3·2778	−1·7	−35·0	407·4943
153	154	1·208	180·040	− 3·4060	− 3·4027	− 3·4044	−3·3	−38·3	404·0899
154	CXIX	·072	180·112	+ 0·3692	+ 0·3689	+ 0·3690	+0·3	−38·0	404·4589
154	155	1·321	181·361	+ 3·2124	+ 3·2177	+ 3·2150	−5·3	−43·6	407·3049
155	156	1·118	182·479	+ 5·1351	+ 5·1347	+ 5·1349	+0·4	−43·2	412·4398
156	157	1·108	183·587	−10·1136	−10·1112	−10·1124	−2·4	−45·6	402·3274
157	158	1·074	184·651	−11·7443	−11·7442	−11·7442	−0·1	−45·7	390·5832
158	159	1·189	185·850	−12·8613	−12·8579	−12·8596	−3·4	−49·1	377·7236
159	160	1·062	186·912	−10·6778	−10·6751	−10·6764	−2·7	−51·8	367·0472
160	CXX	·915	187·827	− 3·7397	− 3·7419	− 3·7408	+2·2	−49·6	363·3064
CXX	161	1·123	188·950	− 5·6303	− 5·6347	− 5·6325	+4·4	−45·2	357·6739
161	162	1·215	190·165	+ 8·3522	+ 8·3490	+ 8·3506	+3·2	−42·0	366·0245

* Rejected.

Results of spirit leveling from Boston, Mo., to Chester, Ark.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark XCVI near Boston, Mo.	Difference of elevation.			Discrepancy (I—K.)		Elevation above mean sea level.
From	To			Rod I.	Rod K.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
162	163	1·228	191·393	+ 5·7026	+ 5·7004	+ 5·7015	+2·2	—39·8	371·7260
163	164	1·205	192·598	+10·5631	+10·5619	+10·5625	+1·2	—38·6	382·2885
164	165	1·220	193·818	+13·3011	+13·3008	+13·3010	+0·3	—38·3	395·5895
165	166	1·230	195·048	+10·3805	+10·3854	+10·3830	—4·9	—43·2	405·9725
166	167	·822	195·870	+ 0·4254	+ 0·4217	+ 0·4236	+3·7	—39·5	406·3961
167	CXXI	·606	196·476	+36·0192	+36·0230	+36·0211	—3·8	—43·3	442·4172
167	168	1·109	196.979	—11·4583	—11·4589	—11·4586	+0·6	—38·9	394·9375
168	169	1·220	198.199	—12·0471	—12·0410	—12·0458	—3·4	—42·3	382·8917
				—12·0479	—12·0472				
169	170	1·482	199·681	— 4·8416	— 4·8366	— 4·8391	—5·0	—47·3	378·0526
170	171	1·016	200·697	+ 6·7943	+ 6·7930	+ 6·7936	+1·3	—46·0	384·8462
171	172	1·003	201·700	— 2·1078	— 2·1074	— 2·1076	—0·4	—46·4	382·7386
172	173	1·114	202·814	+ 3·0166	+ 3·0160	+ 3·0163	+0·6	—45·8	385·7549
173	174	1·245	204·059	— 5·6858	— 5·6865	— 5·6862	+0·7	—45·1	380·0687
174	CXXII	·567	204·626	— 0·1204	— 0·1228	— 0·1216	+2·4	—42·7	379·9471
CXXII	175	1·181	205·807	+ 0·6830	+ 0·6803	+ 0·6816	+2·7	—40·0	380·6287
175	176	1·222	207·029	+ 3·3300	+ 3·3262	+ 3·3281	+3·8	—36·2	383·9568
176	177	1·148	208·177	+ 1·0182	+ 1·0188	+ 1·0185	—0·6	—36·8	384·9753
177	178	1·129	209·306	+ 7·9353	+ 7·9345	+ 7·9349	+0·8	—36·0	392·9102
178	179	1·186	210·492	+ 1·0357	+ 1·0375	+ 1·0366	—1·8	—37·8	393·9468
179	180	1·279	211·771	+ 3·8491	+ 3·8504	+ 3·8498	—1·3	—39·1	397·7966
180	181	1·371	213·142	+10·0641	+10·0646	+10·0644	—0·5	—39·6	407·8610
181	CXXIII	·063	213·205	+ 3·2484	+ 3·2484	+ 3·2484	0·0	—39·6	411·1094
181	182	1·203	214·345	— 3·5317	— 3·5331	— 3·5324	+1·4	—38·2	404·3286
182	183	1·240	215·585	+ 3·4928	+ 3·4929	+ 3·4928	—0·1	—38·3	407·8214
183	184	1·187	216·772	+ 7·3666	+ 7·3662	+ 7·3664	+0·4	—37·9	415·1878
184	CXXIV	1·479	218·251	+ 3·6632	+ 3·6596	+ 3·6614	+3·6	—34·3	418·8492
CXXIV	185	·355	218·606	+ 2·5230	+ 2·5245	+ 2·5238	—1·5	—35·8	421·3730
185	186	1·144	219·750	+ 4·0440	+ 4·0411	+ 4·0426	+2·9	—32·9	425·4156
186	187	1·233	220·983	+ 5·6334	+ 5·6356	+ 5·6345	—2·2	—35·1	431·0501
187	188	1·223	222·206	+ 9·3741	+ 9·3730	+ 9·3736	+1·1	—34·0	440·4237
188	189	1·392	223·598	+ 9·7839	+ 9·7820	+ 9·7830	+1·9	—32·1	450·2067
189	190	1·154	224·752	+ 0·4853	+ 0·4872	+ 0·4862	—1·9	—34·0	450·6929
190	CXXV	·052	224·804	+ 2·8757	+ 2·8754	+ 2·8756	+ 0·3	—33·7	453·5685
190	191	1·222	225·974	+ 9·6875	+ 9·6826	+ 9·6850	+4·9	—29·1	460·3779
191	192	1·116	227·090	+10·6398	+10·6399	+10·6398	—0·1	—29·2	471·0177
192	193	·990	228·080	+11·0064	+11·0079	+11·0072	—1·5	—30·7	482·0249
193	194	1·088	229·168	+11·5128	+11·5107	+11·5118	+2·1	—28·6	493·5367
194	195	1·182	230·350	+12·5789	+12·5747	+12·5768	+4·2	—24·4	506·1135
195	196	1·083	231·433	+11·9027	+11·9020	+11·9024	+0·7	—23·7	518·0159
196	197	1·113	232·546	+10·8874	+10·8874	+10·8874	0·0	—23·7	528·9033
197	a	·147	232·693	+ 0·1497	+ 0·1493	+ 0·1495	+0·4	—23·3	529·0528
a	CXXVI	·037	232·730	+ 1·4195	+ 1·4197	+ 1·4196	—0·2	—23·5	530·4724
197	198	·265	232·811	+14·9308	+14·9337	+14·9322	+2·9	—20·8	543·8355
198	199	·176	232·987	+16·9079	+16·9085	+16·9082	—0·6	—21·4	560·7437
199	200	·140	233·127	+ 8·3037	+ 8·3049	+ 8·3043	—1·2	—22·6	569·0480
200	201	·322	233·449	—14·5902	—14·5893	—14·5898	—0·9	—23·5	554·4582

Results of spirit leveling from Boston, Mo., to Chester, Ark.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark XCVI near Boston, Mo.	Difference of elevation. Rod I.	Difference of elevation. Rod K.	Difference of elevation. Mean.	Discrepancy (I—K.) Partial.	Discrepancy (I—K.) Total.	Elevation above mean sea level.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
200	CXXVII	·033	233·160	+ 2·1605	+ 2·1606	+ 2·1606	− 0·1	−22·7	571·2086
201	202	·159	233·608	−16·9107	−16·9128	−16·9118	+ 2·1	−21·4	537·5464
202	b	·279	233·887	−15·1298	−15·1299	−15·1298	+ 0·1	−21·3	522·4166
b	203	·685	234·572	−14·6437	−14·6452	−14·6444	+ 1·5	−19·8	507·7722
203	204	·690	235·262	−14·2816	−14·2819	−14·2818	+ 0·3	−19·5	493·4904
204	205	·468	235·730	−15·9372	−15·9413	−15·9392	+ 4·1	−15·4	477·5512
205	206	·280	236·010	− 0·1874 − 0·1835	− 0·1869 − 0·1842	− 0·1855	+ 0·1	−15·3	477·3657
206	207	·794	236·804	−16·4925	−16·4872	−16·4898	+ 5·3	−20·6	460·8759
207	208	·242	237·046	− 7·5471	− 7·5455	− 7·5463	− 1·6	−22·2	453·3296
208	209	·304	237·350	− 2·7184	− 2·7182	− 2·7183	− 0·2	−22·4	450·6113
209	210	·617	237·967	−14·3942	−14·3925	−14·3934	− 1·7	−24·1	436·2179
210	211	·512	238·479	−14·6631	−14·6636	−14·6634	+ 0·5	−23·6	421·5545
211	212	·328	238·807	− 2·2991	− 2·2982	− 2·2986	− 0·9	−24·5	419·2559
212	213	·561	239·368	−13·9505	−13·9502	−13·9504	− 0·3	−24·8	405·3055
213	214	·708	240·076	−14·3877	−14·3899	−14·3888	+ 2·2	−22·6	390·9167
214	215	·750	240·826	−16·7365	−16·7362	−16·7364	− 0·3	−22·9	374·1803
215	216	·678	241·504	−15·1141	−15·1150	−15·1146	+ 0·9	−22·0	359·0657
216	217	·664	242·168	−13·7913	−13·7915	−13·7914	+ 0·2	−21·8	345·2743
217	218	·868	243·036	−13·9268	−13·9306	−13·9287	+ 3·8	−18·0	331·3456
218	CXXVIII	·430	243·466	− 1·1454	− 1·1487	− 1·1470	+ 3·3	−14·7	330·1986
CXXVIII	219	·916	244·382	−11·0673	−11·0669	−11·0671	− 0·4	−15·1	319·1315
219	220	1·064	245·446	−11·1420	−11·1480	−11·1450	+ 6·0	− 9·1	307·9865
220	221	1·247	246·693	−12·9645	−12·9667	−12·9656	+ 2·2	− 6·9	295·0209
221	222	1·093	247·786	− 6·4322	− 6·4301	− 6·4312	− 2·1	− 9·0	288·5897
222	223	1·076	248·862	−10·3881	−10·3821	−10·3851	− 6·0	−15·0	278·2046
223	224	1·000	249·862	− 7·2578	− 7·2603	− 7·2590	+ 2·5	−12·5	270·9456
224	225	1·149	251·011	− 9·8259	− 9·8286	− 9·8272	+ 2·7	− 9·8	261·1184
225	XLIX	·698	251·709	− 5·4827	− 5·4851	− 5·4839	+ 2·4	− 7·4	*255·6345
XLIX	XLVIII	·049	251·758	+ 1·1356	+ 1·1354	+ 1·1355	+ 0·2	− 7·2	*256·7700

* Compare with the elevations given for these bench marks on p. 369 of this Report.

The following elevations on the top of the railroad rail, or on top of the ballast of the railroad, in front of the railroad stations unless otherwise stated, were also determined during the course of the leveling, in addition to the elevations shown in the preceding tabulation. These elevations are upon the same basis as the elevations given in the tabulation, and are of course subject to the same corrections, due to adjustments to be made later, as are elevations given for the same locality in the tabulations.

Little Rock, Ark., to Fort Smith, Ark.

	Elevation m.
Coal Hill, ballast, Little Rock and Fort Smith Railroad	142·88
Altea, ballast, Litttle Rock and Fort Smith Railroad	163·30
Ozark, ballast, Little Rock and Fort Smith Railroad	112·85
White Oak, ballast, Little Rock and Fort Smith Railroad	118·77
Pleasant Valley, ballast, Little Rock and Fort Smith Railroad	125·21
Mulberry, ballast, Little Rock and Fort Smith Railroad	119·37
Dyer Station, ballast, Little Rock and Fort Smith Railroad	130·22
Alma, ballast, Little Rock and Fort Smith Railroad	131·70

Railroad crossing, St. Louis and San Francisco and Arkansas branch Texas Railroad	127·34
Van Buren, ballast, Little Rock and Fort Smith Railroad	123·94
Fort Smith, ballast, St. Louis and San Francisco Railroad	128·78
Fort Smith, ballast, Little Rock and Fort Smith Railroad	129·47

Van Buren, Ark., to Chester, Ark.

*Van Buren, ballast, St. Louis and San Francisco Railroad	134·20
Lillie, ballast, St. Louis and San Francisco Railroad	138·36
Rudy, ballast, St. Louis and San Francisco Railroad	150·69
†Lancaster, ballast, St. Louis and San Francisco Railroad	189·24
Mountainburg, ballast, St. Louis and San Francisco Railroad	217·67

Boston, Mo., to Chester, Ark.

Boston, ballast, Missouri Pacific Railroad	287·68
Jasper, ballast, Missouri Pacific Railroad	289·39
Carytown, ballast, Missouri Pacific Railroad	280·88
†Knights, ballast, St. Louis and San Francisco Railroad	329·29
Reeds, ballast, St. Louis and San Francisco Railroad	341·06
Sarcoxie, ballast, St. Louis and San Francisco Railroad	336·70
Talmage, ballast, St. Louis and San Francisco Railroad	374·95
Wentworth, ballast, St. Louis and San Francisco Railroad	374·12
Purdy, rail, St. Louis and San Francisco Railroad	451·76
Pierce City, ballast, St. Louis and San Francisco Railroad	364·98
Butterfield, ballast, St. Louis and San Francisco Railroad	468·41
Washburn, rail, St. Louis and San Francisco Railroad	446·02
Seligman, rail, St. Louis and San Francisco Railroad	468·66
‡Hurds Switch, rail, St. Louis and San Francisco Railroad	486·62
Garfield, rail, St. Louis and San Francisco Railroad	463·31
Avoca, rail, St. Louis and San Francisco Railroad	414·05
Lowell, rail, St. Louis and San Francisco Railroad	409·29
Springdale, rail, St. Louis and San Francisco Railroad	403·85
Fayetteville, rail, St. Louis and San Francisco Railroad	406·72
West Fork, rail, St. Louis and San Francisco Railroad	408·14
Greenland, rail, St. Louis and San Francisco Railroad	380·25
Brentwood, rail, St. Louis and San Francisco Railroad	451·04
Winslow, rail, St. Louis and San Francisco Railroad	526·67
Porter, rail, St. Louis and San Francisco Railroad	330·39

COLORADO SPRINGS–DENVER, AND LIMON–DENVER LINES.

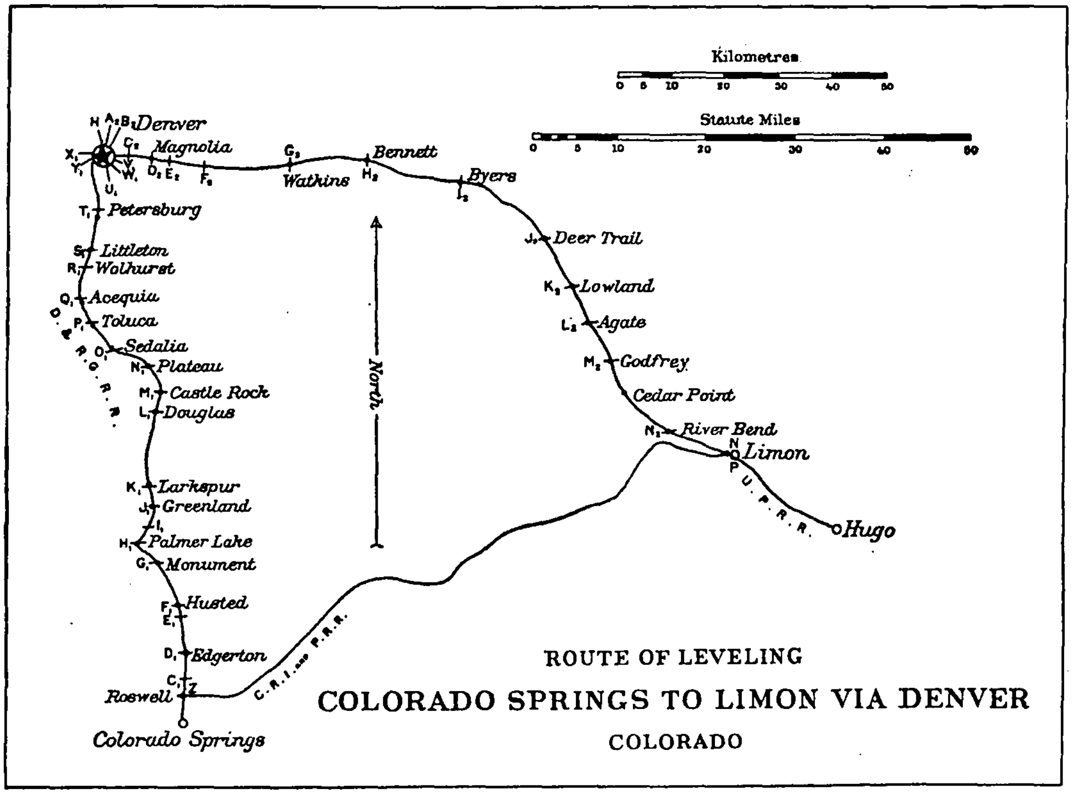
The lines of precise leveling connecting Colorado Springs and Denver, and Limon and Denver, were run by Isaac Winston, Assistant, between July 9 and November 10, 1898, using levels No. 5 and No. 6 and rods P and Q. The leveling was commenced at bench mark Z, at Roswell, Colo., and proceeded northward along the Denver and Rio Grande Railroad to Denver, Colo., 119 kilometres (=74 miles), and thence southeastward over the Union Pacific to bench marks N, O, and P at Limon, 146 kilometres (=91 miles). Bench marks Z, N, O, and P at Roswell and at Limon were established in 1898 on the transcontinental line of levels. The two lines here treated, together with the portion Limon to Colorado Springs of the line Hugo to Colorado Springs, of which the results are published in Appendix No. 3 of Coast and Geodetic Survey Report

*In front of freight depot. †At road crossing. ‡In front of mail stand.

1897–98, pages 215–228, form a closed circuit 387 kilometres (=240 miles) in circumference, of which the closing error is 29 centimetres. All of the lines on this circuit were run as simultaneous double lines, continuously in one direction, clock-wise around the circuit, and the programme of observing indicated on page 417 was used.

The corrections for length and temperature of rods and for the index error of rods,

No. 3.



ROUTE OF LEVELING

COLORADO SPRINGS TO LIMON VIA DENVER

COLORADO

as well as for the measured angle between target and horizon, inequality of collars, curvature, and refraction, were applied in the office computation.

The direct results of these lines are given in the following tabulation. Although the line between Limon and Denver was run in the direction Denver to Limon, it has for convenience been tabulated as if run from Limon toward Denver. The elevation of the top of rail was determined at seventeen points between Colorado Springs and Denver, and at eight points between Limon and Denver, as indicated in the tabulation thus: R. R. S. (1), R. R. S. (2), etc.

Results of spirit leveling from Colorado Springs to Denver, Colo.

[For approximate location of permanent bench marks see sketch p. 384.]

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation. Rod P.	Difference of elevation. Rod Q.	Difference of elevation. Mean.	Discrepancy (P—Q). Partial.	Discrepancy (P—Q). Total.	Elevation above bench mark K_3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	Z		1 464·285*						*1 727·1599
Z	139	·918	1 465·203	+ 5·5876	+ 5·5894	+ 5·5885	−1·8	− 1·8	1 732·7484
139	140	1·097	1 466·300	+10·5425	+10.5429	+10·5427	−0·4	− 2·2	1 743·2911
140	141	1·346	1 467·646	+13·0416	+13·0446	+13·0431	−3·0	− 5·2	1 756·3342
141	142	·846	1 468·492	+ 7·4681	+ 7·4725	+ 7·4703	−4·4	− 9·6	1 763·8045
142	143	1·034	1 469·526	+ 8·6878	+ 8·6899	+ 8·6888	−2·1	−11·7	1 772·4933
143	C_1	·162	1 469·688	− 3·7316	− 3·7321	− 3·7318	+0·5	−11·2	1 768·7615
143	144	1·092	1 470·618	+ 8·4455	+ 8·4455	+ 8·4455	0·0	−11·7	1 780·9388
144	145	1·093	1 471·711	+ 8·4628	+ 8·4608	+ 8·4618	+2·0	− 9·7	1 789·4006
145	146	1·154	1 472·865	+11·4586	+11·4581	+11·4584	+0·5	− 8·2	1 800·8590
146	147	1·089	1 473·954	+ 8·0756	+ 8·0752	+ 8·0754	+0·4	− 8·8	1 808.9344
147	148	1·108	1 475·062	+ 8·9608	+ 8·9575	+ 8·9591	+3·3	− 5·5	1 817·8935
148	D_1	·302	1 475·364	+ 3·1570	+ 3·1573	+ 3·1572	−0·3	− 5·8	1 821·0507
D_1	R. R. S. (1)	·510	1 475·874	+ 5·465		+ 5·465			1 826·516
D_1	149	·982	1 476·346	+ 9·9050	+ 9·9017	+ 9·9033	+3·3	− 2·5	1 830·9540
149	150	1·120	1 477·466	+ 9·1559	+ 9·1496	+ 9·1528	+6·3	+ 3·8	1 840·1068
150	151	1·131	1 478·597	+11·4136	+11·4117	+11·4126	+1·9	+ 5·7	1 851·5194
151	E_1	·990	1 479·587	+ 8·7960	+ 8·7963	+ 8·7962	−0·3	+ 5·4	1 860·3156
E_1	152	1·062	1 480·649	+10·3477	+10·3485	+10·3481	−0·8	+ 4·6	1 870·6637
152	R. R. S. (2)	1·059	1 481·708	+10·046		+10·046			1 880·710
152	F_1	1·250	1 481·899	+10·3870	+10·3893	+10·3881	−2·3	+ 2·3	1 881·0518
152	153	1·260	1 481·909	+10·0079	+10·0104	+10·0092	−2·5	+ 2·1	1 880·6729
153	154	1·094	1 483·003	+ 6·5089	+ 6·5076	+ 6·5082	+1·3	+ 3·4	1 887·1811
154	155	1·081	1 484·084	+11·6279	+11·6305	+11·6292	−2·6	+ 0·8	1 898·8103
155	156	1·050	1 485·134	+12·4553	+12·4534	+12·4544	+1·9	+ 2·7	1 911·2647
156	157	1·008	1 486·142	+14·8470	+14·8499	+14·8484	−2·9	− 0·2	1 926·1131
157	158	1·062	1 487·204	+13·5207	+13·5224	+13·5216	−1·7	− 1·9	1 939·6347
158	159	1·042	1 488·246	+13·6024	+13·6033	+13·6028	−0·9	− 2·8	1 953·2375
159	160	·990	1 489·236	†+12·5640	†+12·5610	+12·5625	+3·0	+ 0·2	1 965·8000
160	161	1·198	1 490·434	+16·0900	+16·0893	+16·0897	+0·7	+ 0·9	1 981·8897
161	G_1	·928	1 491·362	+13·2058	+13·2063	+13·2060	−0·5	+ 0·4	1 995·0957
161	162	·926	1 491·360	+12·9768	+12·9772	+12·9770	−0·4	+ 0·5	1 994·8667
162	R. R. S. (3)			+ 0·301		+ 0·301			1 995·168
162	163	·896	1 492·256	+12·7534	+12·7519	+12·7526	+1·5	+ 2·0	2 007·6193
163	164	1·032	1 493·288	+14·6197	+14·6215	+14·6206	−1·8	+ 0·2	2 022·2399
164	165	1·034	1 494·322	+14·6065	+14·6086	+14·6076	−2·1	− 1·9	2 036·8475
165	166	1·008	1 495·330	+13·7285	+13·7280	+13·7282	+0·5	− 1·4	2 050·5757
166	167	1·168	1 496·498	+16·5160	+16·5147	+16·5154	+1·3	− 0·1	2 067·0911
167	168	·810	1 497·308	+ 8·6254	+ 8·6243	+ 8·6248	+1·1	+ 1·0	2 075·7159
168	R. R. S. (4)			+ 0·348		+ 0·348			2 076·064
168	H_1	·131	1 497·439	+ 0·4401	+ 0·4407	+ 0·4404	−0·6	+ 0·4	2 076·1563

* From Appendix No. 3, Report for 1897–98 † Mean of two measures.

Results of spirit leveling from Colorado Springs to Denver, Colo.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation.			Discrepancy (P−Q).		Elevation above bench mark K_3 at St. Louis.
From	To			Rod P.	Rod Q.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
168	169	1·054	1 498·362	−11·5098	−11·5118	−11·5108	+2·0	+ 3·0	2 064·2051
169	170	1·054	1 499·416	−14·2572	−14·2590	−14·2581	+1·8	+ 4·8	2 049·9470
170	171	·898	1 500·314	−11·9193	−11·9212	−11·9202	+1·9	+ 6·7	2 038·0268
171	172	·812	1 501·126	− 9·6214	− 9·6239	− 9·6227	+2·5	+ 9·2	2 028·4041
172	I_1	·077	1 501·203	− 0·4334	− 0·4336	− 0·4335	+0·2	+ 9·4	2 027·9706
172	173	·955	1 502·081	−10·1494	−10·1483	−10·1488	−1·1	+ 8·1	2 018·2553
173	174	1·012	1 503·093	−10·3552	−10·3570	−10·3561	+1·8	+ 9·9	2 007·8992
174	175	1·404	1 504·497	−13·4418	−13·4431	−13·4425	+1·3	+11·2	1 994·4567
175	176	1·010	1 505·507	−12·2379	−12·2389	−12·2384	+1·0	+12·2	1 982·2183
176	R. R. S. (5)	·394	1 505·901	− 2·850		− 2·850			1 979·368
176	177	·976	1 506·483	− 9·7345	− 9·7366	− 9·7355	+2·1	+14·3	1 972·4828
177	J_1	·064	1 506·547	+ 2·3302	+ 2·3296	+ 2·3299	+0·6	+14·9	1 974·8127
177	178	1·047	1 507·530	−13·7574	−13·7591	−13·7583	+1·7	+16·0	1 958·7245
178	179	1·212	1 508·742	−14·5186	−14·5191	−14·5188	+0·5	+16·5	1 944·2057
179	180	1·200	1 509·942	−14·2055	−14·2046	−14·2051	−0·9	+15·6	1 930·0006
180	181	1·004	1 510·946	−13·5931	−13·5974	−13·5952	+4·3	+19·9	1 916·4054
181	K_1	·588	1 511·534	− 6·9175	− 6·9186	− 6·9181	+1·1	+21·0	1 909·4873
K_1	R. R. S. (6)	·650	1 512·184	− 6·334		− 6·334			1 903·153
K_1	182	1·024	1 512·558	− 9·8361	− 9·8391	− 9·8376	+3·0	+24·0	1 899·6497
182	183	1·008	1 513·566	− 8·9662	− 8·9685	− 8·9674	+2.3	+26·3	1 890·6823
183	184	1·338	1 514·904	− 0·8952	− 0·8947	− 0·8949	−0·5	+25·8	1 889·7874
184	185	·998	1 515·902	− 0·1415	− 0·1420	− 0·1418	+0·5	+26·3	1 889·6456
185	186	1·326	1 517·228	− 9·5489	− 9·5443	− 9.5466	−4·6	+21·7	1 880·0990
186	187	1·074	1 518·302	−11·7511	−11·7516	−11·7513	+0·5	+22·2	1 868·3477
187	188	1·136	1 519·438	−11·4423	−11·4472	−11·4448	+4·9	+27·1	1 856·9029
188	189	1·228	1 520·666	−13·7651	−13·7652	−13·7651	+0·1	+27·2	1 843·1378
189	190	1·078	1 521·744	−10·6219	−10·6224	−10·6222	+0·5	+27·7	1 832·5156
190	191	1·132	1 522·876	−12·6093	−12·6117	−12·6105	+2·4	+30·1	1 819·9051
191	192	1·544	1 524·420	−18·4596	−18·4613	−18·4604	+1·7	+31·8	1 801·4447
192	R. R. S. (7)	·466	1 524·886	− 3·717		− 3·717			1 797·728
192	L_1	·776	1 525·196	− 4·3930	− 4·3969	− 4·3950	+3·9	+35·7	1 797·0497
L_1	193	1·010	1 526·206	− 3·0840	− 3·0839	− 3·0839	−0·1	+35·6	1 793·9658
193	194	1·120	1 527·326	*−11·5294	*−11·5319	−11·5307	+2·5	+38·1	1 782·4351
194	195	1·183	1 528·509	−13·5582	−13·5549	−13·5565	−3·3	+34·8	1 768·8786
195	R. R. S. (8)	·522	1 529·031	− 3·057		− 3·057			1 765·822
195	196	·567	1 529·076	− 3·6425	− 3·6414	− 3·6420	−1·1	+33·7	1 765·2366
196	M_1	·331	1 529·407	− 0·8657	− 0·8689	− 0·8673	+3·2	+36·9	1 764·3693
196	197	1·033	1 530·109	− 8·2680	− 8·2724	− 8·2702	+4·4	+38·1	1 756·9664
197	198	·932	1 531·041	− 5·7903	− 5·7897	− 5·7900	−0·6	+37·5	1 751·1764

* Mean of two measures.

Result of spirit leveling from Colorado Springs to Denver, Colo.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation.			Discrepancy (P−Q.)		Elevation above bench mark K_3 at St. Louis.
From	To			Rod P.	Rod Q.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
198	199	1·096	1 532·137	−14·3869	−14·3878	−14·3873	+0·9	+38·4	1 736·7891
199	200	1·132	1 533·269	−12·1550	−12·1574	−12·1562	+2·4	+40·8	1 724·6329
200	201	1·002	1 534·271	− 8·5474	− 8·5522	− 8·5498	+4·8	+45·6	1 716·0831
201	R. R. S. (9)	·859	1 535·130	− 8·113		− 8·113			1 707·970
201	202	1·058	1 535·329	− 9·7548	− 9·7531	− 9·7540	−1·7	+43·9	1 706·3291
202	203	·563	1 535·892	− 0·1584	− 0·1564	− 0·1574	−2·0	+41·9	1 706·1717
203	N_1	·166	1 536·058	+ 0·4411	+ 0·4418	+ 0·4414	−0·7	+41·2	1 706·6131
203	204	1·006	1 536·898	− 7·4068	− 7·4060	− 7·4064	−0·8	+41·1	1 698·7653
204	205	1·045	1 537·943	*− 8·8850	*− 8·8884	− 8·8867	+3·4	+44·5	1 689·8786
205	206	1·116	1 539·059	−11·2945	−11·2984	−11·2964	+3·9	+48·4	1 678·5822
206	207	1·082	1 540·141	−10·3404	−10·3432	−10·3418	+2·8	+51·2	1 668·2404
207	208	1·022	1 541·163	−13·1120	−13·1112	−13·1116	−0·8	+50·4	1 655·1288
208	O_1	·212	1 541·375	− 1·3067	− 1·3072	− 1·3070	+0·5	+50·9	1 653·8218
O_1	R.R.S.(10)	·634	1 542·009	− 4·824		− 4·824			1 648·998
O_1	209	·835	1 542·210	− 5·5612	− 5·5609	− 5·5610	−0·3	+50·6	1 648·2608
209	210	1·056	1 543·266	− 9·8599	− 9·8593	− 9·8596	−0·6	+50·0	1 638·4012
210	211	1·254	1 544·520	*−11·6954	*−11·6994	−11·6974	+4·0	+54·0	1 626·7038
211	212	·826	1 545·346	− 6·2106	− 6·2099	− 6·2103	−0·7	+53·3	1 620·4935
212	213	1·096	1 546·442	− 9·8641	− 9·8644	− 9·8642	+0·3	+53·6	1 610·6293
213	214	1·132	1 547·574	− 8·3043	− 8·3032	− 8·3038	−1·1	+52·5	1 602·3255
214	R.R.S.(11)	·245	1 547·819	− 2·169		− 2·169			1 600·157
214	215	·986	1 548·560	−10·2377	−10·2348	−10·2362	−2·9	+49·6	1 592·0893
215	216	1·156	1 549·716	− 6·4115	− 6·4126	− 6·4121	+1·1	+50·7	1 585·6772
216	P_1	·222	1 549·938	− 0·9211	− 0·9221	− 0·9216	+1·0	+51·7	1 584·7556
P_1	217	1·078	1 551·016	− 7·5003	− 7·5000	− 7·5001	−0·3	+51·4	1 577·2555
217	218	1·932	1 552·948	−15·8281	−15·8306	−15·8294	+2·5	+53·9	1 561·4261
218	R.R.S.(12)	·920	1 553·868	− 5·923		− 5·923			1 555·503
218	219	·990	1 553·938	− 6·2809	− 6·2832	− 6·2820	+2·3	+56·2	1 555·1441
219	220	·947	1 554·885	*− 2·1158	*− 2·1195	− 2·1177	+3·7	+59·9	1 553·0264
220	Q_1	·176	1 555·061	− 1·6040	− 1·6033	− 1·6036	−0·7	+59·2	1 551·4228
Q_1	221	·992	1 556·053	*+ 0·2723	*+ 0·2720	+ 0·2722	+0·3	+59·5	1 551·6950
221	222	·950	1 557·003	− 6·8520	− 6·8501	− 6·8510	−1·9	+57·6	1 544·8440
222	223	·869	1 557·872	− 5·4496	− 5·4489	− 5·4493	−0·7	+56·9	1 539·3947
223	224	1·042	1 558·914	−10·0009	− 9·9962	− 9·9985	−4·7	+52·2	1 529·3962
224	R.R.S.(13)	·924	1 559·838	− 8·070		− 8·070			1 521·326
224	R_1	·813	1 559·727	*− 7·8930	*− 7·8953	− 7·8942	+2·3	+54·5	1 521·5020
R_1	225	·877	1 560·604	− 3·8433	− 3·8411	− 3·8422	−2·2	+52·3	1 517·6598
225	226	1·389	1 561·993	− 1·9541	− 1·9494	− 1·9517	−4·7	+47·6	1 515·7081
226	227	1·034	1 563·027	− 5·8396	− 5·8442	− 5·8419	+4·6	+52·2	1 509·8662
227	228	1·002	1 564·029	− 1·7546	− 1·7501	− 1·7524	−4·5	+47·7	1 508·1138
228	229	·940	1 564·969	− 1·1501	− 1·1486	− 1·1493	−1·5	+46·2	1 506·9645

* Mean of two measures.

Result of spirit leveling from Colorado Springs to Denver, Colo.—Continued.

Bench marks. From	Bench marks. To	Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation. Rod P.	Difference of elevation. Rod Q.	Difference of elevation. Mean.	Discrepancy (P−Q). Partial.	Discrepancy (P−Q). Total.	Elevation above bench mark K_3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
229	R.R.S.(14)	·185	1 565·154	+ 0·210		+ 0·210			1 507·174
229	S_1	·043	1 565·012	+ 1·3399	+ 1·3400	+ 1·3400	−0·1	+46·1	1 508·3045
229	230	1·002	1 565·971	− 3·8826	− 3·8866	− 3·8846	+4·0	+50·2	1 503·0799
230	231	·972	1 566·943	− 5·4699	− 5·4676	− 5·4685	−1·8	+48·4	1 497·6114
231	232	1·139	1 568·082	− 2·6611	− 2·6579	− 2·6600	−4·1	+44·3	1 494·9514
232	R.R.S.(15)	1·079	1 569·161	− 3·186		− 3·186			1 491·765
232	233	1·235	1 569·317	− 3·8211	− 3·8225	− 3·8218	+1·4	+45·7	1 491·1296
233	T_1	·979	1 570·296	*− 7·5385	*− 7·5377	− 7·5381	−0·8	+44·9	1 483·5915
T_1	234	1·032	1 571·328	+ 1·2957	+ 1·2907	+ 1·2932	+5·0	+49·9	1 484·8847
234	235	1·050	1 572·378	− 4·9259	− 4·9275	− 4·9267	+1·6	+51·5	1 479·9580
235	236	·937	1 573·315	− 2·8005	− 2·7987	− 2·7996	−1·8	+49·7	1 477·1584
236	237	1·042	1 574·357	− 2·0399	− 2·0432	− 2·0415	+3·3	+53·0	1 475·1169
237	238	1·116	1 575·473	− 1·5844	− 1·5882	− 1·5863	+3·8	+56·8	1 473·5306
238	239	·910	1 576·383	*− 1·2442	*− 1·2490	− 1·2466	+4·8	+61·6	1 472·2840
239	240	·870	1 577·253	− 3·8232	− 3·8228	− 3·8230	−0·4	+61·2	1 468·4610
240	241	·892	1 578·145	+ 3·6691	+ 3·6725	+ 3·6708	−3·4	+57·8	1 472·1318
241	242	·967	1 579·112	− 6·8517	− 6·8487	− 6·8502	−3·0	+54·8	1 465·2816
242	243	·902	1 580·014	+ 2·2249	+ 2·2239	+ 2·2244	+1·0	+55·8	1 467·5060
243	U_1	·761	1 580·775	+15·2020	+15·2041	+15·2031	−2·1	+53·7	1 482·7091
U_1	V_1	·126	1 580·901	− 0·2474	− 0·2476	− 0·2475	+0·2	+53·9	1 482·4616
U_1	W_1	·106	1 581·007	+ 0·0485	+ 0·0487	+ 0·0486	−0·2	+53·7	1 482·7577
V_1	244	·856	1 581·757	− 8·5079	− 8·5093	− 8·5086	+1·4	+55·3	1 473·9530
244	245	·845	1 582·602	−11·5356	−11·5404	−11·5380	+4·8	+60·1	1 462·4150
245	246	1·108	1 583·710	− 8·2490	− 8·2502	− 8·2496	+1·2	+61·3	1 454·1654
246	X_1	·048	1 583·758	+ 0·6535	+ 0·6536	+ 0·6536	−0·1	+61·2	1 454·8190
246	Y_1	·049	1 583·759	+ 0·0356	+ 0·0353	+ 0·0354	+0·3	+61·6	1 454·2008
246	R.R.S.(16)			+ 0·088		+ 0·088			1 454·2534
246	R.R.S.(17)			− 0·064		− 0·064			1 454·1014

*Mean of two measures.

Results of spirit leveling from Limon to Denver, Colo.

[For approximate location of permanent bench marks see sketch, p. 384.]

Bench marks.		Distance between successive bench marks.	Distance from bench mark K3 at St. Louis.	Difference of elevation.			Discrepancy (P−Q).		Elevation above bench mark K3 at St. Louis.
From	To			Rod P.	Rod Q.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
	N		1 341·754*						*1 506·0375
N	377	·218	1 341·972	+ 1·0514	+ 1·0512	+ 1·0513	+0·2	+ 0·2	1 507·0888
377	O	·319	1 342·291	+ 5·9501	+ 5·9495	+ 5·9498	+0·6		1 513·0386
									*1 513·0341
								Mean	=1 513·0364
377	P	·319	1 342·291	+ 5·9363	+ 5·9362	+ 5·9362	+0·1		1 513·0250
									*1 513·0219
								Mean	=1 513·0234
377	376	·956	1 342·928	+ 4·7279	+ 4·7276	+ 4·7278	+0·3	+ 0·5	1 511·8166
376	375	1·149	1 344·077	+ 1·9978	+ 1·9990	+ 1·9984	−1·2	− 0·7	1 513·8150
375	374	1·140	1 345·217	+ 3·3568	+ 3·3594	+ 3·3581	−2·6	− 3·3	1 517·1731
374	373	1·148	1 346·365	+ 4·9574	+ 4·9602	+ 4·9588	−2·8	− 6·1	1 522·1319
373	372	1·150	1 347·515	+ 4·9321	+ 4·9341	+ 4·9331	−2·0	− 8·1	1 527·0650
372	371	1·113	1 348·628	+ 5·7570	+ 5·7611	+ 5·7590	−4·1	−12·2	1 532·8240
371	370	1·150	1 349·778	+ 7·5215	+ 7·5261	+ 7·5238	−4·6	−16·8	1 540·3478
370	369	1·148	1 350·926	+ 2·5407	+ 2·5426	+ 2·5417	−1·9	−18·7	1 542·8895
369	368	1·122	1 352·048	+ 4·7763	+ 4·7810	+ 4·7786	−4·7	−23·4	1 547·6681
368	R. R. S. (1)			+ 0·304		+ 0·304			1 547·972
368	367	1·138	1 353·186	+ 2·3695	+ 2·3649	+ 2·3672	+4·6	−18·8	1 550·0353
367	N_2	1·142	1 354·328	− 0·9285	− 0·9225	− 0·9255	−6·0	−24·8	1 549·1098
367	366	1·144	1 354·330	+ 5·2039	+ 5·2041	+ 5·2040	−0·2	−19·0	1 555·2393
366	365	1·148	1 355·478	+ 4·6856	+ 4·6884	+ 4·6870	−2·8	−21·8	1 559·9263
365	364	1·152	1 356·630	+ 2·3524	+ 2·3568	+ 2·3546	−4·4	−26·2	1 562·2809
364	363	1·342	1 357·972	+10·8663	+10·8707	+10·8685	−4·4	−30·6	1 573·1494
363	362	1·059	1 359·031	+10·6996	+10·6975	+10·6986	+2·1	−28·5	1 583·8480
362	361	·966	1 359·997	+ 9·6018	+ 9·6026	+ 9·6022	−0·8	−29·3	1 593·4502
361	360	1·148	1 361·145	+11·3859	+11·3901	+11·3880	−4·2	−33·5	1 604·8382
360	359	1·137	1 362·282	+ 9·7595	+ 9·7632	+ 9·7614	−3·7	−37·2	1 614·5996
359	358	1·132	1 363·414	− 6·5706	− 6·5740	− 6·5723	+3·4	−33·8	1 608·0273
358	R. R. S. (2)			+ 7·022		+ 7·022			1 615·049
358	357	1·133	1 364·547	− 5·2504	− 5·2488	− 5·2496	−1·6	−35·4	1 602·7777
357	356	1·144	1 365·691	− 9·5053	− 9·5061	− 9·5057	+0·8	−34·6	1 593·2720
356	355	1·138	1 366·829	− 6·3327	− 6·3308	− 6·3318	−1·9	−36·5	1 586·9402
355	354	1·152	1 367·981	− 8·1889	− 8·1883	− 8·1886	−0·6	−37·1	1 578·7516
354	M_2	1·097	1 369·078	+ 0·4471	+ 0·4482	+ 0·4476	−1·1	−38·2	1 579·1992
M_2	353	·512	1 369·590	− 1·5515	− 1·5519	− 1·5517	+0·4	−37·8	1 577·6475
353	352	1·128	1 370·718	+ 0·7292	+ 0·7316	+ 0·7304	−2·4	−40·2	1 578·3779
352	351	1·126	1 371·844	− 3·5815	− 3·5777	− 3·5796	−3·8	−44·0	1 574·7983
351	350	1·132	1 372·976	− 4·1824	− 4·1821	− 4·1822	−0·3	−44·3	1 570·6161
350	349	1·152	1 374·128	−11·7052	−11·7055	−11·7054	+0·3	−44·0	1 558·9107
349	348	·970	1 375·098	− 9·7885	− 9·7855	− 9·7870	−3·0	−47·0	1 549·1237
348	347	·838	1 375·936	− 6·6405	− 6·6380	− 6·6392	−2·5	−49·5	1 542·4845
347	346	1·112	1 377·048	− 5·3639	− 5·3675	− 5·3657	+3·6	−45·9	1 537·1188

*From App. No. 3, Report for 1897–98.

Results of spirit leveling from Limon to Denver, Colo.—Continued.

Bench mark. From	Bench mark. To	Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation. Rod P.	Difference of elevation. Rod Q.	Difference of elevation. Mean.	Discrepancy (P—Q). Partial.	Discrepancy (P—Q). Total.	Elevation above bench mark K_3 at St. Louis.
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
346	L_2	·026	1 377·074	+ 1·2243	+ 1·2246	+ 1·2245	−0·3	−46·2	1 538·3433
346	R. R. S. (3)			+ 0·252		+ 0·252			1 537·371
346	345	·377	1 377·425	− 1·6946	− 1·6960	− 1·6953	+1·4	−44·5	1 535·4235
345	344	1·093	1 378·518	−10·8676	−10·8709	−10·8693	+3·3	−41·2	1 524·5542
344	343	1·148	1 379·666	− 9·8642	− 9·8618	− 9·8630	−2·4	−43·6	1 514·6912
343	342	1·130	1 380·796	− 7·2244	− 7·2287	− 7·2265	+4·3	−39·3	1 507·4647
342	341	1·078	1 381·874	− 3·8892	− 3·8883	− 3·8888	−0·9	−40·2	1 503·5759
341	340	1·032	1 382·906	− 4·8764	− 4·8760	− 4·8762	−0·4	−40·6	1 498·6997
340	339	·941	1 383·847	− 2·2190	− 2·2184	− 2·2187	−0·6	−41·2	1 496·4810
339	338	1·139	1 384·986	− 1·6322	− 1·6300	− 1·6311	−2·2	−43·4	1 494·8499
338	337	1·125	1 386·111	− 0·0871	− 0·0857	− 0·0864	−1·4	−44·8	1 494·7635
337	K_2	·024	1 386·135	+ 0·4417	+ 0·4416	+ 0·4416	+0·1	−44·7	1 495·2051
337	336	·941	1 387·052	− 1·4859	− 1·4860	− 1·4860	+0·1	−44·7	1 493·2775
336	335	1·148	1 388·200	− 8·0089	− 8·0107	− 8·0098	+1·8	−42·9	1 485·2677
335	334	1·112	1 389·312	− 6·1062	− 6·1081	− 6·1071	+1·9	−41·0	1 479·1606
334	333	1·151	1 390·463	− 6·8578	− 6·8564	− 6·8571	−1·4	−42·4	1 472·3035
333	332	1·338	1 391·801	+ 3·5063	+ 3·5026	+ 3·5044	+3·7	−38·7	1 475·8079
332	331	1·131	1 392·932	− 3·8172	− 3·8172	− 3·8172	0·0	−38·7	1 471·9907
331	330	1·148	1 394·080	− 8·7256	− 8·7278	− 8·7267	+2·2	−36·5	1 463·2640
330	329	1·114	1 395·194	− 5·1434	− 5·1426	− 5·1430	−0·8	−37·3	1 458·1210
329	328	1·122	1 396·316	− 4·2554	− 4·2571	− 4·2563	+1·7	−35·6	1 453·8647
328	R. R. S. (4)			+ 0·279		+ 0·279			1 454·144
328	J_2	·016	1 396·332	+ 0·0493	+ 0·0495	+ 0·0494	−0·2	−35·8	1 453·9141
328	327	·562	1 396·878	− 1·9004	− 1·8992	− 1·8998	−1·2	−36·8	1 451·9649
327	326	1·133	1 398·011	− 2·4965	− 2·4938	− 2·4951	−2·7	−39·5	1 449·4698
326	325	1·149	1 399·160	− 4·4130	− 4·4172	− 4·4151	+4·2	−35·3	1 445·0547
325	324	1·167	1 400·327	+ 2·6307	+ 2·6352	+ 2·6330	−4·5	−39·8	1 447·6877
324	323	1·156	1 401·483	*+ 9·5910	*+ 9·5950	+ 9·5930	−4·0	−43·8	1 457·2807
323	322	1·144	1 402·627	− 6·7817	− 6·7831	− 6·7824	+1·4	−42·4	1 450·4983
322	321	1·518	1 404·145	+ 1·5031	+ 1·5045	+ 1·5038	−1·4	−43·8	1 452·0021
321	320	1·144	1 405·289	+ 4·5531	+ 4·5560	+ 4·5545	−2·9	−46·7	1 456·5566
320	319	1·158	1 406·447	− 2·2672	− 2·2639	− 2·2656	−3·3	−50·0	1 454·2910
319	318	1·148	1 407·595	− 5·4074	− 5·4092	− 5·4083	+1·8	−48·2	1 448·8827
318	317	1·158	1 408·753	− 0·0191	− 0·0203	− 0·0197	+1·2	−47·0	1 448·8630
317	316	1·138	1 409·891	+ 6·6210	+ 6·6199	+ 6·6205	+1·1	−45·9	1 455·4835
316	315	1·102	1 410·993	+ 2·9364	+ 2·9380	+ 2·9372	−1·6	−47·5	1 458·4207
315	314	1·124	1 412·117	+ 4·7311	+ 4·7305	+ 4·7308	+0·6	−46·9	1 463·1515
314	313	1·137	1 413·254	+ 1·4629	+ 1·4611	+ 1·4620	+1·8	−45·1	1 464·6135
313	312	1·084	1 414·338	+ 2·0982	+ 2·0992	+ 2·0987	−1·0	−46·1	1 466·7122
312	311	·930	1 415·268	− 1·8989	− 1·8968	− 1·8978	−2·1	−48·2	1 464·8144
311	I_2	·950	1 416·218	− 5·4436	− 5·4460	− 5·4448	+2·4	−45·8	1 459·3696
I_2	R. R. S. (5)			+ 0·245		+ 0·245			1 459·615
I_2	310	1·194	1 417·412	+ 3·2005	+ 3·1987	+ 3·1996	+1·8	−44·0	1 462·5692
310	309	1·121	1 418·533	*+11·0512	*+11·0540	+11·0526	−2·8	−46·8	1 473·6218
309	308	·896	1 419·429	+ 9·1903	+ 9·1916	+ 9·1910	−1·3	−48·1	1 482·8128
308	307	·995	1 420·424	+ 6·6988	+ 6·7003	+ 6·6995	−1·5	−49·6	1 489·5123
307	306	1·034	1 421·458	+ 9·3745	+ 9·3714	+ 9·3730	+3·1	−46·5	1 498·8853

*Mean of two measures.

Results of spirit leveling from Limon to Denver, Colo.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation.			Discrepancy (P—Q).		Elevation above bench mark K_3 at St. Louis.
From	To			Rod P.	Rod Q.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
306	305	1·147	1 422·605	+10·2015	+10·2004	+10·2009	+1·1	—45·4	1 509·0862
305	304	·984	1 423·589	+ 7·5653	+ 7·5681	+ 7·5667	—2·8	—48·2	1 516·6529
304	303	1·050	1 424·639	— 4·5151	— 4·5116	— 4·5134	—3·5	—51·7	1 512·1395
303	302	1·130	1 425·769	+ 2·2173	+ 2·2214	+ 2·2194	—4·1	—55·8	1 514·3589
302	301	1·078	1 426·847	— 0·9090	— 0·9087	— 0·9088	—0·3	—56·1	1 513·4501
301	300	·923	1 427·770	+ 3·7126	+ 3·7126	+ 3·7126	0·0	—56·1	1 517·1627
300	299	·968	1 428·738	+ 0·9314	+ 0·9341	+ 0·9327	—2·7	—58·8	1 518·0954
299	298	·924	1 429·662	+ 5·4344	+ 5·4335	+ 5·4340	+0·9	—57·9	1 523·5294
298	297	1·060	1 430·722	+10·7475	+10·7487	+10·7481	—1·2	—59·1	1 534·2775
297	296	·948	1 431·670	+ 9·6300	+ 9·6326	+ 9·6313	—2·6	—61·7	1 543·9088
296	295	1·054	1 432·724	+ 2·3270	+ 2·3259	+ 2·3264	+1·1	—60·6	1 546·2352
295	294	1·098	1 433·822	—10·9243	—10·9251	—10·9247	+0·8	—59·8	1 535·3105
294	293	·948	1 434·770	+ 1·7046	+ 1·7032	+ 1·7039	+1·4	—58·4	1 537·0144
293	292	1·020	1 435·790	+ 8·2876	+ 8·2876	+ 8·2876	0·0	—58·4	1 545·3020
292	H_2	·064	1 435·854	+ 0·2111	+ 0·2113	+ 0·2112	—0·2	—58·6	1 545·5132
292	291	1·262	1 437·052	+ 2·5183	+ 2·5177	+ 2·5180	+0·6	—57·8	1 547·8200
291	R. R. S. (6)			— 2·198		— 2·198			1 545·622
291	290	·930	1 437·982	— 2·9973	— 2·9982	— 2·9978	+0·9	—56·9	1 544·8222
290	289	1·014	1 438·996	— 2·5233	— 2·5254	— 2·5243	+2·1	—54·8	1 542·2979
289	288	1·132	1 440·128	+ 4·1552	+ 4·1557	+ 4·1555	—0·5	—55·3	1 546·4534
288	287	1·095	1 441·223	+ 6·1561	+ 6·1558	+ 6·1559	+0·3	—55·0	1 552·6093
287	286	·893	1 442·116	+ 8·0062	+ 8·0076	+ 8·0069	—1·4	—56·4	1 560·6162
286	285	·856	1 442·972	+ 2·3017	+ 2·3023	+ 2·3020	—0·6	—57·0	1 562·9182
285	284	1·074	1 444·046	— 1·4234	— 1·4221	— 1·4228	—1·3	—58·3	1 561·4954
284	283	1·112	1 445·158	+ 4·1383	+ 4·1435	+ 4·1409	—5·2	—63·5	1 565·6363
283	282	1·003	1 446·161	+ 6·7508	+ 6·7503	+ 6·7506	+0·5	—63·0	1 572·3869
282	281	1·115	1 447·276	— 5·0592	— 5·0597	— 5·0594	+0·5	—62·5	1 567·3275
281	280	1·116	1 448·392	+ 3·8049	+ 3·8056	+ 3·8052	—0·7	—63·2	1 571·1327
280	279	1·114	1 449·506	—10·2803	—10·2798	—10·2801	—0·5	—63·7	1 560·8526
279	278	·875	1 450·381	— 2·3225	— 2·3228	— 2·3226	+0·3	—63·4	1 558·5300
278	277	1·006	1 451·387	— 2·4068	— 2·4060	— 2·4064	—0·8	—64·2	1 556·1236
277	R. R. S. (7)			+ 1·460		+ 1·460			1 557·584
277	G_2	·535	1 451·922	— 0·7721	— 0·7738	— 0·7730	+1·7	—62·5	1 555·3506
277	276	1·126	1 452·513	+ 4·1619	+ 4·1613	+ 4·1616	+0·6	—63·6	1 560·2852
276	275	1·166	1 453·679	+ 8·5855	+ 8·5845	+ 8·5850	+1·0	—62·6	1 568·8702
275	274	1·130	1 454·809	+ 8·7163	+ 8·7155	+ 8·7159	+0·8	—61·8	1 577·5861
274	273	1·072	1 455·881	+10·6701	+10·6700	+10·6701	+0·1	—61·7	1 588·2562
273	272	1·094	1 456·975	+ 1·4532	+ 1·4540	+ 1·4536	—0·8	—62·5	1 589·7098
272	271	1·110	1 458·085	—11·0662	—11·0663	—11·0663	+0·1	—62·4	1 578·6435
271	270	1·060	1 459·145	—11·1479	—11·1478	—11·1478	—0·1	—62·5	1 567·4957
270	269	·929	1 460·074	— 9·6744	— 9·6778	— 9·6761	+3·4	—59·1	1 557·8196
269	268	·966	1 461·040	— 9·0221	— 9·0264	— 9·0243	+4·3	—54·8	1 548·7953
268	267	1·139	1 462·179	— 0·3328	— 0·3307	— 0·3317	—2·1	—56·9	1 548·4636
267	F_2	1·088	1 463·267	— 1·8848	— 1·8868	— 1·8858	+2·0	—54·9	1 546·5778
267	266	1·040	1 463·219	+ 6·9523	+ 6·9539	+ 6·9531	—1·6	—58·5	1 555·4167
266	265	·948	1 464·167	— 9·7104	— 9·7067	— 9·7086	—3·7	—62·2	1 545·7081
265	264	1·056	1 465·223	— 9·1879	— 9·1841	— 9·1860	—3·8	—66·0	1 536·5221
264	263	1·038	1 466·261	— 8·9427	— 8·9409	— 8·9418	—1·8	—67·8	1 527·5803

Results of spirit leveling from Limon to Denver, Colo.—Continued.

Bench marks.		Distance between successive bench marks.	Distance from bench mark K_3 at St. Louis.	Difference of elevation.			Discrepancy (P–Q).		Elevation above bench mark K_3 at St. Louis.
From	To			Rod P.	Rod Q.	Mean.	Partial.	Total.	
		km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
263	E_2	1·024	1 467·285	− 6·6464	− 6·6411	− 6·6437	−5·3	−73·1	1 520·9366
E_2	262	1·372	1 468·657	−10·2413	−10·2401	−10·2407	−1·2	−74·3	1 510·6959
262	261	1·058	1 469·715	− 5·1342	− 5·1336	− 5·1339	−0·6	−74·9	1 505·5620
261	D_2	·892	1 470·607	− 5·0164	− 5·0178	− 5·0171	+1·4	−73·5	1 500·5449
D_2	260	·515	1 471·122	− 1·1484	− 1·1485	− 1·1484	+0·1	−73·4	1 499·3965
260	R. R. S. (8)			+ 0·458		+ 0·458			1 499·854
260	259	1·076	1 472·198	− 4·8598	− 4·8593	− 4·8596	−0·5	−73·9	1 494·5369
259	258	1·059	1 473·257	− 5·5214	− 5·5188	− 5·5201	−2·6	−76·5	1 489·0168
258	257	1·030	1 474·287	− 5·9147	− 5·9143	− 5·9145	−0·4	−76·9	1 483·1023
257	256	·931	1 475·218	*− 4·7790	*− 4·7743	− 4·7766	−4·7	−81·6	1 478·3257
256	255	1·271	1 476·489	+ 3·9783	+ 3·9784	+ 3·9784	−0·1	−81·7	1 482·3041
255	C_2	·182	1 476·671	+ 0·5816	+ 0·5810	+ 0·5813	+0·6	−81·1	1 482·8854
255	254	·950	1 477·439	+ 1·4784	+ 1·4812	+ 1·4798	−2·8	−84·5	1 483·7839
254	253	1·086	1 478·525	− 3·0906	− 3·0898	− 3·0902	−0·8	−85·3	1 480·6937
253	252	1·010	1 479·535	− 4·2408	− 4·2399	− 4·2404	−0·9	−86·2	1 476·4533
252	251	1·297	1 480·832	− 7·9696	− 7·9680	− 7·9688	−1·6	−87·8	1 468·4845
251	250	·950	1 481·782	− 8·8518	− 8·8539	− 8·8528	+2·1	−85·7	1 459·6317
250	Z_1	·970	1 482·752	− 0·0009	− 0·0010	− 0·0010	+0·1	−85·6	1 459 6307
Z_1	B_2	·288	1 483·040	− 0·6841	− 0·6851	− 0·6846	+1·0	−84·6	1 458·9461
Z_1	A_2	·298	1 483·050	− 0·7200	− 0·7205	− 0·7202	+0·5	−85·1	1 458·9105
Z_1	249	1·067	1 483·819	+ 5·8847	+ 5·8866	+ 5·8856	−1·9	−87·5	1 465·5163
249	248	·758	1 484·577	+ 9·2393	+ 9·2412	+ 9·2403	−1·9	−89·4	1 474·7566
248	247	1·023	1 485·600	− 0·3626	− 0·3627	− 0·3626	+0·1	−89·3	1 474·3940
247	244	1·113	1 486.713	− 0·1475	− 0·1470	− 0·1473	−0·5	−89·8	1 474·2467
244	V_1	·856	1 487.569	+ 8·5079	+ 8·5093	+ 8·5086	−1·4	−91·2	1 482.7553

* Mean of two measures.

Key to elevations of top of rail indicated thus, R. R. S. (1), R. R. S. (2), *etc., in the table of results of leveling from Colorado Springs to Denver.*

[The elevation given refers to top of rail in front of station sign unless otherwise stated.]

(1) Edgerton.
(2) Husted.
(3) Monument.
(4) Palmer Lake.
(5) Greenland.
(6) Larkspur.
(7) Douglas.
(8) Castle Rock.
(9) Plateau.
(10) Sedalia.
(11) Toluca.

(12) Acequia.
(13) Wolhurst.
(14) Littleton.
(15) Petersburg.
(16) Denver, Denver and Rio Grande track opposite main entrance Wynkoop street.
(17) Denver, first track opposite main entrance union depot.

Key to elevations of top of rail indicated thus, R. R. S. (1), R. R. S. (2), *etc.*, *in the table of results of leveling from Simon to Denver.*

[Elevations given refer to top of rail in front of station sign.]

(1) River Bend.
(2) Cedar Point.
(3) Agate.
(4) Deer Trail.
(5) Byers.
(6) Bennett.
(7) Watkins.
(8) Magnolia.

LINE ACROSS FLORIDA.

The line across Florida, between St. Augustine and Cedar Keys, connecting with the Atlantic on the eastern end and with the Gulf on the western end, has been leveled three times—in 1892, 1893, and in 1894. It is especially interesting in connection with a study of the errors of precise leveling. The same route was followed by all three of these lines, namely, from St. Augustine southwestward, along the railroad now known as the Florida East Coast, to Palatka; thence westward over the railroad line of the Plant System to Gainesville; thence southwestward over the Florida Central and Peninsular Railroad to Cedar Keys, as indicated in the accompanying route sketch.

The line was leveled independently in the forward and backward directions in 1892, between March 16 and June 30, the leveling in the eastward direction being done by Isaac Winston, Assistant, with level No. 5, and in the westward direction by F. A. Young, Subassistant, with level No. 6. Rods I, K, N, and O were used.

In 1893 a double simultaneous line was run in the direction St. Augustine to Cedar Keys, between February 13 and May 25, by Isaac Winston, Assistant, using level No. 5 and rods N and O.

The programme of observation in both 1892 and 1893 was that indicated on page 417.

The corrections for length and temperature of rods, and for the index error of rods, as well as for the measured angle between target and horizon, inequality of collars, curvature and refraction, were applied in the office computation.

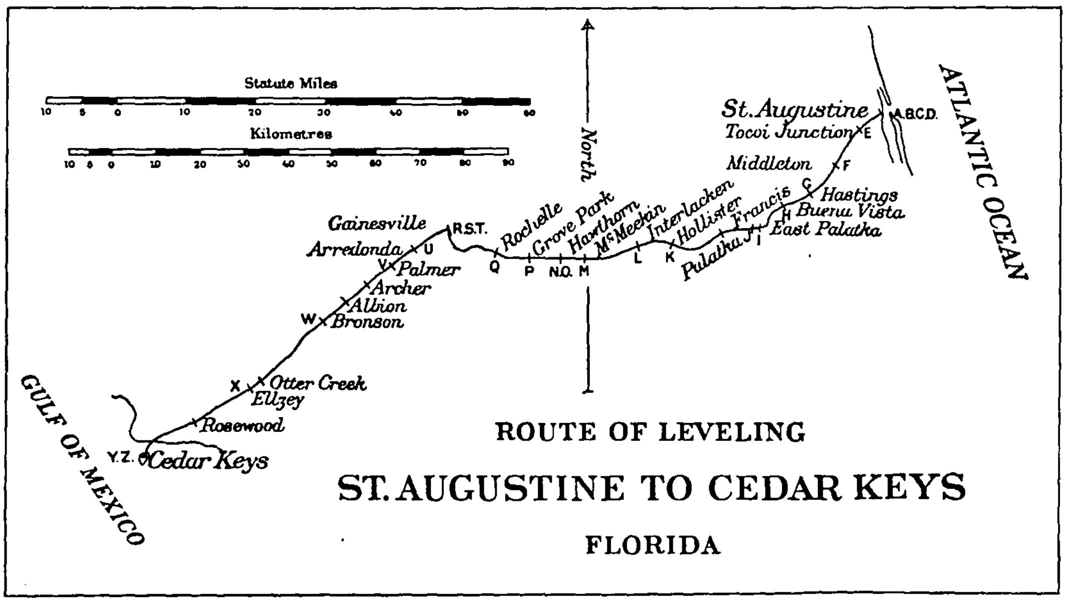
The leveling in 1894 was done by Isaac Winston, Assistant, between March 13 and May 1, in the direction Cedar Keys to St. Augustine.* A radically different instrument

* This releveling of 1894 was ordered by Superintendent Mendenhall for the purpose of testing the method of leveling and the instrument which had been used by Assistant C. H. Van Orden between Boston and Greenbush, and which was afterwards used by him between Dobbs Ferry and Greenbush.

and programme of observation was used than in 1892 and 1893. The instrument was that used by Assistant C. H. Van Orden in running the lines, Boston to Greenbush, N. Y., and from Dobbs Ferry to Greenbush, N. Y. (see page 402). This instrument is shown in illustration No. 5.

"The rods are nonextension and of selected white pine supposed to have been heated to a high temperature and then plunged in boiling paraffin. They are a little over 10 feet in length, made of three pieces bolted together, the cross section being T-shaped. The middle piece, on the edge of which is the graduation, is 35 by 50 millimetres (1⅜ by 2 inches); the side strips are each 25 by 25 millimetres (1 by 1 inch). The targets are square black plates with a vernier on one edge of a square aperture in the center of the face; each has three horizontal white stripes, the lower edge of the middle one (0·01 foot wide) being the zero of the target. The target is moved by an endless chain running over pulleys in each end of rod. The rods are graduated to 0·01 foot (3·048 millimetres) and are read to 0·001 foot by the vernier on the target."

No. 4.



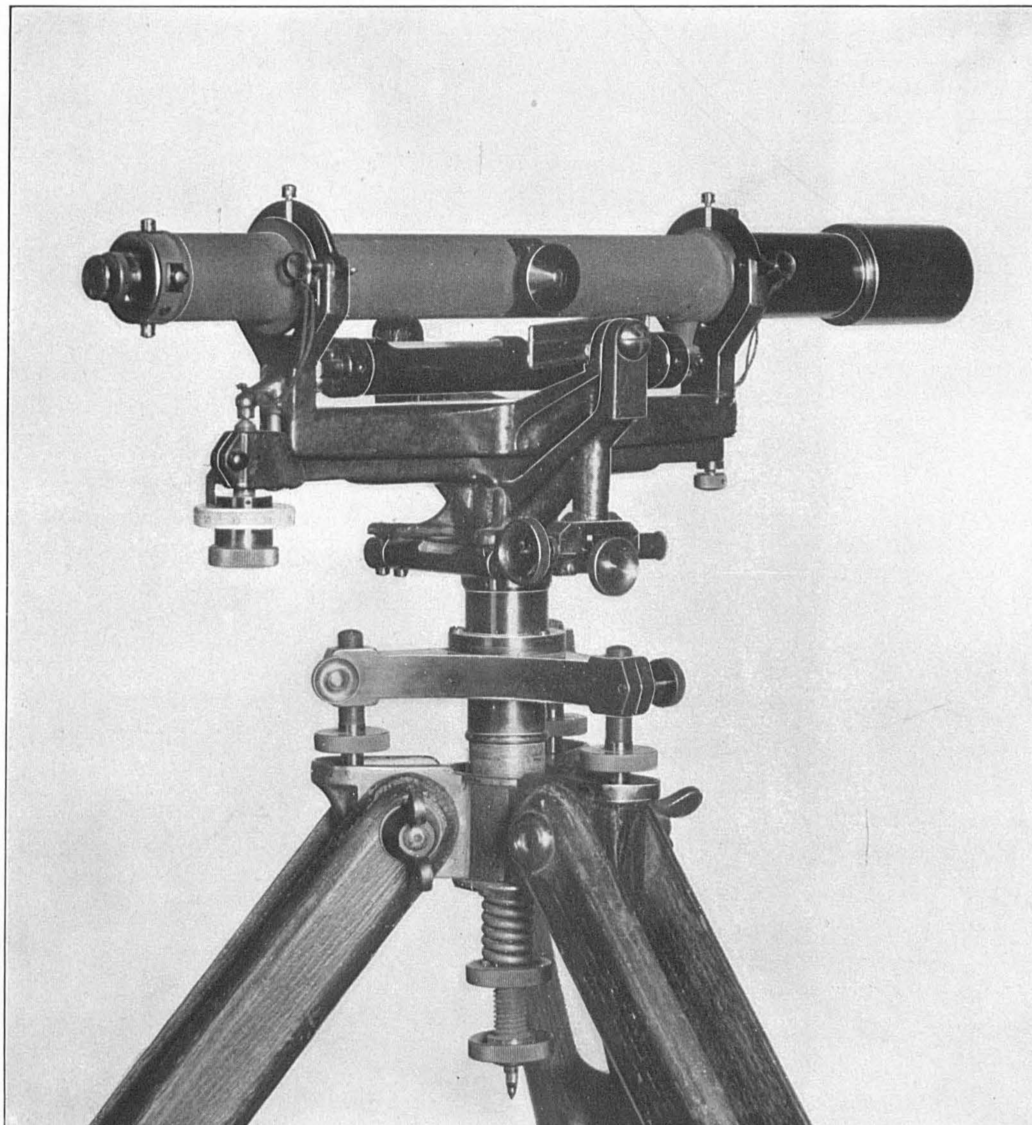
ROUTE OF LEVELING

ST. AUGUSTINE TO CEDAR KEYS

FLORIDA

"The method of observing may be described as follows: The instrument was set up and leveled by the observer. The bubble of the level was then set by an attendant to the middle of its tube by means of the micrometer screw. The target of rod 1 was set near the horizon and the position of the observing line on the narrow white central hand of the target was estimated the instant notice was given by the bubble tender that the bubble was in central position. The small estimated quantity expressed in terms of 0·001 foot was added (always positive) as a correction to the rod reading as noted by the rodman and verified by the observer. The same operation was then gone through with rod 2. The sight lines were kept equal by counting the number of rails, each being 30 feet in length, or otherwise by measuring the distances.* The distance from

* When the velocipede car was used one revolution of the crank lever equaled a distance of 21 feet.



THE VAN ORDEN LEVEL.

instrument to staff was generally 8 or 9 rail lengths, i. e., about 250 feet (76 metres nearly) on the average, while the distances of rods 1 and 2 for the same instrumental station was about 15 feet. The line of levels of 1894, then, is a double one, run simultaneously with two rods, and in the direction from west to east, following the route and using the same bench marks as in the years 1892 and 1893. The method differs principally from the earlier ones by its simplicity due to eliminating instrumental defects of adjustment, of inequality of collars, and effects of curvature and refraction, by keeping the back and fore sights of equal length."

The lengths and index errors of these rods were determined at the Office of Standard Weights and Measures, and the office computation made accordingly. The roadbed along which the line was run was of white sand over nearly the whole route, and in places passed through extensive marshes. It was difficult to find stable positions for the footplate and instrument.

The direct results of these three lines of leveling are shown in condensed form in the following tabulation:

Summary of results of spirit leveling across northern Florida, between St. Augustine and Cedar Keys, in 1892–1893–1894.

[Height of bench marks above bench mark A at sea wall at St. Augustine.]

Locality and designation of bench marks.	Distance from A.	Results of 1892. Young and Winston line.	Results of 1893.	Results of 1894.	Mean 1892–1893–1894.	Δ 1892.	Δ 1893.	Δ 1894.
	km.	*m.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*mm.*
A. St. Augustine....	0·0	0·0000	0·0000	0·0000	0·0000	0·0	0·0	0·0
E. Tocoi Junction ..	7·3	+8·7045	+8·7122	+8·7042	+8·7070	− 2·4	+ 5·2	− 2·8
F. Middleton	18·5	8·4156	8·4296	8·4082	8·4178	− 2·2	+11·8	− 9·6
G. Hastings........	29·5	0·2015	0·1716	0·1725	0·1819	+ 19·6	−10·3	− 9·4
H. Buena Vista	35·6	2·3905	2·3764	2·3799	2·3823	+ 8·2	− 5·9	− 2·4
I. E. Palatka	42·3	3·0288	3·0553	3·0294	3·0378	− 9·0	+17·5	− 8·4
J. Palatka	45·6	1·7597	1·7813	1·7986	1·7799	− 20·2	+ 1·4	+ 18·7
Francis	54·2	19·0705	19·0776	19·0607	19·0696	+ 0·9	+ 8·0	− 8·9
K. Hollister........	65·9	22·4292	22·3991	22·3629	22·3971	+ 32·1	+ 2·0	− 34·2
L. Interlachen	73·8	30·1294	30·0809	30·0189	30·0764	+ 53·0	+ 4·5	− 57·5
M. McMeekin	87·7	34·6438	34·6340	34·5336	34·6038	+ 40·0	+30·2	− 70·2
N. Hawthorn.......	95·2	42·2445	42·2182	42·1625	42·2084	+ 36·1	+ 9·8	− 45·9
O. Hawthorn.......	95·3	42·7598	42·7342	42·6770	42·7237	+ 36·1	+10·5	− 46·7
P. Grove Park	102·8	28·6045	28·6434	28·6147	28·6209	− 16·4	+22·5	− 6·2
Q. Rochelle........	109·4	23·2924	23·3579	23·3471	23·3325	− 40·1	+25·4	+ 14·6
R. Gainesville......	125·0	51·8622	51·9903	51·9962	51·9496	− 87·4	+40·7	+ 46·6
U. Arredonda	133·7	24·9741	25·1172	25·1619	25·0844	−110·3	+32·8	+ 77·5
V. Palmer	141·0	21·1686	21·3285	21·3802	21·2924	−123·8	+36·1	+ 87·8
Archer..........	148·1	23·8228	23·9805	24·0744	23·9592	−136·4	+21·3	+115·2
Albion..........	155·4	(*)	25.0448	25·1805	....	....	....	....
W. Bronson	162·6	19·8544	20·0317	20·1732	20·0198	−165·4	+11·9	+153·4
Otter Creek	181·6	7·7402	7·9323	8·1498	7·9408	−200·6	− 8·5	+209·0
X. Ellzey	184·2	5·6170	5·8311	6·0713	5·8398	−222·8	− 8·7	+231·5
Rosewood.......	200·0	2·2964	2·5230	2·7792	2·5329	−236·5	− 9·9	+246·3
Y. Cedar Keys	215·7	1·8608	+2·0912	+2·3872	2·1131	−252·3	−21·9	+274·1

*The Albion bench mark was not connected with the westward line of 1892.

The separate computation of each of these lines gives the following values for B. M. Y above B. M. A:

Young line of 1892, westward, $Y-A=+1{\cdot}5336$ metres.

Winston line of 1892, eastward, $Y-A=+2{\cdot}1880$ metres.

First line of 1893, with rod N Y—A=+2·0812 metres.
Second line of 1893, with rod O, Y—A=+2·1012 metres.
First line of 1894, with rod 1, Y—A=+2·4131 metres.
Second line of 1894, with rod 2, Y—A=+2·3613 metres.

It should be noted that the two components of the line of 1892 show a much larger divergence than the components for the other years, the three divergences being, for 1892, 654·4 millimetres; for 1893, 20·0 millimetres, and for 1894, 51·8 millimetres. An examination of the computation also shows that 618 millimetres of the divergence in 1892 occurred on the western half of the line between B. M. O at Hawthorn and B. M. Y at Cedar Keys, a distance of only 120 kilometres, the divergence being at the rate of 5 millimetres per kilometre. It is equally important, however, to note that this line of 1892 gives a result which is closer to the mean result from the three years than that from the 1894 line.

The divergence of 618 millimetres between the two components of the 1892 line is of such a sign as to indicate that if it were due to movements of the footplates there was a systematic tendency for the footplates to *rise* between the foresight and the corresponding backsight. It is significant that the divergence of the line of 1893, run in the westward direction, from the line of 1894, run in the eastward direction, is 325 millimetres between these same bench marks, and is again of such a sign as to indicate a systematic rising of the footplates.* A systematic rising of the instrument would also tend to account for the facts here noted.

To determine mean sea level at each end of the line, tidal observations were secured by means of a self-registering tide gauge operated for one year. The following tabulations exhibit the results of these observations by separate lunations. The reading of mean sea level on the staff for each lunation is corrected for the known annual (*Sa*) and semiannual (*Ssa*) inequality in mean sea level. The discrepancies between the various lunations furnish, therefore, a measure of the accuracy with which mean sea level is determined.

ST. AUGUSTINE, FLA.

Lunation begins.				Mean level from hourly ordinates.	Correction for *Sa* and *Ssa*.	Corrected mean sea level.
		d.	*h.*	*Feet.*	*Foot.*	*Feet.*
1892	March	31	0	5·597	+0·142	5·739
	April	29	12	5·758	+0·172	5·930
	May	29	0	5·759	+0·264	6·023
	June	27	12	5·488	+0·222	5·710
	July	27	0	5·777	—0·057	5·720
	Aug.	25	12	6·468	—0·452	6·016
	Sept.	24	0	6·792	—0·695	6·097
	Oct.	23	12	6·244	—0·581	5·663
	Nov.	22	0	6·097	—0·165	5·932
	Dec.	21	12	5·477	+0·277	5·754
1893	Jan.	20	0	5·611	+0·445	6·056
	Feb.	18	12	5·521	+0·338	5·859
Mean				5·882	—0·007	5·875±0.030 ft.

* Compare this with pages 881–882.

CEDAR KEYS, FLA.

Lunation begins.			Mean level from hourly ordinates.	Corrections for *Sa* and *Ssa*.	Corrected mean sea level.
	d.	*h.*	*Feet.*	*Foot.*	*Feet.*
1892 Apr.	12	0	5·478	−0·010	5·468
May	11	12	5·808	−0·173	5·631
June	10	0	5·871	−0·229	5·642
July	9	12	5·920	−0·221	5·699
Aug.	8	0	5·967	−0·215	5·752
Sept.	6	12	5·989	−0·227	5·762
Oct.	6	0	5·897	−0·203	5·694
Nov.	4	12	5·728	−0·076	5·652
Dec.	4	0	5·565	+0·147	5·712
1893 Jan.	2	12	5·144	+0·365	5·509
Feb.	1	0	5·263	+0·428	5·691
Mar.	2	12	5·252	+0·299	5·551
Mean			5·656	−0·010	5·647±0·018 ft.

Converting to metres, the reading of mean sea level on the Atlantic at St. Augustine on the staff is 1·7907 ± 0·0091 metres, and of mean sea level on the Gulf at Cedar Keys on the staff 1·7212 ± 0·0055 metres. The relation of the zero of the staff to the initial bench mark of the level line was determined at each of these points three times by direct leveling with the following results: At St. Augustine B. M. A above zero of staff 3·9382 metres, at Cedar Keys B. M. Y above zero of staff 5·7233 metres, making the elevation of B. M. A above mean sea level 2·1475 ± 0·0091 metres, and of B. M. Y at Cedar Keys above mean sea level on the Gulf 4·0021 ± 0·0055 metres.

Combining these values with the relation between A and Y, shown by leveling, the following values are obtained for the apparent difference of elevation of mean sea level on the Gulf and on the Atlantic:

	Metre.
From the Young line of 1892, westward, Gulf above Atlantic	−0·3210
From Winston line of 1892, eastward, Gulf above Atlantic	+0·3334
Mean	+0·0062
From the first line of 1893, rod N, Gulf above Atlantic	+0·2266
From the second line of 1893, rod O, Gulf above Atlantic	+0·2466
Mean	+0·2366
From the first line of 1894, rod 1, Gulf above Atlantic	+0·5585
From the second line of 1894, rod 2, Gulf above Atlantic	+0·5067
Mean	+0·5326

The mean from the three years indicates that the Gulf is 0·2585 metre higher than the Atlantic. As, however, the six results show a total range of 0·8795 metre, and even the means for the three years show a range of 0·5264 metre, it is not clear that the leveling is of a sufficiently high degree of accuracy to warrant the conclusion that the Gulf is appreciably higher than the Atlantic. The apparent difference may be due to errors of leveling. For a further discussion of the relation between Gulf level and Atlantic level see pages 429–431.

CONDENSED STATEMENT OF DIRECT RESULTS OF OBSERVATION.

On the following pages there is shown in condensed form for convenient reference the direct results of the leveling and the tidal observations which are treated in this appendix.

For each long line of leveling there is stated in the following tabular form the location and designation of the terminal bench marks, the distance between them measured along the level line, the observed difference of elevation, and a reference to the authority from which these facts are obtained. The sign affixed to the difference of elevation indicates the elevation of the first named above the other.

As the desirable information in regard to tidal observations and in regard to the observations fixing the relations between bench marks which are common to two or more level lines at their junction points, can not conveniently be put in this tabular form, it is placed immediately after it in paragraphs which are numbered to correspond with the relation which they bear to the tabular matter. The numbers assigned in the tabulation and the following paragraphs serve also to indicate approximately the order in which the corrected elevations and descriptions of bench marks are given on pages 472–874.

Another distinction may also be made between the paragraphic matter and the tabular matter. All elevations or relative elevations which are stated in the paragraphic matter are determined by the observations with so high a degree of accuracy, as compared with that concerned in the relative elevations stated in the tabular matter, that they in the adjustment are treated as fixed quantities, or, in other words, are assigned infinite weight.

No.	Places.	Distance.	Bench marks.	Difference of elevation.	Reference.
		km.		*m.*	
2	Raritan Bay, N. J.	267	F	−106·3911	C. and G. S. Rep. 1882,
	Harrisburg, Pa.		XXIX		pp. 525–528.
3	Harrisburg, Pa.	119	XXIX	− 59·5851	C. and G. S. Rep. 1882,
	Hagerstown, Md.		A		pp. 528–529.
4	Hagerstown, Md.	308	A	−135·5240	C. and G. S. Rep. 1882,
	Grafton, W. Va.		M		pp. 533–537.
5	Grafton, W. Va.	486	M	+137·1475	C. and G. S. Rep. 1882,
	Cincinnati, Ohio.		T		pp. 540–546.
7	Lawrenceburg, Ind.	414	U	− 13·0744	C. and G. S. Rep. 1882,
	Odin. Ill.		V		pp. 547–552.
8	Odin, Ill.	104	V	+ 34·4398	C. and G. S. Rep. 1882,
	St. Louis, Mo.		K_3		pp. 552–554.
9	St. Louis, Mo. *	205	K_3	− 43·6058	C. and G. S. Rep. 1893,
	Jefferson City, Mo.		90 (85)		pp. 23–32; Rep. 1896; p. 268.
11	Jefferson City, Mo.	198	XXVIII	− 69·6683	C. and G. S. Rep. 1896,
	Pleasant Hill, Mo.		LI		pp. 268–273.
13	Kansas City, Mo.	45	LVIII	− 32·0065	C. and G. S. Rep. 1896,
	Pleasant Hill, Mo.		LII		pp. 273–275.
15	Kansas City, Mo.	23	244	− 2·9496	C. and G. S. Rep. 1896,
	Holliday, Kans.		LXIII		p. 275.
16	Holliday, Kans.	239	LXIII	−120·1134	C. and G. S. Rep. 1897,
	Abilene, Kans.		B_1		pp. 273, 278.
18	Solomon, Kans.	23	C_1	− 15·2899	C. and G. S. Rep. 1897,
	Salina, Kans.		G_1		p. 278.

* This includes a local adjustment of two runnings between M_3 and XIV near New Haven, Mo. (See C. and G. S. Rep. 1893, pp. 25, 28.)

No.	Places.	Distance.	Bench marks.	Difference of elevation.	Reference.
		km.		*m.*	
20	Salina, Kans.	188	H_1	−272·6940	C. and G. S. Rep.
	Ellis, Kans.		A_2		1897–98, p. 190.
22	Ellis, Kans.	372	B_2	−891·8633	C. and G. S. Rep.
	Hugo, Colo.		K		1897–98, pp. 201–209.
23	Hugo, Colo.	25	K	− 93·8534	C. and G. S. Rep.
	Limon, Colo.		N		1897–98, p. 221.
25	Limon, Colo.	123	P	−214·1380	C. and G. S. Rep.
	Colorado Springs, Colo.		Z		1897–98, pp. 221–224.
26	Colorado Springs, Colo.	121	Z	+267·8229	Pp. 385–388 of this Re-
	Denver, Colo.		Z_1		port.
28	Limon, Colo.	141	N	+ 46·4068	Pp. 389–392 of this Re-
	Denver, Colo.		Z_1		port.
30	Mobile, Ala.	93	A	− 1·0250	C. and G. S. Rep. 1887,
	Biloxi, Miss.		E_1		pp. 188–190.
31	Meridian, Miss.	219	C	+101·1643	C. and G. S. Rep. 1888,
	Mobile, Ala.		A		pp. 411–417.
32	Corinth, Miss.	314	V	+ 32·3287	C. and G. S. Rep. 1888,
	Meridian, Miss.		C		pp. 418–422; Rep. 1892,
					pp. 165–169.
34	Cairo, Ill.	265	I	− 41·1591	C. and G. S. Rep. 1892,
	Corinth, Miss.		W		pp. 168–181.
36	Odin, Ill.	194	V	+ 63·0832	C. and G. S. Rep. 1892,
	Cairo, Ill.		2		pp. 180–189.
37	Biloxi, Miss.	136	I_1	+ 4·0261	C. and G. S. Rep. 1887,
	Carrollton, La.		I		pp. 188–201.
39	Carrollton, La.	295	I	− 11·9560	C. and G. S. Rep. 1888,
	Smithland, La.		XLV		pp. 428–432.
40	Smithland, La.	105	XLV	− 3·9620	C. and G. S. Rep. 1888,
	Vidalia, La.		LXI		pp. 432–437.
42	Vicksburg, Miss.	138	215	+ 8·1504	C. and G. S. Rep. 1888,
	Vidalia, La.		LXIV		pp. 437–443.
44	Greenville, Miss.	185	I	+ 12·1193	C. and G. S. Rep. 1888,
	Vicksburg, Miss.		211		pp. 443–450.
46	Little Rock, Ark.	181	3 (or I)	+ 38·0703	C. and G. S. Rep. 1888,
	Arkansas City, Ark.		F		pp. 457–461.
48	Van Buren, Ark.	261	XXXVIII	+ 46·1848	C. and G. S. Rep. 1888,
	Little Rock, Ark.		3 (or I)		pp. 461–462; pp. 362–
					368 of this Report.
50	Van Buren, Ark.	9	XXXIX	− 10·1563	Page 368 of this Report.
	Fort Smith, Ark.		XLI		
51	Chester, Ark.	40	XLVIII	+131·2299	Page 369 of this Report.
	Van Buren, Ark.		XXXIX		
53	Boston, Mo.	252	XCVII	+ 27·5842	Pp. 377–382 of this Re-
	Chester, Ark.		XLIX		port.
55	Harrisonville, Mo.	145	43	+ 25·8493	Pp. 373–376 of this Re-
	Boston, Mo.		XCVI		port.
56	Pleasant Hill, Mo.	13	LI	− 48·3294	Page 372 of this Report.
	Harrisonville, Mo.		43		
57	Holliday, Kans.	75	LXIII	− 76·4352	Pp. 370–372 of this Re-
	Harrisonville, Mo.		43		port.
59	Hagerstown, Md.	137	A	*+140·4503	C. and G. S. Rep. 1896,
	Washington, D. C.		Capitol		pp. 257, 262–263.
61	Washington, D. C.	193	Capitol	− 31·1531 in 1884	C. and G. S. Rep. 1896, pp. 248–255.
	Richmond, Va.		O	*− 30·7612 in 1895	
63	Richmond, Va.	140	O	+ 55·4865 in 1884	C. and G. S. Rep. 1896, pp. 239–244.
	Old Point Comfort, Va.		U	+ 55·5318 in 1891–92	

*This value depends upon the assumption that the Capitol B. M. is 18m·0040 above XI at Georgetown. (See C. and G. S. Rep. 1896, p. 257.)

No.	Places.	Distance.	Bench marks.	Difference of elevation.	Reference.
		km.		*m.*	
64	St. Augustine, Fla. Cedar Keys, Fla.	216	(Sea level) (Sea level)	− 0·2585	Page 397 of this Report.
65	Meridian, Miss. Vicksburg, Miss.	224	C Cistern	+ 45·5885	Pp. 354–360 of this Report.
66	Corinth, Miss. Memphis, Tenn.	151	W Memphis	+ 57·2388	C. and G. S. Rep. 1892, pp. 207–219.
68	Annapolis, Md. Washington, D. C.	63	a Capitol	− 26·3500	C. and G. S. Rep. 1889, p. 463.
69	Denver, Colo. Rock Creek, Wyo.	342	A_2 W	−458·2524	See Appendix No. 5, pp. 289–297 of this Report.
70	Abilene, Kans. Norfolk, Nebr.	469	Y_2 P_1	−113·8389	See Appendix No. 6, pp. 306–319 of this Report.
72	Gibraltar, Mich. Cincinnati, Ohio.	396	1 (of '98) T	+ 12·5465	Pp. 340–342 of this Report.
73	Biloxi, Miss. Carrollton, La.	137	I_1 I	+ 4·0734	Ch. of Eng. Rep. 1884, Pt. 4, pp. 2466–2476.
74	Monroe, La. Smithland, La. (via Shreveport).	538	27 XLV	+ 8·9590	Vicksburg tabulation. Ch. of Eng. Rep. 1893, Pt. 3, pp. 1946–1950.
76	Monroe, La, Rayville, La.	34	24 17	− 4·9980	Vicksburg tabulation. Ch. of Eng. Rep. 1893, Pt. 3, pp. 1945–1946.
78	Rayville, La. Vicksburg, Miss.	79	16 S. W. Base	− 2·1750	Vicksburg tabulation. Ch. of Eng. Rep. 1893, Pt. 3, p. 1945.
79	Concordia, La. Vidalia, La.	11	9 LXIV	− 0·1609	Vicksburg tabulation.
80	Monroe, La. Concordia, La.	168	27 9	+ 4·1753	Vicksburg tabulation.
81	Rayville; La. Concordia, La.	110	17 9	+ 7·2458	Vicksburg tabulation.
83	Jonesville, La. Mouth of Black River.	54	P. B. M. 5 P. B. M. 12a	+ 1·4377	Vicksburg tabulation.
84	Shreveport, La. Jeters Landing, La.	44	P. B. M. 46 P. B. M. 4	− 0·4581	Vicksburg tabulation.
86	Parkeville, La. Monroe, La.	34	Parkeville 24	+ 1·7471	Vicksburg tabulation.
87	Glendora, La. Farmerville, La.	42	P. R. P. Glendora P. B. M. Stein	− 4·7268	Vicksburg tabulation.
88	Little Rock, Ark. Parkeville, La.	338	3 (or I) Parkeville	+ 56·8075	Vicksburg tabulation.
89	Wilkersons Landing, Miss. Parkeville, La.	163	84 74	+ 17·4850	Vicksburg tabulation.
90	Greenville, Miss. Wilkersons Landing, Miss.	32	1 84	− 2·3115	Ch. of Eng. Rep. 1883, Pt. 3, p. 2179.
91	Greenville, Miss. Wilkersons Landing, Miss.	33	1 84	− 2·3033	Vicksburg tabulation.
92	Vicksburg, Miss. Greenville, Miss.	269	P. B. M. 2 1	− 10·5820	Vicksburg tabulation, Ch. of Eng. Rep. 1894, Pt. 3, pp. 1497–1499.
93	Wilkersons Landing, Miss. Friars Point, Miss.	153	84 II	− 12·8985	Ch. of Eng. Rep. 1883, Pt. 3, pp. 2174–2183.
94	Friars Point, Miss. Clarksdale, Miss.	32	II III	+ 2·5630	Vicksburg tabulation.
96	Friars Point, Miss. Memphis, Tenn.	134	II Memphis	− 25·3792	Ch. of Eng. Rep. 1879, Pt. 3, p. 1944; 1878, Pt. 3, p. 1392.
97	Corinth, Miss. Riverton Junction, Ala.	49	V and W T. B. M. 44	+ 11·3865	Ch. of Eng. Rep. 1896, Pt. 3, pp. 1972–1977.

No.	Places.	Distance.	Bench marks.	Difference of elevation.	Reference.
		km.		*m.*	
98	Riverton Junction, Ala. Decatur, Ala.	124	T. B. M. 44 U. X. S.	− 45·7635	Ch. of Eng. Rep. 1896, Pt. 3, pp. 1977–1998.
99	Riverton Junction, Ala. Pittsburg Landing, Tenn.	63	T. B. M. 44 P. B. M. 61	− 1·1236	Ch. of Eng. Rep. 1896, Pt. 3, pp. 1999–2011.
100	Meridian, Miss. York, Ala.	42	C P. B. M. 26	+ 57·4130	Ch. of Eng. Rep. 1899, Pt. 2, pp. 1779–1781.
101	York, Ala. Birmingham, Ala.	207	P. B. M. 26 P. B. M. 1	−138·5920	Ch. of Eng. Rep. 1899, Pt. 2 pp. 1770–1779.
102	York, Ala. Demopolis, Ala.	46	P. B. M. 26 P. B. M. 6	+ 8·7319	Ch. of Eng. Rep. 1899, Pt. 2, pp. 1781–1783.
103	Memphis, Tenn. Cairo, Ill.	330	Memphis P. B. M. 2	− 16·7198	Miss. Riv. Com. Rep. 1881, pp. 52, 63; Ch. of Eng. Rep. 1883, Pt. 3, pp. 2187–2188.
104	Cairo Ill. St. Louis, Mo.	275	P. B. M. 1 K_3	− 29·2737	Ch. of Eng. Rep. 1884, Pt. 4, pp. 2480–2499.
105	St. Louis, Mo. 12 miles above St. Louis, Mo.	21	K_3 P. B. M. 12	− 13·3804	Ch. of Eng. Rep. 1884, Pt. 4, pp. 2479–2480; Rep. 1888, Pt. 4, p. 2328. (Mean of these two measures used.)
106	12 miles above St. Louis, Mo. Albany, Ill.	552	P. B. M. 12 P. B. M. 53	− 42·9398	Ch. of Eng. Rep. 1884, Pt. 4, pp. 2476–2534.
108	Albany, Ill. Fulton, Ill.	6	P. B. M. 53 P. B. M. 56	+ 4·9232	Ch. of Eng. Rep. 1884, Pt. 4, p. 2534; Rep. 1885, Pt. 4, p. 2652. (Mean of these two measures used.)
110	Fulton, Ill. Savanna, Ill.	31	P. B. M. 56 P. B. M. 62	− 2·9032	Ch. of Eng. Rep. 1885, Pt. 4, pp. 2652–2654.
112	Savanna, Ill. Chicago, Ill.	224	P. B. M. 62 P. B. M. 99	+ 0·2105	Ch. of Eng. Rep. 1885, Pt. 4, pp. 2654–2669.
113	Savanna, Ill. St. Paul, Minn.	478	P. B. M. 62 P. B. M. 68	− 33·8437	Ch. of Eng. Rep. 1892, Pt. 4, pp. 2958–3037.
115	St. Paul, Minn. Aitkin, Minn.	315	P. B. M. 68 P. B. M. Court-house.	−156·3467	Ch. of Eng. Rep. 1899, Pt. 5, pp. 3420–3468.
116	St. Paul, Minn. Duluth, Minn.	250	P. B. M. 68 1	+ 23·1902	Ch. of Eng. Rep. 1892, Pt. 4, pp. 3074–3098.
117	Duluth, Minn. Marquette, Mich.	460	1 1	+ 5·1168 =+ 16·79 ft.	Rep. of Deep Waterways Com., Dec. 1896, p. 88.
118	Marquette, Mich. Escanaba, Mich.	105	1 1	+ 5·1565	Professional Papers No. 24 (U. S. Lake Survey Rep.), pp. 603–604.
119	Escanaba, Mich. Chicago, Ill.	440	1 P. B. M. 99	+ 0·5456 =+ 1·79 ft.	Rep. Deep Waterways Com., Dec. 1896, p. 88.
120	12 miles above St. Louis, Mo. Jefferson City, Mo.	214	P. B. M. 12 XXVIII (Capitol)	− 52·1251	Ch. of Eng. Rep. 1888, Pt. 4, p. 2328; 1893, Pt. 6, pp. 4046–4082.
121	Jefferson City, Mo. Kansas City, Mo.	306	90 (85) LVIII	− 58·2482	Ch. of Eng. Rep. 1893, Pt. 6, pp. 3988–4045.
122	Kansas City, Mo. St. Joseph, Mo.	113	244 P. B. M. 287	+ 19·0180	Ch. of Eng. Rep. 1893, Pt. 6, pp. 3964–3988.
124	St. Joseph, Mo. Sioux City, Iowa.	366	P. B. M. 290 P. B. M. 399	− 85·1170	Ch. of Eng. Rep. 1893, Pt. 6, pp. 4138–4208.
125	Escanaba, Mich. Lakeport, Mich.	600	1 2	+ 0·6553 =+ 2·15 ft.	Rep. of Deep Waterways Com., Dec. 1896, p. 88; Professional Papers No. 24, pp. 616–617.
126	Lakeport, Mich. Ft. Gratiot, Mich.	20	2 (1877)	+ 0·2920 =+ 0·958 ft.	Professional Papers No. 24, p. 602.

No.	Place.	Distance.	Bench mark.	Difference of elevation.	Reference.
		km.		*m.*	
127	Ft. Gratiot, Mich. Gibraltar, Mich.	141	(1877) (1877)	+ 2·2714	Professional Papers No. 24, p. 602.
128	Ft. Gratiot, Mich. Gibraltar, Mich.	159	(1877) (1877)	+ 2·3889	Letter from Lt. Col. G. J. Lydecker, U. S. Engr. Office at Detroit, Mich.
129	Erie, Pa. Gibraltar, Mich.	260	1 (1873) 2	− 2·8560 =− 9·37 ft.	Professional Papers No. 24, pp. 615–616.
130	Oswego, N. Y. Erie, Pa.	350	A 1 (1873)	− 98·6433 =−323·636 ft.	Professional Papers No. 24, pp. 614–615.
131	Oswego, N. Y. Greenbush, N. Y.	301	A Gristmill	+ 72·3090 =+237·234 ft.	Professional Papers No. 24, pp. 600–601, 610–614.
132	Oswego, N. Y. Troy, N. Y. (Direct.)	302	A 1	+ 70·3385	Letter from Mr. G. Y. Wisner, of Deep Waterways Commission.
133	Oswego, N. Y. Troy, N. Y. (Via Lake Champlain.)	662	A 1	+ 70·3035	Letter from Mr. G. Y. Wisner, of Deep Waterways Commission.
134	Troy, N. Y. Greenbush, N. Y.	11	1 Gristmill	+ 2·2415 =+ 7·354 ft.	Letter from Mr. G. Y. Wisner, of Deep Waterways Commission.
135	Greenbush, N. Y. Boston, Mass.	320	Gristmill Sea level	+ 4·2898 =+ 14·074 ft.	Rep. Topographical Survey Mass., 1893.
136	Greenbush, N. Y. Dobbs Ferry, N. Y.	195	Gristmill	+ 1·1249	Unpublished.
138	Greenbush, N. Y. Dunkirk, N. Y.	644	Gristmill Nelson Block	−175·1744 =−574·718 ft.	Manuscript furnished by U. S. Geological Survey and Twentieth Annual Report of the U. S. Geological Survey, Part I, pp. 299–310.
139	Dunkirk, N. Y. Erie, Pa.	75	Nelson Block 1 (1873)	+ 4·0508 =+ 13·29 ft.	Manuscript furnished by U. S. Geological Survey.
140	Erie, Pa. West Penn Jc., Pa.	278	1 (1873) P. R. R. 26	− 65·2066 =−213·932 ft.	Manuscript furnished by U. S. Geological Survey.
142	Braddock, Pa. Grafton, W. Va.	225	P. R. R. 88 M	− 51·1913 =−167·950 ft.	Manuscript furnished by U. S. Geological Survey.
143	Harrisburg, Pa. Braddock, Pa.	385	XXIX P. R. R. 88	−143·8841 =−472·060 ft.	Pennsylvania R. R. Bench Mark Book, May 1, 1899.

No. 1.—VICINITY OF NEW YORK CITY.

In 1881 the transcontinental line of levels was commenced at Sandy Hook tide gauge and continued westward to Hagerstown, Md. (See Appendix 11, Coast and Geodetic Survey Report for 1882, pp. 517–525.) The elevations of this line were based upon continuous tidal observations made with the self-registering tide gauge at Sandy Hook during the six years 1876–1881, inclusive. The annual means for these six years show a total range of 0·322 foot (98 millimetres).

In 1886–87 a precise level line was run from Sandy Hook, N. J., to Dobbs Ferry, N. Y. (See Appendix No. 14, Coast and Geodetic Survey Report for 1887, pp. 275–

300.) The elevations along this line were based upon the same tidal observations at Sandy Hook as were used in connection with the transcontinental line.

There is a substantial agreement of the elevations given by these two lines for the bench marks common to them both between Sandy Hook and B. M. VIII near South Amboy. Hence the best elevations available for these bench marks are simply the mean of the values given by the two lines.

Between B. M. VIII and B. M. F, on Raritan Bay, a decided difference suddenly develops between the elevations given by the two level lines of 1881 and 1886–87. At B. M. VIII the 1886–87 line gives an elevation which is only 4·5 millimetres lower than that given by the 1881 line, whereas at B. M. F it gives an elevation 32·3 millimetres lower, although these bench marks are less than one kilometre apart. The question at once arises, "Which elevation for F is correct?"

On the transcontinental line no check on the elevations is available until Hagerstown, Md., is reached. At that point a connection is made with a line of precise levels from Washington, D. C. The check obtained in this way is, however, affected by the errors of leveling over the whole 580 kilometres between Washington and Sandy Hook, and hence it is not capable of detecting an error so small as 32·3 millimetres.

On the line to Dobbs Ferry there are, on the contrary, several good checks upon the elevations. It was connected with mean sea level at the time it was run, at twenty-two other points besides Sandy Hook. At three of these points—Governors Island, Willets Point, and Dobbs Ferry—the series of tidal observations covered nearly one month. At the remaining stations the observations were continued for a few days only. In every case hourly readings of the tide gauge were used, and simultaneous observations were made at Sandy Hook. The computations were made by the differential method, the simultaneous observations being used to refer the local mean sea level to the Sandy Hook mean sea level, and the results are therefore entitled to considerably more weight than would have been the case if the simultaneous observations had not been made at Sandy Hook. The mean of a selected seven of these stations indicates that the elevations given by the leveling of 1886–87 are subject to a correction of + 0·176 foot = + 53·6 millimetres.* Three of these stations, viz, Port Monmouth, Conaskonk, and South Amboy, are between Sandy Hook and B. M. F, and thus indicate that this correction of 53·6 millimetres is applicable between Sandy Hook and B. M. F. But this is contradicted strongly by the close agreement of the 1886–87 leveling and the 1881 leveling between those points. The seven selected stations were chosen because they were more freely exposed to the ocean than the remaining stations. In view, however, of the depth and width of the entrance to New York Bay, and of the Hudson and East Rivers, it is improbable that there is any appreciable difference between the mean sea level even as far up as Dobbs Ferry and mean sea level in the Lower Bay, and in fact the tidal observations do not indicate any well marked difference between the seven selected stations and the remaining stations. Taking the mean, then, from the nineteen tidal stations,† at which connections were made with sea level north of B. M. F, the apparent correction required by the elevations given by the 1886–87 leveling is + 0·147 foot = + 44·8 millimetres. As a further check upon the elevations given by the 1886–87 line, long series of continuous observations made with self-registering tide gauges at Fort Hamil-

* See pp. 297–299 of the 1887 Report.

† See tabulation on pp. 297–298 of the 1887 Report.

ton, Governors Island, and Willets Point are now available. The following table shows the place at which each series of observations was made, the length and date of the series, and the correction to the elevations of 1886-87 line resulting from that series. The last column shows the total range of the values for mean sea level derived from each year separately, and thus serves to indicate the accuracy of the tidal observations.

Place.	Length of series.	Date.	Correction.	Range.
			mm.	*mm.*
Fort Hamilton	7 years (highs and lows)	1893-1899	+10·5	53·7
Fort Hamilton	3 years (hourly ordinates)	1897-1899	− 8·7	7·0
Governors Island	10 years (highs and lows)	1870-1879	+77·4	103·9
Governors Island	3 years (hourly ordinates)	1876-1878	+54·5	79·3
Willets Point	2 years (hourly ordinates)	1891-1892-1894	−35·7	44·2

In deriving the values of mean sea level shown in the above table from readings of high and low water a correction was applied to the half-tide level, or mean between high water and low water, to reduce it to mean sea level, this correction being due to the component of the tide known as M_4 and to the diurnal components.

Additional observations made at Sandy Hook with a self-registering tide gauge between January 1, 1882, and August 31, 1884, and between December 1, 1886, and March 31, 1888, gave values for mean sea level, which fell within the extreme limits given by the observations of 1876-1881. If these three years of observations are used in addition to the six years previously used, the correction to the elevations of the 1881 level line is only −8·8 millimetres. This is about equal to the probable error of the determination of mean sea level and is too small a correction to be of importance.

In view of the various checks upon the elevations stated in the above paragraphs, the best assignable values at present would seem to be obtained by using the mean of the two elevations given by the 1881 line and 1886-87 line between Sandy Hook and B. M. VIII at South Amboy, to use the elevation given by the 1881 line for B. M. F at Raritan Bay, and to apply to all other elevations along the Sandy Hook-Dobbs Ferry line the correction + 32·3 millimetres necessary to make the elevation of B. M. F from the 1886-87 line agree with its elevation derived from the 1881 line. The elevation of B. M. V at Dobbs Ferry is on this basis, 2·9357 metres. The outstanding discrepancies between elevations thus assigned and the various determinations of mean sea level will then be as follows:

	Apparent required correction to elevations.
	mm.
From Sandy Hook tidal observations, 1876-1881.	0·0
From Sandy Hook tidal observations, 9 years, 1876-1881, 1882-1884, 1886-1888.	− 8·8
From short series of observations at 19 stations on New York Lower Bay, New York Harbor, and the Hudson River.	+12·5
From 7 years' observations of high and low water at Fort Hamilton.	−21·8
From 3 years of hourly ordinates at Fort Hamilton.	−41·0
From 10 years' observations of high and low water at Governors Island.	+45·1
From 3 years of hourly ordinates at Governors Island.	+22·2
From 2 years of hourly ordinates at Willets Point.	−68·0

NO. 6.—CINCINNATI, OHIO, TO LAWRENCEBURG, IND.

B. M. T (Cincinnati city B. M. No. 1) was connected with B. M. U on the court-house at Lawrenceburg by the transcontinental line of levels in 1879. These two bench marks were connected again by the line of levels between Gibraltar, Mich., and Cincinnati, Ohio, in 1899. The distance between the bench marks is 37 kilometres. The difference of elevation, T–U, as determined in 1879 was + 18·4435 metres, and in 1899 + 18·4825 metres. The value adopted for this difference was the mean of these two values, giving the leveling of 1899 double weight, viz, + 18·4695 metres. (See Appendix No. 7 of this Report, page 342, and Coast and Geodetic Survey Report 1882, pages 546–547.)

NO. 10.—JEFFERSON CITY, MO.

B. Ms. 90(85), XXVII, and XXVIII (Capitol) were touched by the Coast and Geodetic Survey line of levels between Jefferson City, Mo., and Holliday, Kans., in 1891, and by the lines of levels between St. Joseph and mouth of Missouri River in 1892, run under the direction of the Missouri River Commission. (See p. 268, Coast and Geodetic Survey Report for 1896, and pp. 4045, 4046, Chief of Engineers Report for 1893, Part 6.) The difference of elevation 90(85)–XXVIII was − 21·6787 metres as determined by the Coast and Geodetic Survey, and − 21·6783 metres as determined by the Missouri River Commission. The mean, − 21·6785 metres, was adopted. The difference of elevation 90(85)–XXVII was − 14·8693 metres as determined by the Coast and Geodetic Survey, and − 14·8676 metres as determined by the Missouri River Commission. The mean, − 14·8684 metres, was adopted.

NO. 12.—PLEASANT HILL, MO.

The difference of elevation, LI–LII, was determined on the Coast and Geodetic Survey line Jefferson City, Mo., to Holliday, Kans., in 1891 to be + 1·2064 metres. (See Coast and Geodetic Survey Report of 1896, p. 273.) It was determined again by Coast and Geodetic Survey on the line Olathe, Kans., to Pleasant Hill, Mo., in 1893 to be + 1·2195 metres. (See p. 372 of this Report.) The mean, + 1·2130 metres, was adopted.

NO. 14.—KANSAS CITY, MO.

Several bench marks in the vicinity of Kansas City are common to the Coast and Geodetic Survey line Jefferson City, Mo., to Holliday, Kans., 1891, and the Missouri River Commission line St. Joseph, Mo., to mouth of the Missouri River, 1892. The extreme bench marks in this series are LVIII and P. B. M. 244, 9 kilometres apart. The difference, LVIII–P. B. M. 244, as determined in 1891 is − 1·9753 metres, and in 1892 − 1·9867 metres. The mean, − 1·9810, was adopted. (See Coast and Geodetic Survey Report of 1896, p. 275; Chief of Engineers Report of 1893, Part 6, pp. 3983–3989.)

NO. 17.—ABILENE TO SOLOMON, KANS.

Bench mark B_1, at Abilene, Kans., and C_1, at Solomon, Kans., 14 kilometres apart, were connected by the line between Holliday and Salina in 1895, and by the line Abilene, Kans., to Norfolk, Nebr., in 1899. The difference of elevation, B.M.B_1–B.M.C_1, as determined in 1895 was — 5·6289 metres (see Coast and Geodetic Survey Report 1897, p. 278), and as determined in 1899 was — 5·6268 metres (see p. 306 of this Report). The mean, — 5·6278 metres, was adopted.

The difference of elevation, B. M. B_1–B. M. Y_2, as measured in 1899 is also to be considered fixed.

NO. 19.—SALINA, KANS.

Bench marks G_1 and H_1 at Salina were connected by the lines Holliday to Salina in 1895 (see Coast and Geodetic Survey Report 1897, p. 278) and Salina to Ellis in 1896 (see Coast and Geodetic Survey Report 1897–98, p. 285), with the following results:

	Metres.	
B. M. G_1—B. M. H_1	—0·0456	in 1895.
B. M. G_1—B. M. H_1	—0·0464	in 1896.
Mean	—0·0460	adopted.

NO. 21.—ELLIS, KANS.

Bench marks A_2 and B_2 at Ellis were connected by the lines Salina to Ellis in 1896 (see Coast and Geodetic Survey Report 1897–98, p. 190) and Ellis to Hugo in 1897 (see Coast and Geodetic Survey Report 1897–98, p. 201), with the following results:

	Metres.	
B. M. A_2—B. M. B_2	+0·1152	in 1896.
B. M. A_2—B. M. B_2	+0·1174	in 1897.
Mean	+0·1163	adopted.

NO. 24.—LIMON, COLO.

Bench marks N and P at Limon were connected by the lines Hugo to Colorado Springs (see Coast and Geodetic Survey Report 1897–98, p. 221) and Denver to Limon in 1898 (see p. 389 of this Report), with the following results:

	Metres.	
B. M. N—B. M. P	—6·9844	
B. M. N—B. M. P	—6·9875	
Mean	—6·9860	adopted.

NO. 27.—DENVER, COLO.

Bench mark Z_1 at Denver was connected directly with bench marks A_2 and B_2 in 1898 on the line Denver to Limon (see p. 392). In 1899 B. M. A_2 was connected directly with B. M. B_2 on the line Denver to Rock Creek, Wyoming (see p. 289 of this Report).

The three measures make a small circuit which has been closed by correcting the three measures as indicated below.

	As measured.	As adopted.
	Metres.	*Metres.*
B. M. Z_1—B. M. B_2	+0·6846	+0·6844
B. M. B_2—B. M. A_2	+0·0361	+0·0360
B. M. A_2—B. M. Z_1	—0·7202	—0·7204
Closing error	+0·0005	....

NO. 29.—BILOXI, MISS.

The connection with Gulf level at Biloxi, as used in former publications of the Coast and Geodetic Survey, is shown on pages 198–200 of the Coast and Geodetic Survey Report for 1887. The best connection now available is that shown on pages 3486–3487, 3476–3478, of the Chief of Engineers Report for 1899, part 5. The value there derived for the reading of mean Gulf level on the tide staff is 6·0829 ± 0·0114 metres. This value is based upon five complete years of observations, viz, 1882, 1884, 1896, 1897, and 1898, the total range of the five annual means being 0·1003 feet = 30·6 millimetres. This series of tidal observations includes that formerly used by the Coast and Geodetic Survey. The internal evidence of the series indicates that the elevation of the gauge zero has been kept constant during the observations. All the available evidence indicates that the bench marks in the vicinity of the gauge have maintained their relative elevations within narrow limits during the long period over which the leveling and tidal observations in this vicinity extend, and that upon the whole this connection with the gulf level is worthy of a very high degree of confidence. (See Chief of Engineers Report 1896, part 6, pp. 3478–3484.)

Using the value 6·0829 feet for the mean reading of gulf level upon the gauge as given above, the elevation of B. M. H_1 (=P. B. M. 19) above mean sea level is 11·939 −6·0829=+5·8561 feet=+1·7849 metres, and of B. M. E_1 is 21·803−6·0829= +15·7201 feet=+4·7915 metres. (See Chief of Engineers Report 1899, part 5, p. 3487.)

B. M. H_1 was connected with B. M. F_1 (P. B. M. 21), G_1 (P. B. M. 20), and I_1 (P. B. M. 18) at Biloxi by the level line run under the direction of the Mississippi River Commission between Carrollton and Biloxi in 1882–83 (see Chief of Engineers Report 1884, part 4, pp. 2463–2486), and by the Coast and Geodetic Survey level line between Mobile, Ala., and Carrollton, La., in 1885–86. (See Coast and Geodetic Survey Report 1887, pp. 185–205.) From these measurements the following values are obtained:

	Metres.
1882–83, F_1-H_1	−1·4569
1885–86, F_1-H_1	−1·4589
Mean adopted	−1·4579
1882–83, G_1-H_1	+0·3445
1885–86, G_1-H_1	+0·3418
Mean adopted	+0·3432
1882–83, I_1-H_1	+4·9326
1885–86, I_1-H_1	+4·9326
Mean adopted	+4·9326

Hence the adopted values for the elevations of F_1, G_1, and I_1 are, respectively, +0·3270, +2·1281, and +6·7175 metres.

NO. 33.—CORINTH, MISS.

The two bench marks W and V, in Corinth, were connected by the Coast and Geodetic Survey level line between Corinth, Miss., and Memphis, Tenn., in 1890–91 (see Coast and Geodetic Survey Report 1892, p. 207); by the Coast and Geodetic Survey line between Okolona, Miss., and Greenfield, Tenn., in 1889–90 (see Coast and

Geodetic Survey Report 1892, p. 169), and by the level line of United States engineers between Corinth, Miss., and Decatur, Ala., in 1895 (see Chief of Engineers' Report 1896, part 3, p. 1961). The values of W—V from these three lines were, respectively, +0·0567, +0·0568, and +0·0572 metre, and the mean =+0·0569 metre.

No. 35.—CAIRO, ILL.

The three bench marks P. B. M. 1, P. B. M. 2, and P. B. M. 3 were connected by the line of levels by the United States engineers, of which the results are given in the Chief of Engineers' Report 1883, part 3, p. 2187; by the United States engineers' line between Grafton and Cairo, 1880–81 (see Chief of Engineers' Report 1884, part 4, p. 2498), and by the Coast and Geodetic Survey line between Greenfield, Tenn., and Villa Ridge, Ill., 1888–89 (see Coast and Geodetic Survey Report 1892, part 2, p. 181). P. B. M. 3 is not used in this local adjustment because it is reported that when visited in 1888 the building on which the bench mark was placed showed evidences of having settled. (See Coast and Geodetic Survey Report 1892, p. 200.) The differences of elevation, P. B. M. 2—P. B. M. 1, from the lines named above were, respectively, +0·3976, +0·4042, and +0·4076 metre. The mean of these three values, +0·4031 metre, was adopted.

No. 38.—CARROLLTON, LA.

There are several bench marks in the neighborhood of Carrollton and New Orleans, which are common to the United States engineers' line of 1882–83 and the Coast and Geodetic Survey line of 1885–86. No attempt has been made to make a local adjustment, but a junction of the two lines has been made upon B. M. I at Carrollton.

No. 41.—VIDALIA, LA.

The bench marks LXI and LXIV were connected by the Coast and Geodetic Survey level line between Red River Landing and Bielas Landing, La., in 1880–81 (see Coast and Geodetic Survey Report 1888, p. 437), and by the line of the United States engineers from Monroe to Vidalia in 1893–94, of which the results are given in the Vicksburg tabulation. The extreme bench marks of this series on the Coast and Geodetic Survey line are LXI and LXIV; the difference, LXIV—LXI, by the 1881 line, is +0·9880 metre, and by the 1893–94 line, +0·9881 metre. The mean of these values, +0·9880 metre, was adopted.

No. 43.—VICKSBURG, MISS.

The relative elevations of the following bench marks, 211, 215, S. W. Base, N. E. Base, M. R. C. $\frac{102}{1}$, "Cistern," P. B. M. 1, P. B. M. 2, and B, in the vicinity of Vicksburg, Miss., and at Delta on the opposite bank of the Misssissippi River, are fixed by the local adjustment indicated below. The Coast and Geodetic Survey level line between Bielas Landing, La., and Millikens Bend, La., in 1880, touched upon B. Ms. 211 and 215 near Delta. (See Coast and Geodetic Survey Report 1888, page 443.) The line run by the United States Engineers in 1889 between Delta, La., and Coushatta, La., of which the results are shown in the Vicksburg tabulation, connected with bench marks

215, S. W. Base, M. R. C. 107, "Cistern," P. B. M. 1 and P. B. M. 2. The Coast and Geodetic Survey line between Vicksburg, Miss., and Meridian, Miss., in 1896, touched upon the bench marks 211, S. W. Base, N. E. Base, M. R. C. 107, "Cistern," and B. (See pp. 354–355 of this report.) The United States Engineers' line from Delta, La., to Greenville, Miss., in 1897, and of which the results are given in the Vicksburg tabulation, touched upon bench marks 211, S. W. Base, N. E. Base, M. R. C. 107, "Cistern," P. B. M. 1, P. B. M. 2 and B. The river crossing was made in 1889 between S. W. Base and M. R. C. 107, and in 1896–97 was made between N. E. Base and M. R. C. 107. The following tabulation shows how the results of these various lines of levels have been combined, and it is believed that no other explanations are necessary to justify such a combination than those given by the table itself and its footnotes. It has been assumed in some of the discussions of the leveling in this vicinity that the bench mark M. R. C. 107 changed in elevation some time between 1889 and 1897, but when the lines of levels in both directions from this bench mark are considered it does not seem to the writer that this assumption is warranted. The elevations of the different bench marks relative to 211, as shown in the last column of the table, were adopted.

Differences of elevation in vicinity of Vicksburg, Miss.

Bench marks.	Date.	Observed difference.	Dist.	Corr.	Corrected difference of elevation.	Adjusted elevation above 211.	
		m.	*km.*	*mm.*	*m.*	*m.*	
C. and G. S. 211						0·0000	
211–215	1880	− 0·1138	3·6	− 0·5	− 0·1143	− 0·1143	
211–S. W. Base	1897	+ 1·1309	2·6	+ 0·5	+ 1·1314	+ 1·1314	
211–S. W. Base	1896	+ 1·1484	2·6				Rejected.
215–S. W. Base	1889	+ 1·2462	0·1	− 0·5	+ 1·2457	− 1·1314	
S. W. Base–N. E. Base	1897	− 1·2341	3·1	+ 0·4			
S. W. Base–N. E. Base	1896	− 1·2333	3·1	− 0·4	− 1·2337	+ 0·1023	
N. E. Base–M. R. C. 107	1897	+ 1·0327	2·6	+15·8			
N. E. Base–M. R. C. 107	1897	+ 1·0364	3·4	+12·1	†+ 1·0485	− 0·9462	
N. E. Base–M. R. C. 107*	1896	+ 1·0625	4·7	−14·0			
S. W. Base–M. R. C. 107‡	1889	− 0·1758	5·8	− 9·4	− 0·1852		
M. R. C. 107–Cistern	1897	−32·1425	2·0	− 3·1			
M. R. C. 107–Cistern	1897	−32·1498	3·8	+ 4·2	−32·1456	+31·1994	
M. R. C. 107–Cistern	1896	−32·1444	2·4	− 1·2			
M. R. C. 107–Cistern	1889	−32·0926	1·9				Rejected.
Cistern–P. B. M. 1	1897	+27·6050	3·3	− 2·5	+27·6025	+ 3·5969	
Cistern–P. B. M. 1	1889	+27·5975	6·9	+ 5·0			Weight ½.
P. B. M. 1–P. B. M. 2	1897	+ 1·9298	1·1	− 0·8			
P. B. M. 1–P. B. M. 2	1890	+ 1·9281	1·0	+ 0·9	+ 1·9290	+ 1·6679	
M. R. C. 107–C. and G. S. B.	1897	− 3·1495	1·1	− 0·7			
M. R. C. 107–C. and G. S. B.	1896	− 3·1508	1·4	+ 0·6	− 3.1502	+ 2·2040	

* Given double weight, because maximum sight was about half that of 1897.
† Indiscriminate mean of all four crossings gives + 1.0474.
‡ Given no weight.

No. 45.—WILKERSONS LANDING AND ARKANSAS CITY.

Bench mark F at Arkansas City was connected with bench mark 84 at Wilkersons Landing by the Coast and Geodetic Survey level line between Wilkersons Landing, Miss., and Little Rock, Ark., 1887–88, and by the United States Engineer line between Parkeville and Greenville in 1897. The difference of elevation, F–84, according to the determination of 1887–88, is − 0·0584 metre, and according to the 1897 determination − 0·0543 metre. The mean, − 0·0564 metre, was adopted. The bench marks F and 84 are on opposite sides of the Mississippi River.

No. 47.—LITTLE ROCK, ARK.

Bench marks O, A, B, and I (or 3) were connected by the Coast and Geodetic Survey line from Wilkersons Landing to Little Rock in 1887–88, and by the line Monroe, La., to Little Rock, Ark., by the United States Engineers in 1895 and 1897. A careful investigation of the relative elevations of these four bench marks, as determined by the two level lines, indicated that I (or 3) showed an apparent change of elevation which was very nearly the mean of the apparent changes for all four bench marks. I (or 3) was therefore assumed to be stable during the interval in question, and was used as the junction bench mark.

No. 49.—VAN BUREN, ARK.

The difference of elevation of B. M. XXXIX–XXXVIII as determined in 1893 on the Coast and Geodetic Survey line Van Buren to Chester was − 0·0077 metre, and as determined on the line Little Rock to Fort Smith in 1889 was − 0·0068 metre. The mean, − 0·0072 metre, was adopted.

No. 52.—CHESTER, ARK.

The difference of elevation, B. M. XLIX–B. M. XLVIII, as determined in 1893 on the Coast and Geodetic Survey line Van Buren to Chester was − 1·1362 metres, and as determined in 1894 on the line Chester to Boston − 1·1355 metres. The mean, − 1·1358 metres, was adopted.

No. 54.—BOSTON, MO.

The difference of elevation, B. M. XCVI–B. M. XCVII, as determined in 1893 on the Coast and Geodetic Survey line Harrisonville to Boston, was − 0·0010 metre, and as determined in 1894 on the line Boston to Chester − 0·0007 metre. The mean, − 0·0008 metre, was adopted.

No. 58.—WASHINGTON, D. C.

The elevations 27·7000 metres for the Capitol bench mark and 2·9360 metres for B. M. C at navy-yard, as given on page 257 of the Coast and Geodetic Survey Report for 1896, were adopted. These elevations depend upon tidal observations at the Washington Navy Yard extending over five years, and upon the assumption that the total fall of the Potomac from the Navy Yard to the open sea is 88·0 millimetres. (See page 256 of Coast and Geodetic Survey Report for 1896.)

No. 60.—RICHMOND, VA.

The adopted elevation for B. M. O at Richmond is 58·1957 metres, this being the weighted mean of two determinations of the elevation of this bench by leveling from Old Point Comfort, Va., in 1884 and in 1891–92, and being checked by tidal observations at Richmond. (See p. 244, Coast and Geodetic Survey Report, 1896.)

No. 62.—OLD POINT COMFORT, VA.

The elevation of B. M. U was determined by connection with mean sea level as fixed by twenty-six years of tidal observations, 1853–1878, showing a total range in the annual means of 1·26 feet=0·3840 metre. The resulting elevation of B. M. U= +2·6875 ± 0·0120 metre. (See pp. 238–239 of Coast and Geodetic Survey Report for 1896.)

No. 67.—ANNAPOLIS, MD.

The connection with mean sea level on the Chesapeake Bay at Annapolis was made by two short series of tidal observations with staff gauges November 24 to December 18, 1875, and August 16 to September 18, 1888. These two series gave for the elevation of Perkins tidal bench mark (a) above mean sea level 4·13 feet and 4·19 feet, respectively, and the mean 4·16 feet=1·268 metres was adopted. (See Coast and Geodetic Survey Report, 1889, pp. 462–463.)

No. 71.—GIBRALTAR, MICH.

Bench marks 2 and (1877) were connected by the Lake Survey line of levels run in 1877 between Gibraltar and Lakeport (see pp. 602, 616 of Professional Papers of Corps of Engineers, U. S. A., No. 24), by the level line between Gibraltar and Fort Gratiot in 1898–99 by the United States Engineers, and by the line, Gibraltar to Cincinnati, run by the Coast and Geodetic Survey in 1899 (see Appendix No. 7 of this report). The last two lines mentioned also connect B. M. 1 (of 1898) with B. M. (1877). The differences of elevations as given by these lines are as follows:

	Metres.	
B. M. 2—B. M. (1877) +2·519 feet	+0·7678	(1877)
B. M. 2—B. M. (1877)	+0·7659	(1898–99)
B. M. 2—B. M. (1877)	+0·7677	(1899)

The mean +0·7671 metres was adopted.

	Metres.	
B. M. 1 (of 1898)—B. M. (1877)	+1·5490	(1898–99)
B. M. 1 (of 1898)—B. M. (1877)	+1·5486	(1899)

The mean +1·5488 metres was adopted.

No. 75.—MONROE, LA.

P. B. M. 27 and P. B. M. 24 at Monroe, La., were connected by the United States Engineer line of 1889 between Delta and Coushatta; of 1893–94, between Monroe and Vidalia; and of 1895, between Monroe and Little Rock. The difference of elevation, P. B. M. 24–P. B. M. 27, as determined by these three lines respectively, was −1·9701, −1·9809, and −1·9807 metres. The mean −1.9772 metres was adopted.

No. 77.—RAYVILLE, LA.

P. B. M. 17 and P. B. M. 16 at Rayville were connected by the United States Engineer lines; Delta to Coushatta in 1889, and Rayville to Concordia in 1897–98. The measured difference of elevations by these two lines is $+2.3293^{m}$ and $+2.3294^{m}$, respectively. The difference, $+2.3294^{m}$, was adopted.

No. 82.—JONESVILLE, LA.

Three elevations for P. B. M. 5 may be derived by assuming P. B. M. 3, P. B. M. 4, and T. B. M. 27 in turn to have held a constant elevation from the time when the Monroe to Vidalia line of 1893 was run until the Jonesville to Mouth of Black River line was run in 1894.

	Metres.
From P. B. M. 3 elevation P. B. M. 5 (1894)	22·5544
From P. B. M. 4 elevation P. B. M. 5 (1894)	22·5497
From T. B. M. 27 elevation P. B. M. 5 (1894)	22·5533

Mean 22·5525 metres adopted.

This makes P. B. M. 5 26·4 millimetres higher than in 1893.

There is a similar discrepancy of the same sign on T. B. M. 28.

No. 85.—PARKEVILLE, LA.

B. M. Parkeville and T. B. M. 74 at Parkeville were connected by the United States Engineer lines, Monroe, La., to Little Rock, Ark., in 1895, and Parkeville, La., to Arkansas City, Ark., in 1897, the two values for the measured difference of elevation being, T. B. M. 74–B. M. Parkeville, $+1.2215^{m}$ and $+1.2224^{m}$, respectively. The mean $+1.2220$ metres was adopted.

No. 95.—AUSTIN, MISS.

On the line Friars Point, Miss., to Memphis, Tenn., No. 96 in above list, the leveling was done in two sections, Friars Point to Austin and Austin to Memphis, with an interval of a year between the two sections. On commencing work at Austin at the beginning of the second season it was found that the two bench marks I and II had apparently changed their difference of elevation by 4·4 millimetres since the end of the preceding season. It was assumed that their mean elevation had remained unchanged in deriving the difference of elevation between Friars Point and Memphis shown in No. 96 above. (See p. 1942, Chief of Engineers Report, part 3, 1879.)

No. 107.—GRAFTON, ILL.

The bench marks P. B. M. 1, P. B. M. 2, and P. B. M. 3 at Grafton are common to the United States Engineer lines, Cairo to Grafton and Keokuk to Grafton. P. B. M. 3 was believed by those who were familiar with the local conditions to be more stable than the other two bench marks, and the junction was therefore made upon this bench mark and no local adjustment was made. (See Chief of Engineers Report, 1884, part 4, p. 2512).

NO. 109.—KEOKUK, IOWA.

P. B. M. 1, P. B. M. 2, and P. B. M. 3 at Keokuk are common to the two United States Engineer lines, Keokuk to Grafton and Keokuk to Fulton. The relative elevations of these three bench marks, as shown by the two lines, agree so closely that there is little need for a local adjustment. P. B. M. 1 is taken as the junction bench mark in this report, as it is in the published Report of the Chief of Engineers, 1884, part 4, pages 2499–2513. A local adjustment will change the elevations in this vicinity by not more than half a millimetre.

NO. 111.—SAVANNA, ILL.

P. B. Ms. 62, 63, and 64, in the vicinity of Savanna, are common to the United States Engineer lines, St. Paul to Savanna, and Fulton to Chicago. The local adjustment made in the report of the Chief of Engineers, as stated on page 2957 of the report of 1892, part 4, was accepted. No correction is by this adjustment introduced into the line Fulton to Chicago, but the mean of three independent elevations of T. B. M. 353 of the Savanna–St. Paul line, found by connecting this bench mark with P. B. Ms. 62, 63, and 64, respectively, was adopted.

NO. 114.—ST. PAUL, MINN.

P. B. M. 68, P. B. M. 69, and P. B. M. 71, at St. Paul, are common to the two United States Engineer lines, St. Paul to Savanna and Duluth to St. Paul. P. B. M. 68 was adopted as the junction bench mark. This was also adopted in the published report of Chief of Engineers, 1892, part 4, pages 2958, 3098. The relative elevations of the three bench marks, as shown by the two lines, were such that a local adjustment would make very little change in the adopted values.

NO. 123.—ST. JOSEPH, MO.

P. B. M. 287 and P. B. M. 290 were connected by the United States Engineer lines St. Joseph to the mouth of the Missouri River and Sioux City to St. Joseph, in 1892 (see Chief of Engineers Report, 1893, part 6, pp. 3964, 4208–4209), with the following results:

	Metres.
P. B. M. 287—P. B. M. 290	—0·9905
P. B. M. 287—P. B. M. 290	—0·9880

Mean, —0·9892 metres adopted.

NO. 137.—NEAR SCHENECTADY, N. Y.

The line between Dunkirk, N. Y., and Greenbush, N. Y., by the United States Geological Survey, was connected with the old line of 1875 by the United States Engineers between Greenbush and Oswego by touching upon bench marks 8, 8A, 12, 14, 14A, and 15, of 1875, near Schenectady. These six bench marks are scattered over a distance of 15 kilometres along the line. The relative elevations determined by the two level lines show considerable discrepancies, but none of such magnitude as to justify the rejection of a bench mark. The mean elevation of these six bench marks as given by the United States Engineers in 1875, Professional Papers No. 24, pages 610–611, was 191·510 feet, and the mean elevation by the Geological Survey line in 1898 (see pages 309, 310 of Part 1 of the Twentieth Annual Report of the United States Geological Survey) was 190·512 feet. Hence, the correction to reduce the Engineer elevations to Geological Survey elevations in this region is −0·998 foot, and the elevation of the Gristmill bench mark at Greenbush, on this basis, using the United States Engineer line of 1875 as a continuation of the Geological Survey line to Greenbush, is 13·732 (=14·730 − 0·998) feet.

No. 141.—NEAR PITTSBURG, PA.

There are several bench marks in the vicinity of Pittsburg which are common to the United States Geological Survey line between Erie and Grafton and the Pennsylvania Railway lines of levels. The extreme bench marks of this series are P. R. R. 26 at West Penn Junction (Allegheny Valley) and P. R. R. 88 at Braddock. These bench marks are 63 kilometres apart, measured along the Geological Survey line. The two measured differences of elevations, P. R. R. 26–P. R. R. 88, are −40·03 feet, = −12·2012 metres by the Pennsylvania Railroad (see Bench Mark Book of the Pennsylvania Railroad, May 1, 1899, pp. 74, 77), and −40·240 feet, = −12·2652 metres by the United States Geological Survey, as shown by the manuscript furnished by them. The mean of these two differences, viz, −12·2332 metres, was adopted and considered fixed.

ACKNOWLEDGMENTS.

The authority referred to for the fifteen lines numbered 74, 76, 78–81, 83, 84, 86–89, 91, 92, and 94 is the four Vicksburg tabulation books, showing direct results of the leveling and the descriptions of bench marks with accompanying sketches. These books, which are in the nature of office registers, were kindly loaned to the Survey in March, 1900, by Maj. Thomas L. Casey, of the United States Engineer Corps, stationed at Vicksburg.

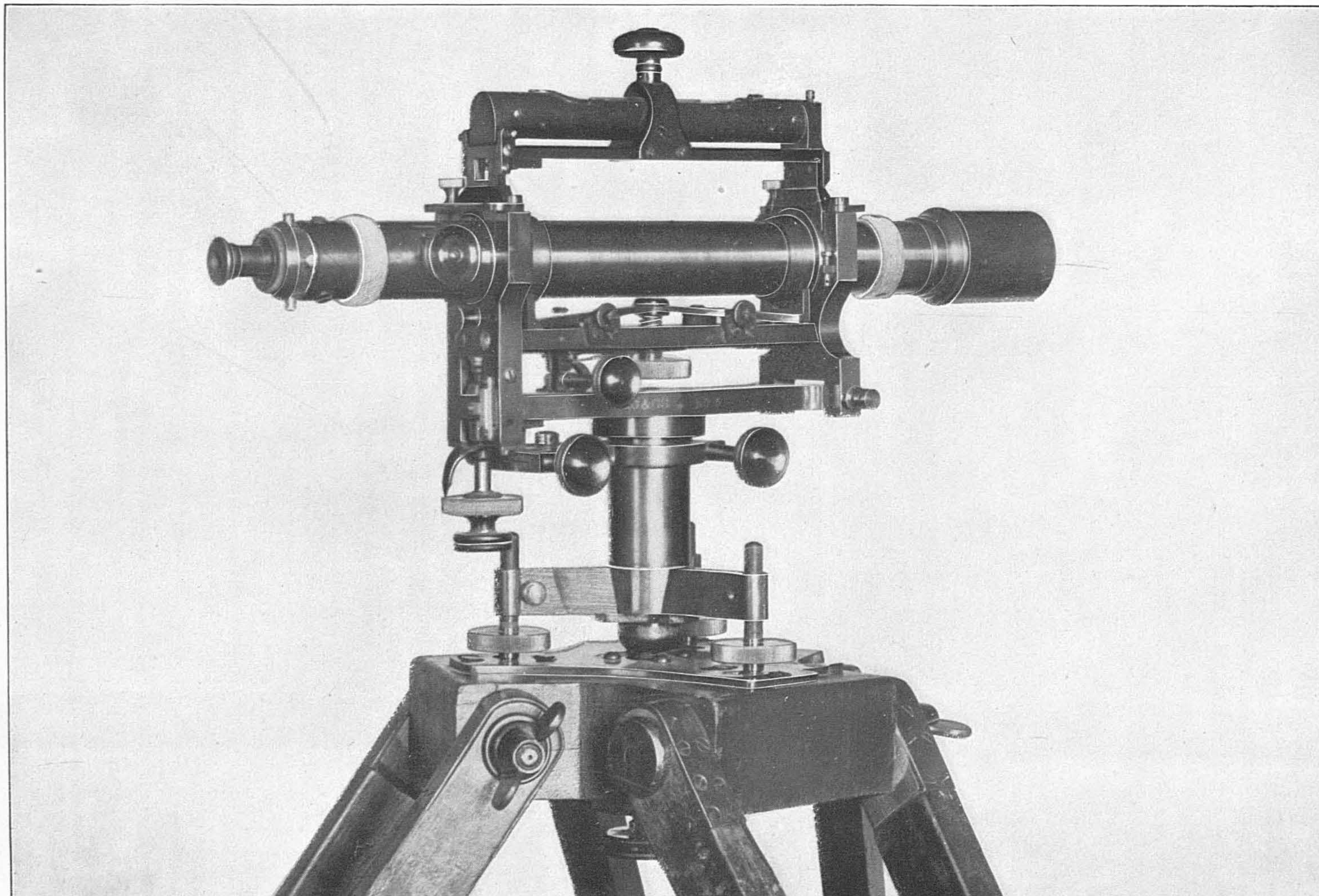
Complete information in regard to line No. 128 and descriptions of bench marks on that portion of line No. 133 which lies between Cape Vincent, N. Y., and Hogansburg, N. Y., were furnished from the Detroit office of the United States Engineers, in a report signed by E. E. Haskell, assistant engineer, and forwarded through the Chief of Engineers by Lieut. Col. G. J. Lydecker.

For data in regard to the lines numbered 132, 133, and 134 the Survey is indebted to Mr. G. Y. Wisner, of the Deep Waterways Commission, who kindly furnished results in manuscript.

For information in regard to lines numbered 139, 140, and 142, and for information supplementing that given in the Twentieth Annual Report of the United States Geological Survey, part 1, pages 299–310, in regard to line No. 138, acknowledgment is due to the Director of the United States Geological Survey and to Mr. H. M. Wilson, geographer.

INSTRUMENTS AND METHODS PREVIOUS TO 1899 IN THE COAST AND GEODETIC SURVEY.

The instruments used by the Coast and Geodetic Survey for precise leveling previous to 1899 were all of the type shown in Illustration No. 6. The particular instrument shown in this illustration is No. 5. No. 6 is a duplicate of No. 5. Levels



LEVEL NO. 5.

No. 1 to No. 4 differ from Nos. 5 and 6 in dimensions and details of design, but not in the general features of the design. The distinctive characteristic of the design of these instruments is that the wyes in which the telescope rests are controlled by a micrometer screw in such a way that the inclination of the telescope may be quickly changed at will, by an amount which is measured with a high degree of accuracy by the readings of the micrometer head. This micrometer screw, with its accurately graduated head, is used to measure the small angle between that position of the telescope in which the distant target, placed approximately in the horizon of the telescope, appears to be bisected, and that position of the telescope which causes the bubble of the striding level to stand in the middle. A very high grade of workmanship was used in the construction of these instruments. Devices shown just below the telescope in the illustration were provided for relieving the micrometer screw from strain and for lifting the telescope from its wyes while the instrument was being carried from station to station.*

The principal constants and dimensions of levels No. 5 and No. 2 are as follows:

	Level No. 5.	Level No. 2.
Clear aperture of telescope	$2^{cm}.9$	$4^{cm}.3$
Focal length of telescope	$34^{cm}.8$	$41^{cm}.0$
Magnifying power of telescope	28	24 to 37
Value of 1 division (2 millimetres) of striding level	$2''.1$	$1''.5$ to $3''.4$
One division of the micrometer head (100 divisions = 1 turn)	$3''.1$	$2''.6$
Angle subtended by stadia lines	18′ 54″	16′ 39″
Weight of instrument alone	$4^{kg}.6 = 10^{lbs}.1$	
Weight of tripod	$7^{kg}.3 = 16^{lbs}.1$	

The rods P and Q used during the years 1895–1898 are described in detail and illustrated in Appendix No. 8 of the Report for 1895, pages 381–382. They are made of well-seasoned white pine thoroughly saturated with paraffin for the purpose of making their lengths independent of the hygrometric state of the atmosphere. Each rod is a little more than 3 metres long and its cross section is a cross of symmetrical proportions. The graduation is carried on a series of silver-faced brass plugs 5 millimetres in diameter inserted in the face of the rod at intervals of 2 centimetres. A millimetre scale attached to the target furnishes a means of reading to tenths of millimetres (estimated) against fine lines drawn upon these plugs. The target may be moved at will by means of an endless chain passing over a pulley at the top of the rod and extending down the back of the rod, and may also be clamped in position quickly at any point by the use of a second endless chain attached to the clamp arm. The front of the rod also carries a painted graduation, which may be read directly from the telescope, and is used for making rough check readings to detect errors in the readings of the target and to make the necessary stadia readings for distance. The thermometer used to determine the temperature is sunk deep into the rod itself at the back and is covered by a wooden lid. The bottom of the rod is made of metal and terminates in a round bronze boss with a radius of 2.7 centimetres. The foot plate is a circular disk of cast iron about 15 centimetres in diameter, with a depression having a radius of 3.5 centimetres in the center for receiving the foot of the rod.

*For a more detailed description of these instruments see Appendix No. 15 of the report for 1879, pp. 202–211.

One of the earlier sets of rods is described and illustrated in Appendix No. 15 of the Report for 1879, page 203. All of the rods distinguished by the letters A, B, etc., to O were of the same type as these and differed only in details of construction. The general dimensions and shape of these rods were the same as for P and Q described above. The material was white pine, but not treated with paraffin. The same foot plates were used. The foot of the rod was similar to that on P and Q, with the exception that whereas the point of support is brought forward in P and Q so as to be in the plane of graduation on the rod it was on the older rods in the axis of the rod prolonged. They were all target rods with a supplementary painted graduation for the purpose of making check readings and stadia readings. The graduation on rods A to O was carried on a strip of brass set into the face of the rod. On the earlier rods this brass strip was fastened in the middle only and expanded in both directions from the middle. On later rods it was fastened at the bottom. As this brass strip, which was the measuring scale upon which all observed differences of elevation depended, had a comparatively high coefficient of expansion, about .000018 per degree centigrade, in marked contrast to the expansion of .000004 of rods P and Q, it is important to note briefly the mode of attachment and exposure of the thermometers used to determine the temperature of the strip. In the earliest rods both the strip and the thermometer bulb were unprotected from the direct rays of the sun. On successive rods of later dates these conditions were gradually improved. On the latest of the rods now under consideration the brass strip was protected from direct sunlight by a strip of felt and the thermometer was sunk deeper into the rod and protected by a metallic cover. Even with these improvements the later rods must be conceded to be very decidedly inferior to rods P and Q.

All of the leveling during the years 1895–1898 was done by the double simultaneous method. In leveling by this method the difference in elevation between two bench marks is determined by observing from the same station and with the same instrument back sights on two different rods set up at unequal distances from the instrument and fore sights on the same two rods carried forward and placed at the same relative distances as before. Previous to 1895 a part of the leveling was done by the double simultaneous method and a part by the forward and backward method, which consisted in leveling between certain bench marks in the direction called the forward direction and later releveling between the same bench marks in the reverse or backward direction.* On some of the double simultaneous leveling done previous to 1895 alternate portions of the line several kilometers long were run in contrary directions for the purpose of eliminating errors, at least in part.

The programme of observation at each station in 1895–1898 was that shown below, in which the order of time is indicated by the order on the page. By a reading of the micrometer on the level is meant a reading of the micrometer corresponding to that position of the telescope in which the bubble is in the middle.

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* For a tabular statement showing which lines were run by the forward and backward and which by the double simultaneous method see pages 883–884.

PROGRAMME OF OBSERVATION AT A STATION.

Coast and Geodetic Survey double simultaneous lines.

Backsight.				
Rod.	Position of telescope.	Position of level.	Reading of micrometer on—	
				Setting of P target.
P	E	D	Level	
P	E	D	Target	
P	E	R	Target	
P	E	R	Level	
P	I	R	Level	
P	I	R	Target	
P	I	D	Target	
P	I	D	Level	
				Reading of upper and lower edges of target and of distance line.
				Setting of Q target.
Q	I	D	Level	
Q	I	D	Target	
Q	I	R	Target	
Q	I	R	Level	
Q	E	R	Level	
Q	E	R	Target	
Q	E	D	Target	
Q	E	D	Level	
				Reading of upper and lower edges of target and of distance line.

The same operations are repeated in the same order on the fore sight.

Besides the record corresponding to the above programme, the rod readings, one on each rod for each back sight and for each fore sight, are also placed in the record at times not interfering with the above programme.

The total number of original entries in the record book per station, exclusive of temperature readings, is 48.

The upper and lower edges of the target were read by the observer for the purpose of checking the target readings. A single line, subtending with the center line of the diaphragm an angle of about 19′, was read for the purpose of giving a stadia measurement of the distance of the rod, this distance being necessary to enable the computation to be made.

If a single line is being run, the programme at a station is of course one-half the length of that shown above.

Such a programme of observation gives from each set of readings on a rod a measure of difference in elevation of the rod and the instrument which is independent of the error of the striding level and the error of collimation of the telescope. Equality in length of fore sights and the corresponding back sights is depended upon to eliminate the effects of refraction, curvature, and inequality of collars only, and even for these purposes entire dependence is not placed upon equality of sights, as the distance measures furnish a means of applying the small corrections corresponding to the small differences of length.

Lines No. 1 to No. 66, of the list on pages 398-402, were run with the instruments and methods described above, with the exception of the 1894 line across Florida.

Line No. 68, Annapolis to Washington, was run independently in the forward and backward directions, using a method which is substantially identical with that used by the United States Engineers on lines 73 to 124.

INSTRUMENTS AND METHODS, COAST AND GEODETIC SURVEY, 1899.

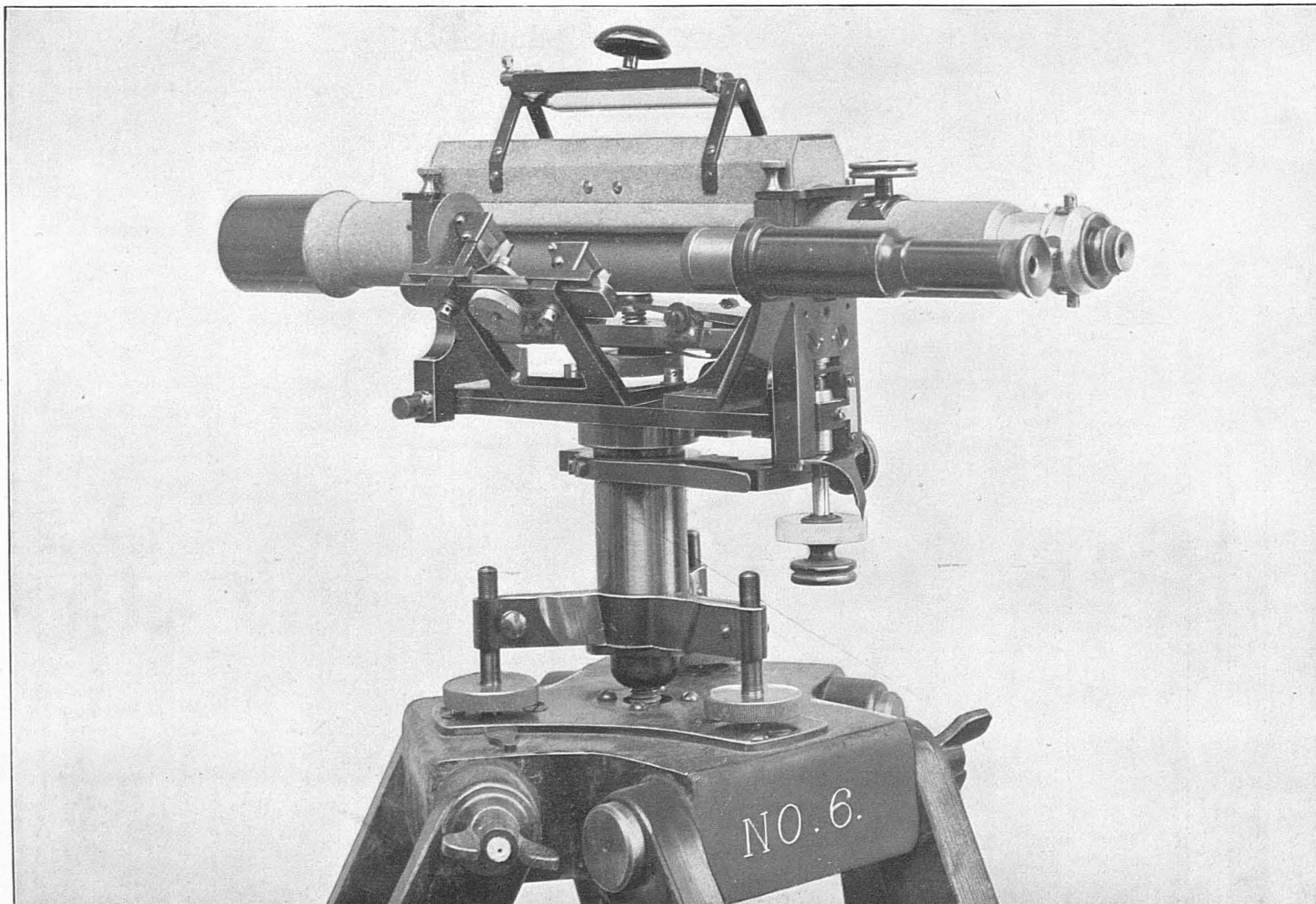
Lines numbered 69, 70, 72 were run in 1899, using direct-reading rods and levels No. 5, No. 6, and No. 1, modified as indicated in illustrations Nos. 7 and 8, and in the text below. The method of observation was also radically changed from that formerly in use.

Each of these three levels was provided with a device for reading the bubble from the eye end of the telescope without moving the eye away from the eyepiece. The device is shown in illustration No. 7. In its essential principles it is the reading device which has been used on the Berthélemy precise levels which have been used extensively in the leveling in France. In its design, however, it differs radically from that device, as may be seen by comparing illustration No. 7 with No. 12.* The light from each end of the bubble passes to the mirror shown above the level vial, thence to two 45-degree prisms at the same elevation as the telescope and to the left, and from them passes through an auxiliary eyepiece to the left eye of the observer. The bubble is seen clearly and slightly magnified, is brightly lighted, and is read without parallax. The two prisms may be so arranged that only the ends of the bubble and a small portion of the graduation are seen in the auxiliary eyepiece. The two bubble ends are apparently so close together that very little movement of the eye is necessary in looking from one to the other. The prisms may be quickly adjusted to accommodate them to varying lengths of the bubble, the auxiliary eyepiece may be focused to fit the eye of the observer, and the distance between the eyepiece of the telescope and the auxiliary eyepiece of the reading device may be adjusted to correspond with the binocular distance of the observer. The mirror projects but little above the striding level. This is a decided advantage in observing on a windy day. No distracting images of surrounding objects are seen in the mirror when reading the bubble. The device is very effective in enabling the observer to make practically simultaneous readings of the rod and the bubble, as he sees both clearly at the same time and needs but to change the attention from one to the other.

The striding levels of these three instruments were remodeled in such a way that the distance between the level vial and the line of collimation of the telescope has been greatly reduced. The level vial was also protected more thoroughly than before against sudden changes of temperature. The principal metallic parts of the striding level and the telescope barrel, including the collars which rest upon the wyes, have been constructed of a nickel-iron alloy having a coefficient of expansion of ·000004, about the same as that of pine. These parts were formerly made of a yellow composition metal having a coefficient of expansion four and a half times as large as this, namely, about ·000018 per degree centigrade.

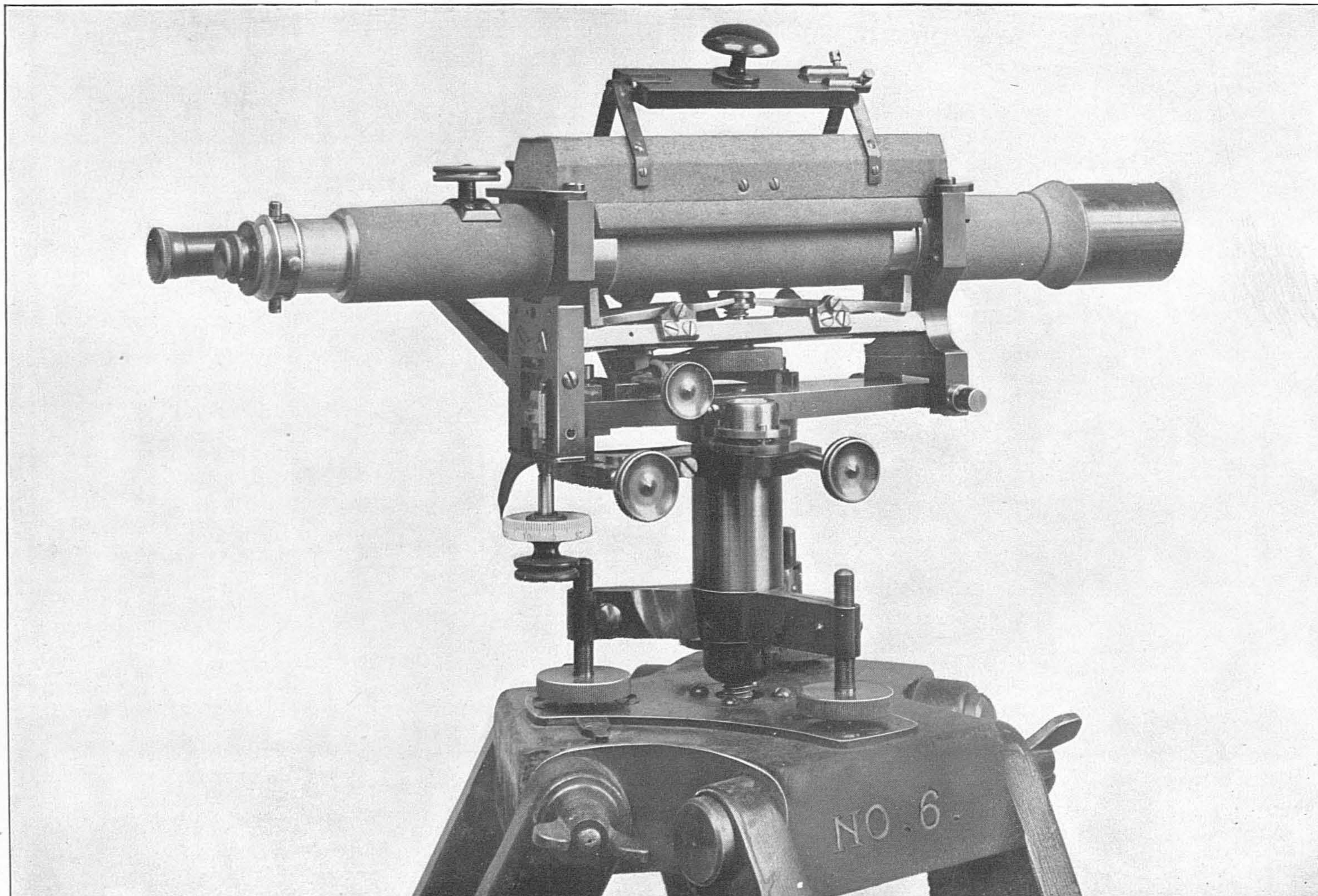
The rods used in 1899 are shown in illustration No. 9. They are like the rods P and Q in general shape and dimensions, in material, and in many other respects. The

* The present device was designed by Mr. E. G. Fischer, chief of the Instrument Division.



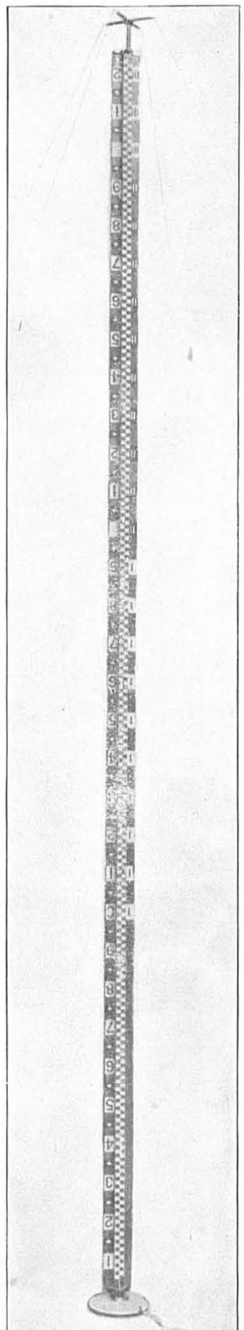
COAST AND GEODETIC SURVEY LEVEL NO. 6.

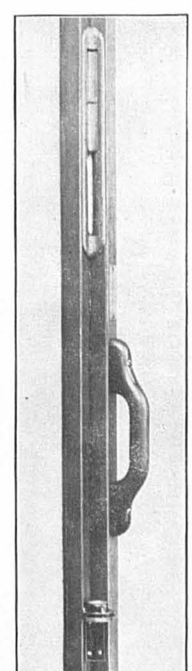
(As used in 1899.)



COAST AND GEODETIC SURVEY LEVEL NO. 6.

(As used in 1899.)





PRESENT RODS.

footplate, the foot of the rod, the placing of the thermometer and of the watch level are the same as in rods P and Q. They differ essentially from rods P and Q as used in 1895–1898 in being direct reading rods instead of target rods. The graduation, which is read directly from the telescope, is in black and white squares 1 centimetre on a side. Metal plugs are inserted at the 0·1, 1·1, 2·1, and 3·1 metre points. A fine graduation on these plugs is used to determine the exact length of the rods and to study their changes of length while in the field. The new rods contain less than 20 per cent of their original weight of paraffin as contrasted with 72 to 95 per cent in rods P and Q. This, together with the omission of the target and connected chains, reduces the weight of the rod from about 10 kilograms to about 4·5 kilograms. These rods with the smaller amount of paraffin are found to be sensibly as constant in length under varying hygrometric conditions as rods P and Q.

The following general instructions for precise leveling, issued at the beginning of the field season of 1899, indicate concisely the programme and method of observation:

"1. Except when specific instructions are given to proceed otherwise, all lines are to be leveled independently in both the forward and the backward direction.

"2. It is desirable that the backward measurement on each section should be made under different atmospheric conditions from those which occurred on the forward measurement. It is especially desirable to make the backward measurement in the afternoon if the forward measurement was made in the forenoon, and vice versa. The observer is to secure as much difference of conditions between the forward and backward measurements as is possible without materially delaying the work for that purpose.

"3. On all sections upon which the forward and backward measures differ by more than $4^{mm}{\cdot}0\sqrt{K}$ (in which K is the distance leveled between adjacent bench marks, in kilometres), both the forward and backward measures are to be repeated until two such measures fall within the limit.

"4. The programme of observation at each station is to be as follows:

"Set up and level the instrument. Read the three lines of the diaphragm as seen projected against the front (or rear) rod, each being taken to the nearest millimetre (estimated), and the bubble being held continuously in the middle of the tube (i. e., both ends reading the same). *As soon as possible* thereafter read the three lines of the diaphragm as seen projected against the rear (or front) rod, estimating to millimetres as before, and holding the bubble continuously in the middle of the tube. During all observations the telescope is to be erect, and the striding level with a particular leg toward the objective—that is, there are to be no reversals of telescope or striding level.

"5. At each rod station the rod thermometer is to be read and the temperature recorded.

"6. At stations of odd numbers the backsight is to be taken before the foresight, and at the even stations the foresight is to be taken before the backsight.

"7. The maximum difference in length between a foresight and the corresponding backsight is to be 10 metres. The actual difference is to be made as small on each pair of sights as is feasible by the use of good judgment without any expenditure of time for this particular purpose.

"8. The recorder shall keep a record of the rod intervals subtended by the extreme lines of the diaphragm on each backsight, together with their continuous sum between bench marks. A similar record shall be kept for the foresights. The two continuous sums shall be kept as nearly equal as is feasible without the expenditure of extra time for that purpose by setting the instrument beyond (or short of) the middle point between the back and front rods. The two continuous sums shall not be allowed to differ by more than a quantity corresponding to a distance of 20 metres.

"9. The inequality of collars shall be determined at the beginning and end of each season of work.

"The collimation error shall be determined once for each day of work by a set of three readings in the direct position and two in the reverse position of the telescope.

"The error of adjustment of the striding level shall be determined at least twice on each day of work by a set of three readings in the ordinary position and two in the reverse position.

"10. Notes for future use in studying leveling errors shall be inserted in the record indicating the time of beginning and ending of the work of each half day, indicating the weather conditions especially as to cloudiness and wind, indicating whether each portion of the line is run toward or away from the sun, and such other notes as promise to be of value in studying errors.

"11. The instrument shall be shaded from the direct rays of the sun both during the observations and the movement from station to station.

"12. The maximum length of sight shall be 150 metres, and the maximum is to be attained only under the most favorable circumstances."

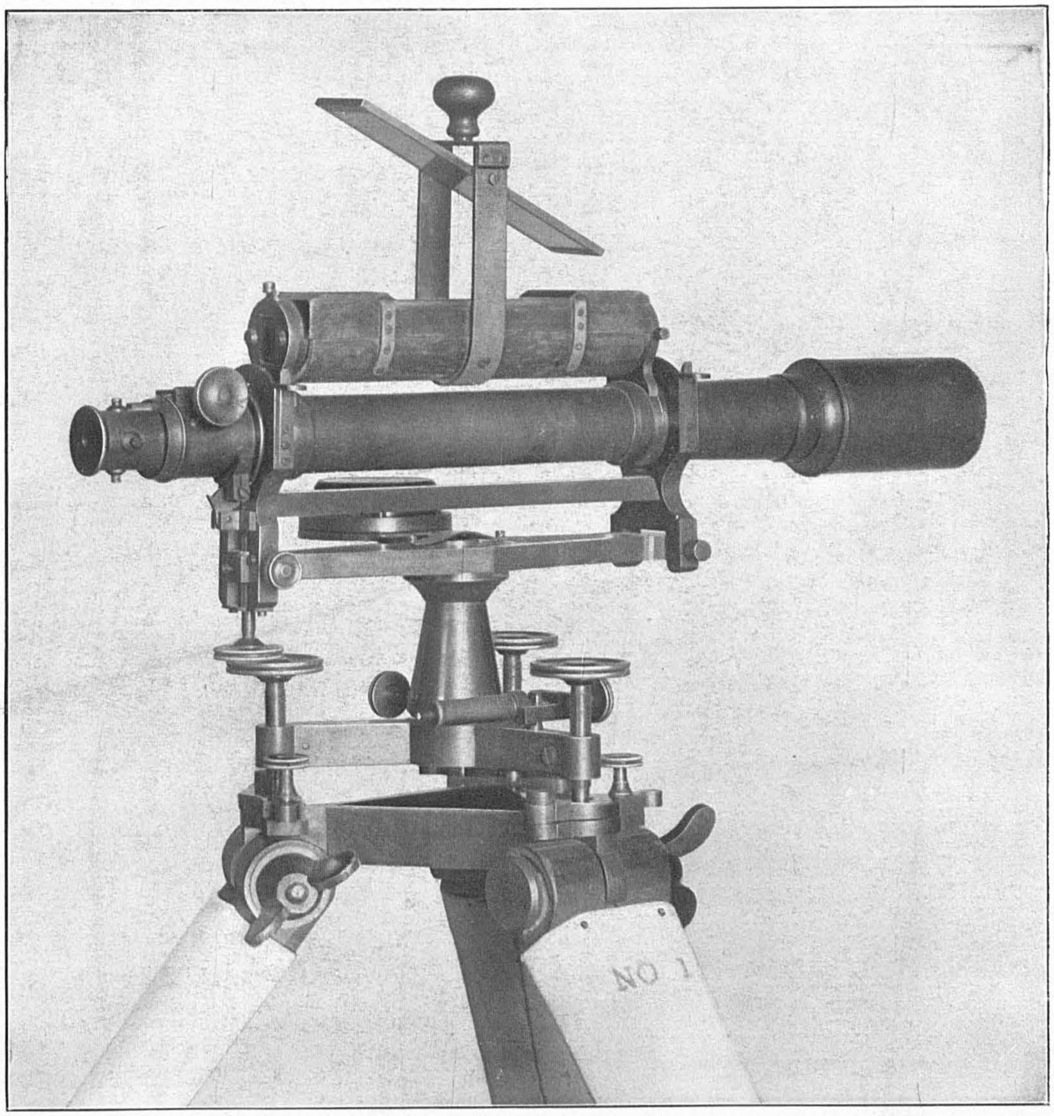
This method is much simpler and more rapid than the old method. There are only seven entries per station on a single line, inclusive of the thermometer reading, whereas in the old method there were twenty-five entries per station under the same conditions. The computation is correspondingly simple and expeditious. The difference of elevation of the rod and the instrument as determined by this method is affected by the error of the striding level and the error of collimation of the telescope. The approximate equality in length between each foresight and the corresponding backsight is relied upon mainly to eliminate these errors as well as those resulting from curvature, refraction, and inequality of collars. The observed values, however, of the collimation error and level error, together with the distance measures furnished by the rod readings, make it possible to apply the proper correction when the observer fails to make foresights and backsights so nearly equal as to render such corrections unnecessary.

The micrometer screw under the eye end of the telescope is used simply as a quick leveling device and is not directly concerned in the measures.

INSTRUMENTS AND METHODS, UNITED STATES ENGINEERS.

Lines numbered 72 to 116, 118, 120–124, 126, and 127, were run under the direction of the United States Engineers with levels made by Kern, of Switzerland. One of these Kern levels, which has been used extensively in the Vicksburg district, is shown in illustration No. 10. The principal statistics in regard to such a level are approximately as follows. They differ, of course, with different instruments:

Aperture of telescope	$3^{cm}.6$
Focal length of telescope	$36^{cm}.8$
Magnifying power of telescope	35 to 50
One division of striding level	$2''$ to $5''$
Angle subtended by stadia lines	$35'$
Weight of instrument alone	$5^{kg}.0 = 11^{lbs}.0$
Weight of tripod	$5^{kg}.8 = 12^{lbs}.8$



THE KERN LEVEL.

The head of the micrometer screw under the eye end of the telescope carries no graduation, as the screw is used simply as a quick leveling device.

The reading of the bubble is made with an inclined mirror. This reading device is open to the objection that the bubble is read with some parallax. The effect of this parallax upon the computed elevation is, however, sensibly eliminated, as it is nearly constant.

The rods used by the engineers have been uniformly of the direct-reading type, carrying a graduation in centimetres painted on the front face of the rod. The cross section of the rod has usually been T-shaped. There have been various changes from time to time in the details of construction of the rod, and especially in the foot piece and in the footplates or pins used to support the rods.

On lines run recently the method of observation has been substantially that described above as having been used by the Coast and Geodetic Survey in 1899. This method has, however, been the result of a gradual development, and on the older lines especially minor departures and in a few cases important departures from the method will be found. In rare cases the line was run twice independently in the same direction instead of in the forward and backward directions, as, for example, between Escanaba and Marquette, Mich. The earlier line between Lakeport and Gibraltar, Mich., was leveled with the Kern instruments but once, in 1877, two parties starting at the ends and working toward each other until they met at the middle. The precaution of making each foresight nearly equal to the corresponding backsight, in addition to making the sum of the foresights and backsights equal on each stretch, has not been always attended to as carefully as in the Coast and Geodetic Survey lines of 1899. The precaution of making alternate foresights before the corresponding backsights has been taken on but a small portion of the work. Upon the whole the method used by the engineers has been the direct-reading differential method used by the Coast and Geodetic Survey in 1899, and is in marked contrast with the target-reading absolute method formerly used by the Coast and Geodetic Survey.

OTHER INSTRUMENTS AND METHODS.

The instrument and method employed in leveling across Florida in 1894, line No. 64, has already been described (see page 394 and illustration No. 5). The same instrument and method was used on lines No. 135 and No. 136.

Lines numbered 138, 140, 141, and 142 were run by the United States Geological Survey with this same type of instrument. Two sets of level vials were used, having values for each division, one-tenth of an inch in length, of four seconds and eight seconds respectively. The rods used were nonextensible target rods, about 10 feet in length, with a T-shaped cross section, made of pine, treated with paraffin. The target readings were taken to thousandths of a foot. The leveling was done by the double simultaneous method continuously in one direction. The micrometre screw was used simply as a quick leveling device, the target being placed in the horizon of the instrument. For a full description of the methods, instruments, and rods used by the United States Geological Survey, see Transactions of the American Society of Civil Engineers, Volume XXXIX, June, 1898, pages 357–366. The observer on lines No. 138 and No. 142 was Mr. E. L. McNair, and on line No. 140, Mr. C. H. Semper.

Line No. 128, and the portion Cape Vincent to Hogansburg, N. Y., of line No. 133, was run partly with Kern levels and partly with the level shown in illustration No. 11, which was designed by T. C. Mendenhall, president of the Worcester Polytechnic Institute, and manufactured by Buff & Berger. The weight of this instrument alone is 5·3 kilogrammes (= 11·7 pounds); the weight of the tripod is 7·3 kilogrammes (= 16·1 pounds). The details of the method of observation used with the Mendenhall level are not known to the writer, but it is believed that they correspond more nearly to the method used by the Engineers with Kern levels than to any other method described in this appendix. The observations on line No. 128, between Gibraltar and Fort Gratiot, were made by O. W. Ferguson and D. A. Molitor, and the line from Cape Vincent to Hogansburg by D. A. Molitor.

Lines Nos. 132 and 134 were run under the direction of the Deep Waterways Commission, by various observers, with Buff & Berger wye levels, using the forward and backward method.

Line No. 133 consists of several different links as follows: From Oswego to Cape Vincent the elevation was transferred by water leveling consisting of simultaneous readings of the two gauges on eleven days, July 27 to August 6, 1898; from Cape Vincent to Hogansburg the elevation was carried by precise leveling already referred to above; from Hogansburg to Coopersville by wye leveling; from Coopersville to Crown Point by water levels along Lake Champlain; and from Crown Point to Troy by wye levels. The wye leveling was all done under the direction of the Deep Waterways Commission with the Buff & Berger instruments and various observers and with methods similar to that used on lines 132 and 134. The water leveling through Lake Champlain was done "in January, 1899, at a time when the entire lake was frozen over from Whitehall to Rouses Point, except about ten miles of the broad lake near Burlington, Vt." "Gauges at Coopersville and Crown Point were read at ten-minute intervals from 8·40 p. m., January 13, 1899, to 8 p. m. on January 15, a continuous set of readings covering a period of nearly forty-eight hours." Aneroid barometer readings were taken at each gauge and served to show that the mean barometric pressure was very nearly the same at the two gauges during the period of observation.

Line No. 131 from Greenbush to Oswego was run twice independently in the westward direction by different parties in 1875 with wye levels.*

Line No. 143, from Harrisburg, Pa., to Braddock, was run under the direction of the Chief Engineer of the Pennsylvania Railroad Company. Little is known to the writer of the details of the method of observation on this line. Various checks which have been obtained on the leveling done by the Pennsylvania Railroad Company indicate it to be of a high degree of accuracy.

Line No. 139, Dunkirk, N. Y., to Erie, Pa., consists of water leveling and depends upon continuous readings of the gauge at Dunkirk for about two years, supplemented by readings for a few weeks or months in each of six other years during intervals when harbor improvements were being made.

The leveling along lines numbered 117, 119, 125, 129 is thus described in Professional Papers No. 24, page 595:

"Depending on the assumption that the mean surface of each lake is level, the relative heights of the pairs of bench marks for the respective lakes were determined.

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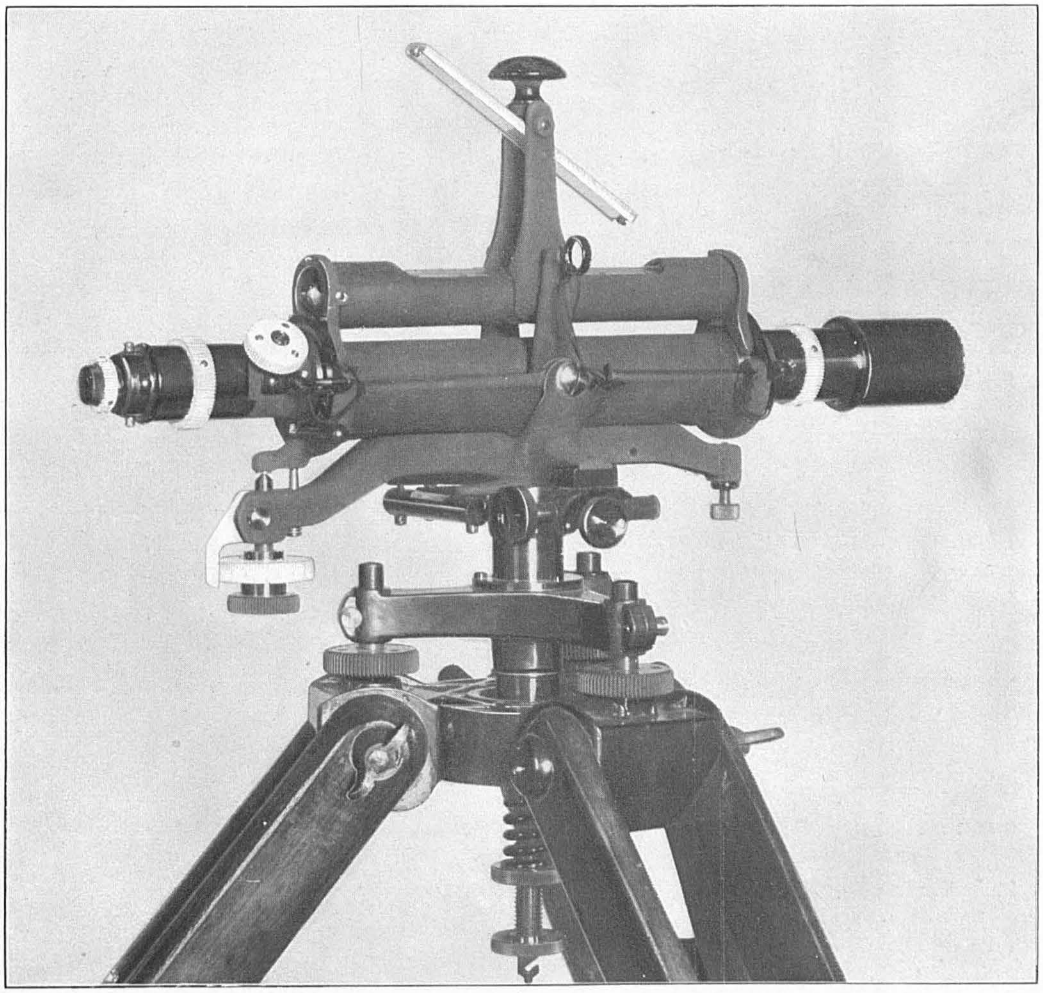
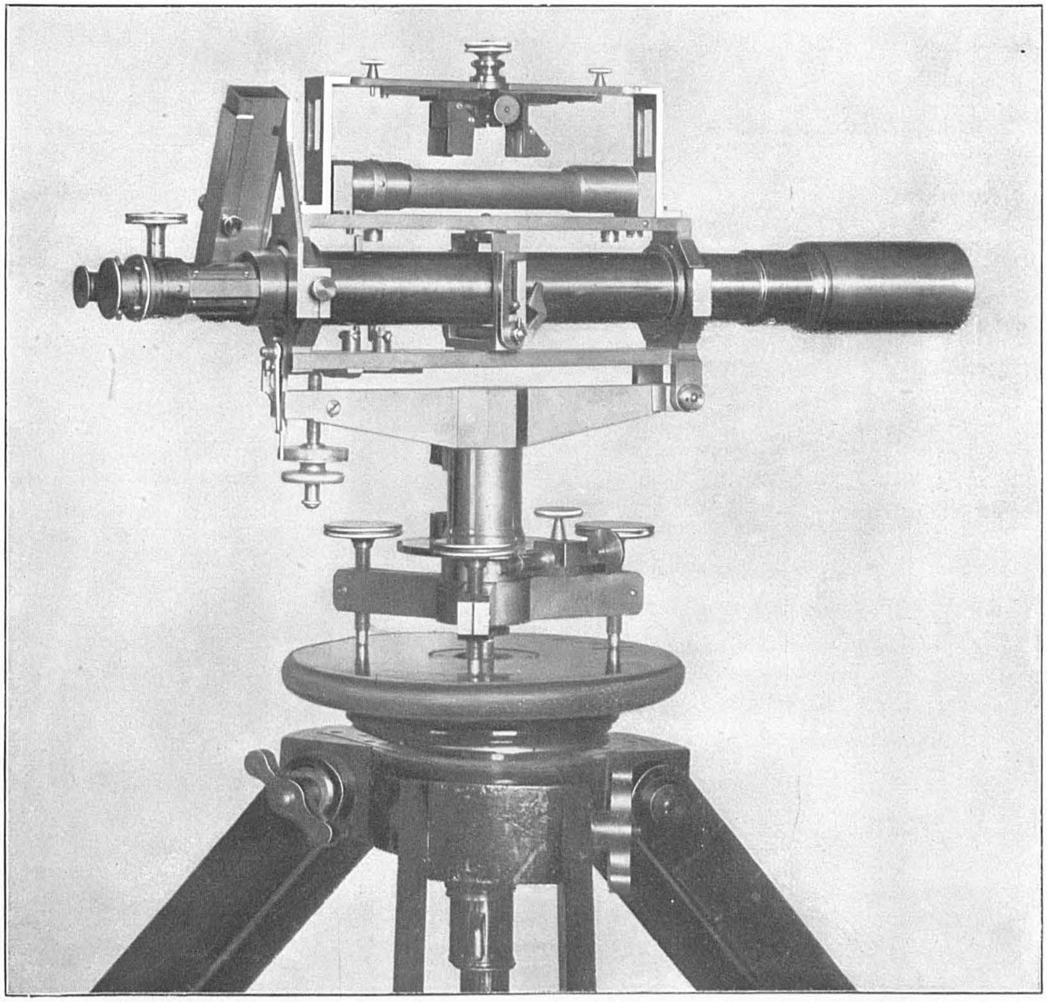
* See Professional Papers No. 24, pages 595–614.



THE MENDENHALL LEVEL.



THE BERTHELEMY (FRENCH) LEVEL.

For this purpose water gauges were fixed near these bench marks and tridaily observations of the height of the water surface at each gauge were made during the months of May, June, July, and August, 1875, this series of observations being taken as of sufficient extent to give a reliable mean. Assuming then that the mean surface of each lake for this period of about four months was level, the differences of the gauge readings gave the relative heights of the zero points of the two gauges on each lake, and as these zero points were carefully referred to the corresponding bench marks the relative heights of these bench marks are also known."

The effect of winds upon these observations was also carefully investigated (see pages 604–608 of that report), as well as the effect of the mean discharge through the Straits of Mackinac from Lake Michigan into Lake Huron. It is the opinion of the Deep Waterways Commission that the water levels through Lake Erie are subject to a correction of 0·18 foot (= 6 centimetres) between the two ends of the lake.* As the revision by the Engineers of all the water levels through the Great Lakes which is now in progress might, and will doubtless, furnish other small corrections to the water levels in addition to this one, it was not deemed advisable to depart at present from the old values.

Line No. 130, from Oswego, N. Y., to Erie, Pa., is made up of three links, namely, water levels similar to those referred to in the preceding paragraphs, between Oswego and Port Dalhousie, on Lake Ontario; and between Port Colborne and Erie, Pa., on Lake Erie; and wye levels between Port Dalhousie and Port Colborne run twice in the southward direction by different parties in 1875.†

The Berthélemy instrument used for precise leveling in France is shown in illustration No. 12. Its most noticeable feature is the device for reading the bubble through an auxiliary eyepiece seen in the illustration just beyond the eyepiece of the telescope. The light from the ends of the bubble passes upward to the two prisms shown just above the level vial, is reflected from them horizontally to a prism in the upper end of the inclined metallic case seen above the eye end of the telescope, thence passes along this case to its lower end, where it is again turned through a right angle by another prism and finally reaches the auxiliary eyepiece.

The principal statistics in regard to this instrument are:

Aperture of telescope	$3^{cm}\cdot6$
Focal length of telescope	$36^{cm}\cdot0$
Magnifying power of telescope	25
Value of one division (3^{mm}) of striding level	$12''$
Angle subtended by stadia lines	$17'$ or $34'$
Weight of instrument alone	$5^{kg}\cdot4=11^{lbs}\cdot9$
Weight of tripod	$6^{kg}\cdot3=13^{lbs}\cdot9$

The method of leveling used in France is in many respects similar to that used by the United States Engineers with the Kern levels and by the Coast and Geodetic Survey in 1899. Each portion of the line is run in the forward and backward direction independently, foresights and corresponding backsights are made nearly equal, direct-reading rods are used, and the micrometer screw under the eye end of the telescope is used

* See Report on the Regulation of the Level of Lake Erie, H. Doc. No. 200, Fifty-sixth Congress, first session, p. 14.

† See Professional Papers No. 24, pp. 596–615.

merely as a quick leveling device. Two observers are used, and each takes all the readings. One observer reads the backsight first at a station and then the foresight, and the second observer immediately repeats the readings, taking the foresight reading first. This reversal of the order of reading by the second observer accomplishes the same purpose as the reading of the foresights before the backsights at alternate stations in the Coast and Geodetic Survey leveling of 1899. The rods are direct-reading, are graduated to centimetres and also carry a graduation in 2-millimetre spaces; three lines are read against the rod.*

ADJUSTMENT OF LEVEL NET.

The relative positions of the various lines forming the level net to be adjusted are shown on the sketch map here inserted. The lines have been drawn nearly in their true location, but the drawing has necessarily been somewhat generalized, and in a few cases it has been necessary to exaggerate distances between points in order to make them show as separate points.

Inside each circuit formed by several level lines there is printed the closing error in millimetres and the total circumference of the circuit in kilometres. A plus sign on the closing error indicates that the elevation as carried around the circuit in a counter-clockwise direction is too great. On all circuits on which the Atlantic, the Gulf of Mexico, or Chesapeake Bay form one side it is assumed that the mean sea surface is everywhere at the same level on the Atlantic, Gulf, and the Chesapeake.

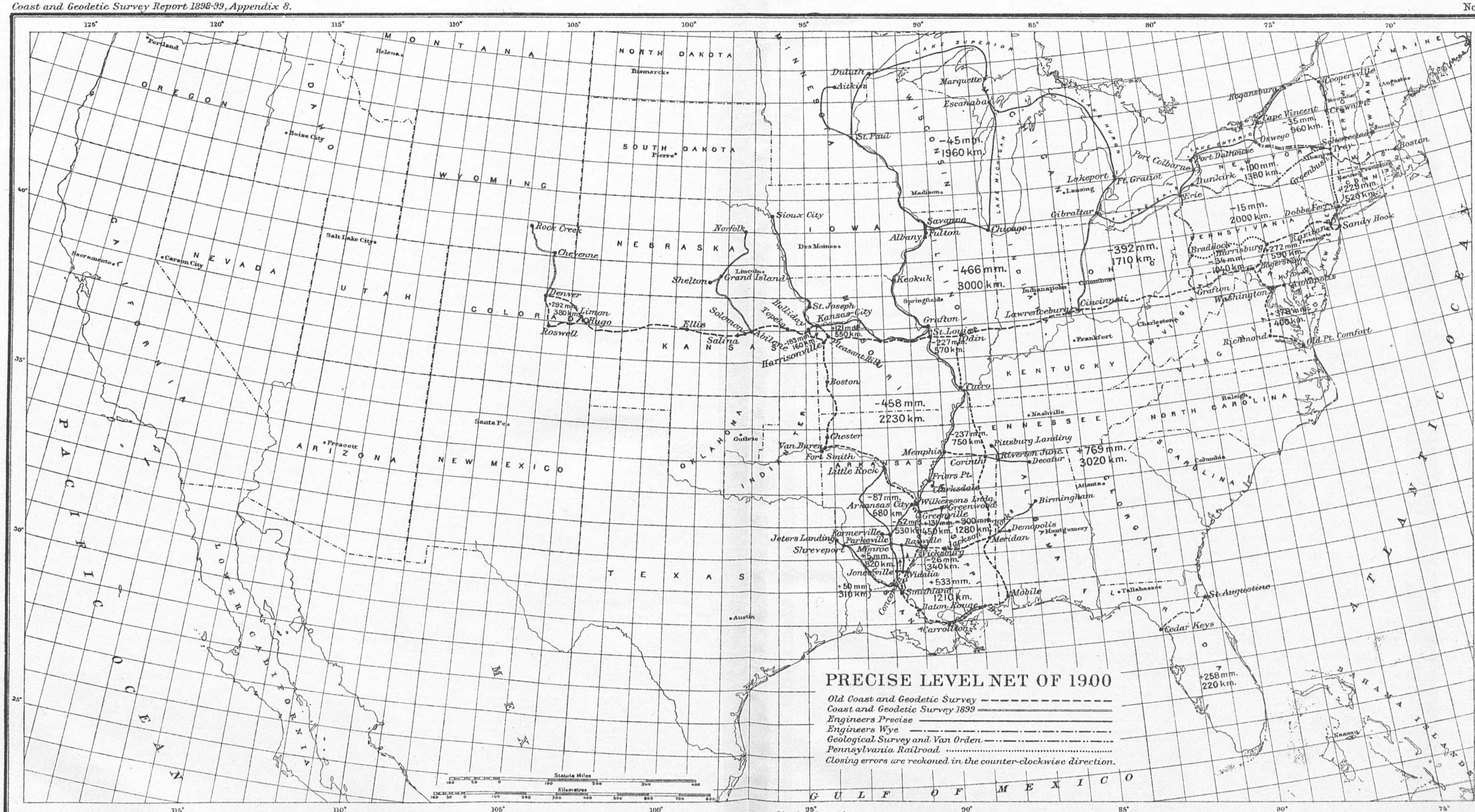
It is evident that in these closing errors there is information of the highest value as to the actual errors of the leveling. The concrete problem in hand is to adjust this net by distributing the closing errors in such a way as to obtain as close an approximation as possible to the truth.

Lines numbered 16, 18, 20, 22, 23, 50, 69, 70, 83, 84, 87, 94, 97, 98, 99, 100, 101, 102, 115, 122, 124 are not concerned in any circuit closure, and therefore have no effect upon the adjustment. Lines numbered 25, 26, and 28 form a circuit—Limon-Denver-Colorado Springs—which stands by itself, being connected to the net by a single line only.

The line numbered 127, between Fort Gratiot and Gibraltar, Mich., has been superseded by a much more accurate line between the same points—No. 128—and is not used in the adjustment. Line No. 131 has also been superseded by later lines, presumably of considerably greater accuracy, namely, Nos. 132, 133, and 134, and therefore is not used in the adjustment. These two lines were omitted in deriving the circuit closures shown on the sketch map.

Certain questions are at once encountered when an attempt is made to adjust the level net. The various lines concerned in the circuit closures have been run with various instruments and radically different methods. What is the relative degree of accuracy attained by the different instruments and methods, and what relative weights must in consequence be assigned to the various lines? Is it possible to discover the law governing any of the errors involved in the circuit closures, and to eliminate such errors by applying the proper corrections? Do nearly all the errors of leveling belong to the

* For complete information in regard to the French method of leveling, see Lever Des Plans et Nivellement par Durand-Claye, Pelletan et Lallemand, Paris, Baudry et Cie, 1889, pp. 511-641.



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accidental class, or are there systematic errors predominating over the accidental errors? If the accidental errors predominate largely, then the total error accumulated on any one line may be expected to increase upon an average as the square root of the distance run, and the relative weight to be assigned to two or more such lines will be inversely proportional to the distance. If, on the other hand, a systematic error predominates largely over the accidental errors, the total error accumulated on any line may be expected to increase in proportion to the distance run, and the relative weights to be assigned to two or more such lines will then be inversely proportional to the square of the distance.

The internal evidence from any one set or group of observations of any kind may furnish an estimate of the upper limit of accuracy of those observations, but it can not until supported by external evidence furnish a reliable estimate of the lower limit. In other words, one may often state with considerable confidence that the mean result from a given group of observations is subject to at least a certain probable error, because the observations show discrepancies of a certain magnitude, but one can not be reasonably certain that the probable error is not much greater than this, because of errors which are constant or nearly so for the whole group of observations, until all the available external evidence has been carefully examined. It is a safe and reasonable practice to assume at the outset in dealing with any class of observations that the probable errors, computed from the internal evidence of separate groups of observations, are to be regarded as lower limits, and that to obtain a reliable estimate the evidence which is external to the separate groups must be carefully considered.

Proceeding upon this basis one should expect that the probable error of the difference of elevation between the terminal bench mark of a line of leveling, as computed from the discrepancies between the two or more measures of each short section of that line between adjacent bench marks, would be too small in general to represent the facts. When a number of such lines are joined to form a net, one should not be surprised if the circuit closures which are developed indicate larger probable errors, but instead should accept this more reliable external evidence of the actual accuracy of the leveling in preference to the unsupported internal evidence furnished by the separate lines. The general European experience has been that the probable errors computed from circuit closures are much larger than those computed from discrepancies on short sections of the separate lines.

The following tables serve to show the magnitude of the accidental errors in precise leveling in the United States as computed from discrepancies on short sections, usually about 1 kilometre, between adjacent temporary or permanent bench marks. The tables show every line for which the information in question was conveniently accessible.

Probable error of completed leveling of a single kilometre—Coast and Geodetic Survey before 1899.

FORWARD AND BACK LINES.

Line.	Millimetres.
New Haven, Mo.-Jefferson City, Mo	± 0·98
Jefferson City, Mo.-Holliday, Kans	± 1·47
Citronelle, Ala.-Quitman, Miss	± 0·79
Quitman, Miss.-Meridian, Miss	± 0·71
Okolona, Miss.-Corinth, Miss	± 0·93
Corinth, Miss.-Greenfield, Tenn	± 1·25
Greenfield, Tenn.-Villa Ridge, Ill	± 1·02
Corinth, Miss.-Memphis, Tenn	± 1·05
Mobile, Ala.-Carrollton, La	± 0·67
Rodney, Miss.-Millikens Bend, La	± 1·12
Millikens Bend, La.-Greenville, Miss	± 1·43
Arkansas City, Ark.-Little Rock, Ark	± 0·86
Little Rock, Ark.-Fort Smith, Ark	± 0·9
Mean	± 1·01

DOUBLE SIMULTANEOUS LINES.

Line.	Millimetres.
Sandy Hook, N. J.-Hagerstown, Md	± 1·03
Hagerstown, Md.-Grafton, W. Va	± 1·18
Grafton, W. Va.-Athens, Ohio	± 1·54
Athens, Ohio,-Mitchell, Ind	± 0·94
Mitchell, Ind.-St. Louis, Mo	± 1·05
St. Louis, Mo.-New Haven, Mo	± 0·83
Holliday, Kans.-Salina, Kans	± 0·85
Salina, Kans.-Ellis, Kans	± 0·89
Ellis, Kans.-Hugo, Colo	± 0·81
Hugo, Colo.-Colorado Springs, Colo	± 0·77
Mobile, Ala.-Citronelle, Ala	± 0·69
Meridian, Miss.-Okolona, Miss	± 0·70
Villa Ridge, Ill.-Odin, Ill	± 0·73
New Orleans, La.-Red River Landing, La	± 0·94
Red River Landing, La.-Rodney, Miss	± 0·95
Van Buren, Ark.-Chester, Ark	± 0·8
Lamar, Mo.-Chester, Ark	± 0·9
Washington, D. C.-Hagerstown, Md	± 0·86
Mean	± 0·91

Probable error of completed leveling of a single kilometre.

COAST AND GEODETIC SURVEY, 1899.

Line.	Millimetres.
Denver, Colo.-Rock Creek, Wyo	± 0·86
Gibraltar, Mich.-Cincinnati, Ohio	± 0·65
Abilene, Kans.-Norfolk, Nebr	± 0·8
Mean	± 0·77

Probable error of completed leveling of a single kilometre—Continued.

ENGINEER LINES.

Line.	Millimetres.
Greenville, Miss.-Arkansas City, Ark	± 0·73
Austin, Miss.-Friars Point, Miss	± 0·63
Prentiss, Miss.-Greenville, Miss	± 0·87
Friars Point, Miss.-Prentiss, Miss	± 1·25
Birmingham, Ala.-Meridian, Miss	± 0·55
St. Paul, Minn.-Savanna, Ill	± 0·62
St. Joseph, Mo.-Mouth of Missouri River	± 0·58
Corinth, Miss.-Decatur, Ala	± 0·62
Fulton, Ill.-Chicago, Ill	± 0·84
Duluth, Minn.-St. Paul, Minn	± 0·99
St. Paul, Minn.-Aitkin, Minn	± 0·54
St. Joseph, Mo.-Sioux City, Iowa	± 0·64
Mean	± 0·74

It should be noted that the two components of a double simultaneous line are much less independent than the two components of a forward and backward line. If the two classes of lines are of equal accuracy, the double simultaneous lines should therefore show a smaller computed probable error.

As the four mean values from the above tables do not differ greatly, and as the individual values in the separate tables lap over, there is not sufficient evidence here to warrant the separation of the leveling into different classes to which different weights are to be assigned.

If the errors of leveling were all accidental, the probable error of closure of any circuit should be the square root of the circumference of the circuit in kilometres times the probable error of leveling for a single kilometre. The circumference and closing error of each of the circuits shown on illustration No. 13 are given in the following table, together with the probable error of the closure of the circuit computed by using as the probable error of the complete leveling of a single kilometre ± 0·86 millimetre, the mean of the four tabular means. If accidental errors predominate largely over systematic, the closing error should be less than the probable error set opposite for about one-half of the circuits. But, as a matter of fact, out of 26 circuits only 2, No. 20 and No. 21, fall within this limit. This indicates, then, that in a considerable number of the lines there must be systematic errors predominating largely over the accidental.

Closing errors of circuits.

[The circumferences given for circuits of which tide water forms one side do not include the tide-water distances.]

No.	Circuit.	Closing error.*	Circumference of circuit.	Probable error of closing.
		mm.	*km.*	*mm.*
1	Pleasant Hill-Holliday-Harrisonville-Pleasant Hill	−183	160	±11
2	New York-Harrisburg-Hagerstown-Washington-Annapolis-New York	+272	590	±21
3	Annapolis-Washington-Old Point Comfort-Annapolis†	+378	400	±17
4	Old Point Comfort-Washington-Hagerstown-Odin-Biloxi-Cedar Keys-St. Augustine-Old Point Comfort †	+769	3 020	±47
5	St. Augustine-Cedar Keys-Strait of Florida-St. Augustine ‡	+258	220	±13
6	Limon-Denver-Roswell	+292	380	±17
7	Biloxi-Meridian-Vicksburg-Vidalia-Smithland-Biloxi §	+533	1 210	±30
8	Vicksburg-Meridian-Corinth-Memphis-Greenville-Greenwood-Vicksburg	−900	1 280	±31
9	Arkansas City-St. Louis-Jefferson City-Pleasant Hill-Harrisonville-Little Rock-Arkansas City ‖	−458	2 230	±41
10	St. Louis-Cairo-Odin-St. Louis	−227	570	±21
11	Cairo-Memphis-Corinth-Cairo	−237	750	±24
12	Jefferson City-Kansas City-Pleasant Hill-Jefferson City	+121	550	±20
13	Grafton-Hagerstown-Harrisburg-Braddock-Grafton	− 34	1 040	±28
14	Vidalia-Vicksburg-Rayville-Concordia-Vidalia	− 26	340	±16
15	Vicksburg-Greenville-Wilkersons Landing-Monroe-Vicksburg	− 52	530	±20
16	Vicksburg-Greenwood-Greenville-Vicksburg	+131	450	±18
17	Parkeville-Arkansas City-Little Rock-Parkeville	− 87	680	±22
18	Cincinnati-Grafton-Erie-Gibraltar-Cincinnati	−392	1 710	±36
19	St. Louis-Cincinnati-Gibraltar-Escanaba-Chicago-St. Louis	−466	3 000	±47
20	Harrisburg-New York-Greenbush-Erie-Braddock-Harrisburg	− 15	2 000	±38
21	Vidalia-Jonesville-Monroe-Shreveport-Smithland-Vidalia	+ 5	820	±25
22	Boston-Greenbush-New York-Boston	+229	520	±20
23	Greenbush-Oswego-Erie-Dunkirk-Greenbush	+100	1 380	±32
24	Troy-Lake Champlain-Cape Vincent-Oswego-Troy	− 35	960	±27
25	Concordia-Rayville-Monroe-Jonesville-Concordia	+ 50	310	±15
26	Savanna-Chicago-Escanaba-Duluth-Savanna	− 45	1 960	±38

*A + closing error means that an elevation carried around the circuit in a counter-clockwise direction is too high.

† Using mean of two lines between Washington and Old Point Comfort and mean of three between Cedar Keys and St. Augustine.

‡ Using mean of three lines between Cedar Keys and St. Augustine.

§ Using mean of Coast and Geodetic Survey and Engineer lines between Biloxi and Carrollton.

‖ Using mean of Coast and Geodetic Survey and Engineer lines between St. Louis and Jefferson City.

In arranging the order of the circuits in the above table those made up entirely of Coast and Geodetic Survey leveling previous to 1899 were placed first, namely, Nos. 1 to 6; then follow circuits composed partly of such leveling, placed approximately in the decreasing order of the percentage of Coast and Geodetic Survey leveling; and finally, Nos. 22 to 26, containing no Coast and Geodetic Survey leveling. Of the first ten circuits no actual closure is less than ten times the computed probable error of closure, whereas among the remaining sixteen only two closures exceed this limit. Among the sixteen there are six of which the closures are less than twice the corresponding computed probable errors. Upon the whole there is a decided tendency for the closures to decrease in the order of the table.

The table indicates very strongly that the Coast and Geodetic Survey leveling previous to 1899 is subject to predominating systematic errors, and that the errors of leveling by the Engineers belong mainly to the accidental class. The other level lines involved in the net will, for the present, be assumed to belong in an intermediate class, and the evidence in regard to them will be examined more carefully later.

In order to study further the errors of the two main classes of leveling it is now proposed to adjust and study separately two level nets, one composed almost wholly of Coast and Geodetic Survey leveling previous to 1899, and the other almost wholly of leveling by the Engineers, with Kern instruments. It is not possible to get an extensive complete net composed entirely of either kind of leveling, and it is therefore necessary in each case to use a few supplementary lines of some other class, forming however so small a portion of the whole as to have little effect on any general conclusion drawn from the net.

RELATIVE ELEVATION OF THE GULF AND THE ATLANTIC.

Before either of these nets is adjusted it is necessary to make a definite decision as to whether it shall be assumed that the mean sea surface on the Gulf and on the Atlantic are at sensibly the same elevation. Both these preliminary level nets are connected with sea level at Biloxi on the Gulf, as well as with Atlantic sea level.

Two lines of investigation are possible in the endeavor to obtain the relative elevations of the Gulf and the Atlantic. One may inquire how great a difference of elevation is necessary to account for the observed velocities of the Gulf Stream; or one may inquire as to the results of the direct leveling between the Atlantic and the Gulf. The first is a theoretical method, as it depends very intimately on the theory of the relation between the velocities in the stream of water and the slope of the surface, the depth, the width, and other modifying conditions. The second is a direct observational method.

Because there is a continuous current, the Gulf Stream, flowing out of the Gulf between Florida and Cuba, it would seem that it must be a physical fact that the Gulf is higher than the Atlantic. How great a difference of elevation is needed to account for this current? A similar question is treated in Professional Papers No. 24 of the Corps of Engineers, page 608, the problem there being to estimate the slope in the Straits of Mackinac. Let Hagen's formula as there stated, namely, $V = 6R^{\frac{1}{2}} I^{\frac{1}{4}}$, be applied to the Gulf Stream in the Straits of Florida. The unit of length in the formula is the foot. Let it be assumed that the average depth in the straits is 100 fathoms and the average current 3 knots, these assumptions being such as to make the computed slope too great rather than too small. The actual depth in the straits varies from 200 to 1 000 fathoms, and the average current certainly does not exceed 3 knots. Upon this basis the slope of the surface, according to the formula, is about 1 foot in 5 000 miles, or a fall of about one-tenth of a foot, or 30 millimetres, in the 500 miles of the straits between its western entrance and the north end of the Bahama Banks. Other formulæ for the slope give results varying widely from this, some of them indicating a very much greater slope, perhaps ten times as great. All of the available formulæ are based on observations upon streams which are much shallower and smaller, and are therefore very unreliable when used as a means of exterpolation to determine the slope of so large a stream.

It may be contended that the winds heap up the water into the Gulf. Between Rebecca Shoal and Havana the depth is from 100 fathoms to nearly 1 000 fathoms, for a width of 73 miles. It is difficult to conceive how the wind *blowing upon the surface* of this great stream could appreciably affect its flow for more than 100 feet below the surface, or from one-sixth to one-sixtieth of the total depth. If the current in but this small portion of the depth is retarded by the wind, the effect on the permanent level of the Gulf must be very small indeed, for the waters deep below the surface will surely flow on in obedience to the difference of pressure caused by the surface slope, irrespective of the winds above. It may be noted in this connection that the only other opening of the Gulf, the Yucatan Channel, is also very deep, more than 1 000 fathoms for nearly a third of its width.

If the average barometric pressure is less on the Gulf than on the Atlantic, the effect will be to make the mean level of the Gulf higher than that of the Atlantic. But to account for a permanent difference of a foot in this way requires the assumption that the average barometric pressure on the Gulf is an inch of mercury less than on the Atlantic.

In any endeavor to estimate the difference of elevation of the Gulf and the Atlantic necessary to account for the observed currents in the Gulf Stream, the effect of the vertical circulation* in the stream and adjacent waters produced by differences of density must also be carefully taken into account.

From the foregoing considerations the writer is forced to conclude that it is useless to attempt to determine the difference of elevation of the Gulf and the Atlantic from the theoretical relations connecting slope, velocity, barometric pressure, winds, and differences of density; that plausible theoretical arguments can be advanced for any estimate varying from one inch to one foot; and that it would be decidedly unwise to introduce into the adjustment of the level nets the assumption that there is any appreciable difference of elevation, unless such difference can be shown to exist from the direct results of the leveling itself.

Four values for the apparent elevation of the Gulf above the Atlantic, which are largely independent, may be derived from the leveling: First, from the leveling across Florida; second, from the line Old Point Comfort, Washington, Hagerstown, Odin, Corinth, Meridian, to Biloxi; third, from the line Sandy Hook, Hagerstown, Odin, St. Louis, (this portion via the C. and G. S. line), Pleasant Hill, Harrisonville, Little Rock, Arkansas City, and thence, by Coast and Geodetic Survey line, to Carrollton and Biloxi; fourth, from the line, mainly by the Engineers, from Boston and New York to Greenbush (the mean of these two being taken), to Oswego (the mean of the two lines being taken), through the lakes, via Chicago and Duluth, to Savannah (the mean again being taken), thence by the river line to Arkansas City, thence to Vidalia (the mean of two Engineer lines between these two points being taken), to Carrollton by Coast and Geodetic Survey line, and, finally, to Biloxi by the Engineers' line. The four values for the apparent elevation of the Gulf above the Atlantic are, respectively, +0·258 metre, +1·028 metres, +0·385 millimetre, +0·175 metre, and their mean is +0·462 metre

*This vertical circulation is discussed in detail by Mr. A. Lindenkohl in Appendix No. 6, pp. 355–369, of the Coast and Geodetic Survey Report for 1895.

The range, 0·85 metre, in these values is so great that it can hardly be contended with confidence that the mean represents an actual difference of elevation. Moreover, an examination of the closing errors in the table on page 428, shows that accumulated errors nearly as large or larger than this mean have repeatedly been found in comparatively small circuits. The line across Florida is very much shorter than any of the other lines connecting the Atlantic and the Gulf, and therefore, a priori, is entitled to greater weight than any of the others. Attention has been called to the fact (see page 397) that the six separate results from this line vary from +0·558 to −0·321 metres. Finally, it should be noted that if the weight assigned to the Engineer line in deriving the mean be increased, as the evidence contained in the list of circuit closures on page 428 indicates that it should be, then the mean for the four lines will approach zero, as the Engineer line gives the lowest value for the apparent elevation of the Gulf.

In view of the above evidence the writer believes that a greater degree of accuracy will be attained in the adjustment of the level net by assuming that the mean surface of the Gulf and of the Atlantic are at sensibly the same elevation, than by introducing any correction, derived either from theory or from the leveling itself, for the elevation of the Gulf above the Atlantic. Such a correction, if introduced, might perchance prove in the course of time to be twice, thrice, or ten times as large as it should be.

The level net adjustments which follow are therefore based upon the assumption that the mean surfaces of the Gulf and of the Atlantic and also of Chesapeake Bay are at one elevation.

PRELIMINARY ADJUSTMENT OF COAST AND GEODETIC SURVEY LEVEL NET.

The net, composed almost wholly of Coast and Geodetic Survey lines, which is available for investigation, is made up of the two lines from Sandy Hook and Washington to Hagerstown, the transcontinental line from Hagerstown to Holliday, the lines from Pleasant Hill and Holliday to Harrisonville, the line from Harrisonville to Arkansas City and down the Mississippi River to Carrollton and thence to Biloxi, the line between Vicksburg and Meridian, and finally the so-called Meridian Line between Odin and Biloxi. The only line by the Engineers involved in the net is the short line of 33 kilometres between Greenville and Wilkersons Landing. The remainder of the lines were leveled by the Coast and Geodetic Survey previous to 1899.

These lines form a net having eleven links, as shown in the following equations, and involving five circuits, including those of which the water levels along the Gulf and Atlantic form one side.

Closing error of circuits.

No.	Circuit.	Closing error.	Circumference of circuit.	Closure per kilometre.
		mm.	*km.*	*mm.*
1	Biloxi–Meridian–Vicksburg–Biloxi.	+ 509·4	1 210	+0·42
2	Vicksburg–Meridian–Odin–Pleasant Hill–Harrisonville–Vicksburg.	−1 802·1	2 610	−0·69
3	Pleasant Hill–Kansas City–Holliday–Harrisonville–Pleasant Hill.	− 183·1	160	−1·14
4	Sandy Hook–Hagerstown–Washington–Sandy Hook.	+ 189·9	520	+0·37
5	Washington–Hagerstown–Odin–Biloxi–Washington.	+1 488·1	2 430	+0·61

In forming these circuit closures, and in the following adjustment, it is assumed, as indicated on page 410, that mean sea level at Washington is 88·0 millimetres above the Chesapeake and the Atlantic, that allowance being made for the fall of the Potomac.

Even though the distance given in the last two circuits does not include the water leveling between Sandy Hook and Washington and between Biloxi and Washington, the closures expressed in millimetres per kilometre are not noticeably greater in these circuits than in the remaining three.

To adjust this net by least squares so as to distribute the closing errors properly, one may write the following observation equations. Only the independent unknowns, namely, the elevations of the various junction points of the net, appear in these equations, and therefore there are no equations of condition. Each equation expresses an observed difference of elevation between two bench marks indicated in parentheses, or between a bench mark and sea level as determined at a tide gauge.

Observation equations.

No.	Equation.		Weight. p.	v.	pv^2.	Length of line.
		m.		*mm.*	*mm.*	*km.*
1	(Vicksburg, 211)—(Sea level at Biloxi.)	=+ 27·6335	1·5	+315·2	149000	674
2	(Meridian, C)—(Vicksburg, 211.)	=+ 76·7879	4·5	+216·5	211000	224
3	(Harrisonville, 43)—(Vicksburg, 211.)	=+282·1450	0·93	−539·4	270600	* 1 081
4	(Meridian, C)—(Sea level at Biloxi.)	=+104·9308	3·2	+ 22·3	1600	312
5	(Odin, V)—(Meridian, C.)	=+ 54·7128	1·3	+804·7	841700	773
6	(Pleasant Hill, LI)—(Harrisonville, 43) (Direct.)	=− 48·3294	76·9	+ 9·3	7700	13
7	(Pleasant Hill, LI)—(Harrisonville, 43) (Via Kansas City.)	=− 48·1463	7·0	−173·8	211400	143
8	(Odin, V)—(Pleasant Hill, LI.)	=−100·5128				
9	(Hagerstown, A)—(Odin, V.)	=+ 7·0186	2·0	−250·8	125800	507
10	(Sea level at Sandy Hook)—(Hagerstown, A.)	=−168·3402	0·83	+655·9	357100	1 208
			2·6	+195·1	99100	387
11	(Hagerstown, A)—(Sea level at Washington.)	=+168·1503	7·3	− 5·2	00000	137
				Σpv^2	2275000	

* The total length of this line is 1 097 kilometres, but the portion, 33 kilometres, between Greenville and Wilkersons Landing, was run twice by the Engineers and is given double weight, and hence in deriving the weight for the line Vicksburg to Harrisonville this section has been counted as 17 kilometres instead of 33.

The following references will serve to show the details in regard to each equation:

No. of equation.	References to lines shown on pages 398–414.
1	29, 37, 38, 39, 40, 41, 42, 43.
2	65, 43.
3	55, 54, 53, 52, 51, 49, 48, 47, 46, 45, 90, 91, 44.
4	29, 30, 31.
5	32, 33, 34, 35, 36.
6	56.
7	12, 13, 14, 15, 57.
8	8, 9, 10, 11.
9	4, 5, 6, 7.
10	1, 2, 3.
11	59, 58.

The weights assigned to the various lines are 1 000 times the reciprocals of the lengths of the lines in kilometres. The lengths given do not include the distances involved in the local relations treated in the paragraphic matter on pages 402–414.

This method of assigning weights amounts to giving infinite weight to determinations of the elevation of tidal bench marks. A comparison of the errors of leveling with the errors in long series of tidal observations shows that whereas this method of weighting would not be permissible if any two tidal stations were quite near to each other, in the actual case in hand, in which the tidal stations are widely separated, the error of leveling between such stations preponderates so largely over the tidal errors that sensibly the same results are reached by giving the tidal observations infinite weight as by assigning to them relatively heavy weights warranted strictly by the evidence.

The elevations for the various junction points of the net resulting from the adjustment are:

Bench mark.	Elevation.
	m.
Vicksburg, 211	27·9487
Meridian, C	104·9531
Harrisonville, 43	309·5543
Pleasant Hill, LI	261·2342
Odin, V	160·4706
Hagerstown, A	168·1451

Each "v" given after an observation equation is the correction to that line of levels resulting from the adjustment. The column of v's therefore indicates how the closing errors of the circuits have been distributed.

The probable error of an observation of unit weight, namely, of leveling along a line 1 000 kilometres in length, $=e$,

$$=\sqrt{\frac{0{\cdot}455\times\Sigma pv^2}{(\text{No. of equations})-(\text{No. of independent unknowns.})}}$$

$$=\sqrt{\frac{(0{\cdot}455)\ (2275000)}{11-6}}=\sqrt{207000}=\pm 450 \text{ millimetres,}$$

hence the probable error of a single kilometre of complete leveling is $\sqrt{207}=\pm 14{\cdot}4$ millimetres.

As a check upon this computed probable error, it is in order to note that upon this basis the probable error of closure of the Colorado circuit should be $\pm 14^{mm}{\cdot}4\sqrt{380}=$ ± 281 millimetres, in close agreement with the actual closure. Also, upon this basis the probable error of the difference of elevation of St. Augustine and Cedar Keys, Fla., from the mean of three years of leveling, should be $\pm 14^{mm}{\cdot}4\sqrt{\frac{220}{3}}=\pm 122$ millimetres, whereas the actual error of this mean, upon the assumption that the Gulf is at the same level as the Atlantic, is 258 millimetres. See page 397.

PRELIMINARY ADJUSTMENT OF THE ENGINEERS LEVEL NET.

The net, composed almost wholly of leveling by the Engineers with Kern instruments, which is available for investigation, is made up of the two Van Orden lines from Boston and New York to Greenbush; the wye level lines from Greenbush to Troy, and from Troy to Oswego by the direct route; the line composed of a mixture of wye, precise and water leveling between Troy and Oswego via Lake Champlain; water leveling through the Great Lakes to Duluth and Chicago, supplemented by short lines of wye leveling or precise leveling between the Lakes; precise level lines from Duluth and Chicago to Savanna; thence a single line down the Mississippi River to Wilkersons Landing; the net work of precise lines by the Engineers in Arkansas and Louisiana, as shown on the sketch map opposite page 424; the Coast and Geodetic Survey level line along the Mississippi River from Vidalia to Carrollton; and finally the Engineer line from Carrollton to Biloxi.

The inclusion of the Coast and Geodetic Survey line between Carrollton and Smithland was absolutely necessary to connect the net with sea level at Biloxi, and the short additional section of river line between Smithland and Vidalia was introduced to develop the large circuit extending to Shreveport. The Deep Waterways Commission lines between Oswego and Greenbush, and the Van Orden lines between Greenbush and Boston and New York, were necessarily included to connect with sea level at the eastern end of the net.

These lines form a net having seventeen links, as shown in equations below, and involving seven circuits, including those of which water levels along the Gulf and Atlantic form one side.

Closing errors of circuits.

No.	Circuit.	Closing error.	Circumference of circuit.	Closure per kilometre.
		mm.	*km.*	*mm.*
1	Smithland-Concordia-Jonesville-Monroe-Shreveport-Smithland	+ 5·4	820	+0·007
2	Concordia-Rayville-Monroe-Jonesville-Concordia	+ 49·7	310	+0·16
3	Monroe-Rayville-Vicksburg-Arkansas City-Monroe	+ 78·2	630	+0·12
4	Savanna-Chicago-Escanaba-Duluth-Savanna	− 45·1	1 960	−0·02
5	Troy-Coopersville-Hogansburg-Oswego-Troy	− 35·0	960	−0·04
6	Boston-Greenbush-New York-Boston	+229·2	520	+0·44
7	New York-Greenbush-Oswego-Chicago-Savanna-Arkansas City-Vicksburg-Rayville-Concordia-Smithland-Biloxi-New York	+ 36·2	5 460	+0·007

Water leveling along the Great Lakes is included in the lengths of the circuits given, but not leveling along tidal waters.

The observation equations in form for the least square adjustment of this net are as follows:

Observation equations.

No. of equation.	Equation.	Weight p.	v.	pv^2.	Length of line.
	m.		*mm.*	*mm.*	*km.*
1	(Smithland, XLV)—(Sea level at Biloxi) =+ 14·6001	2·3	+ 16·4	619	432
2	(Concordia, 9)—(Smithland, XLV) =+ 4·7891	8·6	− 2·4	52	116
3	(Monroe, 27)—(Smithland, XLV) =+ 8·9590	1·9	+ 30·5	1 767	538
4	(Monroe, 27)—(Concordia, 9) =+ 4·1753	6·0	+ 27·5	4 536	168
5	(Rayville, 16)—(Concordia, 9) =+ 4·9164	9·1	− 20·3	3 749	110
6	(Wilkersons Ldg., 84)—(Monroe, 27) =+ 18·4769	5·1	+ 32·6	5 421	197
7	(Rayville, 16)—(Monroe, 27) =+ 0·6914	29·4	+ 1·9	118	34
8	(Wilkersons Ldg., 84)—(Rayville, 16) =+ 17·8637	2·7	− 47·5	6 091	396
9	(Savanna, 62)—(Wilkersons Ldg., 84) =+ 138·1683	0·67	+ 56·3	2 124	1 502
10	(Escanaba, 1)—(Savanna, 62)* =+ 0·3802	0·77	− 13·1	132	1 293
11	(Escanaba, 1)—(Savanna, 62)† =+ 0·3351	1·5	+ 32·0	1 536	664
12	(Escanaba, 1)—(Oswego, A) =+ 104·0683	0·72	− 52·4	1 977	1 388
13	(Troy, 1)—(Oswego, A)‡ =− 70·3035	0·97	− 8·2	65	662
14	(Troy, 1)—(Oswego, A)§ =− 70·3385	1·7	+ 26·8	1 221	302
15	(Troy, 1)—(Greenbush, gristmill) =+ 2·2415	45·5	− 0·8	46	11
16	(Sea level at Boston)—(Greenbush, gristmill) =− 4·2898	1·6	+ 150·9	36 434	320
17	(Greenbush, gristmill)—(Sea level at New York) =+ 4·0606	2·6	+ 78·3	15 941	195
			$\Sigma pv^2=$	81 829	

* Via Duluth. † Via Chicago. ‡ Via Champlain. § Direct.

The following references will serve to indicate the details of formation of each equation:

No. of equation.	References to lines shown on pages 398–414.
1	39, 38, 73, 29.
2	79, 41, 40.
3	74.
4	80.
5	77, 81.
6	89, 85, 86.
7	77, 76, 75.
8	90, 91, 92, 43, 78.
9	110, 109, 108, 107, 106, 105, 104, 35, 103, 96, 95, 93.
10	118, 117, 116, 114, 113, 111.
11	119, 112.
12	125, 126, 128, 71, 129, 130.
13	133.
14	132.
15	134.
16	135.
17	136, 1.

In this adjustment each line, including water lines along the Great Lakes, is given a weight equal to 1 000 times the reciprocal of its length in kilometres, with the following exceptions:

First, portions of lines leveled twic ard and backward two different times, are given double weight.

Second, local adjustments are left undisturbed, i. e., are given an infinite weight, as are also the determinations of elevations of tidal bench marks.

Third, wye levels run under the direction of the Deep Waterways Commission are given half weight.

Fourth, water levels between Cape Vincent and Oswego are given half weight on account of the shortness of the period of observation.

Fifth, the Van Orden lines, Boston to Greenbush, and New York to Greenbush, are given half weight.

The effect of these exceptions is shown in detail below. If a line is to be given half weight, it is evident that its actual length should be doubled to obtain the equivalent length of the line of standard weight to be used in the weight formula $\frac{1000}{L}$, and vice versa.

The actual length of the line, Rayville to Wilkersons Landing, is 396 kilometres, but the equivalent length is 365 kilometres and the weight 2·7, 15 kilometres of the line being within the Vicksburg local adjustment, and therefore subtracted from the actual length, and 33 kilometres between Greenville and Wilkersons Landing, being leveled twice, and hence equivalent to only 17 kilometres of the standard line.

The actual length of the line Wilkersons Landing to Savanna is 1 502 kilometres, but the equivalent length is 1 489, and the weight 0·67, since 21 kilometres of the line between St. Louis and P. B. M. 12 and 6 kilometres between Albany and Fulton were leveled twice.

The actual length of the line between Oswego and Troy by way of Lake Champlain is 662 kilometres. The equivalent distance is 1 031 kilometres and the weight 0·97. The 293 kilometres of wye levels were given half weight and were therefore equivalent to 586 kilometres of the standard line. The 76 kilometres of water levels on Lake Ontario were also given half weight and were therefore equivalent to 152 kilometres.

The direct line between Oswego and Troy, and the lines Troy to Greenbush, Boston to Greenbush, and Dobbs Ferry (New York) to Greenbush, were each given half weight, and hence the equivalent length of standard line is double the actual length of the line in each case.

The elevations for the various junction points of the net resulting from the adjustment are:

Bench marks.	Elevation.
	m.
Smithland, XLV	14·6165
Concordia, 9	19·4032
Monroe, 27	23·6060
Rayville, 16	24·2993
Wilkersons Landing, 84	42·1155
Savanna, 62	180·3401
Escanaba, 1	180·7072
Oswego, A	76·6913
Troy, 1	6·3796
Greenbush, gristmill	4·1389

Each "v" is as before the correction to the observed difference of elevation expressed by the corresponding equation.

The probable error of an observation of unit weight, namely, of leveling along a line 1 000 kilometres in length $= e_1$

$$= \sqrt{\frac{0{\cdot}455\ \Sigma\, pv^2}{(\text{No. of equations})-(\text{No. of independent unknowns})}}$$

$= \sqrt{\frac{(0{\cdot}455)\ (81829)}{17-10}} = \sqrt{5319} = \pm 73$ millimetres, hence, the probable error of a single kilometre of complete leveling is $\sqrt{5{\cdot}319} = \pm 2.3$ millimetres.

PRELIMINARY GENERAL ADJUSTMENT OF COMPLETE NET.

It is now proposed to make a preliminary adjustment of the complete level net, using the best approximations to the true weights for the separate lines that can be obtained from a study of the two preliminary adjustments of partial nets which have just been made. The proposed investigation of a possible correction to be applied for systematic errors will be postponed until after this preliminary adjustment is made. This adjustment is to be used simply to furnish more evidence as to the errors of the different classes of leveling, and will be superseded later by a final adjustment involving the same lines.

The probable error of the complete leveling of a single kilometre as derived from the adjustment of the Coast and Geodetic Survey partial net is $\pm 14{\cdot}4$ millimetres, but from the Engineers' partial net is $\pm 2{\cdot}3$ millimetres, whereas the corresponding probable errors derived from discrepancies on short sections of the separate lines are (see pages 426–427) for Coast and Geodetic Survey lines $\pm 0{\cdot}96$ millimetre, and for Engineers' lines $\pm 0{\cdot}74$ millimetre. Hence it is plain at once that the weights to be assigned to the various lines must be made to depend on the former probable errors, as the latter are evidently much too small to represent the facts. From the two preliminary adjustments it would appear that the weights to be assigned to equal lengths of the old Coast and Geodetic Survey leveling and the leveling of Engineers should be in the ratio of $\left(\frac{1}{14{\cdot}4}\right)^2$ to $\left(\frac{1}{2{\cdot}3}\right)^2$ or 1 to 40. In other words, if the weights to be assigned to the various Engineer lines are to be $\frac{1000}{L}$ as before, those assigned to the Coast and Geodetic Survey lines should be $\frac{25}{L}$, L being the length of each line in kilometres.

An examination of the column of pv^2's in the Engineer adjustment reveals, however, the important fact that the pv^2's for the last two equations involving leveling by Van Orden are very much larger than for any of the other equations. This means that too great weight has been assigned to the Van Orden leveling in this adjustment; for the pv^2's being the residuals of the various equations after they are reduced to a standard accuracy, the mean pv^2 for any group of the equations should be about the same as for any other group, if the weights have been properly assigned, and provided the two groups of lines compared are not in radically different positions in the net, such that the ends of the lines of one group are held much more rigidly by connecting lines than are the ends of the other group.

An approximation to the probable error of an observation of unit weight by the Engineers, $(e_1)_E$, and by Van Orden $(e_1)_{VO}$, may be obtained as follows: The average pv^2

for the first fifteen lines not including the Van Orden leveling is 1 964; for the two Van Orden lines is 26 188, and for all seventeen lines is 4 813. The probable error of an observation of unit weight, e_1, as derived from all the lines combined, is (see page 437) $\sqrt{5319}$. We may now use the principle that $\frac{(e_1)^2_E}{e_1^2} = \frac{(\text{mean } pv^2 \text{ from Engineer lines})}{(\text{mean } pv^2 \text{ from all lines})}$ or $\frac{(e_1)^2_E}{5319} = \frac{1964}{4813}$, whence $(e_1)^2_E = 2171$. Similarly, $\frac{(e_1)^2_{VO}}{5319} = \frac{26188}{4813}$, or $(e_1)^2_{VO} = 28940$.

The weights to be assigned to the Engineer, Van Orden, and Coast and Geodetic Survey leveling respectively are then in the inverse ratio of the numbers 2 171, 28 940, and 207 000 (see page 433). The weights assigned to Engineer lines being for convenience still fixed at $\frac{1000}{L}$, the weights for the Van Orden become $\frac{75}{L}$ and for the Coast and Geodetic Survey lines $\frac{10{\cdot}5}{L}$.

Certain lines run by the Coast and Geodetic Survey in 1899, by the United States Geological Survey, and by the Pennsylvania Railroad, are included in the complete net, and a weight scale must be assigned to each of these. The method and instrument used in the Coast and Geodetic Survey levels of 1899 more nearly resembles that used by the Engineers than that used in either of the other two groups for which the weights have been investigated above. Hence, this leveling will be assigned the same scale of weights as the Engineers' leveling. Similarly, the Geological Survey and Van Orden methods and instruments so closely resemble each other that the proper weights must be nearly the same. The little that is known in regard to the Pennsylvania Railroad leveling seems to justify the arbitrary assignment to it of a weight about half that for the Van Orden levels. The complete scale of weights used in the following preliminary adjustment is then:

Line.	Weight $= p$.
Leveling of Engineers with Kern instruments, by the Coast and Geodetic Survey in 1899, and water leveling along the Great Lakes, except between Cape Vincent and Oswego	$\frac{1000}{L}$
Wye levels run under the direction of the Engineers and Deep Waterways Commission, and water levels between Cape Vincent and Oswego	$\frac{500}{L}$
Van Orden and Geological Survey leveling	$\frac{75}{L}$
Leveling by the Pennsylvania Railroad Company	$\frac{38}{L}$
Coast and Geodetic Survey previous to 1899	$\frac{10{\cdot}5}{L}$.

The circuit closures involved in the net to be adjusted have already been shown (see page 428). Three closures there given involving connections with sea level at Old Point Comfort and Annapolis do not enter in the adjustment, however, since in the adjustment the elevation of the Capitol bench mark at Washington is assumed to be 27·7000 metres as fixed by the considerations set forth on page 410, and the lines between Washington and Old Point Comfort, and Washington and Annapolis are thus eliminated from the adjustment.

The net involves 54 lines and 25 circuits, including those of which water levels along the Gulf and Atlantic form one side. Only the first five columns of the table below refer to the preliminary adjustment. The remaining columns will be explained later. Each of the observation equations expresses a measured difference of elevation, and the "v" set opposite is the correction to the observation given by the adjustment.

General adjustment.

Preliminary general adjustment.					Final general adjustment.			
Col. 1.—No. of eq.	Column 2.—Equation.	Column 3.—Weight. p	Column 4.—v	Column 5.—pv^2	Column 6.—Weight. p	Column 7.—Correction for systematic error.	Column 8.—v	Column 9.—pv^2
	m.		mm.	mm.			mm.	mm.
1	(Sea level at Biloxi)–(Carrollton, I)* =– 2·6914	0·077	+ 46·0	163	0·14	+ 95·4	– 47·6	320
2	(Sea level at Biloxi)–(Carrollton, I)† =– 2·6441	7·3	– 1·3	0	7·3		+ 0·5	0
3	(Smithland, XLV)–(Carrollton, I) =+ 11·9560	0·036	+176·0	1 115	0·028	+ 92·9	+ 99·2	280
4	(Vidalia, LXIV)–(Smithland, XLV) =+ 4·9500	0·10	– 29·2	85	0·23	+ 93·8	–112·2	2 900
5	(Monroe, 27)–(Smithland, XLV) =+ 8·9590	1·9	+ 4·9	38	1·9		+ 15·1	440
6	(Monroe, 27)–(Vidalia, LXIV) =+ 4·0144	5·6	+ 28·7	4 592	5·6		+ 28·1	4 420
7	(Rayville, 16)–(Vidalia, LXIV) =+ 4·7555	8·3	– 19·7	3 237	8·3		– 20·1	3 320
8	(Vicksburg, 211)–(Vidalia, LXIV) =+ 8·0361	0·076	– 3·6	1	0·13	+120·3	–124·1	2 000
9	(Wilkersons Landing, 84)–(Monroe, 27) =+ 18·4769	5·1	+ 27·5	3 876	5·1		+ 27·7	3 930
10	(Rayville, 16)–(Monroe, 27) =+ 0·6914	29·0	+ 1·3	0	29·0		+ 1·5	0
11	(Vicksburg, 211)–(Rayville, 16) =+ 3·3064	13·0	– 9·7	1 170	13·0		– 9·5	1 170
12	(Wilkersons Landing, 84)–(Vicksburg, 211)* =+ 14·4267	0·057	+ 88·3	445	0·072	+138·1	– 50·0	180
13	(Wilkersons Landing, 84)–(Vicksburg, 211)† =+ 14·5573	3·5	– 42·3	6 265	3·5		– 42·5	6 330
14	(Meridian, C)–(Vicksburg, 211) =+ 76·7879	0·047	+359·4	6 071	0·050	+ 58·4	+256·0	3 280
15	(Meridian, C)–(Sea level at Biloxi) =+104·9308	0·034	– 52·8	95	0·025	+270·1	–343·0	2 940
16	(Corinth, V)–(Meridian, C) =+ 32·3287	0·034	+444·8	6 727	0·025	+352·0	+166·7	690
17	(Little Rock, I or 3)–(Wilkersons Landing, 84) =+ 38·0139	0·058	+ 55·9	181	0·075	+128·4	– 69·3	360
18	(Little Rock, I or 3)–(Monroe, 27) =+ 56·5774	2·7	– 3·2	27	2·7		+ 0·2	0
19	(Memphis, "Memphis")–(Wilkersons Landing, 84) =+ 38·2777	3·5	– 1·6	0	3·5		– 1·6	0
20	(Harrisonville, 43)–(Little Rock, I or 3) =+229·7044	0·015	–347·3	1 809	0·0052	+469·0	–848·1	3 740
21	(Pleasant Hill, LI)–(Harrisonville, 43) =– 48·3294	0·81	+ 10·1	81	15·0	+ 18·0	+ 2·2	0
22	(Kansas City, 244)–(Harrisonville, 43) =– 79·3848	0·11	–121·6	1 627	0·25	+ 52·8	–148·2	5 490
23	(Kansas City, 244)–(Pleasant Hill, LI) =– 31·2385	0·23	+ 51·4	607	1·2	+ 35·9	+ 31·6	1 200

*C. & G. S. †U. S. E.

General adjustment—Continued.

Preliminary general adjustment.					Final general adjustment.			
Col. 1.—No. of eq.	Column 2—Equation.	Column 3.—Weight. p	Column 4.—v	Column 5.—pv^2	Column 6.—Weight p	Column 7.—Correction for systematic error.	Column 8.—v.	Column 9.—pv^2
	m.		mm.	mm.			mm.	mm.
24	(Jefferson City, 90)—(Pleasant Hill, L I) =− 91·3468	0·053	− 70·0	260	0·065	+ 27·0	− 80·1	420
25	(Kansas City, 244)—(Jefferson City, 90) =+ 60·2292	3·3	+ 0·5	0	3·3		− 0·3	0
26	(St. Louis, K_3)—(Jefferson City, 90)* =− 43·6058	0·051	−219·9	2 466	0·060	+ 54·6	−273·1	4 470
27	(St. Louis, K_3)—(Jefferson City, 90)† =− 43·8270	4·5	+ 1·3	0	4·5		+ 2·7	40
28	(Cairo, 2)—(Memphis, "Memphis") =+ 16·7198	3·0	− 0·7	0	3·0		− 0·5	0
29	(Corinth, V)—(Memphis, "Memphis") =+ 57·1819	0·070	− 52·2	190	0·11	+ 14·1	− 37·2	150
30	(Cairo, 2)—(Corinth, V) =− 40·6991	0·040	+288·5	3 329	0·035	+256·3	+ 3·3	0
31	(St. Louis, K_3)—(Cairo, 2) =+ 28·8706	3·6	− 0·7	0	3·6		− 1·1	0
32	(Odin, V)—(Cairo, 2) =+ 63·0832	0·054	+224·0	2 710	0·068	+222·0	+ 36·5	90
33	(Savanna, 62)—(St. Louis, K_3) =+ 54·3002	1·7	− 4·5	34	1·7		− 5·7	50
34	(Odin, V)—(St. Louis, K_3) =+ 34·4398	0·10	− 2·5	1	0·23	+ 25·3	+ 7·1	10
35	(Cincinnati, T)—(Odin, V) =+ 5·3951	0·025	+468·4	5 485	0·015	+158·9	+272·3	1 110
36	(Gibralta, r2)—(Cincinnati, T) =+ 11·7648	2·5	+ 2·1	0	2·5		+ 0·9	0
37	(Grafton, M)—Cincinnati, T) =+137·1475	0·022	+299·1	1 968	0·011	+137·4	+153·4	260
38	(Escanaba, 1)—(Savanna, 62)‡ =+ 0·3802	0·77	− 33·2	847	0·77		− 34·0	890
39	(Escanaba, 1)—(Savanna, 62)§ =+ 0·3351	1·5	+ 11·9	210	1·5		+ 11·1	180
40	(Escanaba, 1)—(Gibraltar, 2) =+ 2·5691	1·3	+ 5·9	39	1·3		+ 7·4	60
41	(Erie, 1 [1873])—(Gibraltar, 2) =− 2·8560	3·8	− 0·7	0	3·8		− 1·9	0
42	(Oswego, A)—(Erie, 1 [1873]) =− 98·6433	2·9	+ 7·2	145	2·9		+ 3·3	30
43	(Greenbush, Gristmill)—(Erie, 1 [1873]) =−171·1236	0·12	− 71·2	608	0·080		− 79·6	510
44	(Erie, 1 [1873])—(Braddock, P. R. R. 88) =− 77·4398	0·22	+ 67·5	1 003	0·15		+ 70·6	750
45	(Harrisburg, XXIX)—(Braddock, P. R. R. 88) =−143·8841	0·10	− 59·7	356	0·10		− 38·7	150
46	(Braddock, P. R. R. 88)—(Grafton, M) =− 51·1913	0·33	+ 27·2	244	0·22		+ 30·0	200
47	(Hagerstown, A)—(Grafton, M) =−135·5240	0·034	− 70·4	169	0·028	+ 97·2	−173·3	840
48	(Harrisburg, XXIX)—(Hagerstown, A) =− 59·5851	0·088	+ 71·6	451	0·18	+103·5	− 2·4	0
49	(Hagerstown, A)—(Sea level at Washington) =+168·1503	0·077	+113·5	992	0·13	+ 87·6	+ 34·1	150
50	(Sea level at Sandy Hook)—(Harrisburg, XXIX) =−108·7551	0·039	+ 4·8	1	0·035	+ 90·8	−123·7	540
51	(Oswego, A)—(Greenbush, Gristmill)‖ =+ 72·5800	1·6	− 21·3	720	1·6		− 16·8	450
52	(Oswego, A)—(Greenbush, Gristmill)¶ =+ 72·5450	0·95	+ 13·7	180	0·95		+ 18·2	310
53	(Sea level at Boston)—(Greenbush, Gristmill) =− 4·2898	0·23	+162·8	6 095	0·15		+151·4	3 440
54	(Greenbush, Gristmill)—(Sea level at New York) =+ 4·0606	0·38	+ 66·4	1 676	0·25		+ 77·8	1 510
			Σpv^2	68 391				59 670

*C. & G. S. †U. S. E. ‡Via Duluth. §Via Chicago. ‖Direct. ¶Via Champlain.

The following references will serve to show the details in regard to each equation:

Eq.	References to lines as numbered on pages 398-414.	Eq.	References to lines as numbered on pages 398-414.
1	29, 37.	28	103.
2	29, 73.	29	33, 66.
3	39.	30	35, 34, 33.
4	41, 40.	31	104, 35.
5	74.	32	36.
6	80, 79.	33	110, 109, 108, 107, 106, 105.
7	77, 81, 79.	34	8.
8	43, 42.	35	6, 7.
9	89, 85, 86, 75.	36	71, 72.
10	77, 76, 75.	37	5.
11	43, 78.	38	118, 117, 116, 114, 113, 111.
12	90, 91, 44.	39	119, 112.
13	90, 91, 92, 43.	40	125, 126, 128, 71.
14	65, 43.	41	129.
15	29, 30, 31.	42	130.
16	32.	43	138, 139.
17	46, 45.	44	140, 141.
18	88, 86, 75.	45	143.
19	96, 93.	46	142.
20	55, 54, 53, 52, 51, 49, 48.	47	4.
21	56.	48	3.
22	15, 57.	49	59, 58.
23	14, 13, 12.	50	1, 2.
24	10, 11.	51	132, 134.
25	14, 121.	52	133, 134.
26	9.	53	135.
27	105, 120, 10.	54	1, 136.

It will be noted that the line Vidalia to Concordia, No. 79, is used both in equation No. 6 and in No. 7. Similarly, the line Monroe to Parkeville, No. 86, is used in equations No. 9 and No. 18; and line No. 105, from St. Louis to near the mouth of the Missouri River, is used in both equations No. 27 and No. 33. The line Vidalia to Concordia is thus used twice, and Vidalia treated as a junction point, because the rigid treatment in which Concordia would also be regarded as a junction point would involve a very heavy weight for the link Vidalia to Concordia, on account of its shortness, and the line would necessarily receive a very small correction. The same statement also applies to the other cases cited. This practice of using certain short lines twice and substituting one junction point in the place of two junction points very near each other is merely a device for saving time with but little sacrifice of accuracy.

The elevations for the junction points resulting from this adjustment will be found on page 449.

SYSTEMATIC ERROR IN OLD COAST AND GEODETIC SURVEY LEVELS.

The committee on precise leveling, referred to on page 352, made in the winter of 1898–99 a prolonged investigation with a view to finding, if possible, the laws governing the systematic errors known to exist in Coast and Geodetic Survey leveling. The method of investigation used by them did not involve the use of least squares. The principal conclusion which they reached in regard to systematic errors was that a horizontal surface as defined by Coast and Geodetic Survey leveling of precision is always tipped up slightly with reference to the true horizontal surface, the rotation being about a line 20° north of west or south of east, the inclination being such that the southwestern part of the surface is too low and the northwestern portion too high, regardless of the direction in which the leveling actually progressed. According to this law, a Coast and Geodetic Survey level line running in a direction about 20° east of north will run too low at a maximum rate; a line in the opposite direction will run too high at a maximum rate, and in the two directions at right angles, namely, 20° north of west and 20° south of east, a line will not be subject to a systematic tendency to run either too high or too low. To test the reality of this supposed law, each observation equation in the three preliminary adjustments on the preceding pages has been written with such a sign that if the law is true, the correction, v, to the observed difference of elevation expressed by the equation should be positive. For example, equation No. 5 on page 432 could have been written either (Meridian, C)–(Odin, V) = $-54{\cdot}7128$ metres, or (Odin, V)–(Meridian, C) = $+54{\cdot}7128$ metres. The latter form was purposely chosen, because, if the law in question is true, the observed elevation of Odin above Meridian should be too small, Odin being nearly due north from Meridian, and hence the v of the equation should be positive if the equation was so written. A preponderance in number and size of v's with the plus sign over those with the minus sign will indicate, therefore, the reality of the law.

In the preliminary adjustment shown on page 432, involving Coast and Geodetic Survey levels alone, seven of the v's have a plus sign and only four the minus, and the sum of the plus v's is 2·22 metres, while the sum of the minus v's is 0·97 metre. In the preliminary general adjustment shown on pages 439–440 the number of old Coast and Geodetic Survey lines is twenty-five. Fifteen of the v's have plus signs and only ten the minus, and the sum of the plus v's is 2·70 metres, while the sum of the minus v's is 0·97 metre. As a contrast the same test may be applied to the leveling by the Engineers. In the preliminary adjustment of this leveling shown on page 435 the first and second and sixteenth and seventeenth equations represent lines by others than the Engineers. If these are omitted there remain thirteen v's, of which seven have plus signs and six minus signs. The sum of the plus v's is 0·21 metre, and of the minus v's 0·14 metre. Similarly, in the preliminary general adjustment shown on pages 439–440 there are seventeen Engineer lines. Seven of the v's have plus signs and ten minus signs, the sum of the plus v's being 0·08 metre, and of the minus v's 0·12 metre.

It thus appears that the law holds good for Coast and Geodetic Survey leveling previous to 1899, though it is masked to a considerable extent by other large errors. The same kind of evidence also indicates that systematic errors following this law do not exist in the leveling by the Engineers. There are so few lines of each of the other classes of leveling in the net that it is not feasible to make such investigations for them.

It is desirable to determine the law of this error, which is systematic with respect to direction, more accurately, and to apply to the observations the proper correction to eliminate it so far as is possible. The necessary correction on any line may most conveniently be expressed in the symbolic form $nA + wB$, in which n is the northing and w the westing of one end of the line from the other, and A and B are unknown constants to be determined. The following observation equations were used to derive the most probable values of the unknown constants A and B. The line of levels involved in each equation is indicated by its terminals. The coefficient of A is the northing and of B the westing, in hundreds of kilometres, to the first-named terminal from the second. The second member of each of the last six equations is the correction necessary to make the leveling agree with the tidal determinations as indicated on pages 396–397, 410–411. In the remaining equations the second member, the best available value for the required correction to the line, is the v from the preliminary adjustment shown on pages 439–440. The weights assigned to each line are as before $\frac{10{\cdot}5}{L}$, except for the last six lines, which are given double weight, $\frac{21}{L}$, because both ends of these lines are fixed by tidal observations.

The second solution of these equations indicated in the last three columns is to be explained later (see page 446).

Determination of systematic correction to old Coast and Geodetic Survey levels.

OBSERVATION EQUATIONS.

No.	Line.	Equation.	p	v	pv^2	Second solution.		
						p	v	pv^2
		m.		*mm.*	*mm.*		*mm.*	*mm.*
1	Biloxi-Carrollton	+ ·51 A − 1·24 B = +0·0460	·077	+ 61·0	290	·054	+ 49·4	132
2	Smithland-Carrollton	+1·08 A + 1·45 B = +0·1760	·036	−109·4	431	·011	− 83·1	76
3	Vidalia-Smithland	+ ·71 A − ·27 B = −0·0292	·100	+121·0	1 464	·091	+123·0	1 377
4	Vicksburg-Vidalia	+ ·87 A − ·53 B = −0·0036	·076	+123·9	1 167	·053	+123·9	814
5	Wilkersons-Vicksburg	+1·17 A + ·17 B = +0·0883	·057	+ 38·8	86	·029	+ 49·8	72
6	Meridian-Vicksburg	+ ·03 A − 2·04 B = +0·3594	·047	−275·8	3 575	·020	−301·0	1 812
7	Meridian-Biloxi	+2·17 A − ·20 B = −0·0528	·034	+308·9	3 244	·010	+322·9	1 043
8	Corinth-Meridian	+2·85 A − ·16 B = +0·4448	·034	−112·5	431	·010	− 92·8	86
9	Little Rock-Wilkersons	+1·27 A + ·99 B = +0·0559	·058	+ 50·5	148	·030	+ 72·5	158
10	Harrisonville-Little Rock	+4·26 A + 1·89 B = −0·3473	·015	+760·3	8 671	·0021	+816·3	1 399
11	Pleasant Hill-Harrisonville	+ ·13 A − ·08 B = +0·0101	·810	+ 7·9	49	5·9	+ 7·9	354
12	Kansas City-Harrisonville	+ ·49 A + ·26 B = −0·1216	·110	+167·5	3 087	·10	+174·4	3 042
13	Kansas City-Pleasant Hill	+ ·36 A + ·30 B = +0·0514	·230	− 22·0	110	·50	− 15·5	120
14	Jefferson City-Pleasant Hill	− ·18 A − 1·83 B = −0·0700	·053	+121·3	780	·026	+ 97·0	245
15	St. Louis-Jefferson City	+ ·08 A − 1·67 B = −0·2199	·051	+294·7	4 429	·024	+274·5	1 808
16	Corinth-Memphis	− ·19 A − 1·39 B = −0·0522	·070	+ 85·1	507	·044	+ 66·3	194
17	Cairo-Corinth	+2·22 A + 0·54 B = +0·2885	·040	− 55·7	124	·014	− 32·2	15
18	Odin-Cairo	+1·80 A − ·09 B = +0·2240	·054	− 14·6	11	·027	− 2·0	00
19	Odin-St. Louis	− ·01 A − ·99 B = −0·0025	·100	+ 40·3	162	·093	+ 27·8	72
20	Cincinnati-Odin	+ ·51 A − 3·61 B = +0·4684	·025	−268·2	1 798	·0058	−309·5	556
21	Grafton-Cincinnati	+ ·28 A − 3·85 B = +0·2991	·022	−115·8	295	·0042	−161·7	110
22	Hagerstown-Grafton	+ ·36 A − 1·99 B = −0·0704	·034	+189·8	1 225	·011	+167·6	309
23	Harrisburg-Hagerstown	+ ·69 A − 0·72 B = +0·0716	·088	+ 35·6	112	·070	+ 31·9	71
24	Hagerstown-Washington	+ ·85 A + ·60 B = +0·1135	·077	− 39·9	122	·053	− 25·9	36
25	Sandy Hook-Harrisburg	+ ·25 A − 2·25 B = +0·0048	·039	+112·2	491	·014	+ 86·0	104
26	Washington-Richmond, 1883–84	+1·52 A − ·36 B = + ·6574	·104	−469·4	22 915	·054	−462·4	11 546
27	Washington-Richmond, 1895	+1·52 A − ·36 B = + ·2655	·104	− 77·5	625	·054	− 70·5	268
28	Richmond-Old Point, 1884	+ ·59 A + ·99 B = + ·0217	·150	+ 6·9	8	·10	− 3·0	1
29	Richmond-Old Point, 1891–92	+ ·59 A + ·99 B = − ·0236	·150	+ 52·2	408	·10	− 40·3	162
30	St. Augustine-Cedar Keys, 1892	+ ·79 A − 1·68 B = + ·0062	·097	+150·2	2 188	·042	+135·2	768
31	St. Augustine-Cedar Keys, 1893	+ ·79 A − 1·68 B = + ·2366	·097	− 80·2	624	·042	− 95·2	381
					59 577			27 031

The formation and solution of the normal equations gave the following results: $A=+0.1144\pm0.0205$ metre; $B=-0.0393\pm0.0177$ metre. The probable error of an observation of unit weight was found to be $\sqrt{0.000939}$.

The unit of horizontal distance used in the equations being 100 kilometres, these results mean that to a line running due north the correction to be applied is $+1.144$ millimetres per kilometre, and to a line running due west, -0.393 millimetre per kilometre.

It may be contended that the apparent systematic error shown above is not real, but is simply due to having erroneously assumed the Gulf to be at the same elevation as the Atlantic, whereas it may be claimed that it is considerably above. It is desirable then to obtain some check on the reality of the systematic error which is independent of any such assumption. In the level net as shown on the sketch opposite page 424 there are 18 circuits, of which Coast and Geodetic Survey levels previous to 1899 form a part only, the remainder being either spirit leveling of some other kind or water levels. Only one of these circuits—namely, that given by the level lines from St. Augustine to Cedar Keys and the water leveling from Cedar Keys to St. Augustine through the Straits of Florida—has a closing error which is affected by the assumption as to the relative elevation of the Gulf and the Atlantic. The remaining 17 closures are independent of any such assumption. Of these 17, 14 have closing errors of the sign which would be accounted for by assuming that the closing error is due entirely to the above systematic error in the portion of the circuit run by the Coast and Geodetic Survey previous to 1899. For example, in the circuit Cairo-Odin-St. Louis-Cairo the eastern and northern sides of the circuit were run by the Coast and Geodetic Survey, and according to the law of the supposed systematic error the line from Cairo to St. Louis via Odin should run considerably low and cause the closing error of the circuit to be negative. The actual closing error is -227 millimetres. The only circuits which close with the opposite sign from that which would be accounted for by the systematic errors treated above are Jefferson City-Kansas City-Pleasant Hill-Jefferson City, Arkansas City-St. Louis-Pleasant Hill-Harrisonville-Arkansas City, and Smithland-Vidalia-Jonesville-Monroe-Shreveport-Smithland.

RELATION OF WEIGHT TO LENGTH OF LINE.

Before applying these corrections in the level net and making the final adjustment, it is still necessary to investigate the assumption that the weights to be assigned to the various lines of any class of leveling should be proportional to $\frac{1}{L}$, this being the proper scale of weights if the accidental errors predominate largely over the systematic errors. A direct test of this assumption for the two principal classes of lines may now be made by writing the pv^2's for each class in the order of magnitude of the p's. If, as a rule, the longer lines corresponding to the smaller p's have been assigned weights which are relatively too large, the pv^2's for those lines will be found to be larger on an average than for the shorter lines. On the other hand, if the assigned relation of weight to length is about right, no well-marked progression should be found when the pv^2's are arranged in the order of the p's.

Coast and Geodetic Survey leveling previous to 1899.				
p.	pv^2 before application of systematic correction.		pv^2 after application of systematic correction.	
	mm.	*mm.*	*mm.*	*mm.*
·015	**1 809**		**8 671**	
·022	**1 968**		295	
·025	**5 485**		**1 798**	
·034	95		**3 244**	
·034	169		431	
·034	**6 727**		1 225	
·036	1 115		431	
·039	1		491	
·040	**3 329**		124	
·047	**6 071**		**3 575**	
·051	**2 466**		**4 429**	
·053	260		780	
·054	**2 710**		11	
·057	445		86	
·058	181		148	
Mean	....	2 189	....	1 716
·070	190		507	
·076	1		1 167	
·077	163		290	
·077	992		122	
·088	451		112	
·100	85		**1 464**	
·100	1		162	
·110	**1 627**		**3 087**	
·230	607		110	
·810	81		49	
Mean	....	420	....	707
Mean of all.	....	1 481	....	1 312

Engineer levels.		
p.	pv^2.	
	mm.	*mm.*
0·77	847	
1·7	34	
1·9	38	
2·7	27	
3·0	0	
3·3	0	
3·5	**6 265**	
3·5	0	
3·6	0	
Mean	....	801
4·5	0	
5·1	**3 876**	
5·6	**4 592**	
7·3	0	
8·3	**3 237**	
13·0	1 170	
29·0	0	
Mean	....	1 839
Mean of all.	....	1 255

The pv^2's for the Engineer lines and for the Coast and Geodetic Survey lines without systematic correction are from the preliminary general adjustment shown on pages 439–440. The second set of Coast and Geodetic Survey pv^2's is from the equations on page 443. The values of pv^2 greater than the mean in any column are printed in bold-face type. As abundant evidence has been brought forward to show that systematic errors predominated in the old Coast and Geodetic Survey leveling, it was to be expected, as strongly indicated by the second column of the table, that the accumulated errors on these lines increased much faster than $\sqrt{L}$, and that therefore the weights assigned to the long lines are considerably too great. The third column indicates, however, that even after the best available correction for systematic error has been applied, the weights for the long lines are still relatively much too great, for in the third column four out of the six values for pv^2 which exceed the mean are among the 15 long lines having assigned weights less than ·6, while only one such value falls among the 10 remaining shorter lines. The mean pv^2 for the 15 longer lines is also more than twice as great as for the 10 shorter lines. It is obviously desirable, therefore, to make a closer approximation to the facts in the final adjustment by assigning relatively lighter weights to the longer lines.

With the Engineers' lines, on the contrary, there is a strong indication that the longer lines have been assigned weights which are too small. If this indication represents a fact, then the accumulated errors on lines of this kind increase more slowly than $\sqrt{L}$; that is, more slowly than they would increase according to theory, even if all the errors belonged to the accidental class. As it is very unlikely that such a remarkable condition exists, it will be assumed that the indication shown in the table is a result of chance, and the weights for Engineer lines will in the final adjustment be made proportional to $\frac{1}{L}$, as before.

Other classes of lines will be weighted proportional to $\frac{1}{L}$, the little evidence available in regard to them indicating that they belong with the Engineer lines rather than with the old Coast and Geodetic Survey lines in this respect.

SECOND SOLUTION OF SYSTEMATIC CORRECTION EQUATIONS.

The above evidence having indicated that the accumulated errors of old Coast and Geodetic Survey lines increase faster than $\sqrt{L}$, and that the assigned weights for the long lines must therefore be decreased, the question at once arises, What relation shall now be assumed between the length and weight? As a working hypothesis, weights proportional to $\frac{1}{L^2}$ will be assigned upon the supposition that increase in the accumulated error is proportional to L. This working hypothesis will be tested later.

Using these new weights, namely, $\frac{1000}{L^2}$, the equations on page 443 were solved again with the results shown in the last three columns of the table. The new solution gave $A=+0.1220\pm0.0192$ metre and $B=-0.0268\pm0.0176$ metre, in close agreement with the former results. The probable error of an observation of unit weight was found to be $\sqrt{0.000424}$.

It is interesting to note the close agreement between the direction of the zero line as given by the estimate of the committee on precise leveling in 1898-99 and the above solution. The committee estimated that a line running twenty degrees north of west would have no systematic correction. The above solution indicates that a zero line should make an angle with the due west line of $tan^{-1}\frac{0.0268}{0.1220}=12^{\circ}$.

The assumption that the weights should be proportional to $\frac{1}{L^2}$ may now be tested by arranging the pv^2's of this second solution in the order of magnitude of the p's as before. The values of pv^2 which exceed the mean value are printed in bold-faced type.

Old Coast and Geodetic Survey leveling.

[After systematic correction, in which p is made equal to $\frac{1000}{L^2}$.]

p	pv^2
	mm.
·0021	1 899
·0042	110
·0058	556
·010	1 048
·010	86
·011	309
·011	76
·014	104
·014	15
·020	1 812
·024	1 808
·026	245
·027	0
·029	72
·030	158
Mean	520
·044	194
·053	814
·054	132
·053	36
·070	71
·091	1 877
·093	72
·10	8 042
·50	120
5·9	354
Mean	621
Mean of all..	560

The table indicates that the assumed relation between weight and length is correct, and hence it will be used in the final adjustment.

FINAL GENERAL ADJUSTMENT.

The average pv^2 from all lines in the preliminary general adjustment given on pages 439-440 is 1 266. The average pv^2 from the sixteen Engineer lines, namely 1 255, agrees very closely with this, and indicates that the Engineer lines have been correctly weighted relatively to the average of all the other lines. The weights for the Engineer lines will therefore be preserved unchanged in the final adjustment.

The average pv^2 in the second solution of the equations for determining the systematic correction, as shown on page 443, is 560. To put these weights on the same basis as those assigned to the Engineer lines, they must therefore be increased about in the ratio of 560 to 1 266, or from $\frac{1\,000}{L^2}$ to $\frac{2\,300}{L^2}$, but as the pv^2's will probably be decreased a little in the general adjustment on account of the corrections adjusting themselves to the new weights, the weights assigned will be made a little greater than this, or, adopting a round number, $\frac{2\,500}{L^2}$.

The fact that the four lines of water levels on the Great Lakes, Nos. 39, 40, 41, 42, in the preliminary general adjustment have a mean pv^2 of only 98*, as contrasted with a mean of 1 266 for all lines, indicates very strongly that the weights assigned to these lines are much too small. The indication is not so conclusive as it would be if these lines were not in the edge of the level net, and therefore have their ends rather loosely fixed. To err on the side of caution the weights for these lines will not be increased.

To err similarly in the conservative rather than the radical direction, the weights for the two Deep Waterways lines between Greenbush and Oswego, Nos. 51 and 52, and for the Pennsylvania Railroad line between Harrisburg and Braddock, No. 45, will not be increased, though for the former the mean pv^2 is only 450 and for the latter the pv^2 is 356. The Deep Waterways lines are in the edge of the net, and there is but a single Pennsylvania Railroad line upon which to base a judgment.

The three Geological Survey lines, Nos. 43, 44, 46, in the preliminary general adjustment, have a mean pv^2 of 618, and the two Van Orden lines, Nos. 53 and 54, a mean of 3 886. The Geological Survey lines are held loosely at the ends in comparison with the Van Orden lines, which combined reach nearly from one tidal determination to another. This may account in part for the discrepancy between the two mean pv^2's for these lines on which similar methods and instruments were used. Hence, the five lines will be grouped together with a mean pv^2 of 1 925, indicating that the weights should be decreased in the ratio of 1 925 to 1 266, or from $\frac{75}{L}$ to $\frac{49}{L}$, or, using a round number, to $\frac{50}{L}$.

The weights adopted, then, for the final general adjustment are as follows:

No.	Lines.	Weight p
1	Engineer lines with Kern instrument; Coast and Geodetic Survey of 1899; water leveling on lakes except between Cape Vincent and Oswego	$\frac{1\ 000}{L}$
2	Wye levels run under the direction of the Engineers and Deep Waterways Commission, and the water levels between Cape Vincent and Oswego	$\frac{500}{L}$
3	Geological Survey and Van Orden levels	$\frac{50}{L}$
4	Leveling by the Pennsylvania Railroad	$\frac{38}{L}$
5	Coast and Geodetic Survey previous to 1899	$\frac{2\ 500}{L^2}$

*This small mean pv^2 is interesting in connection with the claim made by Mr. G. K. Gilbert, in Part 2, United States Geological Survey Report for 1896-97, pages 595-647, that the Great Lakes region is tilting steadily toward the southwestward. Observations upon three of these four lines of water levels were made in 1875, whereas the spirit leveling connected with these lines in the adjustment is nearly all of a much later date. If there had been an appreciable change in the relative elevation of the bench marks about the Great Lakes it would become evident in the form of large apparent corrections to these old lines of water levels, whereas they show remarkably small corrections. The estimated rate of tilting in the paper cited was such that two bench marks 100 miles apart, the second being south 27° west from the first (that being the assumed direction of tilting) should change their relative elevation by 0·42 foot per century. The levels are apparently incompetent to determine whether or not so slow a change has been taking place since 1875.

The systematic correction computed from the constants A and B, shown on page 446, are applied, as indicated in column 7 on pages 439–440, to all old Coast and Geodetic Survey level lines before making the final adjustment. The absolute terms in the final adjustment are therefore the algebraic sums of corresponding quantities in columns 7 and 2. The final general adjustment differs from the preliminary general adjustment only in using different weights for certain lines and in using Coast and Geodetic Survey lines after correction for systematic errors. The sixth, eighth, and ninth columns on pages 439–440 show the weights, residuals, and weighted residuals, from the final general adjustment. The *v's* are, as before, the derived corrections to the observed differences of elevation indicated in the equations. In an equation involving old Coast and Geodetic Survey levels the total correction to any observed difference is of course the algebraic sum of the systematic correction given in column 7 and the *v*.

The elevations resulting from the final adjustment are shown below. Opposite them, for convenient reference, are given the corrected elevations from each of the three preliminary adjustments. These serve by comparison as a means of estimating the accuracy of the final elevations and especially as a means of indicating the extent to which the derived elevations are dependent upon the judgment of the computer in fixing the weights assigned and the form of the computation.

The computed elevations.

Bench marks.	From Coast and Geodetic Survey preliminary adjustment.	From Engineers' preliminary adjustment.	From preliminary general adjustment.	Final general adjustment adopted.
	m.	*m.*	*m.*	*m.*
Carrollton, I	2·7550	2·6493	2·6454	2·6436
Smithland, XLV	14·8491	14·6165	14·7774	14·7917
Vidalia, LXIV	19·8481	19·5641	19·6982	19·7233
Monroe, 27	....	23·6060	23·7413	23·7658
Rayville, 16	....	24·2993	24·4340	24·4587
Vicksburg, 211	27·9487	27·5954	27·7307	27·7556
Meridian, C.	104·9531	....	104·8780	104·8579
Wilkerson's Landing, 84	42·2750	42·1155	42·2457	42·2704
Little Rock, I (or 3)	....	....	80·3155	80·3434
Harrisonville, 43	309·5543	....	309·6726	309·6687
Pleasant Hill, LI	261·2342	....	261·3533	261·3595
Kansas City, 244	230·0504	230·0741	230·1662	230·1885
Jefferson City, 90	169·7894	169·8449	169·9365	169·9596
Memphis, "Memphis"	....	....	80·5218	80·5465
Corinth, V	....	....	137·6515	137·7053
Cairo, 2	97·1854	97·1355	97·2409	97·2658
St. Louis, K_3	126·0823	126·0175	126·1108	126·1353
Odin, V	160·4706	....	160.5481	160·6075
Cincinnati, T	....	....	166·4116	166·4338
Savanna, 62	....	180·3401	180·4065	180·4298
Escanaba, 1	....	180·7072	180·7535	180·7760
Gibraltar, 2	....	....	178·1785	178·1995
Erie, 1 (1873)	....	....	175·3218	175·3416
Braddock, P. R. R. 88	....	....	252·6941	252·7108
Grafton, M	....	....	303·8582	303·8721
Hagerstown, A	168·1451	....	168·2638	168·2720
Harrisburg, XXIX	....	....	108·7503	108·7880
Oswego, A	....	76·6913	76·6857	76·7016
Greenbush, "Gristmill"	....	4·1389	4·1270	4·1384

A few points given in columns 2 and 3 are not junction points of the nets to which they are credited. In such cases the elevations have been derived for the present purpose by interpolation between adjacent junction points.

It might seem at first sight that the elevations from the two general adjustments must necessarily fall between those given by the Coast and Geodetic Survey and the Engineer adjustments. That this is not true is due to the fact that the general adjustments include many lines not involved in any of the other adjustments. The comparatively large differences between the second, third, and fourth columns are due largely to different lines being used in the different adjustments, whereas the small differences between columns 4 and 5 are due to improvements in the computation without the addition of new data. The table serves to indicate, then, that small changes would be produced by any further attempt at improvement in the computation, in comparison with those which would probably take place whenever any new lines which may become available are introduced.

The probable error of the elevation of bench mark K_3 at St. Louis has been computed from the adjustment and found to be ± 65 millimetres. It is an even chance, then, that this computed elevation will not be changed more than 65 millimetres by any amount of new leveling, and it is almost certain that it will not be changed by as much as 0·3 metre, or 1 foot.

The probable error of an observation of unit weight is from this adjustment $\pm 32{\cdot}9$ millimetres, and for lines by the Engineers the probable error of the completed leveling of a single kilometre is $\pm 1{\cdot}04$ millimetres.

LIST OF PRECISE ELEVATIONS IN THE UNITED STATES.

The computed elevations given in the following list are not final in the sense that they will remain unchanged. It is not possible to obtain elevations which are final in that sense, unless no more leveling is to be done, or if done is to be ignored. Each new line of leveling connected with the net furnishes the means of making a closer approximation to the truth. Advantage will be taken from time to time of whatever new data are available by making a revision of the adjustment. The elevations here published are believed to represent the best approach to the truth that can be made at present, using all observations that are available at this Office. From time to time this list of elevations as modified by additional observations will be republished.

Two years hence, if the same willingness on the part of various organizations to cooperate in this matter is shown as at present, it will be possible to improve the adjustment considerably. The water leveling through the Great Lakes is now being revised by the Lake Survey. Certain short lines of precise levels have been run by the Engineers in the Vicksburg district, of which the final computation has not been made. The line from Biloxi has been rerun, under the direction of the Mississippi River Commission, to Carrollton and up the river for some distance beyond Baton Rouge. Under the same organization precise level lines now exist, although they are not available for the present adjustment, between New Orleans, Port Eads, and the lower end of the Southwest Pass. Before this appendix has passed through the press, the short gap, less than 80 miles, between Norfolk, Nebr., and Sioux City, Iowa, in the circuit Sioux City–Kansas City–Abilene–Sioux City, will be closed. It is also expected that by that time a new Coast and Geodetic Survey line will be available, running southward from Cincinnati to Decatur and Birmingham, connecting near Knoxville and Chattanooga with the thousand-mile loop of precise leveling by the United States Geological Survey, which starts from the Atlantic at Morehead City, N. C., and reaches it again at Brunswick, Ga. This one new Coast and Geodetic Survey line will introduce five new circuits into the level net.

In deriving the elevations given in the following list the local differences of elevation adopted as indicated on pages 402–414 have been preserved unchanged. For each line which forms a link in the level net, the adjustment in connection with these local relations furnishes a fixed elevation at each end and hence furnishes the required correction to the observed elevation at those two points. For intermediate points the required corrections to the observed elevations have been interpolated between the end points, on the supposition that the correction varies at a uniform rate in millimetres per kilometre along the line. If a bench mark is common to two or more lines between fixed points—as, for example, certain bench marks between Washington and Richmond which were connected with both the line of 1883–84 and of 1895—a mean or weighted mean of the two corrected elevations is taken as the adopted elevation. Such bench marks common to two lines serve to break each of them into sections, each of which, if it contains any intermediate bench marks, is treated as a link having fixed ends in deriving the elevations of these bench marks. With one exception, a constant correction has been applied to all elevations on each spur line equal to the correction applied to the main line at the base of the spur.

The transcontinental line west of Holliday is the one exception. On this line from Holliday to Denver, run by the Coast and Geodetic Survey previous to 1899, a correction for systematic error has been applied in accordance with the constants shown on page 446. The total corrections to the elevations due to this cause, west of Holliday, were as follows for the points named:

Bench marks.	Total systematic correction west of Holliday.
	mm.
Abilene, B_1	− 69·8
Limon, N	−173·0
Roswell, Z	−252·3
Denver, Z_1	−133·8

After applying these corrections at the points named, the corrections at intermediate points were interpolated between them, upon the supposition that the correction varied at a constant rate in millimetres per kilometre of line run. The closing error of the Limon–Roswell–Denver circuit was also distributed uniformly around the circuit.

It may be said in criticism that the systematic error dependent upon direction should be applied to each short portion of the line according to the direction of that portion. The method used applies the proper total correction to any line and insures a fair approximation to the true correction at intermediate points by interpolation. To apply the correction in detail to each short portion of the line would require more computing than would be justified by the slight gain in accuracy, especially when it is considered that the true value of the systematic correction is only approximately known.

The elevations are given in the following list to tenths of millimetres. This does not imply that the tenths are known. For bench marks not more than 2 kilometres apart the difference of elevation is uncertain in the millimetres and tenths; for those which are from 2 to 200 kilometres apart the centimetres are also uncertain, and for greater distances there may be in some cases an uncertainty in the decimetres. Similarly, the uncertainty in the absolute elevations varies with the distance from the nearest tidal connection.

For the lines which are as yet unpublished the column in certain parts of the following table headed "Elevation as reported" gives the elevations reported to this Office as the direct result of the leveling.

For the convenience of those who may wish to compare the elevations here given with others which are expressed in feet, or vice versa, the following conversion table is here inserted:

Metres.	Feet.	Feet.	Metres.
1	3·28083	1	0·304801
2	6·56167	2	0·609601
3	9·84250	3	0·914402
4	13·12333	4	1·219202
5	16·40417	5	1·524003
6	19·68500	6	1·828804
7	22·96583	7	2·133604
8	26·24667	8	2·438405
9	29·52750	9	2·743205
10	32·80833	10	3·048006

INDEX TO ELEVATIONS AND DESCRIPTIONS OF BENCH MARKS.

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ALABAMA.

ARKANSAS.

ARKANSAS—Continued.

COLORADO.

DISTRICT OF COLUMBIA.

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LOUISIANA—Continued.

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MISSISSIPPI—Continued.

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MISSOURI—Continued.

MISSOURI—Continued.

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NEBRASKA—Continued.

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NEW YORK—Continued.

OHIO.

OHIO—Continued.

ONTARIO, CANADA.

PENNSYLVANIA.

PENNSYLVANIA—Continued.

PENNSYLVANIA—Continued.

QUEBEC, CANADA.

TENNESSEE.

VIRGINIA.

WEST VIRGINIA.

WISCONSIN.

WYOMING.

Corrected elevations of permanent bench marks.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Sandy Hook, N. J.	T. H.	3·4881
At Sandy Hook, N. J.	A	3·4751
At Sandy Hook, N. J.	B	2·8630
At Sandy Hook, N. J.	C	5·9531
Near Highlands, N. J.	No. II.	2·3210
Near Branchport, N. J.	No. V.	1·0597
At Red Bank, N. J.	E	11·7284
At Sandy Hook, N. J.	T. of 1886.	3·2802
At Sandy Hook, N. J.	U. of 1886.	1·8770
At Port Monmouth, N. J.	S	3·5559
At Port Monmouth, N. J.	Port Monmouth tidal.	3·5765
At Keyport, N. J.	R	6·9828
At Conaskonk Point, N. J.	Conaskonk Point tidal.	3·9603
At Matawan, N. J.	No. VI.	*16·8599
At South Amboy, N. J.	Tidal—South Amboy.	2·1885
Near South Amboy, N. J.	No. VIII.	4·4368
At Raritan, N. J.	F	2·3640
At Perth Amboy, N. J.	State Geological Survey.	18·5763
Near Gifford, N. Y.	N	21·6607
At Great Kills, N. Y.	O	1·7203
At Great Kills, N. Y.	Great Kills tidal.	2·0008
At Fort Wadsworth, N. Y.	M	12·1584
At Quarantine Dock, N. Y.	Quarantine Dock.	2·5504
At Constables Hook, N. J.	Constables Hook.	2·7324
At Constables Hook, N. J.	P	2·9530
At Bergen, N. J.	Q	4·0705
At Elm Park, N. Y.	Elm Park tidal.	3·3748
At Elizabeth, N. J.	Elizabeth tidal.	3·7910
At Fort Hamilton, N. Y.	L	11·0842
At Bath Beach, N. Y.	Locust Grove tidal.	2·8038
At Bath Beach, N. Y.	K	8·3289
At Bay Ridge, N. Y.	No. 25.	26·5994
At Bay Ridge, N. Y.	Bay Ridge tidal.	1·9460
At Bay Ridge, N. Y.	J	13·3000
At Brooklyn, N. Y.	A	20·0484
At Brooklyn, N. Y.	G	2·8963
At Governors Island, N. Y.	Hydrographic marks.	B.M.$_1$ 3·6951 B.M.$_2$ 8·4710
At Governors Island, N. Y.	H	2·4439
At Governors Island, N. Y.	I	2·6313
At Brooklyn, N. Y.	C	17·0737
At Brooklyn, N. Y.	D	4·1137
At Brooklyn, N. Y.	F	3·1708
At New York City, N. Y.	E	4·0819
At Corlears Hook, N. Y.	Tidal, Corlears Hook.	2·3390
At Hunters Point, N. Y.	Tidal, Hunters Point (No. 8).	1·8172
At Hunters Point, N. Y.	B	2·4207
At Ravenswood, N. Y.	No. 7.	3·0352
At Astoria, N. Y.	No. 6.	3·6297
Near Astoria Dock, N. Y.	No. 4.	1·7992
At Pot Cove, N. Y.	No. 1.	2·9208
At Pot Cove, N. Y.	No. 2.	4·1874
At Polhemus Dock, N. Y.	No. 4a.	2·0778
At New York City, N. Y.	No. 5.	2·2991
At New York City, N. Y.	Tidal, foot of Forty-second street.	† 3·0794 ‡ 4·5927
At Dobbs Ferry, N. Y.	Tidal, Dobbs Ferry.	3·0049

*This elevation for VI at Matawan is derived from the 1886–87 line alone. The elevation given by the 1881 line is 16·7885. † 1885. ‡ 1886.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Dobbs Ferry, N. Y.	V	2·9357
At Long Island City, N. Y.	No. 9.	3·9512
At Flushing, N. Y.	No. 10.	2·5809
At College Point, N. Y.	No. 11.	12·5611
At College Point, N. Y.	Tidal, Station No. 68.	2·9225
At College Point, N. Y.	No. 12.	10·4801
At Willets Point, N. Y.	No. 105.	3·0681
At Willets Point, N. Y.	Tidal, U. S. Engineers.	4·3083
At Sandy Hook, N. J.	No. I.	4·7198
At Navesink Highlands, N. J.	No. III.	61·7145
At Navesink Highlands, N. J.	D	63·2741
At Seabright, N. J.	No. IV.	2·8224
At Morgan, N. J.	No. VII.	1·7050
Near Metuchen, N. J.	No. IX.	25·4930
At South Plainfield, N. J.	No. X.	19·4634
Near Bound Brook, N. J.	No. XI.	9·9022
Near New Market, N. J.	No. XII.	14·9895
At Bound Brook, N. J.	No. XIII.	10·8961
At Somerville, N. J.	No. XIV.	24·9395
At Somerville, N. J.	G	27·8295
At North Branch, N. J.	No. XV.	25·8793
Near Annandale, N. J.	No. XVI.	108·2535
Near Bloomsbury, N. J.	No. XVII.	99·4580
Near Phillipsburg, N. J.	No. XVIII.	80·1874
At Easton, Pa.	No. XIX.	65·3761
At Easton, Pa.	No. XX.	108·9047
At Easton, Pa.	H	110·8262
At Allentown, Pa.	I	97·9269
Near Allentown, Pa.	No. XXI.	90·2120
Near Macungie, Pa.	No. XXII.	116·9851
At Reading, Pa.	J	80·5002
Near Shamrock, Pa.	No. XXIII.	129·3594
Near Robesonia, Pa.	No. XXIV.	131·9182
Near Womelsdorf, Pa.	No. XXV.	147·3599
At Lebanon, Pa.	No. XXVI.	144·6916
At Lebanon, Pa.	K	142·0026
Near Annville, Pa.	No. XXVII.	123·5507
Near Beaver, Pa.	No. XXVIII.	112·1082
At Harrisburg, Pa.	No. XXIX.	108·7880
At Harrisburg, Pa.	L	112·0816
At Carlisle, Pa.	M	144·2420
At Shippensburg, Pa.	No. XXX.	199·2976
At Chambersburg, Pa.	N	189·1278
At Greencastle, Pa.	No. XXXI.	179·3634
At Hagerstown, Md.	A	168·2720
Near Hagerstown, Md.	No. I.	171·7903
Near Hagerstown, Md.	No. II.	176·9528
Near Williamsport, Md.	No. IV.	150·7373
Near Williamsport, Md.	No. V.	136·3275
At Williamsport, Md.	B	109·0528
Near Williamsport, Md.	C	113·2818
Near Williamsport, Md.	No. VI.	113·1989
Near Williamsport, Md.	D	123·2214
Near Cherry Run, Md.	No. VII.	123·5962
Near Hancock, Md.	E	123·3362
Near Hancock, Md.	No. VIII.	127·4805
At Hancock, Md.	F	128·2393

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Hancock, Md.	No. IX.	130·1715
Near Hancock, Md.	G	135·2691
Near Hancock, Md.	No. X.	137·6465
Near Little Orleans, Md.	No. XI.	139·6302
At Little Orleans, Md.	No. XII.	140·1010
Near Little Orleans, Md.	No. XIII.	142·5110
Near Little Orleans, Md.	H	150.0330
Near Little Orleans, Md.	No. XIV.	162·2376
Near Oldtown, Md.	No. XV.	164·6806
Near Cumberland, Md.	No. XVI.	179·0790
At Cumberland, Md.	I	190·0727
Near Cumberland, Md.	No. XVII.	197·2872
Near Cumberland, Md.	No. XVIII.	211·5039
Near Keyser, W. Va.	J	244·7014
At Bloomington, Md.	No. XX.	307·4080
Near Oakland, Md.	No. XXI.	725·0028
Near Oakland, Md.	No. XXII.	732·9058
Near Deer Park, Md.	No. XXIII.	748·6372
Near Huttons Switch, Md.	No. XXIV.	742·0780
Near Bloomington, Md.	No. XXV.	693·3478
Near Oakland, Md.	K	724·1358
Near Cranberry Summit, W. Va.	No. XXVI.	756·2513
Near Cranberry Summit, W. Va.	No. XXVII.	747·6540
Near Rowlesburg, W. Va.	L	495·0108
At Rowlesburg, W. Va.	No. XXVIII.	426·9494
Near Rowlesburg, W. Va.	No. XXIX.	523·4648
Near Grafton, W. Va.	No. XXX.	312·1482
At Grafton, W. Va.	M	303·8721
Near Grafton, W. Va.	No. XXXI.	330·0134
Near Bridgeport, W. Va.	No. XXXII.	298·6196
Near West Union, W. Va.	No. XXXIII.	243·9226
At West Union, W. Va.	N	245·3474
Near West Union, W. Va.	No. XXXIV.	244·7234
At Cornwall, W. Va.	No. XXXV.	211·5140
Near Cairo, W. Va.	No. XXXVI.	209·1020
At Petroleum, W. Va.	No. XXXVII.	212·4479
Near Petroleum, W. Va.	No. XXXVIII.	211·3010
Near Parkersburg, W. Va.	No. XXXIX.	185·1726
At Parkersburg, W. Va.	O	187·7180
At Belpre, Ohio.	No. XL.	189·3684
At Little Hocking, Ohio.	No. XLI.	190·0835
Near Coolville, Ohio.	No. XLII.	193·0882
Near Coolville, Ohio.	No. XLIII.	184·8189
Near Guysville, Ohio.	No. XLIV.	188·2214
Near Guysville, Ohio.	No. XLV.	189·6054
Near Canaanville, Ohio.	No. XLVI.	190·1764
Near Stewart, Ohio.	No. XLVII.	187·9418
Near Stewart, Ohio.	No. XLVIII.	187·6165
Near Canaanville, Ohio.	No. XLIX.	192·1732
At Athens, Ohio.	No. L.	197·9122
At Athens, Ohio.	P	200·0262
At Moonville, Ohio.	No. LI.	217·0990
Near Zaleski, Ohio.	No. LII.	217·7464
Near Hamden, Ohio.	No. LIII.	215·2662
Near Londonderry, Ohio.	No. LIV.	183·0762
Near Schooley, Ohio.	No. LV.	200·4260
At Chillicothe, Ohio.	Q	194·4518
Near Musselmans Junction, Ohio.	No. LVI.	213·2286
Near Musselmans Junction, Ohio.	No. LVII.	217·0484

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Lyndon, Ohio.	No. LVIII.	277·8387
At Martinsville, Ohio.	No. LIX.	321·9746
Near Clinton Valley, Ohio.	No. LX.	301·6790
Near Loveland, Ohio.	No. LXI.	211·0908
At Loveland, Ohio.	R	177·2404
Near Remington, Ohio.	No. LXII.	179·9698
Near Cumminsville, Ohio.	No. LXIII.	154·2125
At Cincinnati, Ohio.	No. LXIV.	150·6698
At Cincinnati, Ohio.	S	150·5669
At Cincinnati, Ohio.	T or City B. M. No. 1.	166·4338
Near Delhi, Ohio.	No. LXV.	Destroyed.
Near Lawrenceburg, Ind.	No. LXVI.	146·8927
At Lawrenceburg, Ind.	U	147·9643
Near Cochran, Ind.	No. LXVII.	150·2842
Near Delaware, Ind.	No. LXVIII.	282·6861
Near North Vernon, Ind.	No. LXIX.	208·5825
Near Medora, Ind.	V	162·5878
Near Fort Ritner, Ind.	No. LXX.	158·8369
Near Scottsville, Ind.	W	156·8848
At Mitchell, Ind.	X	209·1949
At West Shoals, Ind.	Y	158·9460
At Washington, Ind.	Z	155·0183
At Vincennes, Ind.	A_3	132·0240
At Vincennes, Ind.	No. 1.	130·8289
At Olney, Ill.	B_3	147·8506
At Olney, Ill.	No. II.	146·1108
Near Clay City, Ill.	No. III.	130·3615
At Flora, Ill.	C_3	149·0206
Near Iuka, Ill.	No. IV.	143·3890
At Salem, Ill.	D_3	165·6792
At Odin, Ill.	No. V.	160·6075
Near Sandoval, Ill.	No. VI.	148·7360
Near Collins, Ill.	No. VII.	135·9988
Near Carlyle, Ill.	E_3	133·6228
At Carlyle, Ill.	F_3	142·6447
Near Ariston, Ill.	No. VIII.	137·8383
At Lebanon, Ill.	G_3	139·3370
Near Caseyville, Ill.	No. IX.	137·0286
Near East St. Louis, Ill.	H_3	158·9308
At East St. Louis, Ill.	I_3	126·1345
At St. Louis, Mo.	J_3	126·1380
At St. Louis, Mo.	K_3	126·1353
At St. Paul, Mo.	No. X.	132·0376
At Allenton, Mo.	No. XI.	146·3322
Near South Point, Mo.	No. XII.	149·5009
At Washington, Mo.	L_3	166·4168
At New Haven, Mo.	M_3	155·3663
Near New Haven, Mo.	No. XIII.	154·4773
Near Etlah, Mo.	No. XIV.	155·2956
At Berger, Mo.	No. XV.	156·0442
At Hermann, Mo.	N_3	158·4503
Near Gasconade, Mo.	No. XVI.	159·4901
At Gasconade, Mo.	No. XVII.	159·7346
At Gasconade, Mo.	No. XVIII.	160·6698
At Morrison, Mo.	No. XIX.	160·8045
At Chamois, Mo.	O_3	163·5161
At St. Aubert, Mo.	No. XX.	164·2894
Near St. Aubert, Mo.	No. XXI.	164·1212
At Isbell, Mo.	No. XXII.	164·6188

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Bonnots Mill, Mo.	P_3	168·3836
At Osage, Mo.	No. XXIII.	167·1288
At Osage, Mo.	No. XXIV.	166·7328
Near Osage, Mo.	No. XXV.	169·9061
At Jefferson City, Mo.	Old B. M. 90 (85).	169·9596
At Jefferson City, Mo.	No. XXVII.	184·8282
At Jefferson City, Mo.	No. XXVIII.	191·6381
Near Cole, Mo.	No. XXIX.	169·7830
At Scott, Mo.	No. XXX.	177·1070
At Elston, Mo.	No. XXXI.	213·1731
At Centertown, Mo.	No. XXXII.	261·1996
At Centertown, Mo.	M. P. R. R. No. 114.	259·0022
At California, Mo.	No. XXXIII.	267·1531
At California, Mo.	M. P. R. R. No. 122.	271·1624
At Clarksburg, Mo.	No. XXXIV.	275·7952
At Tipton, Mo.	No. XXXV.	282·1182
At Fortuna, Mo.	No. 14.	295·7740
Near Versailles, Mo.	Versailles North Base △.	322·4010
Near Versailles, Mo.	Hunter △.	319·5750
Near Syracuse, Mo.	No. XXXVI.	281·7730
Near Otterville, Mo.	No. XXXVII.	223·5820
Near Otterville, Mo.	M. P. R. R. No. 143.	219·3372
Near Smithton, Mo.	No. XXXVIII.	269·3294
Near Sedalia, Mo.	M. P. R. R. No. 152.	276·6594
At Sedalia, Mo.	No. XXXIX.	277·4951
Near Sedalia, Mo.	No. XL.	226·3848
At Lamonte, Mo.	No. XLI.	264·5116
At Knobnoster, Mo.	No. XLII.	247·0182
Near Knobnoster, Mo.	M. P. R. R. No. 169.	226·9498
At Montserrat, Mo.	No. XLIII or M. P. R. R. No. 171.	243·5246
At Warrensburg, Mo.	No. XLIV or Normal △.	267·9202
At Warrensburg, Mo.	No. XLV.	269·7066
At Center View, Mo.	No. XLVI.	266·1330
At Holden, Mo.	No. XLVII.	260·4830
Near Holden, Mo.	No. XLVIII or M. P. R. R. No. 188.	244·5318
At Kingsville, Mo.	No. XLIX.	279·9586
Near Strasburg, Mo.	No. L.	255·5972
At Pleasant Hill, Mo.	No. LI.	261·3595
Near Pleasant Hill, Mo.	M. P. R. R. No. 201.	260·7815
Near Pleasant Hill, Mo.	No. LII.	260·1465
Near Greenwood, Mo.	M. P. R. R. No. 206.	280·3804
Near Greenwood, Mo.	No. LIII.	280·3740
At Lees Summit, Mo.	No. LIV.	315·8746
Near Little Blue, Mo.	No. LV.	240·2730
Near Independence, Mo.	No. LVI.	310·2235
At Independence, Mo.	No. LVII.	320·6735
At Independence, Mo.	Independence City Directrix.	320·1575
Near Big Blue River, Mo.	No. LVIII.	228·2075
At Kansas City, Mo.	Old M. R. C. B. M. 241.	228·2969
At Kansas City, Mo.	Old M. R. C. B. M. 243.	230·3480
At Kansas City, Mo.	Old M. R. C. B. M. 244.	230·1885
At Kansas City, Mo.	{ M. R. C. $\frac{73}{\text{T}}$ Top of Cap.	*228·8390
	Present M. R. C. $\frac{73}{\text{T}}$ = Top of Cap.	228·8370
At Kansas City, Mo.	Old M. R. C. B. M. 245.	227·5684
At Kansas City, Kans.	No. LIX.	228·4238
At Argentine, Kans.	No. LX.	229·3322
Near Holliday, Kans.	No. LXI.	231·9549
Near Holliday, Kans.	No. LXII.	233·1400

*This elevation has been destroyed.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Holliday, Kans.	No. LXIII.	233·1608
Near Cedar Junction, Kans.	A	238·5857
Near Desoto, Kans.	B	241·0752
At Desoto, Kans.	C	243·5161
Near Weaver, Kans.	D	243·9967
Near Eudora, Kans.	E	247·4336
At Lawrence, Kans.	F	252·1104
At Lawrence, Kans.	G	249·3932
Near Club House, Kans.	H	253·0341
Near Lecompton, Kans.	I	257·2949
Near Lecompton, Kans.	J	258·2280
Near Grover, Kans.	K	261·6625
Near Tecumseh, Kans.	L	264·2115
At Topeka, Kans.	M	271·0406
At Topeka, Kans.	N	269·4378
At Topeka, Kans.	B. M. Jennings.	283·3410
At Topeka, Kans.	O	284·6834
At Silver Lake, Kans.	P	279·1605
Near Rossville, Kans.	Q	283·6617
At St. Marys, Kans.	R	294·6601
Near Belvue, Kans.	S	293·3861
At Wamego, Kans.	T	302·4489
At St. George, Kans.	U	306·2302
At Manhattan, Kans.	V	307·1764
At Ogden, Kans.	W	323·0235
At Fort Riley, Kans.	X	326·5497
At Junction City, Kans.	Y	329·6983
Near Chapman, Kans.	Z	337·8513
At Chapman, Kans.	A_1	341·3668
At Abilene, Kans.	B_1	353·2044
At Solomon, Kans.	C_1	358·8322
At New Cambria, Kans.	D_1	366·1976
Near New Cambria, Kans.	E_1	365·8584
Near New Cambria, Kans.	Salina East Base △.	366·2594
At Salina, Kans.	Salina West Base △.	372·3386
At Salina, Kans.	F_1	373·7288
At Salina, Kans.	G_1	374·1183
At Salina, Kans.	H_1	374·1644
At Bavaria, Kans.	I_1	389·0070
At Brookville, Kans.	J_1	414·7758
Near Terra Cotta, Kans.	K_1	441·3760
At Kanopolis, Kans.	L_1	483·7004
At Ellsworth, Kans.	M_1	469·9628
At Ellsworth, Kans.	N_1	469·8623
At Ellsworth, Kans.	Water gauge B. M.	465·0116
At Wilson, Kans.	O_1	515·5468
At Wilson, Kans.	P_1	515·9092
At Dorrance, Kans.	Q_1	528·2967
At Bunker Hill, Kans.	R_1	569·2713
At Bunker Hill, Kans.	S_1 or Bunker Hill △.	570·4876
Near Homer, Kans.	T_1 or Russell Southeast Base △.	573·5462
At Russell, Kans.	U_1	559·1845
At Gorham, Kans.	V_1	584·7158
At Walker, Kans.	W_1	593·9401
At Victoria, Kans.	X_1	587·9918
At Hays, Kans.	Y_1	609·5017
At Ellis, Kans.	Z_1	647·7200
At Ellis, Kans.	A_2	646·8278
At Ellis, Kans.	B_2	646·7115

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Ogallah, Kans.	C_2	724·9714
At Wakeeney, Kans.	D_2	751·6519
At Collyer, Kans.	E_2	787·5280
At Quinter, Kans.	F_2	817·1628
At Buffalo Park, Kans.	G_2	838·8473
At Grainfield, Kans.	H_2	858·1995
At Grinnell, Kans.	I_2	887·7332
At Oakley, Kans.	J_2	930·7310
At Monument, Kans.	K_2	967·4734
Near Page City, Kans.	L_2	983·9986
At Winona, Kans.	M_2	1 013·8567
At McAllaster, Kans.	N_2	962·2226
At Turkey Creek, Kans.	O_2	985·3779
At Wallace, Kans.	P_2	1 010·5717
Near Wallace, Kans.	Q_2	1 018·3499
At Sharon Springs, Kans.	R_2	1 053·2943
At Monotony, Kans.	S_2	1 152·5078
At Weskan, Kans.	T_2	1 167·5946
Near Weskan, Kans.	U_2	1 181·7679
At Arapahoe, Colo.	A	1 223·6722
At Cheyenne Wells, Colo.	B	1 305·4218
At First View, Colo.	C	1 396·1564
At Kit Carson, Colo.	D	1 307·2244
Near Wildhorse, Colo.	E	1 352·1314
At Aroya, Colo.	F	1 391·1737
At Boyers, Colo.	G	1 445·2064
At Mirage, Colo.	H	1 484·6920
At Hugo, Colo.	I	1 538·1462
At Hugo, Colo.	J	1 538·5130
At Hugo, Colo.	K	1 538·5102
Near Lake, Colo.	L	1 596·7787
At Lake, Colo.	M	1 616·2836
At Limon, Colo.	N	1 632·3593
At Limon, Colo.	O	1 639·3583
At Limon, Colo.	P	1 639·3453
At Resolis, Colo.	Q	1 700·2829
At Mattison, Colo.	R	1 765·1164
At Ramah, Colo.	S	1 857·0221
At Calhan, Colo.	T	1 984·4322
At Peyton, Colo.	U	2 074·1514
At Falcon, Colo.	V	2 084·2869
At Falcon, Colo.	W	2 076·6945
At Elsmere, Colo.	X	1 957·3922
Near Roswell, Colo.	Y	1 864·3059
At Roswell, Colo.	Z	1 853·4973
At Colorado Springs, Colo.	A_1	1 825·3203
At Colorado Springs, Colo.	B_1	1 823·2444
At Colorado Springs, Colo.	City B. M.	1 822·9081
At Colorado Springs, Colo.	North Mast B. M.	1 823·559
At Colorado Springs, Colo.	South Mast B. M.	1 823·246
At Colorado Springs, Colo.	Nail B. M.	1 822·687
At Colorado Springs, Colo.	Reference B. M.	1 823·784
At Colorado Springs, Colo.	V. C. Post B. M.	1 822·291
Near Pike View, Colo.	C_1	1 895·0953
At Edgerton, Colo.	D_1	1 947·3805
Near Husted, Colo.	E_1	1 986·6425
At Husted, Colo.	F_1	2 007·3782
At Monument, Colo.	G_1	2 121·4152
At Palmer Lake, Colo.	H_1	2 202·4710

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Palmer Lake, Colo.	I_1	2 154·2827
At Greenland, Colo.	J_1	2 101·1211
At Larkspur, Colo.	K_1	2 035·7923
Near Douglas, Colo.	L_1	1 923·3452
At Castle Rock, Colo.	M_1	1 890·6622
At Plateau, Colo.	N_1	1 832·9014
At Sedalia, Colo.	O_1	1 780·1063
At Toluca, Colo.	P_1	1 711·0342
Near Acequia, Colo.	Q_1	1 677·6978
At Wolhurst, Colo.	R_1	1 647·7738
At Littleton, Colo.	S_1	1 634·5728
At Petersburg, Colo.	T_1	1 609·8562
At Denver, Colo.	U_1	1 608·9665
At Denver, Colo.	V_1	1 608·7190
At Denver, Colo.	W_1	1 609·0151
At Denver, Colo.	X_1	1 581·0764
At Denver, Colo.	Y_1	1 580·4582
At Denver, Colo.	Z_1	1 585·8847
At Jersey, Colo.	A_2	1 585·1643
At Jersey, Colo.	B_2	1 585·2003
At River Bend, Colo.	River Bend N_2.	1 675·4260
At Godfrey, Colo.	M_2	1 705·5078
At Agate, Colo.	L_2	1 664·6480
At Lowland, Colo.	K_2	1 621·5055
At Deer Trail, Colo.	J_2	1 580·2096
At Byers, Colo.	I_2	1 585·6555
At Bennett, Colo.	H_2	1 671·7897
At Watkins, Colo.	G_2	1 681·6196
Near Magnolia, Colo.	F_2	1 672·8416
Near Magnolia, Colo.	E_2	1 647·1980
At Magnolia, Colo.	D_2	1 626·8046
Near Denver, Colo.	C_2	1 609·1423
At Biloxi, Miss.	I_1 or P. B. M. 18.	6·7175
Near Biloxi, Miss.	H_1 or P. B. M. 19.	1·7849
Near Biloxi, Miss.	G_1 or P. B. M. 20.	2·1281
Near Biloxi, Miss.	F_1 or P. B. M. 21.	0·3270
Near Biloxi, Miss.	E_1	4·7915
At Ocean Springs, Miss.	D_1	7·5369
At Scranton, Miss.	C_1	5·1684
At Grand Bay, Ala.	B_1	32·5401
At St. Elmo, Ala.	A_1	40·4658
At Mobile, Ala.	A	3·7448
At Mobile, Ala.	Astronomical station.	4·6660
At Citronelle, Ala.	B	100·8201
Near Citronelle, Ala.	E_2	71·7500
At Deer Park, Ala.	F_2	46·9314
At Escatawpa, Ala.	G_2	53·6077
Near Escatawpa, Ala.	H_2	65·6536
Near Bucatunna, Miss.	I_2	80·7473
At Bucatunna, Miss.	J_2	46·1248
At Winchester, Miss.	K_2	51·2264
At Waynesboro, Miss.	L_2	58·8028
Near Waynesboro, Miss.	M_2	54·1352
At Shubuta, Miss.	N_2	61·3032
At De Soto, Miss.	O_2	63·3702
At Quitman, Miss.	D_2	70·0582
At Quitman, Miss.	C_2	70·8573

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Enterprise, Miss.	B_2	74·7534
At Meridian, Miss.	C	104·8579
At Meridian, Miss.	D	105·1434
At Scooba, Miss.	E	59·0065
Near Macon, Miss.	F	53·6476
At Macon, Miss.	No. 96.	55·0126
At Artesia, Miss.	G	71·4878
At West Point, Miss.	H	72·6146
At West Point, Miss.	I	74·1600
At Okolona, Miss.	L	93·3525
At Okolona, Miss.	K	94·9102
Near Shannon, Miss.	M	76·3210
At Shannon, Miss.	N	77·4095
At Verona, Miss.	O	96·4410
At Tupelo, Miss.	P	85·2500
At Saltillo, Miss.	Q	95·8332
At Guntown, Miss.	R	121·8175
At Baldwyn, Miss.	S	114·5974
At Booneville, Miss.	T	162·8357
At Rienzi, Miss.	U	139·0092
At Corinth, Miss.	V	137·7053
At Corinth, Miss.	W	137·7622
At Ramer, Tenn.	X	126·5167
At Falcon, Tenn.	Y	131·8103
At Bethel Springs, Tenn.	Z	142·7968
At McNairy, Tenn.	No. XXVII.	139·6008
At Henderson, Tenn.	No. XXVI.	131·5054
At Pinson, Tenn.	No. XXV.	118·0422
Near Jackson, Tenn.	No. XXIV.	107·7112
At Jackson, Tenn.	No. XXIII.	120·8052
At Jackson, Tenn.	No. XXII.	119·8284
At Oakfield, Tenn.	No. XXI.	135·0034
At Medina, Tenn.	No. XX.	153·9430
At Milan, Tenn.	No. XIX.	131·2510
At Milan, Tenn.	No. XVIII.	129·4530
At Bradford, Tenn.	No. XVII.	112·1496
At Greenfield, Tenn.	No. XV.	133·4070
At Sharon, Tenn.	No. XIV.	127·3555
At Martin, Tenn.	No. XIII.	127·2976
At McConnell, Tenn.	No. XII.	108·8480
At Fulton, Ky.	No. XI.	109·8422
At Alexander, Ky.	No. X.	112·9036
At Clinton, Ky.	No. IX.	119·2412
At Arlington, Ky.	No. VIII.	111·3852
At Bardwell, Ky.	No. VII.	119·6852
Near Bardwell, Ky.	No. VI.	97·3662
At Fort Jefferson, Ky.	No. V.	98·6150
At Wickliffe, Ky.	No. IV.	101·9285
At East Cairo, Ky.	No. III.	98·9946
At Cairo, Ill.	P. B. M. 3.	99·6766
At Cairo, Ill.	P. B. M. 2.	97·2658
At Cairo, Ill.	P. B. M. 1.	96·8627
Near Mound City Junction, Ill.	No. II.	99·6603
At Mound City Junction, Ill.	No. I.	98·1017
At Villa Ridge, Ill.	Z_3	117·5486
At Villa Ridge, Ill.	Y_3	115·8686
Near Villa Ridge, Ill.	No. XII_a.	104·5163
Near Ullin, Ill.	No. 139.	102·3131
Near Ullin, Ill.	X_3	102·8019

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Anna, Ill.	W_3	191·7396
Near Makanda, Ill.	V_3	131·3622
At Carbondale, Ill.	T_3	126·5559
Near De Soto, Ill.	U_3	117·4116
At Duquoin, Ill.	R_3	140·8008
Near Radom, Ill.	S_3	152·1577
Near Ashley, Ill.	Q_3	170·1191
Near Richview, Ill.	P_3	165·6731
At Centralia, Ill.	N_3	150·5435
Near Centralia, Ill.	O_3	143·4346
At Odin, Ill.	M_3	160·9678
At Beauvoir, Miss.	J_1 or P. B. M. 17.	7·8491
At Mississippi City, Miss.	K_1 or P. B. M. 16.	6·3596
Near Mississippi City, Miss.	L_1 or P. B. M. 15.	7·6876
Near Pass Christian, Miss.	M_1 or P. B. M. 14.	9·3822
At Pass Christian, Miss.	N_1 or P. B. M. 13.	3·3527
At Hendersons Point, Miss.	O_1 or P. B. M. 12.	2·9558
At Bay St. Louis, Miss.	P_1 or P. B. M. 11.	6·4790
At Bay St. Louis, Miss.	Q_1 or P. B. M. 10.	7·1300
At Waveland, Miss.	R_1 or P. B. M. 9.	4·6773
At Toulmé, Miss.	S_1 or P. B. M. 8.	2·9111
Near Claiborne, Miss.	T_1 or P. B. M. 7.	1·2194
Near East Pearl River, Miss.	U_1 or P. B. M. 6.	3·1815
Near East Pearl River, Miss.	V_1 or P. B. M. 5.	0·5675
At Chef Menteur, La.	W_1 or P. B. M. 4.	2·1592
At New Orleans, La.	X_1 or P. B. M. 3.	1·2910
At New Orleans, La.	Y_1 or P. B. M. 2.	2·7757
Near New Orleans, La.	Z_1 or P. B. M. 1.	0·5566
At Carrollton, La.	P. B. M. Carrollton.	2·7642
At Carrollton, La.	No. I.	2·6436
At Carrollton, La.	Old Hampson (Williams).	2·4456
At Carrollton, La.	New Hampson (Howell).	2·2715
Near Carrollton, La.	No. II.	5·5715
At Kennerville, La.	No. III.	3·3167
Near Kennerville, La.	No. IV.	5·3274
On Destréhan Plantation, La.	No. V.	4·7615
Near Hahnville, La.	No. VI.	4·1901
Near Bonnet Carré, La.	No. VII.	4·8350
Near Bonnet Carré, La.	No. VIII.	4·9100
At Bonnet Carré, La.	No. IX.	6·6780
On Mount Airy Plantation, La.	No. X.	5·5168
On Belle Alliance Plantation, La.	No. XI.	7·0441
On Bellmont Plantation, La.	No. XII.	5·8687
Near St. Michaeltown, La.	No. XIII.	7·9316
At St. James Parish, La.	No. XIV.	7·3460
At St. James Parish, La.	No. XV.	7·1524
Near Donaldsonville, La.	No. XVI.	7·5842
Near Donaldsonville, La.	No. XVII.	6·5956
Near Donaldsonville, La.	No. XVIII.	6·0977
At Ashland Landing, La.	No. XIX.	9·4972
On Southwood Plantation, La.	No. XX.	7·2136
On Indian Camp Plantation, La.	No. XXI.	8·1357
Near Bayou Goula, La.	No. XXII.	7·9905
At St. Gabriel, La.	No. XXIII.	7·0558
At Forlorn Hope P. O., La.	No. XXIV.	7·9683
Near Plaquemine, La.	No. XXV.	8·5157
Near Manchac P. O., La.	No. XXVI.	9·0792
Near Baton Rouge, La.	No. XXVII.	9·4230

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Baton Rouge, La.	No. XXVIII.	9·2666
Near Baton Rouge, La.	No. XXIX.	8·4828
Near Baton Rouge, La.	No. XXX.	8·6401
At Baton Rouge, La.	No. XXXI.	18·9316
Near Baton Rouge, La.	No. XXXII.	8·5859
On Belmont Plantation, La.	No. XXXIII.	9·2800
Near Grossmans Landing, La.	No. XXXIV.	9·5394
Near Profit Island, La.	No. XXXV.	10·4464
Near Hermitage Landing, La.	No. XXXVI.	11·4080
At Waterloo, La.	No. XXXVII.	13·6474
At Pointe Coupée Parish, La.	No. XXXVIII.	11·9337
At Pointe Coupée Parish, La.	No. XXXIX.	11·8015
At Pointe Coupée Settlement, La.	No. XL.	11·2874
On Morrison Plantation, La.	No. XLI.	12·2148
At Morganzia, La.	No. XLII.	14·2668
At Raccourci Landing, La.	No. XLIII.	11·7732
On Bella Vista Plantation, La.	No. XLIV.	13·7140
Near Smithland P. O., La.	No. XLV.	14·7917
On Angola Plantation, La.	No. XLVI.	16·3714
On Tarbert Plantation, Miss.	No. XLVII.	15·1114
At Clarksville Landing, Miss.	No. XLVIII.	23·9972
At Fort Adams, Miss.	No. XLIX.	20·8319
At Lums Point, La.	No. L.	16·1574
At Lums Point, La.	No. LI.	16·1978
On Ballamagan Plantation, La.	No. LII.	17·1934
At Black Hawk P. O., La.	No. LIII.	15·9303
Near Bougére P. O., La.	No. LIV.	17·3612
Near Fairview P. O., La.	No. LV.	17·1147
Near Fairview P. O., La.	No. LVI.	18·8655
On Deer Park Plantation, La.	No. LVII.	18·0296
On Ashley Plantation, La.	No. LVIII.	16·4862
On Moro Plantation, La.	No. LIX.	19·2324
On Moro Plantation, La.	No. LX.	19·5468
Near Vidalia, La.	No. LXI.	18·7353
At Vidalia, La.	No. LXII.	19·2866
At Vidalia, La.	No. LXIII.	18·6201
At Palo Alto, La.	No. LXIV.	19·7233
Near Vidalia, La.	No. LXV.	20·8046
On Bullits Bayou Plantation, La.	No. LXVI.	19·6226
At Gibsons Landing, La.	No. LXVII.	20·1069
Near L'Argent Landing, La.	No. LXVIII.	21·1172
Near L'Argent, La.	No. LXIX.	21·8288
Near Waterproof, La.	No. LXX.	20·6664
At Waterproof, La.	No. LXXI.	20·4835
At Kemps Landing, La.	No. LXXII.	22·0894
On Villa Clara Plantation, La.	No. LXXIII or No. 297.	21·6324
On Duck Pond Plantation, La.	No. 291.	23·1756
On Panola Plantation, La.	No. 286.	24·8997
On Waveland Plantation, La.	No. 280.	23·8413
On Hard Times Plantation, La.	No. 272.	24·1078
On Riverside Plantation, La.	No. 262.	25·3978
On Point Pleasant Plantation, La.	No. 258.	26·7550
On Sargents Point Plantation, La.	No. 246.	26·1196
At Kelloggs Landing, La.	No. 243.	26·9037
On Crystal Springs Plantation, La.	No. 232.	26·7062
On Point Place Plantation, La.	No. 225.	27.7068
At Delta, La.	No. 215.	27.8699
Near Delta, La.	No. 211.	27.7556

*This elevation is from the Engineer line of 1894.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
On Elcho Plantation, La.	No. 207.	29·7686
On Duck Port Plantation, La.	No. 197.	29·6275
On Cabin Teele Plantation, La.	No. 188.	30·0660
On River View Plantation, La.	No. 184.	28·7717
Near Millikens Bend, La.	No. 179.	29·7225
Near Omega, La.	No. 171.	29·4285
Near Hendersons Landing, La.	No. 162.	31·0347
Near Hendersons Landing, La.	No. 161.	30·2268
Near Ingomar, Miss.	No. 153.	31·8264
Near Ingomar, Miss.	No. 150.	32·1609
On Shiloh Plantation, Miss.	No. 140.	33·8153
Near Hays Post-Office, Miss.	No. 137.	32·2913
Near Tallulah Landing, Miss.	No. 128.	32·4074
Near Tallulah Landing, Miss.	No. 124.	31·8127
On Ben Lomond Plantation, Miss.	No. 112.	33·2751
On Reserve Plantation, Miss.	No. 105.	33·0662
Near Mayersville, Miss.	No. 95.	34·1315
Near Mayersville, Miss.	No. 90.	33·8490
On Riverdale Plantation, Miss.	No. 83.	34·5128
On Palmetto Plantation, Miss.	No. 70.	34·7724
Near Leota, Miss.	No. 65.	36.7541
Near Leota, Miss.	No. 62.	36·5990
Near Lake Washington Landing, Miss.	No. 56.	35·9449
On Longwood Plantation, Miss.	No. 46.	36·5525
On Glenora Plantation, Miss.	No. 42.	36·6564
On Auburn Plantation, Miss.	No. 39.	36·1766
Near Lake See, Miss.	No. 33.	37·0435
At Refuge, Miss.	No. 22.	39·6137
On Refuge Plantation, Miss.	No. 19.	39·8710
At Warfield Point, Miss.	No. 11.	39·4360
Near Warfield Point, Miss.	No. 8.	39·8940
Near Greenville, Miss.	No. 5.	39·1804
Near Greenville, Miss.	No. 2.	40·4569
At Greenville, Miss.	Greenville No. 1.	39·9630
At Wilkersons Landing, Miss.	P. B. M. No. 84.	42·2704
At Arkansas City, Ark.	F	42·2140
At McGehee, Ark.	G	*45·6004
At Tillar, Ark.	H	46·5498
At Walnut Lake, Ark.	I	49·8212
At Varner, Ark.	J	54·5607
At Noble Lake, Ark.	K	61·6772
At Pine Bluff, Ark.	N	68·3362
At Pine Bluff, Ark.	L	71·3610
Near Pine Bluff, Ark.	E	103·6409
At Redfield, Ark.	D	93·7274
At Wrightsville, Ark.	C	78·5742
Near Wrightsville, Ark.	No. II.	81·1298
At Little Rock, Ark.	No. I or 3.	80·3434
At Little Rock, Ark.	A	91·0772
At Little Rock, Ark.	B	90·6744
At Little Rock, Ark.	O	87·7888
At Argenta, Ark.	West Base.	78·0343
Near Little Rock, Ark.	No. I.	96·1473
At Marche, Ark.	No. II.	81·8391
At Palarm, Ark.	No. III.	82·2060
At May Flower, Ark.	No. IV.	87·4752

* This elevation is from the Engineer line between Wilkersons Landing and Parkeville in 1897. The description of the bench made at that time indicates that the bench mark had been disturbed.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Preston, Ark.	No. V.	83·9797
At Conway, Ark.	No. VI.	97·5940
Near Conway, Ark.	No. VII.	100·6748
Near Menifee, Ark.	No. VIII.	86·3914
At Menifee, Ark.	No. IX.	87·1604
At Plumerville, Ark.	No. X.	89·0983
At Morrillton, Ark.	No. XI.	118·2678
At Germantown, Ark.	No. XII.	93·4687
At Blackville, Ark.	No. XIII.	99·2518
At Atkins, Ark.	No. XIV.	108·5435
At Galla Creek, Ark.	No. XV.	113·2241
At Russellville, Ark.	No. XVI.	106·8207
At Onita, Ark.	No. XVII.	108·5180
Near Onita, Ark.	No. XVIII.	99·9061
Near Mill Creek, Ark.	No. XIX.	99·3221
At London, Ark.	No. XX.	115·8373
Near Berlin P. O., Ark.	No. XXI.	103·1061
At Knoxville, Ark.	No. XXII.	120·5760
At Lamar P. O., Ark.	No. XXIII.	125·2506
Near Clarksville, Ark.	No. XXIV.	114·6015
At Clarksville, Ark.	No. XXV.	112·6663
At Clarksville, Ark.	No. XXVI.	112·2853
At Spadra, Ark.	No. XXVII.	115·2090
At Hartman, Ark.	No. XXVIII.	123·9024
At Coal Hill, Ark.	No. XXIX.	144·6088
At Altus, Ark.	No. XXX.	165·4642
At Ozark, Ark.	No. XXXI.	121·9687
At Poepping, Ark.	No. XXXII.	116·8379
At White Oak, Ark.	No. XXXIII.	120·8941
Near Mulberry, Ark.	No. XXXIV.	117·3226
At Dyer, Ark.	No. XXXV.	130·9034
At Alma, Ark.	No. XXXVI.	132·6968
At Van Buren, Ark.	No. XXXVII.	125·3294
At Van Buren, Ark.	No. XXXVIII.	126·3864
At Van Buren, Ark.	No. XXXIX.	126·3792
At Van Buren, Ark.	No. XL.	126·3358
At Fort Smith, Ark.	No. XLI.	136·5355
At Fort Smith, Ark.	No. XLII.	130·7441
Near Lillie, Ark.	No. XLIII.	141·1090
Near Rudy, Ark.	No. XLIV.	163·5932
Near Lancaster, Ark.	No. XLV.	185·4493
Near Mountainburg, Ark.	No. XLVI.	211·6396
Near Chester, Ark.	No. XLVII.	249·8184
At Chester, Ark.	No. XLVIII.	257·5874
At Chester, Ark.	No. XLIX.	256·4516
At Porter, Ark.	No. CXXVIII.	331·0113
Near Winslow, Ark.	No. CXXVII.	572·0158
Near Winslow, Ark.	No. CXXVI.	531·2791
At Brentwood, Ark.	No. CXXV.	454·3710
Near Woolseys, Ark.	No. CXXIV.	419·6482
At West Fork, Ark.	No. CXXIII.	411·9055
At Greenland, Ark.	No. CXXII.	380·7386
At Fayetteville, Ark.	No. CXXI.	443·2040
At Johnson, Ark.	No. CXX.	364·0888
At Springdale, Ark.	No. CXIX.	405·2370
At Lowell, Ark.	No. CXVIII.	409·5150
At Rogers, Ark.	No. CXVII.	421·5976
At Avoca, Ark.	No. CXVI.	415·1183
At Brightwater, Ark.	No. CXV.	386·0272

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Garfield, Ark.	No. CXIV.	463·6531
At Seligman, Mo.	No. CXIII.	470·2344
At Washburn, Mo.	No. CXII.	449·5458
At Exeter, Mo.	No. CXI.	475·7756
At Purdy, Mo.	No. CX.	453·1247
At Monett, Mo.	No. CIX.	396·9920
At Pierce City, Mo.	No. CVII.	366·5475
At Wentworth, Mo.	No. CVI.	373·6666
At Sarcoxie, Mo.	No. CV.	332·1108
At Reeds, Mo.	No. CIV.	343·8010
At Carthage, Mo.	No. CIII.	287·1312
Near Carthage, Mo.	No. CII.	288·6504
Near Carthage, Mo.	No. CI.	294·3936
Near Carthage, Mo.	No. C.	280·8501
At Jasper, Mo.	No. XCIX.	289·2486
At Boston, Mo.	No. XCVIII.	287·8488
Near Boston, Mo.	No. XCVII.	283.8990
Near Boston, Mo.	No. XCVI.	283·8982
At Lamar, Mo.	No. XCV.	298·7850
Near Lamar, Mo.	No. XCIV.	288·3732
At Irwin, Mo.	No. XCIII.	296·9731
At Sheldon, Mo.	No. XCII.	281·9502
At Milo, Mo.	No. XCI.	268·1311
At Nevada, Mo.	No. XC.	262·9286
Near Horton, Mo.	No. LXXXIX.	228·2045
At Horton, Mo.	No. LXXXVIII.	236·7606
Near Arthur, Mo.	No. LXXXVII.	228·8897
At Rich Hill, Mo.	No. LXXXVI.	245·7114
At Rich Hill, Mo.	No. LXXXV.	245·7053
Near Rich Hill, Mo.	No. LXXXIV.	231·8437
Near Butler, Mo.	No. LXXXIII.	231·6782
At Butler, Mo.	No. LXXXII.	264·0548
At Passaic, Mo.	No. LXXXI.	263·9289
At Adrian, Mo.	No. LXXX.	264·7049
Near Archie, Mo.	No. LXXIX.	243·0990
At Archie, Mo.	No. LXXVIII.	255·3807
Near Archie, Mo.	No. LXXVII.	243·8497
At Lone Tree, Mo.	No. LXXVI.	268·1964
At Harrisonville, Mo.	No. LXXV.	275·6322
At Harrisonville, Mo.	No. LXXIV.	280·2494
Near Harrisonville, Mo.	No. 43.*	309·6687
Near Pleasant Hill, Mo.	Big Creek.	260·3705
At Kimpton, Mo.	No. LXXIII.	309·1854
At Coleman, Mo.	No. LXXII.	310·4634
At Raymore, Mo.	No. LXXI.	337·0410
At Belton, Mo.	No. LXX.	337·4921
Near Newington, Kans.	No. LXIX.	265·4658
At Morse, Kans.	No. LXVIII.	333·7206
At Olathe, Kans.	No. LXVII.	315·8168
At Olathe, Kans.	No. LXVI.	315·9403
At Olathe, Kans.	No. LXV.	Destroyed.
Near Holliday, Kans.	No. LXIV.	237·9782
At Washington, D. C.	Navy-Yard B. M. C.	2·9360
At Washington, D. C.	Capitol B. M.	27·7000
At Washington, D. C.	Monument B. M.	12·3840
At Washington, D. C.	National Museum B. M.	9·1180
At Georgetown, D. C.	No. XI.	9·6960

* No description is furnished for No. 43, as it was only a temporary bench mark, but its elevation is necessary as a junction point.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Great Falls, Md.	F	50·8210
At Seneca, Md.	E	60·5094
At Whites Ferry, Md.	No. V.	63·2020
At Point of Rocks, Md.	D	68·3376
At Weverton, Md.	C	76·8385
Near Keedysville, Md.	B	119·3663
At Richmond, Va.	O	58·1957
At Laurel, Va.	N_1	66·8683
At Ashland, Va.	N	67·4189
Near Doswell, Va.	M	44·6818
At Rutherglen, Va.	K_3	62·5340
At Penola, Va.	K_2	29·7263
At Milford, Va.	K_1	31·2033
Near Guinea, Va.	I_2	38·6937
Near Summit, Va.	I_1	60·8422
At Fredericksburg, Va.	I	21·0747
At Fredericksburg, Va.	H	13·1526
Near Potomac Run, Va.	G_8	25·9322
At Brooke, Va.	G_7	17·9859
Near Widewater, Va.	G_6	2·2768
At Quantico, Va.	G_5	10·7671
Near Woodbridge, Va.	G_4	20·9897
At Pohick Creek, Va.	G_3	19·4920
Near Accotink, Va.	G_2	25·0703
At Cameron Run, Va.	G_1	15·7270
At Alexandria, Va.	G	14·2896
At Old Point Comfort light-house, Va.	Old Tidal B. M.	2·9352
At Old Point Comfort light-house, Va.	U	2·6875
At Fort Monroe, Va.	Fort B. M.	3·3678
At Newport News, Va.	S	6·8144
At Morrison, Va.	R_3	9·8730
At Lee Hall, Va.	R_2	19·4833
At Williamsburg, Va.	R	27·0919
At Toano, Va.	Q_4	30·8285
At Diascond, Va.	Q_3	13·5427
Near Lanexa, Va.	Q_2	2·3397
At Providence Forge, Va.	Q	9·7976
At Roxbury, Va.	P_5	13·0545
Near Richmond, Va.	P_4	34·2610
At Richmond, Va.	P_3	5·9818
At Richmond, Va.	P_2	6·7256
At Richmond, Va.	New City Hall B. M.	50·0431
At Richmond, Va.	P	62·7532
At Richmond, Va.	City B. M.	7·7678
At St. Augustine, Fla.	B. M. Fairfield.	2·2115
At St. Augustine, Fla.	B. M. Hitchcock.	0·3983
At St. Augustine, Fla.	Tidal Bench Mark.	0·2659
At St. Augustine, Fla.	A	2·1475
At St. Augustine, Fla.	B	2·0388
At St. Augustine, Fla.	C	2·4067
At St. Augustine, Fla.	D	2·4035
At Tocoi Junction, Fla.	E	10·8458
At Middleton, Fla.	F	10·5431
At Hastings, Fla.	G	2·2941
At Buena Vista, Fla.	H	4·4872

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At East Palatka, Fla.	I	5·1346
At Palatka, Fla.	J	3·8728
At Francis, Fla.	B. M. Francis.	21·1522
At Hollister, Fla.	K	24·4657
At Interlachen, Fla.	L	32·1355
At McMeekin, Fla.	M	36·6462
At Hawthorn, Fla.	N	44·2419
At Hawthorn, Fla.	O	44·7570
At Grove Park, Fla.	P	30·6452
At Rochelle, Fla.	Q	25·3489
At Gainesville, Fla.	R	53·9473
At Gainesville, Fla.	S	54·0136
At Gainesville, Fla.	T	54·4760
At Arredonda, Fla.	U	27·0717
At Palmer, Fla.	V	23·2710
At Archer, Fla.	B. M. Archer.	25·9293
At Albion, Fla.	B. M. Albion.	26·9986
At Bronson, Fla.	W	21·9725
At Otter Creek, Fla.	B. M. Otter Creek.	9·8707
At Ellzey, Fla.	X	7·7666
At Rosewood, Fla.	B. M. Rosewood.	4·4408
At Cedar Keys, Fla.	Tidal Bench Mark.	0·9299
At Cedar Keys, Fla.	B. M. Perkins.	3·5713
At Cedar Keys, Fla.	Y	4·0021
At Cedar Keys, Fla.	Z	4·0540
At Cedar Keys, Fla.	B. M. Transit.	3·8859
At Delta, La.	S.W. Base.	26·6242
At Delta, La.	N.E. Base.	27·8579
Near Vicksburg, Miss.	B	29·9596
At Kleinston, Miss.	M. R. C. Stone Line $\frac{107}{1}$.	26·8094
At Kleinston, Miss.	A	28·5796
At Vicksburg, Miss.	B. M. Cistern.	58·9550
At Vicksburg, Miss.	C	62·7048
At Vicksburg, Miss.	D	60·2066
Near Vicksburg, Miss.	E	75·8969
Near Vicksburg, Miss.	F	80·0639
At Newmans, Miss.	G	100·8228
At Bovina, Miss.	H	75·2720
Near Bovina, Miss.	I	46·4213
Near Bovina, Miss.	J	32·0852
At Smiths, Miss.	K	40·9832
At Edwards, Miss.	L	68·8320
Near Edwards, Miss.	M	52·6666
Near Bolton, Miss.	N	62·1473
Near Clinton, Miss.	O	101·1984
At Jackson, Miss.	P	90·6538
At Jackson, Miss.	Q	83·9407
Near Pearsons, Miss.	R	85·4832
At Greenfield, Miss.	S	94·7886
At Brandon, Miss.	T	120·9508
At Rankin, Miss.	U	128·7895
At Pelahatchie, Miss.	W	109·3494
Near Clarksburg, Miss.	X	113·2600
At Morton, Miss.	Y	138·5241
At Forest, Miss.	Z	146·6556
At Lake, Miss.	A_1	137·6660
At Newton, Miss.	B_1	129·3532
At Hickory, Miss.	C_1	99·3660
At Chunkey, Miss.	D_1	95·0476

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Chunkey, Miss.	E_1	90·8255
At Graham, Miss.	F_1	94·3442
Near Meridian, Miss.	G_1	118·6805
At Chewalla, Tenn.	L	126·0227
At Cypress Creek, Tenn.	M	117·2659
At Pocahontas, Tenn.	N	122·1504
At Middleton, Tenn.	O	125·3124
At Saulsbury, Tenn.	P	165·5514
At Grand Junction, Tenn.	R	177·4472
At La Grange, Tenn.	I	162·6433
At La Grange, Tenn.	K	162·6754
At Moscow, Tenn.	H	107·9067
At Wolf River, Tenn.	G	103·0489
At Rossville, Tenn.	F	94·4991
At Collierville, Tenn.	E	117·9014
At Bailey, Tenn.	D	108·9642
At Germantown, Tenn.	C	115·5860
At White, Tenn.	B	95·8536
At Buntyn, Tenn.	A	91·6368
At Memphis, Tenn.	P. B. M. Memphis.	80·5465
At Annapolis, Md.	a	1·2680
At Annapolis, Md.	Wood's.	1·1100
At Annapolis, Md.	b	1·1510
At Annapolis, Md.	5 S. R.	2·8680
At Annapolis, Md.	1 S. R.	5·2710
At Annapolis, Md.	Obs.	7·0140
At Annapolis, Md.	Hern.	8·8990
At Annapolis, Md.	Taylor.	28·9660
At Annapolis, Md.	No. XIII.	12·6132
At Annapolis, Md.	No. XII.	13·0627
At Bowie, Md.	No. VII.	45·3247
At Wilson, Md.	No. IV.	17·9660
Near Washington, D. C.	Hill.	84·1160
At Washington, D. C.	No. II.	2·3883
At Washington, D. C.	No. I or 5.	11·9779
At Washington, D. C.	New C. S. Office.	23·8055
Near Denver, Colo.	N_2	1 565·1693
Near Hazeltine, Colo.	O_2	1 552·8044
Near Henderson, Colo.	P_2	1 535·4206
Near Brighton, Colo.	Q_2	1 526·8684
At Brighton, Colo.	R_2	1 514·6495
Near Lupton, Colo.	S_2	1 505·5071
At Lupton, Colo.	T_2	1 495·7461
Near Lupton, Colo.	U_2	1 485·0625
Near Platteville, Colo.	V_2	1 475·2911
Near Platteville, Colo.	W_2	1 469·8085
Near Platteville, Colo.	X_2	1 462·4886
Near Nantes, Colo.	Y_2	1 440·8634
Near La Salle, Colo.	Z_2	1 418·3050
At Greeley, Colo.	A_3	1 418·6006
At Lucerne, Colo.	B_3	1 447·3489
At Eaton, Colo.	C_3	1 473·5593
At Pierce, Colo.	D_3	1 535·1143
At Dover, Colo.	E_3	1 648·7330
At Carr, Colo.	F_3	1 738·9354
At Athol, Wyo.	A	1 921·2766
At Cheyenne, Wyo.	B	1 847·7840

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Cheyenne, Wyo.	C	1 847·5950
At Cheyenne, Wyo.	D	1 847·5572
At Cheyenne, Wyo.	E	1 859·1694
At Borie, Wyo.	F	2 014·4972
At Otto, Wyo.	G	2 120·1554
At Granite Canyon, Wyo.	H	2 229·6509
At Sherman, Wyo.	I	2 515·2999
At Sherman, Wyo.	J	2 524·9048
At Dale Creek, Wyo.	K	2 440·0102
At Dale Creek, Wyo.	L	2 439·0992
At Red Buttes, Wyo.	M	2 225·9898
At Laramie, Wyo.	N	2 184·0093
At Laramie, Wyo.	O	2 173·8038
At Howell, Wyo.	P	2 164·9818
At Wyoming, Wyo.	Q	2 157·5414
At Coopers Lake, Wyo.	R	2 146·9648
At Lookout, Wyo.	S	2 186·1456
At Harper, Wyo.	T	2 136·4336
Near Rock Creek, Wyo.	U	2 043·5448
At Rock Creek, Wyo.	V	2 043·3524
At Rock Creek, Wyo.	W	2 043·4167
At Solomon, Kans.	W_2	356·3944
At Solomon, Kans.	X_2	357·7914
At Abilene, Kans.	Z_2	353·2450
At Abilene, Kans.	Y_2	350·9315
At Talmage, Kans.	A_3	369·6597
At Manchester, Kans.	B_3	395·0992
At Longford, Kans.	C_3	401·1991
At Oak Hill, Kans.	D_3	387·3006
At Catlin, Kans.	E_3	405·2147
At Miltonvale, Kans.	F_3	419·9678
At Sulphur Springs, Kans.	G_3	480·0677
At Aurora, Kans.	H_3	452·0655
At Huscher, Kans.	I_3	447·2180
At Concordia, Kans.	J_3	422·8504
At Concordia, Kans.	Concordia City B. M.	419·7784
At Concordia, Kans.	K_3	417·3654
At Hannum, Kans.	L_3	415·9403
At Oneonta, Kans.	M_3	426·2716
At Kackley, Kans.	N_3	461·8395
At Courtland, Kans.	O_3	457·8890
At Lovewell, Kans.	P_3	471·4590
At Webber, Kans.	Q_3	508·8169
Near Superior, Nebr.	R_3	473·0216
At Superior, Nebr.	B	480·1279
Near Superior, Nebr.	Superior No. 2.	476·9460
At Bostwick, Nebr.	C	489·2951
At Guide Rock, Nebr.	D	507·8151
At Amboy, Nebr.	E	515·8370
At Cowles, Nebr.	F	546·8741
Near Blue Hill, Nebr.	G	594·3587
At Blue Hill, Nebr.	H	601·3644
Near Blue Hill, Nebr.	Blue Hill $\triangle$.	622·4977
At Ayr, Nebr.	I	560·6131
At Brickton, Nebr.	J	558·0916
At Hastings, Nebr.	K	588·9725
At Hastings, Nebr.	Bank.	589·0797
At Hastings, Nebr.	Tower.	589·4221
At Hansen, Nebr.	L	592·4556

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Doniphan, Nebr.	M	593·2315
At Rivers, Nebr.	N	571·5019
Near Grand Island, Nebr.	O	572·6306
At Grand Island, Nebr.	P	568·6606
At Grand Island, Nebr.	Q	566·1902
Near Grand Island, Nebr.	R	579·9919
Near Alda, Nebr.	S	591·3160
At Wood River, Nebr.	T	599·5768
At Shelton, Nebr.	Shelton East Base △.	616·1120
At Lockwood, Nebr.	U	550·2700
At Chapman, Nebr.	V	540·1279
At Paddock, Nebr.	W	525·2301
At Central City, Nebr.	X	519·1550
At Thummel, Nebr.	Y	505·9650
At Clarks, Nebr.	Z	495·9981
At Havens, Nebr.	A_1	483·3928
At Silver Creek, Nebr.	B_1	472·1583
At Duncan, Nebr.	C_1	455·3829
Near Columbus, Nebr.	Columbus No. 2.	443·6372
Near Columbus, Nebr.	Columbus No. 3.	440·2711
At Columbus, Nebr.	D_1	441·3979
At Columbus, Nebr.	E_1	441·8351
Near Columbus, Nebr.	F_1	446·5474
At Oconee, Nebr.	G_1	455·5442
At Platte Center, Nebr.	H_1	469·1247
At Tarnov, Nebr.	I_1	495·6492
At Humphrey, Nebr.	J_1	516·5317
Near Madison, Nebr.	K_1	495·2459
At Madison, Nebr.	L_1	485·1791
Near Madison, Nebr.	M_1	517·7665
Near Norfolk, Nebr.	N_1	464·3781
At Norfolk, Nebr.	O_1	465·5346
At Norfolk, Nebr.	P_1	464·7704
Near Norfolk, Nebr.	Norfolk No. 3.	462·4421
At Gibraltar, Mich.	Gibraltar 1877.	177·4324
At Gibraltar, Mich.	2 of 1875.	178·1995
At Gibraltar, Mich.	U. S. P. B. M. 1.	178·9812
At South Rockwood, Mich.	A	178·8971
At Newport, Mich.	B	176·7821
At Monroe, Mich.	C	176·9844
At Monroe, Mich.	D	179·9426
Near La Salle, Mich.	E	177·3672
At Vienna, Mich.	F	179·3494
At Alexis, Ohio.	U	178·3291
At Toledo, Ohio.	Toledo City No. 165.	181·6624
At Toledo, Ohio.	Park △.	183·0948
At Toledo, Ohio.	V	179·4366
At Toledo, Ohio.	Power House.	177·4818
At Toledo, Ohio.	W	183·9387
At Toledo, Ohio.	Post Office.	183·5342
At Toledo, Ohio.	Toledo City No. 44.	181·6475
At Toledo, Ohio.	Toledo City No. 296.	179·8130
Near Perrysburg, Ohio.	X	183·7070
At Perrysburg, Ohio.	Y	187·5370
At Roachton, Ohio.	Z	197·2593
At Hull Prairie, Ohio.	A_1	201·1967
At Haskins, Ohio.	B_1	203·3878
At Tontogany, Ohio.	C_1	203·9382
At Weston, Ohio.	D_1	208·2355

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Weston, Ohio.	E_1	207·9595
At Weston, Ohio.	Weston Village B. M.	207·7533
At Milton Center, Ohio.	F_1	210·1290
At Custar, Ohio.	G_1	212·2053
At Deshler, Ohio.	H_1	217·4103
At Deshler, Ohio.	I_1	217·2347
At Belmore, Ohio.	J_1	224·4156
At Leipsic, Ohio.	K_1	233·3348
At Leipsic, Ohio.	L_1	232·6456
Near Ottawa, Ohio.	M_1	226·5467
At Ottawa, Ohio.	N_1	222·1703
Near Columbus Grove, Ohio.	O_1	227·3833
At Columbus Grove, Ohio.	P_1	234·8662
At Columbus Grove, Ohio.	Q_1	236·3674
Near Monroe, Ohio.	R_1	240·7915
At West Cairo, Ohio.	S_1	248·1622
Near Lima, Ohio.	T_1	254·7995
At Lima, Ohio.	U_1	267·8069
At Lima, Ohio.	V_1	267·3126
At Lima, Ohio.	Lima City B. M.	265·8666
Near Cridersville, Ohio.	W_1	264·7188
At Cridersville, Ohio.	X_1	271·8655
Near Wapakoneta, Ohio.	Y_1	269·9507
At Wapakoneta, Ohio.	Z_1	273·7331
Near Wapakoneta, Ohio.	A_2	279·0337
At Botkins, Ohio.	B_2	306·1831
At Anna, Ohio.	C_2	313·9253
At Swanders, Ohio.	D_2	308·7004
Near Swanders, Ohio.	E_2	306·5015
At Sidney, Ohio.	F_2	304·8942
At Sidney, Ohio.	Sidney City B. M.	291·5741
At Sidney, Ohio.	G_2	293·2853
Near Sidney, Ohio.	H_2	293·0296
At Kirkwood, Ohio.	I_2	300·4223
Near Piqua, Ohio.	J_2	284·6229
At Piqua, Ohio.	K_2	273·8601
At Piqua, Ohio.	Penn. R. R. B. M.	263·6429
At Piqua, Ohio.	L_2	267·1289
At Farrington, Ohio.	M_2	260·5288
Near Troy, Ohio.	N_2	257·2696
At Troy, Ohio.	O_2	254·5016
At Troy, Ohio.	P_2	256·2110
At Troy, Ohio.	Troy City B. M.	255·1860
At Troy, Ohio.	Q_2	253·1928
Near Troy, Ohio.	R_2	252·0136
Near Troy, Ohio.	S_2	247·6114
At Tippecanoe City, Ohio.	T_2	245·8116
At Tippecanoe City, Ohio.	U_2	244·0678
Near Tippecanoe City, Ohio	V_2	242·8534
At Tadmor, Ohio	W_2	240·9632
Near Tadmor, Ohio	X_2	235·5944
Near Dayton, Ohio	Y_2	229·8806
At Dayton, Ohio	Z_2	226·7562
At Dayton, Ohio	Dayton City B. M.	226·5461
At Dayton, Ohio	A_3	226·4559
At Dayton, Ohio	B_3	226·6489
Near Dayton, Ohio	E_4	224·3944
Near Dayton, Ohio	C_3	221·8654
Near Alexandria, Ohio	D_4	219·9697
Near Whitfield, Ohio	D_3	217·5778

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Carrollton, Ohio	C_4	216·6983
At Miamisburg, Ohio	B_4	215·5858
Near Miamisburg, Ohio	E_3	213·1331
At Miamisburg, Ohio	F_3	212·2964
At Miamisburg, Ohio	A_4	214·7772
Near Miamisburg, Ohio	G_3	211·3118
Near Franklin, Ohio	Z_3	214·4684
Near Carlisle, Ohio	H_3	210·8007
At Franklin, Ohio	I_3	209·8516
Near Carlisle, Ohio	J_3	206·5042
Near Franklin, Ohio	Y_3	208·4756
Near Poast Town, Ohio	K_3	200·5007
Near Middletown, Ohio	X_3	205·5020
At Heno, Ohio	L_3	195·8519
At Middletown, Ohio	M_3	203·0039
At Excello Mills, Ohio	W_3	194·3871
Near Trenton, Ohio	N_3	192·7946
At Le Sourdsville, Ohio	V_3	190·3345
Near Overpeck, Ohio	O_3	193·5096
Near Rockdale, Ohio	U_3	191·9826
Near Hamilton, Ohio	P_3	182·0169
Near Wooddale, Ohio	T_3	187·8998
At Hamilton, Ohio	Q_3	180·0194
At Hamilton, Ohio	Hamilton City B. M.	183·2297
At Hamilton, Ohio	R_3	184·3532
At Hamilton, Ohio	S_3	181·5137
Near Hamilton, Ohio	Telegraph Pole No. 745.	185·8591
Near Hamilton, Ohio	F_4	183·4453
Near Flockton, Ohio	P. R. R. No. 24.	186·7450
Near Flockton, Ohio	P. R. R. No. 23.	184·4539
Near Jones, Ohio	G_4	194·6168
At Port Union, Ohio	P. R. R. No. 21.	181·5400
Near Crescentville, Ohio	P. R. R. No. 20.	179·5029
Near Crestvue, Ohio	H_4	197·0200
Near Crescentville, Ohio	P. R. R. No. 19.	176·3801
Near Port Union, Ohio	P. R. R. No. 17.	174·7162
Near Glendale, Ohio	I_4	184·9256
Near Glendale, Ohio	J_4	174·5943
At Lockland, Ohio	T_4	174·8319
At Rensselaer, Ohio	K_4	164·1339
At Carthage, Ohio	L_4	167·9181
At Carthage, Ohio	S_4	167·8755
At St. Bernard, Ohio	R_4	166·9878
At Ivorydale, Ohio	M_4	152·0931
At Winston Springs, Ohio	U. S. G. S. No. 498.	151·6326
At Cincinnati, Ohio	Q_4	164·8334
At Cincinnati, Ohio	N_4	152·5452
At Cincinnati, Ohio	O_4	149·7061
At Cincinnati, Ohio	Cincinnati City.	153·5648
At Cincinnati, Ohio	P_4	166·0570
At Cincinnati, Ohio	Reference mark to Cincinnati City No. 1.	168·0715
At Cincinnati, Ohio	Y_4	168·4273
At Cincinnati, Ohio	Z_4	149·4506
At Cincinnati, Ohio	Gauge B. M.	149·6989
At Cincinnati, Ohio	U_4	150·4163
At Ludlow, Ky.	A_5	162·3489
At Cincinnati, Ohio	V_4	153·5685
At Cincinnati, Ohio	U. S. H.	152·1240

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Sedamsville, Ohio	U. S. G. S.	149·7120
At Cincinnati, Ohio	W_4	150·5672
At St. Joseph, Ohio	X_4	147·9562
At Delhi, Ohio	Canal Stone.	148·5058
Near Delhi, Ohio	B_5	150·4684
At North Bend, Ohio	C_5	149·7392
Near Lawrenceburg, Ind.	D_5	146·9558
At Lawrenceburg, Ind.	E_5	147·3545
At Carrollton, La.	B. M. 3 (Ripley, 1875).	3·3916
At Carrollton, La.	B. M. 4 (Ripley, 1875).	3·1345
At Carrollton, La.	B. M. 5 (Burney, 1875).	2·6467
At Carrollton, La.	City B. M. XX stone.	1·3819
Near New Orleans, La.	City stone (corner Washington and Carrollton avenues).	1·3797
At New Orleans, La.	Halfway House.	1·6034
Near New Orleans, La.	Height of Metairie Ridge.	1·2917
At West End, La.	B. M. Lake House.	0·7408
At Monroe, La.	P. B. M. 24.	21·7886
At Monroe, La.	P. B. M. 25.	24·6008
At Monroe, La.	P. B. M. 26.	24·6496
At Monroe, La.	P. B. M. 27.	23·7658
At West Monroe, La.	P. B. M. 28.	23·0190
At Chênière, La.	P. B. M. 29.	27·2953
At Calhoun, La.	P. B. M. 30.	50·4275
At Choudrant, La.	P. B. M. 32.	46·3974
At Ruston, La.	P. B. M. 33.	95·8303
At Allen Green, La.	P. B. M. 34.	100·6180
At Simsboro, La.	P. B. M. 35.	97·6137
At Arcadia, La.	P. B. M. 36.	112·4490
At Gibsland, La.	P. B. M. 37.	73·7246
At Taylor, La.	P. B. M. 38.	66·5099
At Dubberly, La.	P. B. M. 39.	77·9926
At Sibley, La.	P. B. M. 40.	57·5818
At Bayou Dorcheat, La.	P. B. M. 41.	42·9304
At Doyle, La.	P. B. M. 42.	68·0194
At Haughton, La.	P. B. M. 43.	72·1446
At Bodcau, La.	P. B. M. 44.	62·0720
Near Shreveport, La.	P. B. M. 45.	52·1679
At Shreveport, La.	P. B. M. 46.	59·6423
At Kincaid place, La.	P. B. M. 47.	49·9354
At Lotus Landing, La.	P. B. M. 48.	48·0272
On Cash Plantation, La.	P. B. M. 49.	46·3955
At Caspiana Landing, La.	P. B. M. 50.	45·1318
On Campo Bello Plantation, La.	P. B. M. 51.	44·6124
On Bonner's Plantation, La.	P. B. M. 52.	43·8734
Near Howard P. O., La.	P. B. M. 53.	43·0690
Near Loggy Bayou, La.	P. B. M. 54.	43·8014
At Eastpoint, La.	P. B. M. 55.	43·1864
On Chrichton's Plantation, La.	P. B. M. 56.	41·9594
At Coushatta, La.	P. B. M. 57.	40·2844
At Coushatta, La.	P. B. M. 58.	40·7085
On Upper Brownsville Plantation, La.	P. B. M. 59.	38·5129
Near Old River, La.	P. B. M. 60.	36·9063
Near Campti, La.	P. B. M. 61.	36·1789
Near Willow P. O., La.	P. B. M. 62.	36·2543
Near Tiger Island, La.	P. B. M. 63.	34·3553
At St. Maurice, La.	P. B. M. 64.	32·7984

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported above Cairo datum.
		metres.	*metres.*
Near Dunns Landing, La.	P. B. M. 65.	31·9025	
Near Montgomery, La.	P. B. M. 66.	30·2054	
At Buxtons Landing, La.	P. B. M. 67.	28·0898	
Near Colfax, La.	P. B. M. 68.	26·3682	
At Colfax, La.	P. B. M. 69.	29·2906	
Near Fairmount P. O., La.	P. B. M. 70.	28·7932	
At Boyce, La.	P. B. M. 71.	26·1393	
Near Rapides P. O., La.	P. B. M. 72.	23·8821	
At Alexandria, La.	P. B. M. 73.	22·4331	
At Alexandria, La.	P. B. M. 74.	21·5857	
Near Alexandria, La.	P. B. M. 75.	22·0644	
Near Grand Bend, La.	P. B. M. 76.	21·6366	
Near Jones Quarter Landing, La.	P. B. M. 77.	20·1781	
Near Poland P. O., La.	P. B. M. 78.	18·5172	
At Egg Bend Landing, La.	P. B. M. 79.	18·7139	
At David Ferry, La.	P. B. M. 80.	20·1953	
At Normands Landing, La.	P. B. M. 81.	18·7255	
At Normands Landing, La.	P. B. M. 82.	18·8070	
At Marksville, La.	P. B. M. 83.	26·6449	
At Mansura, La.	P. B. M. 84.	23·2636	
At Mansura, La.	P. B. M. 85.	24·2583	
At Moreauville, La.	P. B. M. 86.	18·6405	
At Hamburg, La.	P. B. M. 87.	16·9455	
Near Simmesport, La.	P. B. M. 88.	15·3661	
At Simmesport, La.	P. B. M. 89.	12·7590	
Near Water Valley Landing, La.	P. B. M. 90.	12·9874	
Near Merrick P. O., La.	P. B. M. 91.	13·5527	
Near Barbre Landing, La.	P. B. M. 92.	13·6339	
Near Barbre Landing, La.	P. B. M. 93.	15·1382	
Near Barbre Landing, La.	P. B. M. 94.	15·3386	
Near Torras Landing, La.	M. R. C. B. M. $\frac{149}{3}$.	15·9151	
At Rayville, La.	P. B. M. 16.	24·4587	
At Rayville, La.	P. B. M. 17.	26·7881	32·9918
Near Rayville, La.	P. B. M. 18.	24·3687	
At Girard, La.	P. B. M. 19.	24·1170	
At Girard, La.	P. B. M. 20.	26·2590	
At Crew Lake, La.	P. B. M. 21.	20·2384	
At Gordon, La.	P. B. M. 23.	19·5820	
At Mound, La.	P. B. M. 2.	25·3101	
At California, La.	P. B. M. 3.	26·8586	
At Barnes, La.	P. B. M. 4.	24·6686	
At Tallulah, La.	P. B. M. 5.	27·9529	
At Tallulah, La.	P. B. M. 6.	27·5570	
Near Lake One, La.	P. B. M. 7.	23·5338	
At Quebec, La.	P. B. M. 8.	22·8550	
Near Quebec, La.	P. B. M. 9.	23·7879	
At Dallas, La.	P. B. M. 10.	23·2014	
At Waverly, La.	P. B. M. 11.	23·9107	
Near Bayou Maçon, La.	P. B. M. 12.	22·5945	
At Delhi, La.	P. B. M. 13.	28·7201	
At Carpenter, La.	P. B. M. 14.	26·3082	
At Holly Ridge, La.	P. B. M. 15.	25·8842	
At Vidalia, La.	M. R. C. Stone $\frac{132}{3}$.	18·0773	24·3034
At Vidalia, La.	M. R. C. Stone $\frac{132}{.4}$.	17·6423	23·8684
At Vidalia, La.	B. M. 1858.	19·5378	25·7639

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported above Cairo datum.
		metres.	*metres.*
At Vidalia, La.	B. M. Court-house Pedestal.	20.1961	26.4222
At Natchez, Miss.	B. M. Polk 1.	23.3398	29.5659
At Natchez, Miss.	B. M. Polk 2.	24.9946	31.2207
At Natchez, Miss.	B. M. Polk 3.	12.2514	18.4775
At Natchez, Miss.	B. M. cor. of State and Broad-way sts.	59.2967	65.5228
At Natchez, Miss.	P. B. M. 1.	59.4598	65.6859
At Natchez, Miss.	B. M. No. 7 (Melvin, 1879).	65.7214	71.9475
At Natchez, Miss.	B. M. (Babbitt, 1874) No. 3.	24.4573	30.6834
At Natchez, Miss.	B. M. N (Ewens, 1886).	21.5765	27.8026
At Monroe, La.	B. M. C (Burrows, 1883).	24.6412	30.8355
At Monroe, La.	B. M. D (Burrows, 1883).	24.4878	30.6821
At Logtown, La.	P. B. M. 9.	21.6481	27.8460
At Blankston, La.	P. B. M. 10.	19.5649	25.7658
Near Waverly, La.	T. B. M. 125.	21.5863	27.7891
Near Riverton, La.	P. B. M. 11.	19.2234	25.4271
Near Riverton, La.	Gauge B. M. B	23.3875	29.5912
At Riverton, La.	Gauge B. M. A	17.1262	23.3299
At Columbia, La.	P. B. M. 12.	18.6733	24.8784
At Gibsons Landing, La.	P. R. P. Gibson.	18.6439	24.8514
At Coles Landing, La.	P. B. M. 13.	18.4338	24.6425
At Cottingham Landing, La.	P. B. M. 14.	17.6072	23.8174
At Danville, La.	B. M. B	18.3256	24.5363
Near Danville, La.	B. M. A	18.2354	24.4474
At Staffords, La.	P. B. M. 8.	17.1477	23.3622
At Catahoula Shoals, La.	P. B. M. 7.	17.3985	23.6142
At Harrisonburg, La.	T. B. M. H	18.3442	24.5612
At Harrisonburg, La.	B. M. V	20.5015	26.7185
At Harrisonburg, La.	P. B. M. 6.	24.0673	30.2843
At Trinity, La.	P. B. M. 5.	*16.3315	22.5261
At Jonesville, La.	P. B. M. 4.	16.4256	22.6462
At Black River, La.	P. B. M. 3.	15.5707	21.7913
At Frogmore, La.	P. B. M. 2.	17.1620	23.3852
At Concordia, La.	T. B. M. 9.	19.5624	25.7460
At Burke, La.	P. B. M. Burke.	23.0343	29.2365
At Archibald, La.	P. B. M. Archibald.	23.4106	29.6116
At Mangham, La.	P. B. M. Mangham.	22.7286	28.9287
At Big Creek, La.	P. B. M. Big Creek.	22.6565	28.8562
At Baskin, La.	P. B. M. Baskin.	22.4624	28.6613
At Steeles Switch, La.	P. B. M. Steele.	22.0022	28.1997
At Winnsboro, La.	P. B. M. Winnsboro.	21.9738	28.1707
At Eden, La.	P. B. M. Eden.	21.8299	28.0257
At Gilbert, La.	P. B. M. Gilbert.	23.6849	29.8791
At Wisner, La.	P. B. M. Wisner.	22.7714	28.9640
At Elam, La.	P. B. M. Elam.	21.9992	28.1914
At Peck, La.	P. B. M. Peck.	22.7871	28.9787
Near Peck, La.	P. B. M. Newman.	21.7544	27.9453
Near Florence, La.	P. B. M. Chisum.	21.8572	28.0477
At Florence, La.	P. B. M. Florence.	22.0508	28.2410
At Copeland, La.	P. B. M. Copeland.	19.5178	25.7065
At Kirks Ferry, La.	P. B. M. Kirk.	19.7918	25.9805
At Greenville, La.	P. B. M. Tensas.	19.6484	25.8363
At Lee Bayou, La.	P. B. M. Lee Bayou.	19.3162	25.5035
At Clayton, La.	P. B. M. Clayton.	18.6910	24.8773
At Cypress City, La.	P. B. M. Cypress.	17.7488	23.9342
At Helena, La.	P. B. M. Helena.	18.4062	24.5905
At Concordia, La.	P. B. M. Concordia.	18.3858	24.5699
At Concordia, La.	B. M. 384.	20.7740	26.9578

*Line of 1894 only used in deriving this elevation.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported above Cairo datum.
		metres.	*metres.*
At Jones Bayou, La.	P. B. M. 5 a.	*17·9231	24·1413
At McClures Landing, La.	P. B. M. 6 a.	16·9594	23·1774
At Eva P. O., La.	P. B. M. 7 a.	16·2978	22·5160
At Hardscramble Landing, La.	P. B. M. 8 a.	16·4962	22·7144
At Lums, La.	P. B. M. 9 a.	15·8997	22·1179
At New Era P. O., La.	P. B. M. 10 a.	15·8115	22·0297
At Acme P. O., La.	P. B. M. 11 a.	15·2716	21·4898
Near Acme P. O., La.	Discharge Jar.	15·4328	21·6510
Near Acme P. O., La.	P. B. M. 12 a.	14·8938	21·1120
At Albany Pt., La.	P. B. M. 1.	67·9101	74·1125
At Henderson Mill, La.	P. B. M. 2.	74·4581	80·6605
At Mooringsport, La.	P. B. M. 3.	55·7991	62·0015
At Jeters Landing, La.	P. B. M. 4.	60·1004	66·3028
Near Bayou Siord, La.	P. R. P. Pargoud.	31·4777	37·6718
At Bank Smith Place, La.	P. R. P. Zeph.	24·0576	30·2511
At Rock Row Shoals, La.	P. R. P. Rock Row.	23·3290	29·5221
Near Pace Lake, La.	P. R. P. Glendora.	24·7063	30·8990
At Glendora, La.	T. B. M. 79.	†26·0325	32·2192
At Parkeville, La.	P. R. P. Parkeville.	23·5381	29·7302
At Parkeville, La.	T. B. M. 74.	24·7601	30·9517
At Port Union Landing, La.	P. B. M. Port Union.	25·7715	31·9582
Near Point Pleasant, La.	P. B. M. Hay.	41·1958	47·3825
Near Farmerville, La.	P. B. M. White.	54·5685	60·7552
Near Farmerville, La.	P. B. M. Rogers.	53·4482	59·6349
At Farmerville, La.	P. B. M. Farmerville.	54·6944	60·8811
At Scotts Bluff, La.	P. B. M. Scott.	23·1130	29·2997
At Steins Bluff, La.	P. B. M. Stein.	29·4331	35·6198
Near Bayou D'Arbonne, La.	P. B. M. Cox Ferry.	21·5088	27·6955
Near Mill Bayou, La.	P. R. P. Cashill.	21·7494	27·9416
Near Fishtrap Shoals, La.	P. R. P. Fishtrap.	21·1763	27·3685
At Alabama Landing, La.	P. R. P. Alabama.	21·1662	27·3584
At Frank Pierre Creek, La.	P. R. P. Frank Pierre.	17·0052	23·1974
Near Shiloh Shoals, La.	P. R. P. Shiloh.	17·2546	23·4469
Near Lake Landing, Ark.	P. R. P. Lake.	17·9696	24·1620
Near Bayou Lapile, Ark.	P. R. P. Lapile.	18·6910	24·8834
Near Ouachita Belle Landing, Ark.	P. R. P. Belle Point.	19·5714	25·7638
Near Belle Point Landing, Ark.	T. B. M. 39.	20·6672	26·8596
Near Eutaw Shoals, Ark.	P. R. P. Eutaw.	22·0396	28·2320
Near Jacks Island, Ark.	P. R. P. Jacks Island.	23·7416	29·9342
At Careyville Landing, Ark.	P. R. P. Careyville.	24·9781	31·1707
At Pigeon Hill Landing, Ark.	P. R. P. Pigeon Hill.	27·7772	33·9698
Near Fletchers Landing, Ark.	P. R. P. Fletcher.	25·6813	31·8739
Near Franklin Bayou, Ark.	P. R. P. Franklin.	22·6081	28·8008
Near Champagnolle, Ark.	P. R. P. Bell Field.	24·6290	30·8217
At Champagnolle Landing, Ark.	P. R. P. Champagnolle.	29·6742	35·8669
At El Dorado Landing, Ark.	P. R. P. El Dorado.	26·7870	32·9798
Near Smackover Creek, Ark.	P. R. P. Smackover.	26·3471	32·5399
At Leppards Camp, Ark.	P. R. P. Leppard.	27·5474	33·7402
Near Little Bay, Ark.	P. R. P. Little Bay.	27·5484	33·7412
Near Beech Hill, Ark.	P. R. P. Beech Hill.	28·3203	34·5132
Near Walnut Hill, Ark.	P. R. P. Walnut Hill.	27·5033	33·6962
Near Walnut Hill, Ark.	T. B. M. 5.	31·6198	37·8127
At Frenchport, Ark.	P. R. P. Frenchport II.	37·4763	43·6692
At Frenchport, Ark.	P. R. P. Frenchport I.	34·7357	40·9287
At Elliott, Ark.	P. R. P. Elliott.	77·4201	83·6131

* Mean derived from P. B. M 3 and P. B. M. 4 of line of 1894.

† From line of 1897-98.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported above Cairo datum.
		metres.	*metres.*
At Camden, Ark.	Gauge B. M. A (Ewens, 1890).	40·6803	46·8734
Near Camden, Ark.	P. B. M. Camden IV.	35·0542	41·2473
At Camden, Ark.	P. B. M. Camden III.	32·8035	38·9966
At Camden, Ark.	P. B. M. Camden II.	60·7398	66·9329
At Camden, Ark.	P. B. M. Camden I.	42·2077	48·4008
At Lester, Ark.	P. B. M. Lester.	34·6634	40·8566
At Chidester, Ark.	P. B. M. Chidester.	70·2030	76·3963
At Little Missouri River, Ark.	P. B. M. Little Missouri.	50·5212	56·7146
At Whelen, Ark.	P. B. M. Whelen.	76·9075	83·1009
At Gurdon, Ark.	P. B. M. Gurdon II.	63·4914	69·6848
At Gurdon, Ark.	P. B. M. Gurdon I.	63·6428	69·8362
Near Smithton, Ark.	P. B. M. Smithton.	62·8511	69·0446
At Curtis, Ark.	P. B. M. Curtis.	56·4103	62·6038
At Gum Springs, Ark.	P. B. M. Gum Springs.	65·1886	71·3821
At Arkadelphia, Ark.	P. B. M. Arkadelphia II.	65·8879	72·0815
At Arkadelphia, Ark.	P. B. M. Arkadelphia I.	57·3947	63·5883
Near Arkadelphia, Ark.	Gauge B. M. B (Ewens, 189–).	56·7413	62·9349
Near Arkadelphia, Ark.	P. B. M. Ouachita River.	59·3967	65·5903
At Daleville, Ark.	P. B. M. Daleville.	56·9931	63·1867
At Donaldson, Ark.	P. B. M. Donaldson.	69 6181	75·8118
At Malvern, Ark.	P. B. M. Malvern.	82·5096	88·7035
At Traskwood, Ark.	P. B. M. Traskwood.	88·9753	95·1693
At Saline River, Ark.	P. B. M. Saline River.	86·0558	92·2498
At Benton, Ark.	P. B. M. Benton.	90·9442	97·1382
At Alexander, Ark.	P. B. M. Alexander.	99·4419	105·6360
At Mabelvale, Ark.	P. B. M. Mabelvale.	94·5046	100·6988
At Ensign, Ark.	P. B. M. Ensign.	89·3970	95·5912
At Little Rock, Ark.	B. M. Whittemore.	80·3314	86·5257
At Little Rock, Ark.	B. M. Abert.	75·1291	81·3234
At Little Rock, Ark.	B. M. Merrill.	77·9655	84·1598
At Little Rock, Ark.	S. S. Gauge, B. M.	75·8286	82·0229
At Little Rock, Ark.	B. M. State House Steps.	87·7700	93·9643
At Little Rock, Ark.	Gauge B. M. A (Ewens).	73·7394	79·9337
At Little Rock, Ark.	B. M. 1 (Ewens, 1887).	71·9737	78·1680
At Little Rock, Ark.	No. 6 (Gauge B. M.).	80·0675	*86·2618
On Bayou Bartholomew, La.	P. B. M. Sandidge.	27·1516	33·3437
On Bayou Bartholomew, La.	P. B. M. Myers.	27·6367	33·8281
On Bayou Bartholomew, La.	P. B. M. Williams.	26·3995	32·5900
On Bayou Bartholomew, La.	P. B. M. Anderson.	27·4928	33·6830
On Bayou Bartholomew, La.	P. B. M. Bonner.	27·9670	34·1562
On Bayou Bartholomew, La.	P. B. M. Davis No. 2.	29·1639	35·3519
At Wards Ferry, La.	P. B. M. Ward.	29·5891	35·7765
Near Bayou Bartholomew, La.	P. B. M. Wells.	30·4495	36·6355
At Mound Landing, La.	P. B. M. Mound.	31·1758	37·3611
At Lindgrove, La.	P. B. M. Lindgrove.	32·1948	38·3789
At Bonita, La.	P. B. M. Bonita.	32·4011	38·5844
At Jones, La.	P. B. M. Jones.	32·5244	38·7067
Near Jones, La.	P. B. M. Louisiana-Arkansas.	32·6368	38·8184
At Wilmot, Ark.	P. B. M. Wilmot.	34·8604	41·0407
On Bayou Bartholomew, Ark.	P. B. M. Noble.	34·6782	40·8578
At Parkdale, Ark.	P. B. M. Parkdale.	35·4869	41·6661
At Sunshine, Ark.	P. B. M. Sunshine.	35·9605	42·1385
At Portland, Ark.	P. B. M. Portland.	38·8513	45·0283
At Kidds Spur, Ark.	P. B. M. Kidd.	37·8735	44·0492
At Morrell, Ark.	P. B. M. Morrell.	39·6623	45·8371
At Hudspeth, Ark.	P. B. M. Hudspeth.	40·5274	46·7008
At Dermott, Ark.	P. B. M. Dermott.	42·6790	48·8509
At Baxter, Ark.	P. B. M. Baxter.	43·2125	49·3844

*The elevation of No. 1 or 3 as reported here = 86·5377.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported above Cairo datum.
		metres.	*metres.*
At McGehee, Ark.	P. B. M. McGehee.	45·2783	51·4485
At Trippe Junction, Ark.	P. B. M. Trippe.	44·0630	50·2323
At Trippe Junction, Ark.	T. B. M. 117 = Levee B. M.	44·0786	50·2461
Near Arkansas City, Ark.	M. R. C. Stone $\frac{63}{3}$.	41·4735	47·6410
Near Arkansas City, Ark.	M. R. C. Stone $\frac{63}{2}$.	44·1553	50·3225
Near Port Anderson, Miss.	T. B. M. 121 = Levee Board B. M.	44·0807	*50·2487
At Millers Bend, Miss.	P. B. M. Millers Bend.	38·6761	44·8459
At Greenville, Miss.	B. M. O	38·1063	44·2776
At Vicksburg, Miss.	P. B. M. 1.	31·3525	
Near Vicksburg, Miss.	P. B. M. 2.	29·4235	
On Blakely Plantation, Miss.	P. B. M. 3.	34·4127	
At Yazoo River, Miss.	P. B. M. 4.	28·6939	
At Yazoo River, Miss.	P. B. M. 5.	32·1171	
On Belle Isle Plantation, Miss.	P. B. M. 6.	28·3809	
At Calmar P. O., Miss.	P. B. M. 7.	31·0305	
Near L'Argent, Miss.	P. B. M. 8.	28·7889	
At L'Argent, Miss.	P. B. M. 9.	26·8474	
At Satartia, Miss.	P. B. M. 10.	29·6199	
At Enola, Miss.	P. B. M. 11.	30·2736	
At Yazoo City, Miss.	P. B. M. 12.	35·7425	
At Yazoo City, Miss.	P. B. M. 13.	31·1999	
At Bee Lake, Miss.	P. B. M. 29.	32·8019	
At Tchula, Miss.	P. B. M. 28.	35·9464	
At Tchula, Miss.	P. B. M. 27.	34·7843	
At Sidon, Miss.	P. B. M. 26.	37·2213	
At Greenwood, Miss.	P. B. M. 25.	38·0927	
At Greenwood, Miss.	P. B. M. 24.	39·2890	
At Fort Loring, Miss.	P. B. M. 23.	40·9017	
At Fort Loring, Miss.	P. B. M. 22.	39·0435	
At Itta Bena, Miss.	P. B. M. 21.	38·0313	
Near Baird, Miss.	P. B. M. 20.	35·6469	
Near Baird, Miss.	P. B. M. 19.	34·9194	
Near Baird, Miss.	P. B. M. 18.	38·4643	
At Indianola, Miss.	P. B. M. 17.	35·7313	
At Heathman, Miss.	P. B. M. 16.	36·9394	
At The Bogue, Miss.	P. B. M. 15.	34·9313	
At Stoneville, Miss.	P. B. M. 14.	37·2199	
At Greenville, Miss.	Greenville North Base △.	38·3525	
Near Argyle, Miss.	P. B. M. 88.	38·1049	
At Millers Bend, Miss.	P. B. M. 87.	39·4003	
Near Offutts Landing, Miss.	P. B. M. 86.	41·1470	
At Port Anderson, Miss.	P. B. M. 85.	41·6282	
Near Wilkersons Landing, Miss.	P. B. M. 84.	42·2704	
Near Wilkersons Landing, Miss.	P. B. M. 83.	42·3134	
At Mound Place, Miss.	P. B. M. 82.	42·2454	
At Childers, Miss.	P. B. M. 81.	42·6913	
At Content, Miss.	P. B. M. 80.	43·5578	
At Buck Ridge, Miss.	P. B. M. 79.	43·1213	
At Bolivar, Miss.	P. B. M. 78.	42·8736	
At Stormville, Miss.	P. B. M. 77.	43·2420	
At Nebletts Landing, Miss.	P. B. M. 76.	44·2224	
Near Prentiss, Miss.	P. B. M. 75.	45·2668	
Near Prentiss, Miss.	P. B. M. 74.	45·1521	

* The elevation of P. B. M. 84 as reported here = 48·4376.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported above Cairo datum.
		metres.	*metres.*
Near Prentiss, Miss.	P. B. M. 73.	44·6597	
Near Clarks Landing, Miss.	P. B. M. 72.	45·1509	
Near Beulah, Miss.	P. B. M. 71.	44·4888	
At Riverton, Miss.	P. B. M. 70.	45·7653	
At Rosedale, Miss.	P. B. M. 69.	46·1209	
At Rosedale, Miss.	P. B. M. 68.	44·7163	
Near Terrene, Miss.	P. B. M. 67.	47·1970	
Near Concordia, Miss.	P. B. M. 66.	47·1531	
At Concordia, Miss.	P. B. M. 65.	48·1640	
At Carsons, Miss.	P. B. M. 64.	49·0967	
Near Australia Post-Office, Miss.	P. B. M. 63.	49·3339	
At Lake Charles Landing, Miss.	P. B. M. 62.	50·4331	
At Robinsonville, Miss.	P. B. M. 61.	49·2910	
Near Sunflower Landing, Miss.	P. B. M. 60.	51·2842	
Near Hughes Landing, Miss.	P. B. M. 59.	52·9677	
Near Hughes Landing, Miss.	P. B. M. 58.	52·2745	
Near Friars Point, Miss.	P. B. M. 57.	52·1794	
At Friars Point, Miss.	P. B. M. Friars Point II.	55·1680	
At Friars Point, Miss.	P. B. M. Friars Point III.	53·7134	59·8444
At Coahoma, Miss.	P. B. M. Coahoma.	54·1390	60·2700
Near Clover Hill, Miss.	P. B. M. Clover Hill.	52·7531	58·8841
At Lyon, Miss.	P. B. M. Lyon.	52·9158	59·0468
At Clarksdale, Miss.	P. B. M. Clarksdale I.	52·8684	58·9994
At Clarksdale, Miss.	P. B. M. Clarksdale II.	52·4897	58·6207
Near Clarksdale, Miss.	P. B. M. Clarksdale III.	52·6051	58·7361
At Austin, Miss.	B. M. Austin II.	59·2268	
At Austin, Miss.	B. M. Austin I.	59·8994	
Near Austin, Miss.	B. M. Trotters Landing.	56·3415	
At Glendale, Miss.	B. M. Glendale.	56·2299	
Near Friars Point, Miss.	B. M. Delta.	54·6701	
At Friars Point, Miss.	B. M. Friars Point I.	55·7970	
At Helena, Ark.	B. M. Helena I.	58·5092	
At Helena, Ark.	B. M. Helena II.	58·5157	
At Horn Lake Creek, Miss.	B. M. Horn Lake Creek.	67·1401	
At Star Landing, Miss.	B. M. Star Landing.	63·0204	
At Commerce, Miss.	B. M. Commerce.	59·9488	
At Mhoons Landing, Miss.	B. M. Mhoons Landing.	59·2301	
At Corinth, Miss.	T. B. M. 1.	137·2852	
At Burnsville, Miss.	P. B. M. 1.	143·3547	
At Burnsville, Miss.	P. B. M. 2.	141·8923	
At Iuka, Miss.	P. B. M. 3.	171·2546	
Near Pegram, Ala.	T. B. M. 41.	131·1612	
Near Riverton Junction, Ala.	T. B. M. 43.	125·2094	
At Margerum, Ala.	T. B. M. 45.	132·2423	
Near Margerum, Ala.	T. B. M. 47.	133·8554	
Near Cherokee, Ala.	T. B. M. 49.	147·8965	
Near Barton, Ala.	T. B. M. 58.	150·1184	
At Barton, Ala.	T. B. M. 59.	146·1696	
Near Prides, Ala.	T. B. M. 63.	130·3536	
At Prides, Ala.	T. B. M. 72.	129·9539	
At Prides, Ala.	P. B. M. 7.	127·8764	
At Prides, Ala.	T. B. M. 73.	126·8348	
Near Prides, Ala.	T. B. M. 68.	147·8568	
Near Prides, Ala.	T. B. M. 71.	137·1130	
At Tuscumbia, Ala.	T. B. M. 79.	136·3279	
At Tuscumbia, Ala.	T. B. M. 80.	141·8565	
At Tuscumbia, Ala.	P. B. M. 8.	145·4402	

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Tuscumbia, Ala.	P. B. M. 9.	142.2698
Near Florence, Ala.	T. B. M. 86.	140.4182
Near Florence, Ala.	P. B. M. 10.	133.6341
At Florence, Ala.	T. B. M. 87.	136.3990
At Florence, Ala.	Old Gauge B. M.	130.4690
At Florence, Ala.	P. B. M. 11.	130.6798
At Florence, Ala.	P. B. M. 12.	130.7798
At Florence, Ala.	T. B. M. 90.	138.9349
At Florence, Ala.	P. B. M. 13.	138.3351
At East Florence, Ala.	P. B. M. 14.	143.1290
Near East Florence, Ala.	T. B. M. 93.	132.4955
Near East Florence, Ala.	P. B. M. 15.	134.1094
Near East Florence, Ala.	P. B. M. 16.	132.5117
Near Bainbridge, Ala.	P. B. M. 17.	129.7990
Near Bainbridge, Ala.	T. B. M. 99.	130.3999
At Bainbridge, Ala.	P. B. M. 18.	133.0398
At Lock 9, Muscle Shoals Canal, Ala.	T. B. M. 102.	132.0664
At Lock 9, Muscle Shoals Canal, Ala.	P. B. M. 19.	132.0725
At Lock 8, Muscle Shoals Canal, Ala.	T. B. M. 103.	135.1385
At Lock 8, Muscle Shoals Canal, Ala.	P. B. M. 20.	135.1439
At Lock 7, Muscle Shoals Canal, Ala.	T. B. M. 104.	137.7222
At Lock 7, Muscle Shoals Canal, Ala.	P. B. M. 21.	138.7887
Near Lock 7, Muscle Shoals Canal, Ala.	P. B. M. 22.	138.6374
Near Lock 7, Muscle Shoals Canal, Ala.	T. B. M. 105.	139.0273
At Lock 6, Muscle Shoals Canal, Ala.	T. B. M. 107.	141.5282
At Lock 6, Muscle Shoals Canal, Ala.	P. B. M. 23.	142.7450
Near Lock 6, Muscle Shoals Canal, Ala.	T. B. M. 108.	142.5014
Near Lock 6, Muscle Shoals Canal, Ala.	P. B. M. 24.	142.8071
Near Lock 6, Muscle Shoals Canal, Ala.	T. B. M. 109.	142.6871
Near Lock 5, Muscle Shoals Canal, Ala.	P. B. M. 25.	142.8454
At Lock 5, Muscle Shoals Canal, Ala.	T. B. M. 113.	146.3858
At Lock 5, Muscle Shoals Canal, Ala.	P. B. M. 26.	146.3793
Near Lock 5, Muscle Shoals Canal, Ala.	P. B. M. 27.	146.4062
Near Lock 5, Muscle Shoals Canal, Ala.	T. B. M. 114.	146.2547
Near Lock 4, Muscle Shoals Canal, Ala.	P. B. M. 28.	147.4770
At Lock 4, Muscle Shoals Canal, Ala.	T. B. M. 116.	149.9252
At Lock 4, Muscle Shoals Canal, Ala.	P. B. M. 29.	149.4655
Near Lock 3, Muscle Shoals Canal, Ala.	P. B. M. 30.	151.3045
At Lock 3, Muscle Shoals Canal, Ala.	T. B. M. 118.	153.1349
At Lock 3, Muscle Shoals Canal, Ala.	P. B. M. 31.	153.1271
Near Lock 3, Muscle Shoals Canal, Ala.	T. B. M. 119.	153.2227
Near Lock 2, Muscle Shoals Canal, Ala.	T. B. M. 120.	153.7756
At Lock 2, Muscle Shoals Canal, Ala.	T. B. M. 121.	154.9812
At Lock 2, Muscle Shoals Canal, Ala.	P. B. M. 32.	154.9834
Near Lock 2, Muscle Shoals Canal, Ala.	P. B. M. 33.	155.5789
Near Lock 1, Muscle Shoals Canal, Ala.	T. B. M. 125.	157.9947
At Lock 1, Muscle Shoals Canal, Ala.	P. B. M. 34.	158.0015
Near Lock 1, Muscle Shoals Canal, Ala.	T. B. M. 126.	157.9154
Near Lambs Ferry, Ala.	T. B. M. 128.	156.0091
At Sycamore Landing, Ala.	P. B. M. 35.	159.3059
At Sycamore Landing, Ala.	P. B. M. 36.	160.3189
Near Lock B, Elk River Canal, Ala.	P. B. M. 37.	162.4690
Near Lock B, Elk River Canal, Ala.	P. B. M. 38.	165.6499
At Lock B, Elk River Canal, Ala.	T. B. M. 140.	160.5566
At Lock B, Elk River Canal, Ala.	P. B. M. 39.	160.5611
At Lock A, Elk River Canal, Ala.	P. B. M. 40.	163.1964
At Lock A. Elk River Canal, Ala.	T. B. M. 141.	163.6627
Near Lock A, Elk River Canal, Ala.	P. B. M. 41.	162.7187

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Lock A, Elk River Canal, Ala.	P. B. M. 42.	163·1968
Near Lock A, Elk River Canal, Ala.	T. B. M. 142.	162·4260
Near Miltons Bluff, Ala.	P. B. M. 43.	162·8824
At Miltons Bluff, Ala.	T. B. M. 143.	162·4449
Near Miltons Bluff, Ala.	T. B. M. 146.	163·4200
Near Browns Ferry, Ala.	P. B. M. 44.	163·8263
Near Browns Ferry, Ala.	P. B. M. 45.	165·3408
Near Browns Ferry, Ala.	P. B. M. 46.	165·5564
Near Findlays Landing, Ala.	P. B. M. 47.	166·3776
At Decatur, Ala.	T. B. M. 176.	163·3446
At Decatur, Ala.	P. B. M. 48.	164.1146
At Decatur, Ala.	P. B. M. 49.	166.2057
At Decatur, Ala.	P. B. M. 50.	168.6796
At Decatur, Ala.	Old B. M. U. S.	172·1109
At Decatur, Ala.	P. B. M. 51.	171·4946
At Decatur, Ala.	Old Railroad B. M.	172·3413
At Decatur, Ala.	P. B. M. 52.	172·2785
At Riverton, Ala.	P. B. M. 4.	121·1480
Near Riverton, Ala.	Lift lock center line stone 3.	117·6732
Near Riverton, Ala.	P. B. M. 5.	125·3365
Near Riverton, Ala.	P. B. M. 6.	127·7129
Near Riverton, Ala.	P. B. M. 53.	122·4678
Near Paynes Landing, Ala.	P. B. M. 54.	120·6330
Near Indian Creek, Miss.	P. B. M. 55.	125·5208
At Buggs Landing, Miss.	P. B. M. 56.	112·3282
Near Buggs Landing, Miss.	P. B. M. 57.	117·1653
Near Yellow Creek, Tenn.	P. B. M. 58.	123·2396
Near Yellow Creek, Tenn.	P. B. M. 59.	111·6955
Near Boyds Landing, Tenn.	P. B. M. 60.	121·5932
Near Hamburg Landing, Tenn.	Old P. B. M. 1.	106·2806
At Pittsburg Landing, Tenn.	Old P. B. M. 2.	117·2600
At Pittsburg Landing, Tenn.	P. B. M. 61.	127·4710
At Birmingham, Ala.	P. B. M. 1.	180·0369
At Birmingham, Ala.	T. B. M. 1.	184·7998
At Birmingham, Ala .	P. B. M. 2.	181·5196
At Birmingham, Ala.	P. B. M. 3.	180·4187
At Birmingham, Ala.	T. B. M. 2.	176·1224
At Elyton, Ala.	T. B. M. 3.	174·0550
Near West End, Ala.	T. B. M. 7.	166·0012
Near Powderly, Ala.	P. B. M. 4.	160·3517
At Powderly, Ala.	T. B. M. 8.	157·2698
Near Powderly, Ala.	T. B. M. 9.	159·8487
Near Hillman, Ala.	T. B. M. 10.	159·0080
Near Hillman, Ala.	T. B. M. 11.	156·2246
At Turpin P. O., Ala.	T. B. M. 13.	157·8727
At Bessemer, Ala.	T. B. M. 14.	159·0114
At Bessemer, Ala.	T. B. M. 15.	157·0449
At Bessemer, Ala.	P. B. M. 5.	156·4014
At Jonesboro, Ala.	T. B. M. 18.	154·8958
Near McCalla, Ala.	T. B. M. 24.	150·4969
Near Baylor, Ala.	T. B. M. 27.	151·9367
At Kimbrel, Ala.	P. B. M. 6.	149·6717
Near Standiford, Ala.	T. B. M. 32.	147·3462
Near Woodstock, Ala.	T. B. M. 39.	151·5147
Near Bibbville, Ala.	T. B. M. 42.	151·0614
Near Vance, Ala.	P. B. M. 7.	147·5320

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Vance, Ala.	T. B. M. 47.	143·8133
Near Coaling Station, Ala.	P. B. M. 8.	113·2584
Near Johnson, Ala.	T. B. M. 60.	98·9927
Near Olmstead, Ala.	T. B. M. 63.	90·8196
Near Cottondale, Ala.	P. B. M. 9.	74·8187
Near Cottondale, Ala.	T. B. M. 69.	106·7079
Near Cottondale, Ala.	T. B. M. 70.	110·1581
Near Tuscaloosa, Ala.	T. B. M. 75.	65·2321
At Tuscaloosa, Ala.	P. B. M. 11.	67·8703
Near Tuscaloosa, Ala.	Old B. M. 3.	44·7202
At Tuscaloosa, Ala.	P. B. M. 12.	34·2774
Near Tuscaloosa, Ala.	Old B. M. 4.	34·2712
Near Tuscaloosa, Ala.	Old B. M. 5.	28·0417
Near Tuscaloosa, Ala.	P. B. M. 13.	38·5733
At Tuscaloosa, Ala.	P. B. M. 10.	50·8441
Near Tuscaloosa, Ala.	T. B. M. 78.	51·6958
Near Tuscaloosa, Ala.	T. B. M. 80.	41·9983
At Englewood, Ala.	T. B. M. 88.	42·1890
At Hull, Ala.	T. B. M. 94.	39·1649
At Hull, Ala.	P. B. M. 14.	39·4376
At Moundville, Ala.	T. B. M. 100.	49·8921
At Moundville, Ala.	P. B. M. 15.	49·9031
At Powers, Ala.	P. B. M. 16.	41·7115
At Akron, Ala.	P. B. M. 17.	39·6825
At Warrior River, Ala.	P. B. M. 18.	36·2036
At Warrior River, Ala.	T. B. M. 122.	38·6012
Near Eutaw, Ala.	T. B. M. 123.	35·7340
Near Eutaw, Ala.	T. B. M. 124.	36·0573
At Eutaw, Ala.	P. B. M. 19.	53·0651
At Eutaw, Ala.	P. B. M. 20.	65·8565
Near Hairston, Ala.	T. B. M. 132.	49·7248
Near Hairston, Ala.	T. B. M. 138.	40·3268
Near Boligee, Ala.	T. B. M. 139.	37·3844
Near Boligee, Ala.	P. B. M. 21.	37·3847
Near Miller, Ala.	T. B. M. 150.	33·9098
Near Epes, Ala.	P. B. M. 22.	29·7074
At Epes, Ala.	P. B. M. 23.	34·8119
At Epes, Ala.	T. B. M. 152.	42·7713
Near Epes, Ala.	T. B. M. 153.	49·1802
Near Parker, Ala.	T. B. M. 156.	72·9162
At Parker, Ala.	T. B. M. 157.	81·4353
Near Livingston, Ala.	T. B. M. 160.	71·8281
Near Livingston, Ala.	T. B. M. 162.	55·5662
At Livingston, Ala.	P. B. M. 24.	48·9308
Near Livingston, Ala.	P. B. M. 25.	37·2038
Near York, Ala.	T. B. M. 172.	42·7217
Near York, Ala.	T. B. M. 175.	48·9437
At York, Ala.	P. B. M. 26.	47·4449
Near York, Ala.	T. B. M. 179.	48·6407
Near York, Ala.	T. B. M. 182.	50·8832
At Cuba, Ala.	P. B. M. 27.	65·4277
Near Cuba, Ala.	T. B. M. 188.	72·8606
At Toomsuba, Miss.	P. B. M. 28.	88·6146
Near Russell, Miss.	T. B. M. 207.	125·9192
At Meridian, Miss.	T. B. M. 217.	101·8674
At Meridian, Miss.	P. B. M. 29.	103·8818
At Coatopa, Ala.	P. B. M. 1.	38·4704

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At McDowell, Ala.	P. B. M. 2.	29·0450
Near McDowell, Ala.	P. B. M. 3.	28·1362
Near McDowell, Ala.	P. B. M. 4.	28·1287
At Demopolis, Ala.	Old B. M.	36·6310
At Demopolis, Ala.	P. B. M. 5.	38·4047
At Demopolis, Ala.	P. B. M. 6.	38·7130
At Columbus, Ky.	P. B. M. 7.	95·9903
At Columbus, Ky.	P. B. M. 8.	93·7818
At Columbus, Ky.	P. B. M. 9.	94·3198
At Columbus, Ky.	P. B. M. 10.	137·7962
Near Worshams Landing, Ky.	P. B. M. 11.	93·4202
Near Worshams Landing, Ky.	P. B. M. 12.	92·2638
Near Hickman, Ky.	P. B. M. 13.	91·8280
At Hickman, Ky.	P. B. M. 14.	109·7292
At Hickman, Ky.	P. B. M. 15.	94·4350
Near Hickman, Ky.	P. B. M. 16.	91·6717
Near Hickman, Ky.	P. B. M. 17.	90·5926
Near Hickman, Ky.	P. B. M. 18.	89·8762
Near Hickman, Ky.	P. B. M. 19.	90·2092
Near Lesters Landing, Tenn.	P. B. M. 20.	89·6902
Near Lesters Landing, Tenn.	P. B. M. 21.	89·3546
At Tiptonville, Tenn.	P. B. M. 22.	88·3617
At Tiptonville, Tenn.	P. B. M. 23.	90·0671
Near Tiptonville, Tenn.	P. B. M. 24.	85·3023
Near Tiptonville, Tenn.	P. B. M. 25.	85·5393
Near Reelfoot Landing, Tenn.	P. B. M. 26.	84·7307
At Mott Landing, Tenn.	P. B. M. 27.	82·3853
Near Booths Point Landing, Tenn.	P. B. M. 28.	82·2755
Near Booths Point, Tenn.	P. B. M. 29.	80·2520
Near Booths Point, Tenn.	P. B. M. 30.	80·1508
Near Booths Point, Tenn.	P. B. M. 31.	80·3734
Near Hales Point, Tenn.	P. B. M. 32.	79·3352
Near Hales Point, Tenn.	P. B. M. 33.	79·0760
Near Hales Point, Tenn.	P. B. M. 34.	77·6395
Near Forked Deer Island, Tenn.	P. B. M. 35.	77·8574
Near Ashport, Tenn.	P. B. M. 36.	77·5522
Near Ashport, Tenn.	P. B. M. 37.	77·4765
Near Ashport, Tenn.	P. B. M. 38.	76·4916
Near Plum Point, Tenn.	P. B. M. 39.	75·9784
Near Plum Point, Tenn.	P. B. M. 40.	75·3251
Near Fort Pillow Landing, Tenn.	P. B. M. 41.	77·3552
Near Fulton, Tenn.	P. B. M. 42.	90·9175
Near Fulton, Tenn.	P. B. M. 43.	75·1955
Near Randolph, Tenn.	P. B. M. 44.	74·1794
Near Randolph, Tenn.	P. B. M. 45.	73·9370
At Randolph, Tenn.	P. B. M. 46.	104·2080
Near Randolph, Tenn.	P. B. M. 47.	119·6061
Near Richardsons Landing, Tenn.	P. B. M. 48.	73·3333
Near Richardsons Landing, Tenn.	P. B. M. 49.	72·2002
Near Paynes Landing, Tenn.	P. B. M. 50.	71·9845
Near Thomas Landing, Tenn.	P. B. M. 51.	72·0131
Near Thomas Landing, Tenn.	P. B. M. 52.	70·6636
Near Brinkleys Landing, Tenn.	P. B. M. 53.	69·0074
Near Island No. 40, Tenn.	P. B. M. 54.	68·2488
Near Island No. 40, Tenn.	P. B. M. 55.	67·4278
Near Memphis, Tenn.	P. B. M. 56.	67·3742

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Cairo, Ill.	P. B. M. 4.	95·0981
At Cairo, Ill.	P. B. M. 5.	95·7327
At Fort Jefferson, Ky.	P. B. M. 6.	97·8799
Near Grafton, Ill.	P. B. M. 1.	128·3610
Near Grafton, Ill.	P. B. M. 2.	130·2174
At Grafton, Ill.	P. B. M. 3.	133·1657
At Grafton, Ill.	P. B. M. 4.	135·9260
At Grafton, Ill.	P. B. M. 5.	135·2847
At Jersey Landing, Ill.	P. B. M. 6.	128·8882
Near Piasa Creek, Ill.	P. B. M. 7.	137·5724
At Alton, Ill.	P. B. M. 8.	130·8012
At Alton, Ill.	P. B. M. 9.	148·3156
Near Alton, Ill.	P. B. M. 10.	129·9002
Near Alton, Ill.	P. B. M. 11.	126·0857
Near Wilsons Island No. 5, Ill.	P. B. M. 12.	139·5157
Near St. Louis, Mo.	P. B. M. 13.	131·4949
At St. Louis, Mo.	P. B. M. 14.	129·9745
At St. Louis, Mo.	P. B. M. 15.	126·9523
At St. Louis, Mo.	P. B. M. 16.	153·2072
At Carondelet, Mo.	P. B. M. 17.	132·5431
At Jefferson Barracks, Mo.	P. B. M. 18.	150·7603
At Cliff Cave, Mo.	P. B. M. 19.	120·0560
Near Cliff Cave, Mo.	P. B. M. 20.	124·9578
Near Jefferson Station, Mo.	P. B. M. 21.	123·9080
At Kimmswick, Mo.	P. B. M. 22.	124·5512
At Sulphur Springs, Mo.	P. B. M. 23.	123·1714
At Illinois, Mo.	P. B. M. 24.	125·6136
At Platin Rock Creek, Mo.	P. B. M. 25.	117·5003
Near Rush Tower, Mo.	P. B. M. 26.	118·5189
At Rush Tower, Mo.	P. B. M. 27.	120·5401
Near Cliff P. O., Mo	P. B. M. 28.	115·4098
Near Cliff P. O., Mo.	P. B. M. 29.	124·8985
Near White Sand Depot Landing, Mo.	P. B. M. 30.	118·5482
Near Ste. Genevieve, Mo.	P. B. M. 31.	122·7654
At Ste. Genevieve, Mo.	P. B. M. 32.	119·0154
At Ste. Genevieve, Mo.	P. B. M. 33.	122·1762
At Quarrytown, Mo.	P. B. M. 34.	117·1153
At Ste. Marys, Mo.	P. B. M. 35.	118·5228
At Ste. Marys, Mo.	P. B. M. 36.	120·6398
Near Ste. Marys, Mo.	P. B. M. 37.	111·9735
At Chester, Ill.	P. B. M. 38.	115·9518
Near Chester, Ill.	P. B. M. 39.	116·1284
Near Chester, Ill.	P. B. M. 40.	111·9130
At Bois Brulé P. O., Mo.	P. B. M. 41.	110·4371
Near Grand Eddy P. O., Mo.	P. B. M. 42.	113·2866
Near Grand Eddy P. O., Mo.	P. B. M. 43.	112·6325
Near Wittenberg, Mo.	P. B. M. 44.	112·4123
At Wittenberg, Mo.	P. B. M. 45.	110·4575
Near Wittenberg, Mo.	P. B. M. 46.	110·3327
Near Tower Rock, Mo.	P. B. M. 47.	104·8642
At Birmingham Point, Mo.	P. B. M. 48.	103·8928
In Cape Girardeau County, Mo.	P. B. M. 49.	104·0622
In Cape Girardeau County, Mo.	P. B. M. 50.	104·0868
Near Bainbridge Creek, Mo.	P. B. M. 51.	102·9952
Near Cape Rock, Mo.	P. B. M. 52.	104·4355
Near Cape Rock, Mo.	P. B. M. 53.	102·6251

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Cape Girardeau, Mo.	P. B. M. 54.	105·6106
At Cape Girardeau, Mo.	P. B. M. 55.	108·6341
At Cape Girardeau, Mo	P. B. M. 56.	100·9858
At Grays Point, Mo.	P. B. M. 57.	104·7667
Near Commerce, Mo.	P. B. M. 58.	104·5384
At Commerce, Mo.	P. B. M. 59.	112·6151
At Commerce, Mo.	P. B. M. 60.	104·3643
At Commerce, Mo.	P. B. M. 61.	110·4918
Near Cairo, Ill.	P. B. M. 62.	98·4689
Near Cairo, Ill.	P. B. M. 63.	102·6578
Near Cairo, Ill.	P. B. M. 64.	101·4027
Near Cairo, Ill.	P. B. M. 65.	97·3216
Near Cairo, Ill.	P. B. M. 66.	95·3388
At Keokuk, Iowa	P. B. M. 1.	150·3888
At Keokuk, Iowa	P. B. M. 2.	150·6038
At Keokuk, Iowa	P. B. M. 3.	155·2416
Near Keokuk, Iowa	P. B. M. 4.	152·2762
At Alexandria, Mo.	P. B. M. 5.	151·8606
At Gregorys Landing, Mo.	P. B. M. 6.	148·6210
Near Gregorys Landing, Mo.	P. B. M. 7.	151·0870
At Canton, Mo.	P. B. M. 8.	150·6378
At Canton, Mo.	P. B. M. 9.	150·4371
Near Lagrange, Mo.	P. B. M. 10.	147·4642
At Lagrange, Mo.	P. B. M. 11.	147·4315
At West Quincy, Mo.	P. B. M. 12.	145·5711
At Fabius River, Mo.	P. B. M. 13.	145·7671
Near Hilton Station, Mo.	P. B. M. 14.	144·6590
Near Hilton Station, Mo.	P. B. M. 15.	143·6034
At Hannibal, Mo.	P. B. M. 16.	149·1178
Near Hannibal, Mo.	P. B. M. 17.	141·6536
At Saverton, Mo.	P. B. M. 18.	141·2329
Near Ashburn, Mo.	P. B. M. 19.	145·6026
Near Ashburn, Mo.	P. B. M. 20.	144·4292
Near Ashburn, Mo.	P. B. M. 21.	139·0585
Near Louisiana, Mo.	P. B. M. 22.	142·8334
At Louisiana, Mo.	P. B. M. 23.	142·8250
At Louisiana, Mo.	P. B. M. 24.	142·5438
At Louisiana, Mo.	P. B. M. 25.	141·1360
Near Clarksville, Mo.	P. B. M. 26.	140·5004
At Clarksville, Mo.	P. B. M. 27.	141·8716
At Clarksville, Mo.	P. B. M. 28.	140·4143
In Illinois, opposite Clarksville, Mo.	P. B. M. 29.	136·7377
In Illinois, opposite Clarksville, Mo.	P. B. M. 30.	136·7215
In Illinois, opposite Clarksville, Mo.	P. B. M. 31.	135·8636
Near Hamburg, Ill.	P. B. M. 32.	142·4535
Near Hamburg, Ill.	P. B. M. 33.	156·8907
Near Hamburg, Ill.	P. B. M. 34.	135·5446
Near Hamburg, Ill.	P. B. M. 35.	133·7687
Near Reds Landing, Ill.	P. B. M. 36.	133·5140
Near Sterling Island, Ill.	P. B. M. 37.	133·4225
Near Hogville Landing, Ill.	P. B. M. 38.	132·5607
At Turners Landing, Ill.	P. B. M. 39.	133·4285
Near Turners Landing, Ill.	P. B. M. 40.	132·4889
At West Point, Ill.	P. B. M. 41.	135·8190
Near Hastings Landing, Ill.	P. B. M. 42.	134·9402
Near Martins Landing, Ill.	P. B. M. 43.	132·7542
Near Millers Landing, Ill.	P. B. M. 44.	132·6295

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Thomas Landing, Ill.	P. B. M. 45.	130·8689
Near Dixons Landing, Ill.	P. B. M. 46.	138·5256
Near Point Landing, Ill.	P. B. M. 47.	131·6896
Near Keokuk, Iowa	P. B. M. 1.	152·8055
At Nashville, Iowa	P. B. M. 2.	154·7410
At Montrose, Iowa	P. B. M. 3.	161·6008
Near Viele Station, Iowa	P. B. M. 4.	165·5196
Near Viele Station, Iowa	P. B. M. 5.	163·7119
Near Viele Station, Iowa	P. B. M. 6.	165·2229
At Fort Madison, Iowa	P. B. M. 7.	162·8424
At Fort Madison, Iowa	P. B. M. 8.	164·4142
Near Fort Madison, Iowa	P. B. M. 9.	166·3422
Near Fort Madison, Iowa	P. B. M. 10.	166·9753
Near Burlington, Iowa	P. B. M. 11.	164·5603
At Burlington, Iowa	P. B. M. 12.	162·0168
At Burlington, Iowa	P. B. M. 13.	165·2479
At Burlington, Iowa	P. B. M. 14.	165·2863
At Burlington, Iowa	P. B. M. 15.	161·5274
At Burlington, Iowa	P. B. M. 16.	162·0145
At Oquawka, Ill.	P. B. M. 17.	163·3771
At Oquawka, Ill.	P. B. M. 18.	166·9876
At Keithsburg, Ill.	P. B. M. 19.	164·4759
At Keithsburg, Ill.	P. B. M. 20.	167·4995
Near New Boston, Ill.	P. B. M. 21.	169·1128
At New Boston, Ill.	P. B. M. 22.	166·1145
At New Boston, Ill.	P. B. M. 23.	173·8623
At Port Louisa, Iowa	P. B. M. 24.	166·1578
Near Muscatine, Iowa	P. B. M. 25.	165·8514
Near Muscatine, Iowa	P. B. M. 26.	167·1047
At Muscatine, Iowa	P. B. M. 27.	167·6873
At Muscatine, Iowa	P. B. M. 28.	168·1470
At Muscatine, Iowa	P. B. M. 29.	168·2851
Near Muscatine, Iowa	P. B. M. 30.	168·6436
Near Muscatine, Iowa	P. B. M. 31.	168·4048
Near Muscatine, Iowa	P. B. M. 32.	171·0382
At Fairport, Iowa	P. B. M. 33.	169·2391
Near Montpelier, Iowa	P. B. M. 34.	168·9498
Near Montpelier, Iowa	P. B. M. 35.	172·0610
Near Montpelier, Iowa	P. B. M. 35a.	169·7732
At Buffalo, Iowa	P. B. M. 36.	172·2505
Near Buffalo, Iowa	P. B. M. 37.	173·3168
At West Davenport, Iowa	P. B. M. 38.	172·8788
Near West Davenport, Iowa	P. B. M. 39.	174·7246
On Arsenal Island, Ill.	P. B. M. 40.	175·9636
At Rock Island, Ill.	P. B. M. 41.	177·1550
Near Moline, Ill.	P. B. M. 42.	173·4205
At Watertown, Ill.	P. B. M. 43.	175·2779
At Hampton, Ill.	P. B. M. 44.	176·8483
At Hampton, Ill.	P. B. M. 45.	173·7932
At Rapids City, Ill.	P. B. M. 46.	175·6910
Near Port Byron, Ill.	P. B. M. 47.	176·8007
At Port Byron, Ill.	P. B. M. 48.	177·2507
At Port Byron, Ill.	P. B. M. 49.	179·0527
At Cordova, Ill.	P. B. M. 50.	174·9038
At Cordova, Ill.	P. B. M. 51.	181·3638
At Albany, Ill.	P. B. M. 52.	181·5483
Near Albany, Ill.	P. B. M. 53.	182·4502

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Albany, Ill.	P. B. M. 54.	176·1487
Near Fulton, Ill.	P. B. M. 55.	177·1426
Near Fulton, Ill.	P. B. M. 56.	177·5270
At Fulton, Ill.	P. B. M. 57.	182·0398
Near Fulton, Ill.	P. B. M. 58.	177·6024
At Fulton, Ill.	B. M. 35.	178·6311
Near Fulton, Ill.	P. B. M. 59.	179·6796
At Thomson, Ill.	P. B. M. 60.	184·7118
Near Savanna, Ill.	P. B. M. 61.	178·8555
At Savanna, Ill.	P. B. M. 62.	180·4298
At Savanna, Ill.	Captain McKenzie's B. M. 34.	180·4308
At Savanna, Ill.	P. B. M. 63.	182·7057
At Savanna, Ill.	P. B. M. 64.	180·9367
Near Hickory Grove, Ill.	P. B. M. 65.	205·3548
At Mount Carroll, Ill.	P. B. M. 66.	248·9651
Near Lanark, Ill.	P. B. M. 67.	240·3646
At Lanark, Ill.	P. B. M. 68.	269·1366
Near Lanark, Ill.	P. B. M. 69.	256·0371
Near Lanark, Ill.	P. B. M. 70.	288·6922
At Forreston, Ill.	P. B. M. 71.	267·2508
At Adeline, Ill.	P. B. M. 72.	228·7837
At Leaf River, Ill.	P. B. M. 73.	216·0477
At Byron, Ill.	P. B. M. 74.	222·2476
Near Byron, Ill.	P. B. M. 75.	211·2682
At Stillman Valley, Ill.	P. B. M. 76.	215·3628
Near Davis Junction, Ill.	P. B. M. 77.	246·3689
At Monroe, Ill.	P. B. M. 78.	256·8455
At Fielding, Ill.	P. B. M. 79.	239·4707
At Kirkland, Ill.	P. B. M. 80.	236·0700
At Kingston, Ill.	P. B. M. 81.	245·2638
At Genoa, Ill.	P. B. M. 82.	255·5405
At Hampshire, Ill.	P. B. M. 83.	274·3340
At Pingree Grove, Ill.	P. B. M. 84.	279·6641
Near Dumser, Ill.	P. B. M. 85.	259·2110
At West Elgin, Ill.	P. B. M. 86.	218·6010
At West Elgin, Ill.	P. B. M. 87.	217·9806
At East Elgin, Ill.	B. M. Newcomb.	227·2565
Near Elgin, Ill.	P. B. M. 88.	219·9336
At Bartlett, Ill.	P. B. M. 89.	244·9873
At Roselle, Ill.	P. B. M. 90.	235·2644
At Itasca, Ill.	P. B. M. 91.	212·9987
At Bensenville, Ill.	P. B. M. 92.	207·5294
At Manheim, Ill.	P. B. M. 93.	198·3622
At Cragin, Ill.	P. B. M. 94.	188·3016
At Chicago, Ill.	P. B. M. 95.	180·2992
At Chicago, Ill.	P. B. M. 96.	182·2936
At Chicago, Ill.	P. B. M. 97.	181·5218
At Chicago, Ill.	P. B. M. 98.	182·3453
At Chicago, Ill.	P. B. M. 99.	180·2230
In Lake Michigan, Ill.	P. B. M. 100.	179·1269
At Chicago, Ill.	B. M. I.	181·4580
At Chicago, Ill.	B. M. II.	180·9705
At Chicago, Ill.	B. M. III.	179·7083
At Chicago, Ill.	B. M. IV.	180·8912
At Chicago, Ill.	B. M. VI.	181·3504
At Chicago, Ill.	B. M. VII.	181·4774
At Chicago, Ill.	B. M. VIII.	180·7116
At Chicago, Ill.	B. M. IX.	180·8124

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Chicago, Ill.	B. M. XIII.	179·4902
At St. Paul, Minn.	T. B. M. 1.	218·3646
At St. Paul, Minn.	P. B. M. 65.	217·6844
At St. Paul, Minn.	P. B. M. 66.	218·9042
At St. Paul, Minn.	P. B. M. 67.	215·9046
At St. Paul, Minn.	P. B. M. 68.	214·2611
At St. Paul, Minn.	Old U. S. B. M. A	215·4777
At St. Paul, Minn.	P. B. M. 70.	214·7101
At St. Paul, Minn.	P. B. M. 71.	215·9320
At St. Paul, Minn.	P. B. M. 72.	237·7402
At St. Paul, Minn.	Old U. S. B. M. 2½.	211·8193
At St. Paul, Minn.	P. B. M. 73.	213·3262
At St. Paul, Minn.	P. B. M. 74.	214·5457
At Daytons Bluff, Minn.	P. B. M. 75.	212·7778
At Daytons Bluff, Minn.	P. B. M. 76.	213·9953
Near Highwood Station, Minn.	T. B. M. 8.	215·7178
Near Highwood Station, Minn.	T. B. M. 9.	212·7120
Near Highwood Station, Minn.	T. B. M. 10.	216·8145
Near Highwood Station, Minn.	P. B. M. 77.	215·2147
Near Highwood Station, Minn.	P. B. M. 78.	216·4333
Near Red Rock, Minn.	T. B. M. 11.	221·3084
At Newport, Minn.	T. B. M. 12.	226·7056
At Newport, Minn.	P. B. M. 79.	225·5346
At Newport, Minn.	P. B. M. 80.	226·7534
At Newport Landing, Minn.	Old U. S. B. M. 12.	211·2281
At St. Paul Park, Minn.	P. B. M. 81.	227·2246
Near St. Paul Park, Minn.	T. B. M. 14.	229·3851
Near St. Paul Park, Minn.	P. B. M. 83.	228·7615
Near St. Paul Park, Minn.	P. B. M. 84.	229·9781
Near Pullman, Minn.	T. B. M. 17.	227·2764
Near head of Nininger Slough, Minn.	P. B. M. 85.	211·4949
Near head of Nininger Slough, Minn.	P. B. M. 86.	212·7188
Near Island 18, Minn.	T. B. M. 22.	211·2688
At foot of Nininger Slough, Minn.	P. B. M. 87.	210·7464
Near mouth of Nininger Slough, Minn.	Old U. S. B. M. 23.	211·6342
Near Hastings, Minn.	T. B. M. 23.	211·5002
Near Hastings, Minn.	P. B. M. 88.	210·8018
Near Hastings, Minn.	P. B. M. 89.	212·0233
Near Hastings, Minn.	P. B. M. 96.	210·6319
At Hastings, Minn.	P. B. M. 97.	211·7506
At Point Douglas, Minn.	T. B. M. 26.	216·0069
At Point Douglas, Minn.	P. B. M. 90.	217·0821
At Prescott, Wis.	T. B. M. 27.	212·7644
At Prescott, Wis.	P. B. M. 91.	211·8416
At Prescott, Wis.	T. B. M. 28.	213·7220
Near Prescott, Wis.	T. B. M. 30.	208·9595
Near Prescott, Wis.	P. B. M. 92.	209·4569
Near Prescott, Wis.	P. B. M. 93.	210·6743
Near Prescott, Wis.	P. B. M. 94.	207·1938
Near Prescott, Wis.	P. B. M. 95.	208·4123
Near Smiths Bar, Wis.	T. B. M. 35.	208·3684
At Smiths Landing, Wis.	P. B. M. 98.	207·4768
At Smiths Landing, Wis.	P. B. M. 99.	208·6955
At Smiths Landing, Wis.	T. B. M. 37.	207·1058
Near Smiths Landing, Wis.	T. B. M. 38.	208·2966
Near Morgans Coulee, Wis.	T. B. M. 39.	209·6217

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Diamond Bluff, Wis.	T. B. M. 40.	211·9628
Near Diamond Bluff, Wis.	T. B. M. 47.	207·1018
Near Diamond Bluff, Wis.	P. B. M. 100.	208·4760
Near Diamond Bluff, Wis.	P. B. M. 101.	209·6929
At Diamond Bluff, Wis	T. B. M. 45.	220·3972
At Diamond Bluff, Wis.	P. B. M. 102.	220·1877
At Diamond Bluff, Wis.	P. B. M. 103.	221·4036
Near Diamond Bluff, Wis.	T. B. M. 46.	221·0312
Near Diamond Bluff, Wis.	P. B. M. 104.	219·5300
Near Diamond Bluff, Wis.	P. B. M. 105.	220·7523
Near Diamond Bluff, Wis.	T. B. M. 48.	220·2455
At Trenton, Wis.	T. B. M. 50.	233·1346
At Trenton Landing, Wis.	T. B. M. 51.	205·9384
At Trenton Landing, Wis.	P. B. M. 106.	205·6150
At Trenton Landing, Wis.	P. B. M. 107.	206·8384
Near Island 24, Wis.	T. B. M. 52.	206·3832
Near Pucketville, Wis.	T. B. M. 53.	206·2803
Near Pucketville, Wis.	P. B. M. 108.	205·4585
Near Pucketville, Wis.	P. B. M. 109.	206·6750
At Pucketville, Wis.	P. B. M. 110.	205·2946
At Pucketville, Wis.	P. B. M. 111.	206·5044
At Red Wing, Minn.	P. B. M. 112.	209·6831
At Red Wing, Minn.	P. B. M. 113.	206·4974
Near Red Wing, Minn.	T. B. M. 57.	209·6784
Near Red Wing, Minn.	T. B. M. 58.	215·7248
Near Red Wing, Minn.	P. B. M. 114.	212·4980
Near Red Wing, Minn.	P. B. M. 115.	213·7132
Near Red Wing, Minn.	T. B. M. 59.	204·9123
Near Red Wing, Minn.	T. B. M. 60.	204·9398
Near Red Wing, Minn.	T. B. M. 61.	204·6408
Near Wacouta, Minn.	P. B. M. 116.	206·1586
Near Wacouta, Minn.	P. B. M. 117.	207·3750
At Wacouta, Minn.	P. B. M. 118.	206·1217
At Wacouta, Minn.	P. B. M. 119.	207·3409
Near Lake Side, Minn.	P. B. M. 120.	205·5873
Near Lake Side, Minn.	P. B. M. 121.	206·8070
Near Lake Side, Minn.	T. B. M. 66.	204·9155
Near Lake Side, Minn.	T. B. M. 67.	204·6835
Near Lake Side, Minn.	T. B. M. 69.	204·3052
Near Lake Side, Minn.	T. B. M. 70.	203·9272
At Lake Side, Minn.	P. B. M. 122.	205·7181
At Lake Side, Minn.	P. B. M. 123.	206·9339
At Florence, Minn.	T. B. M. 76.	208·9228
At Florence, Minn.	P. B. M. 124.	207·1572
At Florence, Minn.	P. B. M. 125.	208·3767
Near Florence, Minn.	T. B. M. 77.	204·9993
At Central Point, Minn.	P. B. M. 126.	205·9372
At Central Point, Minn.	P. B. M. 127.	207·1521
At Lake City, Minn.	P. B. M. 128.	210·2244
At Lake City, Minn.	P. B. M. 129.	210·2525
At Lake City, Minn.	Old U. S. B. M.	205·7998
Near Lake City, Minn.	P. B. M. 130.	210·9608
Near Lake City, Minn.	P. B. M. 131.	212·1819
Near Lake City, Minn.	T. B. M. 84.	208·6075
Near Kings Coulee, Minn.	T. B. M. 86.	207·2536
At Keplers Coulee, Minn.	P. B. M. 132.	207·5237
At Kings Coulee, Minn.	T. B. M. 87.	207·4343
Near Kings Coule, Minn.	P. B. M. 133.	208·1466

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Kings Coule, Minn.	P. B. M. 134.	209·3690
At Dutchmans Coulee, Minn.	T. B. M. 88.	207·0289
Near Kings Coulee, Minn.	T. B. M. 89.	208·4590
Near Reeds Landing, Minn.	T. B. M. 90.	207·6950
Near Reeds Landing, Minn.	P. B. M. 135.	208·8534
Near Reeds Landing. Minn.	P. B. M. 136.	210·0720
Near Roscoes Coulee, Minn.	T. B. M. 91.	208·5079
At Reeds Landing, Minn.	P. B. M. 137.	209·1270
At Reeds Landing, Minn.	T. B. M. 93.	208·3313
At Reeds Landing, Minn.	Old U. S. B. M. A	210·3550
At Reeds Landing, Minn.	P. B. M. 138.	208·8667
At Reeds Landing, Minn.	P. B. M. 139.	210·0825
At Wabasha, Minn.	P. B. M. 140.	210·5021
At Wabasha, Minn.	Old U. S. B. M. 62¼.	206·4928
At Wabasha, Minn.	Old U. S. B. M. E	210·4653
At Wabasha, Minn.	P. B. M. 141.	206·7899
At Wabasha, Minn.	P. B. M. 142.	208·0004
At Teepeeota Point, Minn.	P. B. M. 143.	205·1562
At Teepeeota Point, Minn.	P. B. M. 144.	206·3702
Near Alma, Wis.	P. B. M. 145.	202·3532
Near Alma, Wis.	P. B. M. 146.	203·5702
At Alma, Wis.	T. B. M. 104.	205·4465
At Alma, Wis.	P. B. M. 147.	205·4475
At Alma, Wis.	Old U. S. B. M. 1.	207·4033
At Alma, Wis.	Old U. S. B. M. 3.	207·9993
At Alma, Wis.	P. B. M. 148.	209·5212
At Alma, Wis.	Old U. S. B. M. 4	207·2717
Near Alma, Wis.	T. B. M. 105.	206·7358
Near Alma, Wis.	P. B. M. 149.	205·9610
Near Alma, Wis.	P. B. M. 150.	207·1731
Near Alma, Wis.	T. B. M. 107.	205·4122
Near Alma, Wis.	P. B. M. 151.	203·6943
Near Alma, Wis.	P. B. M. 152.	204·9109
Near Cochrane, Wis.	P. B. M. 153.	204·2013
Near Cochrane, Wis.	P. B. M. 154.	205·4228
Near Fountain City, Wis.	T. B. M. 117.	203·6394
Near Fountain City, Wis.	P. B. M. 155.	200·3944
Near Fountain City, Wis.	P. B. M. 156.	201·6122
Near Fountain City, Wis.	T. B. M. 121.	201·3217
Near Fountain City, Wis.	P. B. M. 157.	199·6332
Near Fountain City, Wis.	P. B. M. 158.	200·8530
At Fountain City, Wis.	T. B. M. 122.	203·0318
At Fountain City, Wis.	Old U. S. B. M. 1 H. W. G.	200·8802
At Fountain City, Wis.	Old U. S. B. M. A	204·9037
At Fountain City, Wis.	P. B. M. 159.	205·8524
Near Fountain City, Wis.	T. B. M. 123.	202·4817
Near Fountain City, Wis.	P. B. M. 160.	203·9531
Near Fountain City, Wis.	P. B. M. 161.	205·1720
Near Island 65, Wis.	T. B. M. 124.	203·4436
At Island 65, Wis.	T. B. M. 125.	201·9237
At Island 65, Wis.	P. B. M. 162.	201·2402
At Island 65, Wis.	P. B. M. 163.	201·9579
Near Island 65, Wis.	T. B. M. 126.	202·7491
Opposite Winona, Minn., in Wis.	T. B. M. 127.	203·7838
Opposite Winona, Minn., in Wis.	P. B. M. 164.	197·3562
Opposite Winona, Minn., in Wis.	P. B. M. 165.	198·5692
At Winona, Minn.	Old U. S. B. M. XVII.	200·8129
At Winona, Minn.	P. B. M. 166.	200·5689

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Winona, Minn.	P. B. M. 167.	201·7207
At Winona, Minn.	New Gauge at Winona.	195·1136
At Winona, Minn.	Old U. S. B. M. b.	200·9353
At Winona, Minn.	Winona City B. M.	200·6100
At Winona, Minn.	Old U. S. B. M.	200·8406
At Winona, Minn.	P. B. M. 168.	203·1057
At Winona, Minn.	Old U. S. B. M. B	200·4753
At Winona, Minn.	Old U. S. B. M. on Liberty and Second streets.	201·5047
At Winona, Minn.	Old U. S. B. M. on Keys's barn.	203·5280
At Winona, Minn.	P. B. M. 169.	202·3553
At Minneopa, Minn.	P. B. M. 170.	198·2136
At Minneopa, Minn.	P. B. M. 171.	199·4304
Near Winona, Minn.	T. B. M. 130.	199·9463
Near Homer, Minn.	T. B. M. 131.	201·3096
Near Homer, Minn.	P. B. M. 172.	200·5661
Near Homer, Minn.	P. B. M. 173.	201·7826
Near Homer, Minn.	T. B. M. 132.	200·6002
Near Homer, Minn.	T. B. M. 133.	201·3167
Near Homer, Minn.	P. B. M. 174.	203·8882
Near Homer, Minn.	P. B. M. 175.	205·1079
Near Lamoille, Minn.	T. B. M. 135.	200·0664
At Lamoille, Minn.	P. B. M. 176.	199·4048
At Lamoille, Minn.	P. B. M. 177.	200·6202
Near Richmond, Minn.	T. B. M. 142.	204·2271
At Richmond, Minn.	P. B. M. 178.	199·8111
At Richmond, Minn.	P. B. M. 179.	201·0309
At Richmond, Minn.	T. B. M. 144.	199·8839
Near Dakota, Minn.	T. B. M. 146.	204·5865
Near Richmond, Minn.	P. B. M. 180.	202·0645
Near Richmond, Minn.	P. B. M. 181.	203·2864
At Dakota, Minn.	P. B. M. 182.	202·0164
At Dakota, Minn.	P. B. M. 183.	203·2354
At Dakota, Minn.	Old U. S. B. M. 131.	198·9562
At Dresbach, Minn.	Old U. S. B. M. 130½.	197·5790
At Dresbach, Minn.	P. B. M. 184.	210·1960
Near Dresbach, Minn.	T. B. M. 151.	201·1220
Near Dresbach, Minn.	P. B. M. 185.	200·0354
Near Dresbach, Minn.	P. B. M. 186.	201·2576
Near Dresbach, Minn.	T. B. M. 153.	202·1737
Near River Junction, Minn.	T. B. M. 154.	201·2551
Near La Crescent, Minn.	P. B. M. 187.	198·9585
Near La Crescent, Minn.	P. B. M. 188.	200·1834
Near La Crescent, Minn.	T. B. M. 155.	196·2710
Near La Crosse, Wis.	Old U. S. B. M. 139.	198·5719
Near La Crosse, Wis.	P. B. M. 189.	199·0797
Near La Crosse, Wis.	P. B. M. 190.	199·1028
At North La Crosse, Wis.	T. B. M. 157.	197·9120
At North La Crosse, Wis.	P. B. M. 191.	197·1980
At North La Crosse, Wis.	T. B. M. 158.	196·8612
At La Crosse, Wis.	La Crosse City B. M.	198·5632
At La Crosse, Wis.	P. B. M. 192.	207·1449
At La Crosse, Wis.	T. B. M. 160.	200·4220
At La Crosse, Wis.	La Crosse City B. M.	195·3774
At La Crosse, Wis.	P. B. M. 193.	196·2832
At La Crosse, Wis.	T. B. M. 161.	201·2989
At La Crosse, Wis.	T. B. M. 162.	205·5039
At La Crosse, Wis.	P. B. M. 194.	198·0135

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At La Crosse, Wis.	P. B. M. 195.	199·2312
Near Stoddard, Wis.	P. B. M. 196.	196·0815
Near Stoddard, Wis.	P. B. M. 197.	197·2951
Near Stoddard, Wis.	T. B. M. 170.	195·9667
Near Stoddard, Wis.	T. B. M. 172.	195·3890
At Stoddard, Wis.	P. B. M. 198.	196·7661
At Warners Landing, Wis.	P. B. M. 199.	194·0963
At Warners Landing, Wis.	P. B. M. 200.	195·3149
At Britts Landing, Wis.	T. B. M. 175.	196·2062
Near Genoa, Wis.	P. B. M. 201.	194·5686
Near Genoa, Wis.	P. B. M. 202.	195·7922
Near Genoa, Wis.	T. B. M. 177.	195·1353
Near Genoa, Wis.	T. B. M. 178.	195·7116
Near Genoa, Wis.	P. B. M. 203.	200·1837
At Genoa, Wis.	Old U. S. B. M. i.	195·0708
Near Genoa, Wis.	T. B. M. 180.	195·6219
Near Genoa, Wis.	P. B. M. 204.	193·3688
Near Genoa, Wis.	P. B. M. 205.	194·5877
At Tippets Landing, Wis.	T. B. M. 186.	195·3784
At Tippets Landing, Wis.	P. B. M. 206.	195·8841
At Tippets Landing, Wis.	P. B. M. 207.	197·1064
At Victory, Wis.	P. B. M. 208.	195·1829
Near Victory, Wis.	T. B. M. 188.	194·5829
Near De Soto, Wis.	P. B. M. 209.	193·0153
Near De Soto, Wis.	P. B. M. 210.	194·2369
Near De Soto, Wis.	T. B. M. 192.	194·4566
At De Soto, Wis.	T. B. M. 193.	195·7120
At De Soto, Wis.	P. B. M. 211.	190·9525
At De Soto, Wis.	P. B. M. 212.	193·9924
Near De Soto, Wis.	T. B. M. 195.	194·0030
Near De Soto, Wis.	P. B. M. 213.	192·5187
Near De Soto, Wis.	P. B. M. 214.	193·7279
Near De Soto, Wis.	T. B. M. 196.	193·7367
Near Rush Creek, Wis.	T. B. M. 197.	193·9619
Near Ferryville, Wis.	T. B. M. 198.	193·0804
Near Ferryville, Wis.	P. B. M. 215.	192·6904
Near Ferryville, Wis.	P. B. M. 216.	193·9110
Near Ferryville, Wis.	T. B. M. 200.	192·8759
At Ferryville, Wis.	P. B. M. 217.	191·6567
At Ferryville, Wis.	P. B. M. 218.	192·8782
Near Ferryville, Wis.	T. B. M. 202.	193·6371
Near Ferryville, Wis.	T. B. M. 204.	191·9427
Near Ferryville, Wis.	P. B. M. 219.	190·3221
Near Ferryville, Wis.	P. B. M. 220.	191·5405
Near Lynxville, Wis.	P. B. M. 221.	191·8982
Near Lynxville, Wis.	P. B. M. 222.	193·1183
Near Lynxville, Wis.	T. B. M. 206.	192·8223
At Lynxville, Wis.	T. B. M. 207.	193·5453
At Lynxville, Wis.	U. S. B. M.	194·3965
At Lynxville, Wis.	P. B. M. 223.	194·5797
Near Lynxville, Wis.	T. B. M. 209.	192·8033
At Viola, Wis.	T. B. M. 211.	192·7533
At Viola, Wis.	P. B. M. 224.	191·9850
At Viola, Wis.	P. B. M. 225.	193·2034
Near Viola, Wis.	T. B. M. 212.	193·4643
Near Viola, Wis.	T. B. M. 213.	193·6197
Near Charme, Wis.	T. B. M. 215.	191·7238
Near Charme, Wis.	P. B. M. 226.	192·2138

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Charme, Wis.	P. B. M. 227.	193·4336
Near Charme, Wis.	P. B. M. 228.	193·6375
At Charme, Wis.	T. B. M. 216.	193·1267
Near Charme, Wis.	T. B. M. 218.	192·5689
Near Charme, Wis.	P. B. M. 229.	192·1174
Near Charme, Wis.	P. B. M. 230.	193·3358
At Prairie du Chien, Wis.	P. B. M. 231.	196·0783
At Prairie du Chien, Wis.	T. B. M. 225.	194·7829
At Prairie du Chien, Wis.	T. B. M. 226.	190·7595
At Prairie du Chien, Wis.	P. B. M. 232.	192·2991
At Prairie du Chien, Wis.	Old U. S. B. M. a.	192·2993
At McGregor, Iowa	T. B. M. 227.	189·1472
At North McGregor, Iowa	P. B. M. 233.	192·3670
At South McGregor, Iowa	T. B. M. 228.	191·6186
At South McGregor, Iowa	P. B. M. 234.	192·4774
At South McGregor, Iowa	P. B. M. 235.	192·8276
Near South McGregor, Iowa	T. B. M. 230.	192·6317
Near South McGregor, Iowa	P. B. M. 236.	191·2921
Near South McGregor, Iowa	P. B. M. 237.	192·5118
Near South McGregor, Iowa	P. B. M. 238.	193·7598
Near South McGregor, Iowa	T. B. M. 231.	191·2272
Near Island 176, Iowa	T. B. M. 232.	190·3911
Near Sny McGill, Iowa	P. B. M. 239.	190·3037
Near Sny McGill, Iowa	P. B. M. 240.	191·4214
At Clayton, Iowa	Old U. S. B. M. b.	189·6928
At Clayton, Iowa	Old U. S. B. M.	190·7889
At Clayton, Iowa	P. B. M. 241.	198·1556
Near Clayton, Iowa	T. B. M. 239.	192·5919
Near Clayton, Iowa	P. B. M. 242.	192·1704
Near Clayton, Iowa	T. B. M. 241.	191·4491
Near Eckard Siding, Iowa	P. B. M. 243.	188·9182
Near Eckard Siding, Iowa	P. B. M. 244.	190·1390
Near Eckard Station, Iowa	T. B. M. 245.	189·8336
Near Guttenberg, Iowa	P. B. M. 245.	188·1629
Near Guttenberg, Iowa	P. B. M. 246.	189·3802
At Guttenberg, Iowa	P. B. M. 247.	192·4462
At Guttenberg, Iowa	P. B. M. 248.	194·4600
At Guttenberg, Iowa	T. B. M. 250.	187·7848
Near Guttenberg, Iowa	T. B. M. 252.	189·8219
Near Guttenberg, Iowa	P. B. M. 249.	187·9490
Near Guttenberg, Iowa	P. B. M. 250.	189·1669
Near Guttenberg, Iowa	T. B. M. 253.	189·5872
Near Guttenberg, Iowa	T. B. M. 254.	192·1691
Near Turkey River Junction, Iowa	T. B. M. 256.	190·3356
At Turkey River Junction, Iowa	P. B. M. 251.	190·8602
At Turkey River, Iowa	T. B. M. 257.	187·8378
At Turkey River Junction, Iowa	P. B. M. 252.	187·8414
Near Turkey River Junction, Iowa	T. B. M. 258.	189·8596
Near Buena Vista, Iowa	P. B. M. 253.	188·0280
Near Buena Vista, Iowa	P. B. M. 254.	189·2472
Near Buena Vista, Iowa	T. B. M. 262.	190·6390
At Buena Vista, Iowa	T. B. M. 264.	191·1000
At Buena Vista, Iowa	P. B. M. 255.	191·1973
Near Buena Vista, Iowa.	T. B. M. 265.	191·3940
Near Buena Vista, Iowa	T. B. M. 267.	191·2508
Near Waupeton, Iowa	P. B. M. 256.	190·0580
Near Waupeton, Iowa	P. B. M. 257.	191·2771
Near Waupeton, Iowa	T. B. M. 269.	191·7812

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Waupeton, Iowa	T. B. M. 270.	190·8251
Near Waupeton, Iowa	P. B. M. 258.	187·6369
Near Waupeton, Iowa	P. B. M. 259.	188·8526
Near Waupeton, Iowa	T. B. M. 273.	190·8686
At Finley Landing, Iowa	P. B. M. 260.	188·5583
At Finley Landing, Iowa	P. B. M. 261.	189·7780
Near Island 207, Iowa	P. B. M. 262.	187·5678
At Frenchtown Landing, Iowa	T. B. M. 277.	187·0724
At Frenchtown Landing, Iowa	P. B. M. 263.	186·1209
At Frenchtown Landing, Iowa	P. B. M. 264.	187·3402
At Specht Ferry, Iowa	Old P. B. M. No. 30.	187·5147
At Specht Ferry, Iowa	Old U. S. B. M. a.	187·6597
At Specht Ferry, Iowa	P. B. M. 265.	186·2826
At Specht Ferry, Iowa	P. B. M. 266.	187·5012
At Specht Ferry, Iowa	T. B. M. 279.	188·2605
Near Specht Ferry, Iowa	T. B. M. 280.	188·4626
Near Specht Ferry, Iowa	P. B. M. 267.	185·7213
Near Specht Ferry, Iowa	P. B. M. 268.	186·9443
2¼ miles above Little Maquoketa River, Iowa	P. B. M. 269.	188·3175
2¼ miles above Little Maquoketa River, Iowa	P. B. M. 270.	189·5444
1½ miles above Little Maquoketa River, Iowa	T. B. M. 283.	187·8594
¾ miles above Edmore, Iowa	P. B. M. 271.	186·5534
¾ miles above Edmore, Iowa	P. B. M. 272.	187·7723
2·3 miles above Eagle Point, Iowa	T. B. M. 287.	186·2774
2·3 miles above Eagle Point, Iowa	P. B. M. 273.	185·3259
2·3 miles above Eagle Point, Iowa	P. B. M. 274.	186·5434
Near Eagle Point, Iowa	T. B. M. 289.	188·3926
At Eagle Point, Iowa	Old U. S. B. M. 23.	181·1311
At Eagle Point, Iowa	T. B. M. 291.	185·5004
At Dubuque, Iowa	P. B. M. 275.	184·5898
At Dubuque, Iowa	P. B. M. 276.	185·2424
At Dubuque, Iowa	P. B. M. 277.	186·4599
At Dubuque, Iowa	T. B. M. 293.	186·1766
At Dubuque, Iowa	T. B. M. 294.	185·6928
At Dubuque, Iowa	P. B. M. 278.	185·7314
At Dubuque, Iowa	T. B. M. 295.	185·0981
At Dubuque, Iowa	P. B. M. 279.	196·4639
At Dubuque, Iowa	City B. M. Julien Ho.	186·6457
At Dubuque, Iowa	City B. M. Jess's store.	185·5329
At Dubuque. Iowa	T. B. M. 296.	185·3552
At Dubuque, Iowa	P. B. M. 280.	188·3164
At East Dubuque, Ill.	Old U. S. B. M. a.	187·4419
At East Dubuque, Ill.	Old U. S. B. M. b.	187·2187
At Dubuque, Iowa	T. B. M. 297.	185·3299
At Dubuque, Iowa	Old U. S. B. M. a.	185·0677
At Dubuque, Iowa	Old U. S. B. M. b.	184·7211
At Dubuque, Iowa	P. B. M. 281.	186·5956
Near Dubuque, Iowa	T. B. M. 299.	186·0823
Near Dubuque, Iowa	P. B. M. 282.	185·8557
Near Dubuque, Iowa	P. B. M. 283.	187·0747
Near Cattes Siding, Iowa	T. B. M. 301.	187·9175
Near Cattes Siding, Iowa	P. B. M. 284.	186·7662
Near Cattes Siding, Iowa	P. B. M. 285.	187·9854
At Cattes Siding, Iowa	T. B. M. 302.	188·0453
Near Cattes Siding, Iowa	T. B. M. 303.	187·3833
Near Cattes Siding, Iowa	T. B. M. 304.	185·0231
Near Cattes Siding, Iowa	Old U. S. B. M. 24.	180·0631
At Shawondasee Club Grounds, Iowa	P. B. M. 286.	183·6383

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Shawondasee Club Grounds, Iowa	P. B. M. 287.	184·8575
Near Massey, Iowa	T. B. M. 307.	185·7465
Near Massey, Iowa	T. B. M. 308.	184·9513
Near Ninemile Island, Iowa	P. B. M. 288.	183·9417
Near Ninemile Island, Iowa	P. B. M. 289.	185·1607
Near Ninemile Island, Iowa	T. B. M. 311.	186·3129
Near Snyders, Iowa	T. B. M. 312.	186·2930
Near Gordons Ferry, Iowa	P. B. M. 290.	184·1364
Near Gordons Ferry, Iowa	P. B. M. 291.	185·3565
Near Gordons Ferry, Iowa	T. B. M. 314.	182·5423
Near Gordons Ferry, Iowa	P. B. M. 292.	183·0055
Near Gordons Ferry, Iowa	P. B. M. 293.	184·2257
Near Gordons Ferry, Iowa	T. B. M. 315.	186·4725
At Gordons Ferry, Iowa	P. B. M. 294.	187·1541
At Gordons Ferry, Iowa	P. B. M. 295.	188·3684
Near Gordons Ferry, Iowa	T. B. M. 318.	186·1962
Near Gordons Ferry, Iowa	P. B. M. 296.	184·9842
Near Gordons Ferry, Iowa	P. B. M. 297.	186·2069
Near Smiths Station, Iowa	T. B. M. 321.	185·1061
Near Smiths Station, Iowa	P. B. M. 298.	183·4416
Near Smiths Station, Iowa	P. B. M. 299.	184·6556
Near Smiths Station, Iowa	T. B. M. 323.	185·4674
Near Smiths Station, Iowa	P. B. M. 300.	184·6765
Near Smiths Station, Iowa	P. B. M. 301.	185·8881
Near North Bellevue, Iowa	P. B. M. 302.	190·8691
Near North Bellevue, Iowa	P. B. M. 303.	180·2739
Near North Bellevue, Iowa	P. B. M. 304.	181·4849
At Bellevue, Iowa	P. B. M. 305.	188·5452
At Bellevue, Iowa	P. B. M. 306.	189·7633
At Bellevue, Iowa	P. B. M. 307.	188·6656
At Bellevue, Iowa	Old U. S. B. M.	181·8798
At Bellevue, Iowa	T. B. M. 326.	185·3306
At Bellevue, Iowa	P. B. M. 308.	186·0933
Near Bellevue, Iowa	P. B. M. 309.	184·3576
Near Bellevue, Iowa	P. B. M. 310.	185·5702
Near Bellevue, Iowa	T. B. M. 329.	184·5258
Near Bellevue, Iowa	T. B. M. 331.	182·9080
Near Bellevue, Iowa	P. B. M. 311.	181·4519
Near Bellevue, Iowa	P. B. M. 312.	182·6687
Near Bellevue, Iowa	P. B. M. 313.	179·4285
Near Bellevue, Iowa	P. B. M. 314.	180·6388
Near Goldens, Iowa	P. B. M. 315.	179·0379
Near Goldens, Iowa	P. B. M. 316.	180·2463
At Harris Landing, Ill.	P. B. M. 317.	186·1519
At Harris Landing, Ill.	P. B. M. 318.	187·3609
At Harris Landing, Ill.	P. B. M. 319.	186·4961
At Harris Landing, Ill.	P. B. M. 320.	187·7146
Near Harris Landing, Ill.	P. B. M. 321.	188·8725
Near Harris Landing, Ill.	P. B. M. 322.	190·0916
Opposite foot of Island 256	P. B. M. 323.	190·1467
Opposite foot of Island 256	P. B. M. 324.	191·3650
Near Arnold Landing, Ill.	P. B. M. 325.	178·6150
Near Arnold Landing, Ill.	P. B. M. 326.	179·8320
At Arnold Landing, Ill.	P. B. M. 327.	186·2904
Near Arnold Landing, Ill.	P. B. M. 328.	180·9715
Near Arnold Landing, Ill.	P. B. M. 329.	182·1806
Near Marcus, Ill.	P. B. M. 330.	177·9790
Near Marcus, Ill.	P. B. M. 331.	179·2003

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Savanna, Ill.	P. B. M. 332.	179·6770
Near Savanna, Ill.	P. B. M. 333.	180·8994
Near Savanna, Ill.	P. B. M. 334.	180·3535
Near Savanna, Ill.	P. B. M. 335.	181·5703
At Savanna, Ill.	Old U. S. B. M. 18.	176·7506
At Savanna, Ill.	P. B. M. 336.	182·4648
At Savanna, Ill.	P. B. M. 337.	178·5079
At Savanna, Ill.	P. B. M. 338.	179·7247
At St. Paul, Minn.	T. B. M. 23.	248·5337
At St. Paul, Minn.	T. B. M. 22.	252·3928
At St. Paul, Minn.	P. B. M. Macalester.	284·3180
	Top of cap over same.	285·5275
At St. Paul, Minn.	T. P. M. 18.	276·9992
At St. Paul, Minn.	T. B. M. 16.	264·9636
At Minneapolis, Minn.	T. B. M. 13.	256·1462
At Minneapolis, Minn.	P. B. M. University Campus.	256·8483
At Minneapolis, Minn.	P. B. M. Pillsbury Hall.	258·5027
At Minneapolis, Minn.	T. B. M. 12.	252·4803
At Minneapolis, Minn.	P. B. M. $\frac{265}{2}$.	242·0867
	Top of cap over same.	243·2997
At Minneapolis, Minn.	P. B. M. Great Northern.	258·4432
At Minneapolis, Minn.	P. B. M. Brewery.	248·8251
At Minneapolis, Minn.	T. B. M. 11.	252·2925
At Minneapolis, Minn.	P. B. M. Gluck.	253·4052
At Minneapolis, Minn.	P. B. M. $\frac{266}{2}$.	253·0526
	Top of cap over same.	254·2661
At Minneapolis, Minn.	T. B. M. 3.	253·9709
Near Minneapolis, Minn.	P. B. M. $\frac{267}{2}$.	253·4991
	Top of cap over same.	254·7062
Near Fridley, Minn.	P. B. M. $\frac{268}{2}$.	258·2616
	Top of cap over same.	259·4736
Near Anoka, Minn.	T. B. M. 27.	270·5782
Near Anoka, Minn.	P. B. M. △ Dunn.	267·3859
	Top of cap over same.	268·6005
Near Anoka, Minn.	T. B. M. 29.	260·7674
Near Anoka, Minn.	P. B. M. $\frac{269}{2}$.	254·6176
	Top of cap over same.	255·8230
Near Anoka, Minn.	P. B. M. △ Powell.	264·4110
	Top of cap over same.	265·6260
Near Anoka, Minn.	P. B. M. $\frac{270}{2}$.	261·0380
	Top of cap over same.	262·2462
At Anoka, Minn.	P. B. M. Anoka.	258·9305
At Anoka, Minn.	P. B. M. $\frac{271}{2}$.	256·7487
	Top of cap over same.	257·9619
Near Anoka, Minn.	P. B. M. $\frac{272}{2}$.	261·3320
	Top of cap over same.	262·5400

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Itasca, Minn.	P. B. M. $\frac{273}{2}$.	268·3031
	Top of cap over same.	269·5135
Near Elk River, Minn.	P. B. M. $\frac{274}{2}$.	270·0646
	Top of cap over same.	271·2710
At Elk River, Minn.	P. B. M. $\frac{275}{2}$.	271·7791
	Top of cap over same.	272·9842
At Elk River, Minn.	P. B. M. Elk River.	266·2908
Near Otsego, Minn.	P. B. M. $\frac{276}{2}$.	273·6909
	Top of cap over same.	274·8970
Near Monticello, Minn.	P. B. M. $\frac{277}{2}$.	271·7619
	Top of cap over same.	272·9656
Near Monticello, Minn.	P. B. M. $\frac{278}{2}$.	282·3364
	Top of cap over same.	283·5273
Near Monticello, Minn.	P. B. M. △ East Base.	283·9384
	Top of cap over same.	285·1525
Near Monticello, Minn.	P. B. M. △ West Base.	283·8230
	Top of cap over same.	285·0304
At Monticello, Minn.	P. B. M. $\frac{279}{2}$.	284·5790
	Top of cap over same.	285·7858
At Monticello, Minn.	T. B. M. 70.	278·3618
Near Monticello, Minn.	P. B. M. $\frac{280}{2}$.	289·5314
	Top of cap over same.	290·7397
Near Monticello, Minn.	P. B. M. $\frac{281}{2}$.	289·0665
	Top of cap over same.	290·2779
Near Bear Island, Minn.	P. B. M. $\frac{282}{2}$.	294·3484
	Top of cap over same.	295·5533
Near Bear Island, Minn.	P. B. M. $\frac{283}{1}$.	295·8036
	Top of cap over same.	297·0115
Near Clearwater, Minn.	P. B. M. $\frac{284}{1}$.	298·7899
	Top of cap over same.	300·0006
Near Clearwater, Minn.	P. B. M. $\frac{285}{2}$.	291·1178
	Top of cap over same.	292·3262
Near Clearwater, Minn.	P. B. M. $\frac{286}{2}$.	304·9483
	Top of cap over same.	306·1550
Near St. Augusta, Minn.	P. B. M. $\frac{287}{1}$.	307·7968
	Top of cap over same.	309·0010
Near St. Cloud, Minn.	P. B. M. $\frac{288}{2}$.	312·6756
	Top of cap over same.	313·8817

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At East St. Cloud, Minn.	P. B. M. $\frac{289}{2}$.	308·4899
	Top of cap over same.	309·6985
At St. Cloud, Minn.	P. B. M. St. Cloud.	314·7989
Near St. Cloud, Minn.	T. B. M. 110.	306·1933
Near Sauk Rapids, Minn.	P. B. M. $\frac{290}{2}$.	305·3539
	Top of cap over same.	306·5615
Near Sauk Rapids, Minn.	T. B. M. 112.	306·9143
Near Sauk Rapids, Minn.	P. B. M. $\frac{291}{2}$.	312·7230
	Top of cap over same.	313·9335
Near Little Rock, Minn.	P. B. M. $\frac{292}{2}$.	312·1118
	Top of cap over same.	313·3195
Near Rice, Minn.	P. B. M. $\frac{293}{2}$.	314·2678
	Top of cap over same.	315·4786
Near Rice, Minn.	P. B. M. △ Back Base.	321·8841
	Top of cap over same.	323·0968
Near Rice, Minn.	P. B. M. △ River Base.	320·7880
	Top of cap over same.	322·0009
Near Rice, Minn.	P. B. M. $\frac{294}{2}$.	321·3976
	Top of cap over same.	322·6096
Near Rice, Minn.	P. B. M. $\frac{295}{2}$.	320·9762
	Top of cap over same.	322·1867
Near North Prairie, Minn.	P. B. M. $\frac{296}{2}$.	318·5420
	Top of cap over same.	319·7501
Near North Prairie, Minn.	P. B. M. $\frac{297}{2}$.	324·7989
	Top of cap over same.	326·0115
Near Royalton, Minn.	P. B. M. $\frac{298}{2}$.	331·4977
	Top of cap over same.	332·7094
Near Royalton, Minn.	P. B. M. $\frac{299}{2}$.	332·9274
	Top of cap over same.	334·1275
Near Little Falls, Minn.	P. B. M. $\frac{300}{2}$.	336·2427
	Top of cap over same.	337·4456
Near Little Falls, Minn.	P. B. M. $\frac{301}{2}$.	339·1004
	Top of cap over same.	340·3108
At Little Falls, Minn.	T. B. M. 152.	339·5360
Near Little Falls, Minn.	P. B. M. $\frac{302}{2}$.	340·9454
	Top of cap over same.	342·1422
At Belle Prairie, Minn.	P. B. M. $\frac{303}{2}$.	343·9220
	Top of cap over same.	345·1343
Near Belle Prairie, Minn.	P. B. M. $\frac{304}{2}$.	346·2408
	Top of cap over same.	347·4512

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Fort Ripley, Minn.	P. B. M. $\frac{305}{2}$.	348·2909
	Top of cap over same.	349·5056
Near Fort Ripley, Minn.	P. B. M. $\frac{306}{2}$.	350·8218
	Top of cap over same.	352·0388
Near Fort Ripley, Minn.	P. B. M. $\frac{307}{2}$.	353·8102
	Top of cap over same.	355·0248
Near Old Fort Ripley, Minn.	P. B. M. $\frac{308}{2}$.	353·6236
	Top of cap over same.	354·8343
Near Island No. 22, Minn.	P. B. M. $\frac{309}{2}$.	360·8253
	Top of cap over same.	362·0356
Near Old Crow Wing Ferry, Minn.	P. B. M. $\frac{310}{2}$.	361·8434
	Top of cap over same.	363·0541
Near Old Crow Wing Ferry, Minn.	P. B. M. $\frac{311}{2}$.	358·8342
	Top of cap over same.	360·0442
Near Brainerd, Minn.	P. B. M. $\frac{312}{2}$.	363·3551
	Top of cap over same.	364·5637
Near Brainerd, Minn.	T. B. M. 195.	377·4028
Near Brainerd, Minn.	T. B. M. 196.	372·4772
At Brainerd, Minn.	P. B. M. $\frac{313}{2}$.	370·6368
	Top of cap over same.	371·8461
At Brainerd, Minn.	P. B. M. Sanitarium.	368·3941
	Top of cap over same.	369·6371
At Brainerd, Minn.	P. B. M. △ South Base.	369·6681
	Top of cap over same.	370·8802
At Brainerd, Minn.	P. B. M. △ North Base.	366·9683
	Top of cap over same.	368·1821
At Brainerd, Minn.	P. B. M. $\frac{314}{2}$.	367·4726
	Top of cap over same.	368·6808
Near Brainerd, Minn.	P. B. M. $\frac{315}{2}$.	370·5682
	Top of cap over same.	371·7815
Near mouth of Rabbit River, Minn.	P. B. M. $\frac{317}{2}$.	368·4873
	Top of cap over same.	369·6931
Near mouth of Rabbit River, Minn.	P. B. M. $\frac{318}{2}$.	377·9012
	Top of cap over same.	379·1081
Near Old Indian Mission, Minn.	P. B. M. $\frac{319}{2}$.	359·3755
	Top of cap over same.	360·5842
Near mouth of Pine River, Minn.	P. B. M. $\frac{320}{2}$.	364·4804
	Top of cap over same.	365·6900
Near Island Lake, Minn.	P. B. M. $\frac{321}{2}$.	362·3827
	Top of cap over same.	363·5866

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Towhead Rapids, Minn.	P. B. M. $\frac{322}{2}$.	364·1683
	Top of cap over same.	365·3792
Near Island No. 1, Minn.	P. B. M. $\frac{323}{2}$.	367·6665
	Top of cap over same.	368·8779
Near Dean Brook, Minn.	P. B. M. $\frac{324}{2}$.	369·2993
	Top of cap over same.	370·5095
Near mouth of Hay Creek, Minn.	P. B. M. $\frac{325}{2}$.	367·4632
	Top of cap over same.	368·6725
Near mouth of Cedar Brook, Minn.	P. B. M. $\frac{326}{2}$.	365·0569
	Top of cap over same.	366·2678
Near Aitkin, Minn.	P. B. M. $\frac{327}{2}$.	365·1948
	Top of cap over same.	366·4009
At Aitkin, Minn.	P. B. M. Court-house.	370·6077
At Aitkin, Minn.	P. B. M. $\frac{328}{2}$.	365·1381
	Top of cap over same.	366·3491
At Aitkin, Minn.	P. B. M. △ Lower Base.	365·2049
	Top of cap over same.	366·4183
At Duluth, Minn.	B. M. 1 of U. S. Engineers.	191·0642
At Duluth, Minn.	B. M. 19 of U. S. Engineers.	185·1379
At Duluth, Minn.	B. M. 23 of U. S. Engineers.	185·7144
At West Duluth, Minn.	B. M. Iron Bay Iron Works.	191·6081
Near Duluth, Minn.	P. B. M. 1.	193·5037
Near Duluth, Minn.	P. B. M. 1A.	194·7160
At Smithville, Minn.	P. B. M. 2.	214·2049
At Smithville, Minn.	P. B. M. 2A.	215·4182
At Short Line Park, Minn.	P. B. M. 3.	291·3072
At Short Line Park, Minn.	P. B. M. 3A.	292·5249
At Thomson, Minn.	P. B. M. 4.	326·2651
At Thomson, Minn.	P. B. M. 4A.	327·4771
At Carlton, Minn.	P. B. M. 5.	332·1122
Near Carlton, Minn.	P. B. M. 6.	339·3408
Near Carlton, Minn.	P. B. M. 6A.	340·5547
Near Barnum, Minn.	P. B. M. 7.	332·5150
Near Barnum, Minn.	P. B. M. 7A.	333·7334
Near Barnum, Minn.	P. B. M. 8.	355·2563
Near Barnum, Minn.	P. B. M. 8A.	356·4663
Near Barnum, Minn.	P. B. M. 9.	360·1605
Near Barnum, Minn.	P. B. M. 9A.	361·3835
At Moose Lake, Minn.	P. B. M. 10.	323·0246
At Moose Lake, Minn.	P. B. M. 10A.	324·2409
At Sturgeon Lake, Minn.	P. B. M. 11.	325·4385
At Sturgeon Lake, Minn.	P. B. M. 11A.	326·6618
At Willow River, Minn.	P. B. M. 12.	313·1163
At Willow River, Minn.	P. B. M. 12A.	314·3308
At Kettle River, Minn.	P. B. M. 13.	314·0792
At Kettle River, Minn.	P. B. M. 13A.	315·2943
At Miller, Minn.	P. B. M. 14.	344·3197
At Miller, Minn.	P. B. M. 14A.	345·5318

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Sandstone Junction, Minn.	P. B. M. 15.	341·1074
At Sandstone Junction, Minn.	P. B. M. 15A.	342·3264
At Hinckley, Minn.	P. B. M. 16.	313·7526
At Hinckley, Minn.	P. B. M. 17.	314·0410
At Hinckley, Minn.	P. B. M. 17A.	315·2609
At Mission Creek, Minn.	P. B. M. 18.	300·6568
At Mission Creek, Minn.	P. B. M. 18A.	301·8771
At Browns Hill, Minn.	P. B. M. 19.	296·7102
At Browns Hill, Minn.	P. B. M. 19A.	297·9290
At Pine City, Minn.	P. B. M. 20.	289·1717
At Pine City, Minn.	P. B. M. 21.	288·3889
At Pine City, Minn.	P. B. M. 21A.	289·6097
At Brock Creek, Minn.	P. B. M. 22.	284·7704
At Brock Creek, Minn.	P. B. M. 22A.	285·9903
At Rush City, Minn.	P. B. M. 23.	279·1351
At Rush City, Minn.	P. B. M. 23A.	280·3514
At Rush City, Minn.	P. B. M. 24.	280·2091
At Harris, Minn.	P. B. M. 25.	273·6464
At Harris, Minn.	P. B. M. 25A.	274·8577
At North Branch, Minn.	P. B. M. 26.	272·6047
At North Branch, Minn.	P. B. M. 27.	272·1238
At North Branch, Minn.	P. B. M. 27A.	273·3423
At Stacy, Minn.	P. B. M. 28.	271·6371
At Stacy, Minn.	P. B. M. 28A.	272·8514
At Wyoming, Minn.	P. B. M. 29.	270·5427
At Wyoming, Minn.	P. B. M. 29A.	271·7595
At Forest Lake, Minn.	P. B. M. 30.	278·9559
At Forest Lake, Minn.	P. B. M. 31.	277·3781
At Forest Lake, Minn.	P. B. M. 31A.	278·6017
At Forest Lake, Minn.	P. B. M. 32.	277·3274
At Forest Lake, Minn.	P. B. M. 32A.	278·5433
At Centerville, Minn.	P. B. M. 33.	284·0555
At Centerville, Minn.	P. B. M. 33A.	285·2732
At Bald Eagle Junction, Minn.	P. B. M. 34.	282·9648
At Bald Eagle Junction, Minn.	P. B. M. 34A.	284·1779
At White Bear, Minn.	P. B. M. 35.	286·1265
At White Bear, Minn.	P. B. M. 36.	285·1446
At White Bear, Minn.	P. B. M. 36A.	286·3629
At White Bear, Minn.	P. B. M. 37.	285·0874
At White Bear, Minn.	P. B. M. 37A.	286·3032
Near White Bear, Minn.	P. B. M. 38.	282·1946
Near White Bear, Minn.	P. B. M. 38A.	283·4136
Near White Bear, Minn.	T. B. M. 185.	275·3519
At Gladstone, Minn.	P. B. M. 39.	273·2005
At Gladstone, Minn.	P. B. M. 39A.	274·4174
At Gladstone, Minn.	P. B. M. 40.	272·7759
At Gladstone, Minn.	P. B. M. 40A.	273·9855
At St. Paul, Minn.	T. B. M. 193.	216·8540
At Escanaba, Mich.	B. M. 1 (Escanaba), (1874).	180·7760
At Escanaba, Mich.	B. M. 3 (1876).	178·7978
At Maple Ridge, Mich.	B. M. 4 (1876).	292·2215
At Sands, Mich.	B. M. 5 (1876).	366·4374
At Marquette, Mich.	B. M. 6 (1876).	191·3973
At Marquette, Mich.	B. M. 1 (Marquette), (1871).	185·9353
At Marquette, Mich.	B. M. 2 (Marquette), (1874).	185·7829
At Marquette, Mich.	B. M. 3 (Marquette), (1874).	185·7586

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Columbia Bottom, Mo.	P. B. M. $2 = \frac{1}{1}$.	129·9400
	Top of cap over same.	131·1794
At Columbia Bottom, Mo.	P. B. M. 3.	131·1380
At Columbia Bottom, Mo.	T. B. M. 2.	130·9278
Near Fort Bellefontaine, Mo.	P. B. M. $4 = \frac{2}{1}$.	131·1408
	Top of cap over same.	132·3794
Near Mouth of Cold Water Creek, Mo.	P. B. M. 5.	131·3204
At Jamestown Landing, Mo.	P. B. M. 6.	128·4336
Near Jamestown Landing, Mo.	P. B. M. 7.	132·1112
	Top of cap over same.	133·3451
Near Jamestown Landing, Mo.	P. B. M. 8.	127·4250
Near Jamestown Landing, Mo.	P. B. M. $9 = \frac{3}{1}$.	134·5307
	Top of cap over same.	135·7704
Near Musics Ferry, Mo.	P. B. M. 10.	138·9113
Near Musics Ferry, Mo.	P. B. M. 11.	132·1624
	Top of cap over same.	133·4019
Near Musics Ferry, Mo.	P. B. M. 12; old P. B. M. 11, 1887.	133·7887
At Musics Ferry, Mo.	P. B. M. 13.	137·0209
At Musics Ferry, Mo.	P. B. M. $14 = \frac{4}{1}$.	134·3173
	Top of cap over same.	135·5554
Near Musics Ferry, Mo.	P. B. M. 15.	135·7078
	Top of cap over same.	136·9451
At Charbonnier Point, Mo.	P. B. M. $16 = \frac{5}{1}$.	132·5830
	Top of cap over same.	133·8196
Near St. Charles, Mo.	P. B. M. 17.	133·3528
	Top of cap over same.	134·5893
Near St. Charles, Mo.	P. B. M. 18.	132·7006
	Top of cap over same.	133·9320
At St. Charles, Mo.	P. B. M. 19.	139·0842
At St. Charles, Mo.	P. B. M. 20; old B. M. 17.	135·3488
At St. Charles, Mo.	T. B. M. 23.	137·1098
At St. Charles, Mo.	T. B. M. 24 = gauge B. M.	136·3833
At St. Charles, Mo.	P. B. M. $21 = \frac{6}{2}$.	135·7351
	Top of cap over same.	136·9712
At St. Charles, Mo.	T. B. M. 25. City B. M.	139·0314
Near St. Charles, Mo.	T. B. M. 32.	138·8135
Near St. Charles, Mo.	P. B. M. $22 = \frac{6}{1}$.	146·3566
	Top of cap over same.	147·5948
Near St. Charles, Mo.	P. B. M. 23.	136·2817
	Top of cap over same.	137·5232
Near Creve Cœur Lake, Mo.	P. B. M. $24 = \frac{7}{2}$.	137·0894
	Top of cap over same.	138·3291
Near Creve Cœur Lake, Mo.	P. B. M. 25.	136·1977
	Top of cap over same.	137·4367
Near Creve Cœur Lake, Mo.	P. B. M. 26.	139·0416
Near Mona, Mo.	T. B. M. 45.	138·1482
At Mona, Mo.	P. B. M. $27 = \frac{8}{1}$.	137·4371
	Top of cap over same.	138·6755

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Drew, Mo.	P. B. M. 28.	141·1062
	Top of cap over same.	142·3421
At Drew, Mo.	T. B. M. 51.	140·5055
At Gumbo, Mo.	P. B. M. 29 = $\frac{9}{1}$.	141·4198
	Top of cap over same.	142·6549
At Stevens, Mo.	P. B. M. 30.	140·3053
	Top of cap over same.	141·5435
At Bon Homme, Mo.	P. B. M. 31 = $\frac{10}{1}$.	140·3075
	Top of cap over same.	141·5453
At Bon Homme, Mo.	P. B. M. 32.	144·3531
At Bon Homme, Mo.	T. B. M. 56.	140·8456
At Centaur, Mo.	P. B. M. 33.	140·2711
	Top of cap over same.	141·5059
Near Centaur, Mo.	P. B. M. 34.	143·3044
Near Port Royal, Mo.	T. B. M. 61.	143·9733
At Port Royal, Mo.	P. B. M. 35 = $\frac{11}{1}$.	144·6443
	Top of cap over same.	145·8864
At Port Royal, Mo.	T. B. M. 62.	144·1970
Near Port Royal, Mo.	T. B. M. 63.	145·6732
Near Port Royal, Mo.	P. B. M. 36.	146·0406
	Top of cap over same.	147·2789
Near Port Royal, Mo.	P. B. M. 37.	154·0624
At St. Albans, Mo.	P. B. M. 38 = $\frac{12}{1}$.	146·0637
	Top of cap over same.	147·3001
Near Becker, Mo.	T. B. M. 69.	149·8459
Near Becker, Mo.	P. B. M. 39.	146·9814
	Top of cap over same.	148·2207
Near Becker, Mo.	P. B. M. 40.	145·7825
Near Becker, Mo.	P. B. M. 41.	142·0246
	Top of cap over same.	143·2620
Near Labaddie, Mo.	P. B. M. 42.	149·5054
Near Boles, Mo.	P. B. M. 43 = $\frac{13}{1}$.	142·8048
	Top of cap over same.	144·0410
Near Boles, Mo.	T. B. M. 78.	148·9954
Near Boles, Mo.	P. B. M. 44.	148·0441
Near Boles, Mo.	T. B. M. 80.	147·5498
At Boles, Mo.	T. B. M. 81.	148·0958
Near Boles, Mo.	P. B. M. 45.	144·5126
	Top of cap over same.	145·7441
Near Boles, Mo.	T. B. M. 83.	148·8179
Near South Point, Mo.	T. B. M. 84.	148·6261
Near South Point, Mo.	T. B. M. 85.	147·0138
Near South Point, Mo.	P. B. M. 46 = $\frac{14}{1}$.	147·7114
	Top of cap over same.	148·9461
Near South Point, Mo.	T. B. M. 86.	148·0948
Near South Point, Mo.	P. B. M. 47.	150·2325
Near South Point, Mo.	T. B. M. 87.	148·3140
Near South Point, Mo.	T. B. M. 88.	147·2292
At South Point, Mo.	P. B. M. 48.	147·6034
	Top of cap over same.	148·8426
At South Point, Mo.	T. B. M. 89.	148·9799
Near Washington, Mo.	T. B. M. 90.	149·1197
At Washington, Mo.	P. B. M. 50.	150·4989

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Washington, Mo.	T. B. M. 92.	149·6942
At Washington, Mo.	T. B. M. 94 = Old B. M. 75, 1879.	151·7312
At Washington, Mo.	T. B. M. 95.	151·9381
At Washington, Mo.	P. B. M. 51 = $\frac{15}{1}$.	151·1484
	Top of cap over same.	152·3854
At Washington, Mo.	T. B. M. 96 = Old B. M. 42a.	149·5194
Near Washington, Mo.	T. B. M. 97.	150·0048
Near Washington, Mo.	P. B. M. 52.	152·8398
Near Washington, Mo.	T. B. M. 98.	151·5128
Near Washington, Mo.	P. B. M. 53.	148·7820
	Top of cap over same.	150·0168
Near Washington, Mo.	T. B. M. 99 = Old B. M. 43a.	150·0660
Near Washington, Mo.	T. B. M. 100.	152·0317
Near Dundee, Mo.	P. B. M. 54 = $\frac{16}{1}$.	151·3481
	Top of cap over same.	152·5852
Near Dundee, Mo.	T. B. M. 105.	151·5333
Near Dundee, Mo.	P. B. M. 55.	152·0248
	Top of cap over same.	153·2578
Near Dundee, Mo.	T. B. M. 106.	152·9638
Near Dundee, Mo.	P. B. M. 56.	154·1184
At Dundee, Mo.	P. B. M. 57 = $\frac{17}{1}$.	147·3176
	Top of cap over same.	148·5572
At Dundee, Mo.	T. B. M. 108 = Old B. M. 46 (b).	151·0544
At Dundee, Mo.	T. B. M. 107 = Old R. R. B. M.	152·9083
At Dundee, Mo.	T. B. M. 109 = Old B. M. 46a.	152·9273
At Kent, Mo.	T. B. M. 110.	152·8325
Near Kent, Mo.	T. B. M. 111 = Old B. M. 47.	152·7645
Near Kent, Mo.	T. B. M. 112.	153·5990
Near New Haven, Mo.	P. B. M. 58.	154·0637
	Top of cap over same.	155·3020
Near New Haven, Mo.	T. B. M. 113.	153·6485
Near New Haven, Mo.	P. B. M. 59.	155·2661
Near New Haven, Mo.	T. B. M. 114.	154·6486
At New Haven, Mo.	P. B. M. 60 = $\frac{18}{1}$.	153·7380
	Top of cap over same.	154·9786
At New Haven, Mo.	T. B. M. 115.	155·3452
At New Haven, Mo.	T. B. M. 116.	154·2009
Near New Haven, Mo.	P. B. M. 61.	156·4285
Near Etlah, Mo.	T. B. M. 118.	154·9240
Near Etlah, Mo.	P. B. M. 62.	154·3311
	Top of cap over same.	155·5710
Near Etlah, Mo.	T. B. M. 119.	155·1202
Near Etlah, Mo.	T. B. M. 120.	155·0780
At Etlah, Mo.	P. B. M. 63 = $\frac{19}{1}$.	155·9300
	Top of cap over same.	157·1721
Near Etlah, Mo.	T. B. M. 122.	155·6687
Near Etlah, Mo.	T. B. M. 123 = Old R. R. B. M.	154·5290
Near Berger, Mo.	T. B. M. 125.	155·9377
Near Berger, Mo.	P. B. M. 64.	156·7966
	Top of cap over same.	158·0286
Near Berger, Mo.	T. B. M. 126.	155·2342
Near Berger, Mo.	P. B. M. 65.	157·0072

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Berger, Mo.	P. B. M. 66 = $\frac{20}{1}$.	154·8757
	Top of cap over same.	156·1124
Near Berger, Mo.	T. B. M. 128.	155·8341
Near Hermann, Mo.	P. B. M. 67.	154·7528
	Top of cap over same.	155·9921
Near Hermann, Mo.	T. B. M. 129.	155·9869
Near Hermann, Mo.	T. B. M. 130.	157·0460
Near Hermann, Mo.	P. B. M. 68.	155·8446
	Top of cap over same.	157·0799
Near Hermann, Mo.	T. B. M. 132.	156·1054
Near Hermann, Mo.	P. B. M. 69.	158·1963
Near Hermann, Mo.	T. B. M. 133.	156·9363
At Hermann, Mo.	P. B. M. 70 = $\frac{21}{1}$.	155·7991
	Top of cap over same.	156·0330
At Hermann, Mo.	P. B. M. 71.	155·7444
At Hermann, Mo.	T. B. M. 135.	158·2143
At Hermann, Mo.	P. B. M. 72 = Old B. M. 59.	157·7283
Near Hermann, Mo.	P. B. M. 73.	159·5087
	Top of cap over same.	160·7483
Near Hermann, Mo.	T. B. M. 136.	157·6864
Near Hermann, Mo.	T. B. M. 137.	159·1934
Near Hermann, Mo.	P. B. M. 74.	157·5863
Near Gasconade, Mo.	T. B. M. 139.	160·2324
Near Gasconade, Mo.	T. B. M. 141.	159·6744
Near Gasconade, Mo.	P. B. M. 75 = $\frac{22}{1}$.	159·6916
	Top of cap over same.	160·9294
Near Gasconade, Mo.	T. B. M. 140.	157·5836
Near Gasconade, Mo.	P. B. M. 76.	158·8192
	Top of cap over same.	160·0550
Near Gasconade, Mo.	T. B. M. 142 = Old R. R. B. M.	158·0956
Near Gasconade, Mo.	T. B. M. 143.	160·4597
At Gasconade, Mo.	T. B. M. 144, Gasconade Survey B. M. 1879.	159·7062
At Gasconade, Mo.	P. B. M. 77.	159·7027
Near Gasconade, Mo.	T. B. M. 145.	160·4667
Near Gasconade, Mo.	T. B. M. 146.	157·8317
Near Gasconade, Mo.	P. B. M. 78 = $\frac{23}{1}$.	160·6832
	Top of cap over same.	161·9207
Near Gasconade, Mo.	P. B. M. 79.	159·6734
Near Morrison, Mo.	T. B. M. 148.	159·5633
Near Morrison, Mo.	T. B. M. 149 = Old R. R. B. M.	160·1341
At Morrison, Mo.	P. B. M. 80.	160·8327
	Top of cap over same.	161·0706
At Morrison, Mo.	P. B. M. 81.	162·2305
At Morrison, Mo.	T. B. M. 150.	161·1273
Near Morrison, Mo.	T. B. M. 151.	160·2220
Near Morrison, Mo.	P. B. M. 82.	162·7086
Near Morrison, Mo.	P. B. M. 83 = $\frac{24}{1}$.	162·4487
	Top of cap over same.	163·6855
Near Morrison, Mo.	T. B. M. 153.	162·5559
Near Chamois, Mo.	T. B. M. 154.	161·3355
Near Chamois, Mo.	T. B. M. 155.	161·6537
Near Chamois, Mo.	P. B. M. 84.	160·9510
	Top of cap over same.	162·1890

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Chamois, Mo.	T. B. M. 157.	164·5392
Near Chamois, Mo.	T. B. M. 158.	162·3038
At Chamois, Mo.	P. B. M. 85.	164·0168
At Chamois, Mo.	P. B. M. 86=$\frac{25}{1}$.	161·7050
	Top of cap over same.	162·9479
Near Chamois, Mo.	T. B. M. 160=Old R. R. B. M.	163·1733
Near Deer Creek, Mo.	P. B. M. 87.	163·6620
	Top of cap over same.	164·9059
Near Deer Creek, Mo.	T. B. M. 161.	165·1250
Near Deer Creek, Mo.	P. B. M. 88.	162·3745
Near St. Aubert, Mo.	P. B. M. 89=Old B. M. 74.	161·5517
Near St. Aubert, Mo.	T. B. M. 163.	162·5796
Near St. Aubert, Mo.	T. B. M. 164.	164·7397
At St. Aubert, Mo.	P. B. M. 90=$\frac{26}{1}$.	164·7719
	Top of cap over same.	166·0138
At Shipley Landing, Mo.	P. B. M. 91.	164·1208
	Top of cap over same.	165·3594
At Shipley Landing, Mo.	T. B. M. 167.	165·6463
Near Loose Creek, Mo.	T. B. M. 168.	166·7318
At Isbell, Mo.	P. B. M. 92=$\frac{27}{1}$ Isbell.	161·9368
	Top of cap over same.	163·1703
At Isbell, Mo.	P. B. M. 93.	167·2794
At Isbell, Mo.	T. B. M. 169.	166·4806
Near Isbell, Mo.	T. B. M. 170.	167·9622
Near Bonnots Mill, Mo.	T. B. M. 171=Old R. R. B. M.	165·2384
Near Bonnots Mill, Mo.	P. B. M. 94.	163·2418
	Top of cap over same.	164·4772
Near Bonnots Mill, Mo.	T. B. M. 172.	164·3533
Near Bonnots Mill, Mo.	T. B. M. 173.	166·2896
At Bonnots Mill, Mo.	T. B. M. 174.	166·5305
At Bonnots Mill, Mo.	T. B. M. 175=Old R. R. B. M.	165·9531
At Bonnots Mill, Mo.	P. B. M. 95=$\frac{28}{1}$.	162·3171
	Top of cap over same.	163·5561
Near Osage, Mo.	T. B. M. 178=Old B. M. 81.	165·9952
Near Osage, Mo.	T. B. M. 177=Old B. M. 80.	166·0190
Near Bonnots Mill, Mo.	P. B. M. 96.	167·2649
Near Osage, Mo.	T. B. M. 179.	165·3752
Near Osage City, Mo.	P. B. M. 97.	164·3953
	Top of cap over same.	165·6370
Near Osage City, Mo.	T. B. M. 180=Old R. R. B. M.	165·8311
At Osage City, Mo.	P. B. M. 98.	166·6766
At Osage City, Mo.	T. B. M. 182=Old R. R. B. M.	166·6820
At Osage City, Mo.	P. B. M. 99.	167·0844
	Top of cap over same.	168·3235
At Osage City, Mo.	T. B. M. 183.	168·5845
Near Osage City, Mo.	T. B. M. 184=Old R. R. B. M.	170·3091
At Ewings Landing, Mo.	P. B. M. 100=$\frac{29}{1}$.	165·2663
	Top of cap over same.	166·5105
Near Jefferson City, Mo.	P. B. M. 101.	177·1770
Near Jefferson City, Mo.	P. B. M. 102.	174·1069
	Top of cap over same.	175·3440
Near Jefferson City, Mo.	T. B. M. 190.	174·1865
Near Jefferson City, Mo.	T. B. M. 191.	169·6718
Near Jefferson City, Mo.	T. B. M. 192.	169·6764

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Jefferson City, Mo.	P. B. M. 103.	167·0404
	Top of Cap over same.	168·2783
At Jefferson City, Mo.	T. B. M. 193=Old B. M. 88.	169·7330
Near Jefferson City, Mo.	P. B. M. 104.	170·4350
Near Jefferson City, Mo.	T. B. M. 194.	169·5439
At Jefferson City, Mo.	T. B. M. 195.	169·2920
At Jefferson City, Mo.	T. B. M. 196. Gauge B. M. 1st.	169·4302
At Jefferson City, Mo.	City B. M.	194·3193
At Jefferson City, Mo.	T. B. M. 197.	191·4484
At Jefferson City, Mo.	P. B. M. 105.	170·7230
At Jefferson City, Mo.	T. B. M. 199.	169·2169
At Jefferson City, Mo.	T. B. M. 198=Old B. M. 90a (c) Gauge B. M. 2d.	165·2395
At Jefferson City, Mo,	T. B. M. 200.	170·0368
At Jefferson City, Mo.	T. B. M. 201=Old B. M. 90 (b) Gauge B. M. P. H.	166·2796
At Jefferson City, Mo.	P. B. M. 107=$\frac{30}{1}$.	168·7525
	Top of cap over same.	169·9903
Near Jefferson City, Mo.	T. B. M. 202.	170·8619
Near Jefferson City, Mo.	P. B. M. 108.	168·5805
	Top of cap over same.	169·8193
Near Jefferson City, Mo.	T. B. M. 203=Old B. M.	169·1019
Near Jefferson City, Mo.	T. B. M. 204.	169·6163
Near Grays Creek, Mo.	P. B. M. 109.	171·8037
Near Grays Creek, Mo.	T. B. M. 205.	170·8798
Near Grays Creek, Mo.	T. B. M. 206.	170·9875
At Grays Creek, Mo.	T. B. M. 207=Old R. R. B. M.	169·8305
At Grays Creek, Mo.	P. B. M. 110=$\frac{31}{1}$.	171·9178
	Top of cap over same.	173·1606
Near Grays Creek, Mo.	T. B. M. 209.	165·0229
Near Claysville, Mo.	T. B. M. 213.	168·6214
Near Claysville, Mo.	P. B. M. 111.	169·3417
Near Claysville, Mo.	P. B. M. 112.	167·7461
	Top of cap over same.	168·9836
Near Claysville, Mo.	P. B. M. 113=$\frac{32}{1}$.	171·6969
	Top of cap over same.	172·9357
Near Stanleys Landing, Mo.	T. B. M. 218.	169·1036
At Sugar Loaf Rock, Mo.	P. B. M. 114.	173·6592
Near Marion, Mo.	P. B. M. 115.	169·2107
	Top of cap over same.	170·4479
Near Marion, Mo.	T. B. M. 220.	170·8527
Near Bull Rock, Mo.	T. B. M. 223.	167·2937
At Bull Rock, Mo.	P. B. M. 116.	169·0601
At Bull Rock, Mo.	P. B. M. 117.	174·4072
	Top of cap over same.	175·6446
Near Marion, Mo.	T. B. M. 224.	168·2460
Near Marion, Mo.	T. B. M. 225.	167·2924
Near Marion, Mo.	T. B. M. 226.	169·8573
At Marion, Mo.	P. B. M. 118=$\frac{33}{1}$.	175·0279
	Top of cap over same.	176·2686
At Marion, Mo.	P. B. M. 119.	170·9727
At Marion, Mo.	T. B. M. 230.	166·5462
Near Marion, Mo.	T. B. M. 232.	168·9808
At Moniteau Creek, Mo.	P. B. M. 120.	172·5341
	Top of cap over same.	173·7750

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Sandy Hook Landing, Mo.	T. B. M. 236.	172·0232
Near Sandy Hook Landing, Mo.	P. B. M. 121.	171·0231
At Sandy Hook Landing, Mo.	P. B. M. 122=$\frac{34}{1}$.	177·2146
	Top of cap over same.	178·4555
Near Sandy Hook Landing, Mo.	P. B. M. 123.	172·8174
Near Sandy Hook Landing, Mo.	T. B. M. 240.	171·5027
Near Geigers Landing, Mo.	T. B. M. 241.	169·9573
At Geigers Landing, Mo.	P. B. M. 124.	177·2505
	Top of cap over same.	178·4877
At Geigers Landing, Mo.	P. B. M. 125.	175·4704
At Geigers Landing, Mo.	T. B. M. 242.	173·7687
Near Geigers Landing, Mo.	T. B. M. 243.	174·3001
Near Wolf Point, Mo.	P. B. M. 126=$\frac{35}{1}$.	176·5179
	Top of cap over same.	177·7573
At Wolf Point, Mo.	P. B. M. 127=$\frac{36}{1}$.	179·0229
	Top of cap over same.	180·2634
At Wolf Point, Mo.	T. B. M. 250.	177·1676
At Wolf Point, Mo.	P. B. M. 128.	184·7523
At Mount Vernon Landing, Mo.	P. B. M. 129.	179·2145
	Top of cap over same.	180·4507
At Mount Vernon Landing, Mo.	T. B. M. 253.	172·2495
At Mount Vernon Landing, Mo.	P. B. M. 130.	175·6877
Near Terrapin Island, Mo.	P. B. M. 131=$\frac{37}{1}$.	177·7276
	Top of cap over same.	178·9696
Near Rocheport, Mo.	P. B. M. 132.	175·9323
	Top of cap over same.	177·1696
Near Overton, Mo.	P. B. M. 133=$\frac{38}{1}$.	180·8432
	Top of cap over same.	182·0858
Near Boonville, Mo.	P. B. M. 134.	179·7160
Near Elliotts Landing, Mo.	P. B. M. 135.	179·1526
	Top of cap over same.	180·3900
At Elliotts Landing, Mo.	P. B. M. 136.	181·3756
At Elliotts Landing, Mo.	P. B. M. 137=$\frac{39}{1}$.	182·3414
	Top of cap over same.	183·5789
Near Franklin Island, Mo	T. B. M. 271.	175·9872
Near Boonville, Mo.	P. B. M. 138.	178·4590
Near Boonville, Mo.	P. B. M. 139.	177·4216
	Top of cap over same.	178·6647
Near Boonville, Mo,	T. B. M. 276.	178·4885
Near Boonville, Mo.	P. B. M. 140=$\frac{40}{1}$.	179·1898
	Top of cap over same.	180·4262
At Boonville, Mo.	T. B. M. 279.	182·8183
At Boonville, Mo.	High-water mark, 1844.	182·6404
At Boonville, Mo.	P. B. M. 144=Old B. M. 121.	178·9329
At Boonville, Mo.	U. S. Signal Service gauge.	172·5685
At Boonville, Mo.	High water, 1844.	182·5772
At Boonville, Mo.	P. B. M. 141.	181·8824
At Boonville, Mo.	P. B.M. 142=40½, Boonville.	181·6774
	Top of cap over same.	182·9188
At Boonville, Mo.	T. B. M. 280.	186·2695
At Boonville, Mo.	P. B. M. 143.	186·2708
At Boonville, Mo.	P. B. M. 145.	185·4036

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Franklin, Mo.	P. B. M. 146.	180·9759
	Top of cap over same.	182·2181
Near Boonville, Mo.	P. B. M. 147=$\frac{41}{3}$ (new position).	181·9155
	Top of cap over same.	183·1513
Near Boonville, Mo.	T. B. M. 286.	183·9686
Near Boonville, Mo.	P. B. M. 148.	183·1074
	Top of cap over same.	184·3465
Near Lisbon, Mo.	P. B. M. 149.	184·3759
	Top of cap over same.	185·6132
Near Lisbon, Mo.	P. B. M. 150.	183·6707
Near Lisbon, Mo.	P. B. M. 151=$\frac{43}{3}$.	189·0160
	Top of cap over same.	190·2549
Near Lisbon, Mo,	T. B. M. 295.	183·7214
Near Lisbon, Mo.	P. B. M. 152=$\frac{44}{3}$.	187·3197
	Top of cap over same.	188·5595
Near Lisbon, Mo.	T. B. M. 297.	188·6015
Near Lisbon, Mo.	P. B. M. 153.	185·1084
Near Lisbon, Mo.	T. B. M. 300.	184·5287
Near Lisbon, Mo.	P. B. M. 154=$\frac{45}{3}$.	183·0915
	Top of cap over same.	184·3154
Near Lisbon, Mo.	T. B. M. 301.	184·5127
Near Lisbon, Mo.	T. B. M. 302.	185·2690
Near Lisbon, Mo.	T. B. M. 303.	187·6636
Near Bluffport, Mo.	T. B. M. 304.	186·4553
Near Richland Creek, Mo.	P. B. M. 155.	186·5303
	Top of cap over same.	187·7688
Near Bluffport, Mo.	P. B. M. 156.	189·0294
Near Richland Creek, Mo.	T. B. M. 305.	188·6482
Near Glasgow, Mo.	P. B. M. 157=$\frac{46}{2}$.	186·2122
	Top of cap over same.	187·4505
Near Glasgow, Mo.	T. B. M. 309.	186·1645
At Glasgow, Mo.	P. B. M. 159=$\frac{47}{3}$.	188·3769
	Top of cap over same.	189·6132
At Glasgow, Mo.	P. B. M. 160.	194·3940
At Glasgow, Mo.	T. B. M. 314.	192·0268
At Glasgow, Mo.	T. B. M. 315=Old B. M. 141 (a).	187·2234
Near Glasgow, Mo.	P. B. M. 161.	202·3490
Near Glasgow, Mo.	P. B. M. 158=$\frac{47}{2}$.	188·5767
	Top of cap over same.	189·8149
Near Cambridge, Mo.	P. B. M. 162.	190·6890
	Top of cap over same.	191·9292
At Cambridge, Mo.	P. B. M. 163.	194·4813
At Cambridge, Mo.	T. B. M. 325.	193·8427
At Cambridge, Mo.	P. B. M. 164=$\frac{48}{1}$.	191·3976
	Top of cap over same.	192·6335
At Cambridge, Mo.	T. B. M. 326.	192·5236
Near Salt Creek, Mo.	P. B. M. 165.	188·8807
	Top of cap over same.	190·1179

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At New Frankfort, Mo.	P. B. M. $166=\frac{49}{1}$.	191·0169
	Top of cap over same.	192·2597
Near New Frankfort, Mo.	P. B. M. 167.	191·0794
	Top of cap over same.	192·3156
Near Buckhorn Point, Mo.	P. B. M. $168=\frac{50}{1}$.	192·1267
	Top of cap over same.	193·3680
At Cromwell Point, Mo.	P. B. M. 169.	193·0436
	Top of cap over same.	194·2834
Near Grand River, Mo.	P. B. M. $170=\frac{51}{1}$.	193·6678
	Top of cap over same.	194·9071
Near Dewitt, Mo.	P. B. M. $171=\frac{52}{1}$.	193·9187
	Top of cap over same.	195·1548
Near Miami, Mo.	P. B. M. 172.	194·7196
	Top of cap over same.	195·9611
Near Miami, Mo.	P. B. M. 173.	195·8370
Near Miami, Mo.	T. B. M. 357=B. M. C. of 1878.	196·9966
At Miami, Mo.	P. B. M. $175=\frac{53}{1}$.	196·5669
	Top of cap over same.	197·8104
At Miami, Mo.	T. B. M. 358.	197·7298
Near Miami, Mo.	P. B. M. 176.	195·3666
Near Miami, Mo.	T. B. M. 359.	194·6075
Near Miami, Mo.	T. B. M. 360.	198·3950
Near Miami, Mo.	P. B. M. $177=\frac{54}{1}$.	196·1804
	Top of cap over same.	197·4233
Near Teteseau Bend, Mo.	P. B. M. 178.	197·3683
	Top of cap over same.	198·6000
Near Laynesville, Mo.	P. B. M. $179=\frac{55}{2}$.	198·6434
	Top of cap over same.	199·8840
At Malta Bend Landing, Mo.	P. B. M. 180.	198·8899
	Top of cap over same.	200·1303
Near Malta Bend Landing, Mo.	P. B. M. 181.	199·5959
	Top of cap over same.	200·8346
Near Waverly, Mo.	P. B. M. $182=\frac{56}{1}$.	200·9184
	Top of cap over same.	202·1620
Near Waverly, Mo.	P. B. M. 183.	205·5193
	Top of cap over same.	206·7590
Near Waverly, Mo.	T. B. M. 389.	204·9513
Near Waverly, Mo.	P. B. M. $184=\frac{57}{1}$.	201·0700
	Top of cap over same.	202·3111
Near Waverly, Mo.	T. B. M. 392.	207·1952
At Waverly, Mo.	P. B. M. $185=\frac{58}{1}$.	208·7971
	Top of cap over same.	210·0445
Near Waverly, Mo.	P. B. M. 186.	205·0906
Near Waverly, Mo.	T. B. M. 396.	206·5064
Near Waverly, Mo.	P. B. M. 187.	205·9660
Near Waverly, Mo.	T. B. M. 397.	206·5101
Near Waverly, Mo.	P. B. M. 188.	205·7822
	Top of cap over same.	207·0175

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Waverly, Mo.	P. B. M. 189=$\frac{59}{1}$.	212·7469
	Top of cap over same.	213·9866
Near Edwards, Mo.	P. B. M. 190.	209·5497
Near Edwards, Mo.	T. B. M. 402.	209·0155
At Edwards, Mo.	P. B. M. 191.	208·3349
At Edwards, Mo.	P. B. M. 192.	205·7015
	Top of cap over same.	206·9448
At Edwards, Mo.	T. B. M. 403.	206·9098
Near Dover, Mo.	P. B. M. 193=$\frac{60}{1}$.	207·6776
	Top of cap over same.	208·9172
Near Dover, Mo.	T. B. M. 407.	207·6951
Near Dover, Mo.	T. B. M. 408.	208·3511
At Dover, Mo.	P. B. M. 194.	206·5856
	Top of cap over same.	207·8256
At Berlin, Mo.	P. B. M. 195=$\frac{61}{1}$.	208·1614
	Top of cap over same.	209·3970
At Berlin, Mo.	P. B. M. 196.	208·9303
At Berlin, Mo.	T. B. M. 411.	209·5570
Near Northrup, Mo.	P. B. M. 197.	208·0256
Near Northrup, Mo.	T. B. M. 412.	208·2869
At Northrup, Mo.	P. B. M. 198.	210·1407
	Top of cap over same.	211·3764
Near Northrup, Mo.	T. B. M. 415.	210·9673
Near Lexington, Mo.	P. B. M. 199=$\frac{62}{1}$.	206·3179
	Top of cap over same.	207·5627
Near Lexington, Mo.	T. B. M. 419.	212·0298
Near Lexington, Mo.	P. B. M. 200.	212·4262
Near Lexington, Mo.	T. B. M. 420.	214·8972
Near Lexington, Mo.	P. B. M. 201.	213·2089
	Top of cap over same.	214·4496
Near Lexington, Mo.	P. B. M. 202.	212·2186
Near Lexington, Mo.	T. B. M. 422.	210·6373
At Lexington, Mo.	P. B. M. 203=$\frac{63}{1}$.	209·8560
	Top of cap over same.	211·0960
At Lexington, Mo.	T. B. M. 423.	211·2361
At Lexington, Mo.	P. B. M. 204.	209·7989
At Lexington, Mo.	T. B. M. 424.	209·5459
At Lexington, Mo.	P. B. M. 205=old B. M. 190.	219·5753
Near Lexington, Mo.	T. B. M. 425=old B. M. 191.	212·4260
Near Lexington, Mo.	P. B. M. 206.	211·5827
Near Lexington, Mo.	P. B. M. 207.	211·2414
	Top of cap over same.	212·4821
Near Wellington, Mo.	P. B. M. 208.	212·5497
	Top of cap over same.	213·7825
Near Wellington, Mo.	T. B. M. 429=old B. M. 194.	212·4603
Near Wellington, Mo.	P. B. M. 209=$\frac{64}{1}$.	214·5809
	Top of cap over same.	215·8245
At Wellington, Mo.	P. B. M. 210.	218·5260
At Wellington, Mo.	T. B. M. 431.	219·3536
Near Waterloo, Mo.	P. B. M. 211.	212·2254
	Top of cap over same.	213·4611

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Napoleon, Mo.	P. B. M. 212=$\frac{66}{1}$.	215·6061
	Top of cap over same.	216·8468
Near Napoleon, Mo.	T. B. M. 436.	219·7033
Near Napoleon, Mo.	P. B. M. 213.	215·5423
	Top of cap over same.	216·7794
Near Sibley Bridge, Mo.	P. B. M. 214=$\frac{67}{1}$.	216·8230
	Top of cap over same.	218·0633
At Matthews Landing, Mo.	T. B. M. 445=Old B. M. 210.	218·8197
Near Sibley, Mo.	P. B. M. 215.	218·1383
	Top of cap over same.	219·3736
At Sibley, Mo.	P. B. M. 216.	227·6146
Near Sibley, Mo.	P. B. M. 217=cap over $\frac{68}{1}$.	216·1284
Near New Sibley, Mo.	P. B. M. 218.	217·5334
	Top of cap over same.	218·7665
Near New Sibley, Mo.	T. B. M. 457.	223·1625
At Little Blue River, Mo.	T. B. M. 458.	223·8062
Near Missouri City, Mo.	P. B. M. 219=$\frac{69}{1}$.	218·5607
	Top of cap over same.	219·8036
At Atherton, Mo.	P. B. M. 220.	222·4130
	Top of cap over same.	223·6500
Near Atherton, Mo.	P. B. M. 221.	224·7660
	Top of cap over same.	225·9988
At Blue Mills Landing, Mo.	T. B. M. 465.	227·9774
At Blue Mills Landing, Mo.	T. B. M. 466=Old B. M. 33 of 1878.	223·4486
At Blue Mills Landing, Mo.	T. B. M. 467=Old B. M. 228.	220·9498
At Courtney, Mo.	P. B. M. 222.	223·4937
	Top of cap over same.	224·7253
Near Courtney, Mo.	T. B. M. 470.	226·3205
Near Independence, Mo.	T. B. M. 471.	229·9335
Near Independence, Mo.	P. B. M. 223=$\frac{71}{1}$.	223·4786
	Top of cap over same.	224·7199
At Wayne, Mo.	P. B. M. 224.	227·6319
Near Wayne, Mo.	P. B. M. 225.	228·2557
	Top of cap over same.	229·4918
Near Independence, Mo.	P. B. M. 226.	226·7208
At Big Blue River, Mo.	P. B. M. 227.	224·1105
	Top of cap over same.	225·3479
Near Kansas City, Mo.	P. B. M. 228=$\frac{72}{1}$.	224·0236
	Top of cap over same.	225·2642
At Kansas City, Mo.	T. B. M. 478=Old B. M. 240.	226·3429
At Kansas City, Mo.	T. B. M. 479.	228·2777
At Kansas City, Mo.	P. B. M. 229.	228·4440
At Kansas City, Mo.	T. B. M. 480=Old B. M. 242.	233·7555
At Kansas City, Mo.	P. B. M. 230=$\frac{73}{1}$.	227·5924
At Kansas City, Mo.	T. B. M. 481.	229·5682
At Kansas City, Mo.	P. B. M. 233.	228·9419
At Kansas City, Mo.	T. B. M. 482.	228·0750
At Kansas City, Kans.	P. B. M. 234.	229·7448
At Kansas City, Kans.	T. B. M. 483.	228·4790
At Kansas City, Kans.	P. B. M. 235.	226·2146
At Kansas City, Kans.	T. B. M. 484.	225·6832
At Kansas City, Kans.	T. B. M. 485=Old B. M. 248.	237·1887

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Kansas City, Kans.	T. B. M. 486=City B. M.	237·4534
At Kansas City, Kans.	T. B. M. 487.	232·6117
At Kansas City, Kans.	P. B. M. 236.	228·6207
	Top of cap over same.	229·8590
At Kansas City, Kans.	P. B. M. 237.	229·4845
Near Quindaro, Kans.	P. B. M. 238=$\frac{74}{1}$.	227·7595
	Top of cap over same.	229·0000
Near Quindaro, Kans.	T. B. M. 492.	235·8085
Near Nearman, Kans.	P. B. M. 239.	227·9007
	Top of cap over same.	229·1324
Near Pomeroy, Kans.	P. B. M. 240.	231·1816
Near Pomeroy, Kans.	T. B. M. 495.	231·1816
Near Pomeroy, Kans.	P. B. M. 241.	230·6030
	Top of cap over same.	231·8395
At Pomeroy, Kans.	P. B. M. 242.	236·3860
At Pomeroy, Kans.	P. B. M. 243.	229·7750
	Top of cap over same.	231·0080
Near Pomeroy, Kans.	P. B. M. 244=Old B. M. 260.	236·0815
Near Pomeroy, Kans.	T. B. M. 499.	229·9377
At Connors, Kans.	P. B. M. 245=$\frac{76}{1}$.	230·1770
	Top of cap over same.	231·4184
At Connors, Kans.	P. B. M. 246.	235·4218
Near Connors, Kans.	P. B. M. 247.	230·4859
	Top of cap over same.	231·7203
At Popes, Kans.	T. B. M. 506.	232·3904
Near Leavenworth Junction, Kans.	P. B. M. 248=$\frac{77}{1}$	243·8557
	Top of cap over same.	245·0987
At Leavenworth Junction, Kans.	P. B. M. 249.	230·7354
	Top of cap over same.	231·9743
Near Leavenworth, Kans.	T. B. M. 513.	232·8114
Near Leavenworth, Kans.	T. B. M. 514.	235·0355
Near Leavenworth, Kans.	P. B. M. 250=$\frac{78}{1}$.	246·4191
	Top of cap over same.	247·6582
Near Leavenworth, Kans.	T. B. M. 515.	234·0655
At Leavenworth, Kans.	P. B. M. 251.	238·4976
At Leavenworth, Kans.	P. B. M. 252.	239·9716
At Leavenworth, Kans.	T. B. M. 516=Old B. M. 270.	234·6153
At Leavenworth, Kans.	P. B. M. 253.	236·3973
At Leavenworth, Kans.	T. B. M. 517.	235·3015
Near Leavenworth, Kans.	T. B. M. 518.	237·4582
At Fort Leavenworth, Kans.	P. B. M. 254=$\frac{79}{1}$.	240·3050
	Top of cap over same.	241·5503
At Fort Leavenworth, Kans.	P. B. M. 255.	240·4438
At Fort Leavenworth, Kans.	T. B. M. 520.	238·4922
At Fort Leavenworth, Kans.	T. B. M. 521=gauge B. M.	239·5691
At Fort Leavenworth, Kans.	P. B. M. 256.	236·6323
Near Fort Leavenworth, Kans.	P. B. M. 257.	235·8224
	Top of cap over same.	237·0622
Near Fort Leavenworth, Kans.	P. B. M. 258=$\frac{80}{1}$.	234·5553
	Top of cap over same.	235·7985
Near Wade, Kans.	T. B. M. 525.	235·9417
Near Kickapoo, Kans.	P. B. M. 259.	235·9593
	Top of cap over same.	237·1957

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Kickapoo, Kans.	P. B. M. 260.	242·2704
Near Kickapoo, Kans.	T. B. M. 529=Old B. M. 278.	242·3948
Near Kickapoo, Kans.	T. B. M. 530.	241·8242
At Kickapoo, Kans.	P. B. M. 261 = $\frac{81}{1}$.	244·3728
	Top of cap over same.	245·6110
At Kickapoo, Kans.	T. B. M. 531.	243·0486
Near Oak Mills, Kans.	P. B. M. 262.	236·1651
	Top of cap over same.	237·3963
At Oak Mills, Kans.	P. B. M. 263.	240·9611
At Oak Mills, Kans.	P. B. M. 264 = $\frac{82}{1}$.	238·1307
	Top of cap over same.	239·3699
Near Oak Mills, Kans.	P. B. M. 265.	239·4930
Near Oak Mills, Kans.	T. B. M. 540.	239·6248
Near Atchison, Kans.	P. B. M. 266 = $\frac{83}{1}$.	239·2667
	Top of cap over same.	240·4937
Near Atchison, Kans.	T. B. M. 542.	240·3215
Near Atchison, Kans.	P. B. M. 267.	242·7880
	Top of cap over same.	244·0261
Near Atchison, Kans.	T. B. M. 543.	240·9729
Near Atchison, Kans.	P. B. M. 268=Old B. M. 287.	243·7070
At Atchison, Kans.	P. B. M. 269 = $\frac{84}{1}$.	243·4520
	Top of cap over same.	244·6779
At Atchison, Kans.	T. B. M. 548. City B. M.	244·4514
At Atchison, Kans.	P. B. M. 270.	255·9507
At Atchison, Kans.	T. B. M. 549.	253·2098
At Atchison, Kans.	T. B. M. 550=Old gauge B. M.	241·2434
At Atchison, Kans.	P. B. M. 271.	243·5510
At Atchison, Kans.	P. B. M. 272.	242·8129
At Atchison, Kans.	T. B. M. 551.	243·2886
Near East Atchison, Mo.	P. B. M. 273=$\frac{84}{2}$.	238·7815
	Top of cap over same.	240·0107
Near Rushville, Mo.	P. B. M. 274.	240·4503
	Top of cap over same.	241·6820
At Rushville, Mo.	P. B. M. 275=$\frac{85}{3}$.	245·9777
	Top of cap over same.	247·2070
Near Halls, Mo.	P. B. M. 276=$\frac{86}{2}$.	245·8731
	Top of cap over same.	247·1050
At Halls, Mo.	P. B. M. 277.	243·4670
	Top of cap over same.	244·7042
Near Kenmoor, Mo.	P. B. M. 278=$\frac{87}{2}$.	249·4768
	Top of cap over same.	250·7055
Near St. Joseph, Mo.	P. B. M. 279.	245·6812
	Top of cap over same.	246·9238
Near St. Joseph, Mo.	P. B. M. 280=$\frac{88}{2}$.	251·7209
	Top of cap over same.	252·9472
At St. George, Mo.	P. B. M. 281.	251·4664
	Top of cap over same.	252·7009
At St. George, Mo.	T. B. M. 579.	250·6012
At St. Joseph, Mo.	T. B. M. 580.	252·1050

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At St. Joseph, Mo.	P. B. M. 282.	250·2598
At St. Joseph, Mo.	T. B. M. 582=old B. M. 313.	251·2313
At St. Joseph, Mo.	T. B. M. 583=old B. M. 312.	251·0105
At St. Joseph, Mo.	P. B. M. 283=$\frac{89}{3}$.	250·1650
	Top of cap over same.	251·3910
At St. Joseph, Mo.	P. B. M. 284.	253·9426
At St. Joseph, Mo.	T. B. M. 584.	252·0562
At St. Joseph, Mo.	P. B. M. 285.	266·7462
At St. Joseph, Mo.	P. B. M. 286.	256·6402
At St. Joseph, Mo.	T. B. M. 585. City B. M.	255·3965
At St. Joseph, Mo.	T. B. M. 586.	252·6364
Near St. Joseph, Mo.	P. B. M. 287=89½.	249·2065
	Top of cap over same.	250·4304
Near St. Joseph, Mo.	P. B. M. 288.	247·8706
	Top of cap over same.	249·1038
Near St. Joseph, Mo.	T. B. M. 589.	250·1575
Near St. Joseph, Mo.	P. B. M. 289.	251·1443
Near St. Joseph, Mo.	P. B. M. 290=$\frac{90}{2}$.	250·1957
	Top of cap over same.	251·3836
Near Amazonia, Mo.	P. B. M. 291.	254·7610
	Top of cap over same.	255·9868
Near Amazonia, Mo.	P. B. M. 292=$\frac{91}{2}$.	253·1838
	Top of cap over same.	254·3956
Near Amazonia, Mo.	P. B. M. 293.	252.2918
	Top of cap over same.	253·5169
Near Amazonia, Mo.	P. B. M. 294=$\frac{92}{3}$.	254·2182
	Top of cap over same.	255·4283
Near Nodaway, Mo.	P. B. M. 295.	253·7985
Near Nodaway, Mo.	P. B. M. 296=$\frac{93}{3}$.	257·3443
	Top of cap over same.	258·5545
Near Forbes, Mo.	P. B. M. 297.	255·8216
	Top of cap over same.	257·0274
Near Forbes, Mo.	P. B. M. 298=$\frac{94}{3}$.	260·5679
	Top of cap over same.	261·7726
Near Curzons, Mo.	P. B. M. 299.	257·6780
	Top of cap over same.	258·9086
Near Curzons, Mo	P. B. M. 300=$\frac{95}{3}$.	258·6061
	Top of cap over same.	259·8192
Near Forest City, Mo.	T. B. M. 632.	260·5514
Near Forest City, Mo.	P. B. M. 301=$\frac{96}{2}$.	262·9816
	Top of cap over same.	264·1917
At Forest City, Mo.	P. B. M. 302.	261·8995
Near Forest City, Mo.	P. B. M. 303.	259·1866
	Top of cap over same.	260·4107
At Napier, Mo.	P. B. M. 304.	258·2954
	Top of cap over same.	259·5268
Near Bigelow, Mo.	P. B. M. 305.	258·7621
	Top of cap over same.	259·9865
At Bigelow, Mo.	P. B. M. 306.	260·7157
	Top of cap over same.	261·9430

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Bigelow, Mo.	P. B. M. 307.	261·3896
	Top of cap over same.	262·6189
Near Craig, Mo.	P. B. M. 308.	263·5733
Near Craig, Mo.	P. B. M. 309.	263·6349
	Top of cap over same.	264·8584
Near Craig, Mo.	P. B. M. 310.	264·3365
Near Corning, Mo.	P. B. M. 311.	264·5112
	Top of cap over same.	265·7385
At Corning, Mo.	P. B. M. 312.	266·9728
Near Corning, Mo.	P. B. M. 313.	266·7034
	Top of cap over same.	267·9248
At Nishnabotna, Mo.	P. B. M. 314.	266·3006
	Top of cap over same.	267·5259
Near Nishnabotna, Mo.	P. B. M. 315.	269·5365
Near Langdon, Mo.	P. B. M. 316.	269·3040
	Top of cap over same.	270·5301
Near Phelps, Mo.	P. B. M. 317.	269·8817
	Top of cap over same.	271·1085
At Phelps, Mo.	P. B. M. $318=\frac{106}{3}$.	270·7926
	Top of cap over same.	272·0155
Near Watson, Mo.	P. B. M. 319.	271·4453
	Top of cap over same.	272·6730
Near Watson, Mo.	P. B. M. $320=\frac{107}{2}$.	273·5707
	Top of cap over same.	274·7926
At Watson, Mo.	P. B. M. 321.	272·9172
	Top of cap over same.	274·1403
Near Watson, Mo.	P. B. M. 322.	275·1664
	Top of cap over same.	276·3930
Near Hamburg, Iowa	P. B. M. 323.	277·2161
Near Hamburg, Iowa	P. B. M. 324.	275·6006
	Top of cap over same.	276·8286
Near Hamburg, Iowa	P. B. M. $325=\frac{110}{2}$.	276·3692
	Top of cap over same.	277·5853
Near Nebraska City Junction, Iowa	P. B. M. 326.	279·5254
	Top of cap over same.	280·7516
Near Nebraska City Junction, Iowa	P. B. M. 327.	280·6821
	Top of cap over same.	281·9084
Near Percival, Iowa	P. B. M. 328.	280·8361
	Top of cap over same.	282·0620
At Percival, Iowa	P. B. M. 329.	282·6786
	Top of cap over same.	283·9064
Near McPaul, Iowa	P. B. M. $330=\frac{114}{3}$.	284·2574
	Top of cap over same.	285·4739
Near McPaul, Iowa	P. B. M. 331.	285·9414
	Top of cap over same.	287·1654
Near Bartlett, Iowa	P. B. M. 332.	286·3744
	Top of cap over same.	287·5982
Near Bartlett, Iowa	P. B. M. 333.	287·3723
	Top of cap over same.	288·5968
Near Haynies, Iowa	P. B. M. $334=\frac{116}{3}$.	288·2856
	Top of cap over same.	289·5067
At Haynies, Iowa	P. B. M. 335.	289·2495
	Top of cap over same.	290·4725

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench marks.	Corrected elevation.
		metres.
Near Pacific Junction, Iowa	P. B. M. 336=$\frac{117}{3}$.	289·8078
	Top of cap over same.	291·0326
Near Pacific Junction, Iowa	P. B. M. 337.	291·4457
	Top of cap over same.	292·6679
Near Hentons, Iowa	P. B. M. 338.	292·3964
	Top of cap over same.	293·6238
At Hentons, Iowa	P. B. M. 339.	293·6859
	Top of cap over same.	294·9081
Near Hentons, Iowa	P. B. M. 340	295·7613
	Top of cap over same.	296·9841
Near Island Park, Iowa	P. B. M. 341.	295·3687
	Top of cap over same.	296·5941
Near Council Bluffs, Iowa	P. B. M. 342.	296·2081
	Top of cap over same.	297·4305
At Council Bluffs, Iowa	P. B. M. 343.	299·4234
At Omaha, Nebr.	City B. M., Omaha.	317·7029
At Omaha, Nebr.	P. B. M. 344.	317·3868
At Omaha, Nebr.	P. B. M. 345.	299·5705
At Omaha, Nebr.	P. B. M. 346 = gauge B. M.	296·5729
	Top of cap over same.	297·7819
Near Omaha, Nebr.	T. B. M. 804.	307·0238
At Council Bluffs, Iowa	P. B. M. 347.	301·1219
At Council Bluffs, Iowa	P. B. M. 348 = $\frac{121}{2}$.	302·2714
	Top of cap over same.	303·4961
At Council Bluffs, Iowa	P. B. M. 349 = $\frac{122}{2}$.	297·7074
	Top of cap over same.	2[illegible]8·9320
Near Council Bluffs, Iowa	P. B. M. 350.	303·8830
	Top of cap over same.	305·1040
Near Council Bluffs, Iowa	P. B. M. 351.	301·1803
	Top of cap over same.	302·4041
At Crescent, Iowa	P. B. M. 352.	301·7010
	Top of cap over same.	302·9258
Near Honey Creek, Iowa	P. B. M. 353.	304·0383
	Top of cap over same.	305·2601.
At Honey Creek, Iowa	P. B. M. 354.	306·6961
Near Honey Creek, Iowa	P. B. M. 355.	305·4281
	Top of cap over same.	306·6529
At Loveland, Iowa	P. B. M. 356.	305·2723
Near Missouri Valley, Iowa	P. B. M. 357.	303·7125
	Top of cap over same.	304·9352
At Missouri Valley, Iowa	P. B. M. 358.	307·2060
Near Missouri Valley, Iowa	P. B. M. 359.	305·7409
	Top of cap over same.	306·9653
Near California Junction, Iowa	P. B. M. 360 = $\frac{127}{3}$.	305·9995
	Top of cap over same.	307·2206
Near California Junction, Iowa	P. B. M. 361.	306·8594
	Top of cap over same.	308·0825
Near Modale, Iowa	P. B. M. 362.	307·9143
	Top of cap over same.	309·1311
Near Modale, Iowa	P. B. M. 363.	308·3363
	Top of cap over same	309·5587
Near Mondamin, Iowa	P. B. M. 364.	309·4602
	Top of cap over same.	310·6843
At Mondamin, Iowa	P. B. M. 365.	312·8898

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
Near Mondamin, Iowa	P. B. M. 366.	311·9632
	Top of cap over same.	313·1832
Near Mondamin, Iowa	P. B. M. 367 = $\frac{130}{2}$.	311·5095
	Top of cap over same.	312·7266
Near River Sioux, Iowa	P. B. M. 368.	313·1416
	Top of cap over same.	314·3619
Near River Sioux, Iowa	P. B. M. 369 = $\frac{131}{3}$.	315·0132
	Top of cap over same.	316·2317
Near River Sioux, Iowa	P. B. M. 370.	314·0822
	Top of cap over same.	315·3032
Near Blencoe, Iowa	P. B. M. 371.	314·7595
	Top of cap over same.	315·9803
Near Blencoe, Iowa	P. B. M. 372 = $\frac{132}{4}$.	....
	Top of cap over same.	315·0027
Near Blencoe, Iowa	P. B. M. 373.	315·6768
	Top of cap over same.	316·8969
At Blencoe, Iowa	P. B. M. 374 = $\frac{133}{4}$.	316·6231
	Top of cap over same.	317·8397
Near Onawa, Iowa	P. B. M. 375.	318·1618
	Top of cap over same.	319·3880
Near Onawa, Iowa	P. B. M. 376.	318·8481
	Top of cap over same.	320·0737
At Onawa, Iowa	P. B. M. 377.	321·2662
At Onawa, Iowa	P. B. M. 378 = $\frac{134}{3}$.	319·8110
	Top of cap over same.	321·0503
Near Onawa, Iowa	P. B. M. 379.	319·9929
	Top of cap over same.	321·2117
Near Whiting, Iowa	P. B. M. 380.	320·8905
	Top of cap over same.	322·1168
Near Whiting, Iowa	P. B. M. 381.	322·6829
	Top of cap over same.	323·9239
Near Whiting, Iowa	P. B. M. 382.	323·7182
	Top of cap over same.	324·9420
Near Sloan, Iowa	P. B. M. 383 = $\frac{138}{3}$.	324·4481
	Top of cap over same.	325·6862
Near Sloan, Iowa	P. B. M. 384.	326·0504
	Top of cap over same.	327·2705
At Sloan, Iowa	P. B. M. 385.	328·6556
Near Sloan, Iowa	P. B. M. 386 = $\frac{139}{3}$.	326·5246
	Top of cap over same.	327·7447
Near Salix, Iowa	P. B. M. 387.	327·1974
	Top of cap over same.	328·4241
Near Salix, Iowa	P. B. M. 388.	329·3013
	Top of cap over same.	330·5210
Near Salix, Iowa	P. B. M. 389.	331·3883
	Top of cap over same.	332·6095
Near Sargents Bluff, Iowa	P. B. M. 390.	331·3001
	Top of cap over same.	332·5240
At Sargents Bluff, Iowa	P. B. M. 391 = $\frac{142}{3}$.	332·8323
	Top of cap over same.	334·0486

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported.
		metres.	
Near Sargents Bluff, Iowa	P. B. M. 392.	333·6787	
	Top of cap over same.	334·9025	
At Sioux City, Iowa	P. B. M. 393.	335·2040	
	Top of cap over same.	336·4307	
At Sioux City, Iowa	P. B. M. 394.	337·5317	
At Sioux City, Iowa	P. B. M. 395, gauge B. M.	....	
	Top of cap over same.	334·0098	
At Sioux City, Iowa	P. B. M. $396=\frac{143}{3}$.	337·6973	
	Top of cap over same.	338·9223	
At Sioux City, Iowa	T. B. M. 966.	338·3994	
Near Sioux City, Iowa	P. B. M. 397.	335·9126	
	Top of cap over same.	337·1351	
Near Sioux City, Iowa	P. B. M. 398.	336·6862	
	Top of cap over same.	337·9083	
Near Sioux City, Iowa	P. B. M. 399.	335·3120	
	Top of cap over same.	336·5327	
At Fort Gratiot, Mich.	U.S.B.M. Fort Gratiot (1877).	179·8229	
At Lakeport, Mich.	B. M. 2 (1875).	180·1142	
At Lakeport, Mich.	B. M. 3 (1875).	182·4886	
At Trenton, Mich.	U. S. B. M. Trenton (1877).	183·8237	183·9203
At Wyandotte, Mich.	U.S.B.M. Wyandotte (1877).	178·6082	178·7048
At Detroit Junction, Mich.	U.S.B.M. Detroit Jun. (1877).	180·5697	
At Detroit, Mich.	U. S. B. M. Detroit (1871).	178·1618	
At New Haven, Mich.	U.S.B.M. New Haven (1877).	192·2126	
At Pine River, Michigan	U. S. B. M. Pine River (1877).	191·6137	
At Trenton, Mich.	P. B. M. 2.	183·2774	183·3741
Near Sibley's stone quarry, Mich.	P. B. M. 3.	180·7656	180·8622
At Wyandotte, Mich.	P. B. M. 4.	178·4115	178·5081
At Ecorse, Mich.	P. B. M. 5.	178·1198	178·2163
At Delray, Mich.	P. B. M. 7.	180·7225	180·8189
At Detroit, Mich.	P. B. M. 8.	183·2189	183·3153
At Detroit, Mich.	P. B. M. 9.	177·5806	177·6770
At Detroit, Mich.	P. B. M. 10.	180·5670	180·6634
At Detroit, Mich.	P. B. M. 11.	178·9684	179·0648
At Windmill Point, Mich.	P. B. M. 12.	177·9503	178·0466
At Windmill Point, Mich.	Old B. M. W.	177·5053	177·6016
At Cottage Grove, Mich.	P. B. M. 13.	180·3458	180·4420
Near Mount Clemens, Mich.	P. B. M. 41.	180·0726	180·1687
Near McSweeney's clubhouse, Mich.	P. B. M. 40.	176·7350	176·8311
At L'Anse Creuse, Mich.	P. B. M. 39.	176·9784	177·0745
At Milk River Point, Mich.	P. B. M. 38.	176·9968	177·0928
Near Milk River Point, Mich.	P. B. M. 37.	178·0911	178·1871
At Grosse Pointe Farms, Mich.	P. B. M. 36.	184·6208	184·7168
At Grosse Pointe Farms, Mich.	P. B. M. 35.	184·2653	184·3613
At New Baltimore, Mich.	P. B. M. 34.	179·7921	179·8880
At New Baltimore, Mich.	P. B. M. 33.	179·2913	179·3872
At New Baltimore, Mich.	P. B. M. 32.	182·7856	182·8815
Near Swan Creek, Mich.	P. B. M. 31.	177·8270	177·9228
At Fair Haven, Mich.	P. B. M. 30.	177·7327	177·8285
At Algonac, Mich.	P. B. M. 29.	178·1613	178·2570
At Algonac, Mich.	P. B. M. 28.	178·2370	178·3327
Near Roberts Landing, Mich.	P. B. M. 27.	178·2535	178·3491
At Marine City, Mich.	P. B. M. 26.	178·6363	178·7318
At Marine City, Mich.	P. B. M. 25.	179·1552	179·2507
At Marine City, Mich.	P. B. M. 24.	179·6706	179·7661
At East China, Mich.	P. B. M. 23.	179·9741	180·0695
At St. Clair, Mich.	P. B. M. 22.	182·6665	182·7619

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported.
		metres.	*metres.*
At St. Clair, Mich.	P. B. M. 21.	179·3536	179·4490
At St. Clair, Mich.	P. B. M. 20.	191·0854	191·1809
At Marysville, Mich.	P. B. M. 19.	179·7216	179·8171
At Marysville, Mich.	P. B. M. 18.	178·8530	178·9484
Near Back River, Mich.	P. B. M. 17.	181·7682	181·8635
At Port Huron, Mich.	P. B. M. 16.	181·3234	181·4186
At Port Huron, Mich.	P. B. M. 15.	182·5895	182·6847
At Port Huron, Mich.	P. B. M. 14.	182·8096	182·9048
At Port Colborne, Ontario.	B. M. Custom-house.	178·0987	
At Port Colborne, Ontario.	B. M. Baptist Church.	176·8186	
At Port Colborne, Ontario.	B. M. Church of England.	176·3766	
At Port Dalhousie, Ontario.	B. M. A.	80·3769	
At Port Dalhousie, Ontario.	B. M. B.	78·5542	
At Port Dalhousie, Ontario.	B. M. C.	78·6091	
At Greenbush, N. Y.	B. M. Gristmill.	4·1384	
At Greenbush, N. Y.	B. M. (1875.)	4·1798	
At East Albany, N. Y.	B. M. 1. (1875.)	7·8850	
At Albany, N. Y.	B. M. Miter sill.	1·5590	
At Albany, N. Y.	B. M. 2. (1875.)	5·0130	
At Lock No. 2, N. Y.	B. M. 3. (1875.)	7·8738	
At West Troy, N. Y.	B. M. 5. (1875.)	8·9787	
At West Troy, N. Y.	B. M. 5a. (1875.)	8·6614	
At Lock No. 4, N. Y.	B. M. 6. (1875.)	14·8045	
At Lock No. 4, N. Y.	B. M. 6a. (1875.)	14·7813	
At Lock No. 6, N. Y.	B. M. 7. (1875.)	21·1379	
At Lock No. 6, N. Y.	B. M. 7a. (1875.)	21·1257	
At Lock No. 15, N. Y.	B. M. 8. (1875.)	48·6067	
At Lock No. 15, N. Y.	B. M. 8a. (1875.)	48·5796	
Near Cohoes, N. Y.	B. M. 9. (1875.)	58·9959	
Near Cohoes, N. Y.	B. M. 9a. (1875.)	58·7636	
Near Cohoes, N. Y.	B. M. 10. (1875.)	58·6555	
Near Cohoes, N. Y.	B. M. 10a. (1875.)	58·2391	
Near Cohoes, N. Y.	B. M. 11. (1875.)	58·1719	
Near Cohoes, N. Y.	B. M. 11a. (1875.)	57·8147	
Near Lock No. 19, N. Y.	B. M. 12. (1875.)	58·0706	
Near Lock No. 19, N. Y.	B. M. 12a. (1875.)	58·0343	
At Vischer Ferry, N. Y.	B. M. 13. (1875.)	61·2714	
At Vischer Ferry, N. Y.	B. M. 13a. (1875.)	61·7070	
At Lock No. 20, N. Y.	B. M. 14. (1875.)	63·3719	
At Lock No. 20, N. Y.	B. M. 14a. (1875.)	63·4029	
Near Schenectady, N. Y.	B. M. 15. (1875.)	66·0949	
Near Schenectady, N. Y.	B. M. 15a. (1875.)	66·8645	
At Schenectady, N. Y.	B. M. 16. (1875.)	71·5558	
At Schenectady, N. Y.	B. M. 16a. (1875.)	71·6107	
Near Schenectady, N. Y.	B. M. 18. (1875.)	76·3049	
Near Schenectady, N. Y.	B. M. 18a. (1875.)	76·2573	
Near Lock No. 25, N. Y.	B. M. 19. (1875.)	76·3192	
Near Lock No. 25, N. Y.	B. M. 19a. (1875.)	75·4859	
At Pattersonville, N. Y.	B. M. 20. (1875.)	78·7463	
At Pattersonville, N. Y.	B. M. 20a. (1875.)	78·5445	
At Lock No. 26, N. Y.	B. M. 21. (1875.)	80·2117	
At Lock No. 26, N. Y.	B. M. 21a. (1875.)	80·2226	
Near Lock No. 27, N. Y.	B. M. 23. (1875.)	82·7293	
Near Lock No. 27, N. Y.	B. M. 23a. (1875.)	82·7129	
At Lock No. 28, N. Y.	B. M. 24. (1875.)	85·1524	
At Lock No. 28, N. Y.	B. M. 24a. (1875.)	85·1601	
Near Schoharie Creek, N. Y.	B. M. 25. (1875.)	91·9988	
Near Schoharie Creek, N. Y.	B. M. 25a. (1875.)	91·9967	

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported.
		metres.	*metres*
At Fultonville, N. Y.	B. M. 26. (1875.)	91·3977	
At Fultonville, N. Y.	B. M. 26a. (1875.)	87·8093	
Near Sprakers Basin, N. Y.	B. M. 28. (1875.)	91·5877	
Near Sprakers Basin, N. Y.	B. M. 28a. (1875.)	91·1775	
At Sprakers Basin, N. Y.	B. M. 29. (1875.)	92·9375	
At Sprakers Basin, N. Y.	B. M. 29a. (1875.)	92·9476	
Near Sprakers Basin, N. Y.	B. M. 30. (1875.)	92·4717	
Near Sprakers Basin, N. Y.	B. M. 30a. (1875.)	92·4546	
At Canajoharie, N. Y.	B. M. 31. (1875.)	93·2919	
At Canajoharie, N. Y.	B. M. 31a. (1875.)	93·1341	
Near Canajoharie, N. Y.	B. M. 32. (1875.)	93·2500	
Near Lock No. 33, N. Y.	B. M. 34. (1875.)	97·2648	
Near Lock No. 33, N. Y.	B. M. 34a. (1875.)	97·2523	
Near Lock No. 34, N. Y.	B. M. 35. (1875.)	99·7735	
Near Lock No. 34, N. Y.	B. M. 35a. (1875.)	99·9378	
Near Lock No. 35, N. Y.	B. M. 36. (1875.)	102·3280	
Near Lock No. 35, N. Y.	B. M. 36a. (1875.)	102·3448	
At Lock No. 36, N. Y.	B. M. 37. (1875.)	104·5843	
At Lock No. 36, N. Y.	B. M. 37a. (1875.)	104·5856	
Near Lock No. 39, N. Y.	B. M. 38. (1875.)	115·2146	
Near Lock No. 39, N. Y.	B. M. 38a. (1875.)	115·1975	
Near Lock No. 41, N. Y.	B. M. 39. (1875.)	119·8421	
Near Lock No. 41, N. Y.	B. M. 39a. (1875.)	119·8552	
Near Lock No. 43, N. Y.	B. M. 40. (1875.)	124·5722	
Near Lock No. 43, N. Y.	B. M. 40a. (1875.)	124·6040	
At Frankfort, N. Y.	B. M. 41. (1875.)	127·5487	
At Frankfort, N. Y.	B. M. 41a. (1875.)	128·7761	
Near Frankfort, N. Y.	B. M. 42. (1875.)	130·6099	
Near Frankfort, N. Y.	B. M. 42a. (1875.)	130·5538	
Near Utica, N. Y.	B. M. 43. (1875.)	130·6107	
Near Utica, N. Y.	B. M. 43a. (1875.)	130·9667	
At Utica, N. Y.	B. M. 44. (1875.)	131·7546	
At Utica, N. Y.	B. M. 44a. (1875.)	131·6897	
Near Utica, N. Y.	B. M. 45. (1875.)	131·9510	
Near Utica, N. Y.	B. M. 45a. (1875.)	132·0100	
Near Utica, N. Y.	B. M. 46. (1875.)	131·9115	
Near Utica, N. Y.	B. M. 46a. (1875.)	131·4619	
Near Rome, N. Y.	B. M. 47. (1875.)	131·7858	
Near Rome, N. Y.	B. M. 47a. (1875.)	131·7999	
At Rome, N. Y.	B. M. 48. (1875.)	131·4311	
At Rome, N. Y.	B. M. 48a. (1875.)	131·7590	
Near Rome, N. Y.	B. M. 49. (1875.)	131·7467	
Near Rome, N. Y.	B. M. 49a. (1875.)	132·1158	
Near Higginsville, N. Y.	B. M. 51. (1875.)	131·3106	
Near Higginsville, N. Y.	B. M. 51a. (1875).	131·8500	
At Oswego, N. Y.	B. M. A (Oswego).	76·7016	
At Oswego, N. Y.	B. M. B (Oswego).	76·8579	
At Oswego, N. Y.	B. M. C (Oswego).	79·7727	
At St. Regis, Que., Canada	P. B. M. A St. Regis.	51·7422	52·0810
At St. Regis, Que., Canada	P. B. M. B St. Regis.	50·8387	51·1775
At Hogansburg, N. Y.	P. B. M. P Hogansburg.	54·3062	54·6450
At Hogansburg, N. Y.	P. B. M. C Hogansburg.	54·8214	55·1602
Near Racket River, N. Y.	P. B. M. 1.	52·3622	52·7009
Near Grass River, N. Y.	P. B. M. 2.	63·3657	63·7043
On River Road, N. Y.	P. B. M. 3.	62·2674	62·6060
On River Road, N. Y.	P. B. M. 4.	67·4492	67·7877
On River Road, N. Y.	P. B. M. 5.	75·3678	75·7063
At Richards Landing, N. Y.	P. B. M. 6.	70·8030	71·1415
At Louisville Landing, N. Y.	P. B. M. Louisville Landing.	70·0806	70·4190

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported.
		metres.	*metres.*
Near Louisville Landing, N. Y.	P. B. M. 7.	68·3131	68·6514
At Bradfords Hill, N. Y.	P. B. M. 8.	79·0436	79·3818
Near Egg Island, N. Y.	P. B. M. 9.	72·7681	73·1063
Near Murphys Island, N. Y.	P. B. M. 10.	71·9872	72·3253
At Waddington, N. Y.	P. B. M. 11.	84·8308	85·1687
At Waddington, N. Y.	P. B. M. A Waddington.	83·1490	83·4869
At Waddington, N. Y.	P. B. M. B Waddington.	84·1190	84·4569
Near Waddells Point, N. Y.	P. B. M. 12.	77·1791	77·5169
At Tilden, N. Y.	P. B. M. 13A.	83·3141	83·6518
At Tilden, N. Y.	P. B. M. 13.	82·2565	82·5942
Near Lisbon, N. Y.	P. B. M. 14.	83·3452	83·6829
At Lisbon, N. Y.	P. B. M. 15.	84·9297	85·2673
Near Ogdensburg, N. Y.	P. B. M. 16.	85·9990	86·3364
At Ogdensburg, N. Y.	P. B. M. A Ogdensburg.	84·6784	85·0158
At Ogdensburg, N. Y.	P. B. M. B Ogdensburg.	85·5464	85·8838
At Ogdensburg, N. Y.	P. B. M. C Ogdensburg.	88·3298	88·6672
At Ogdensburg, N. Y.	P. B. M. D Ogdensburg.	76·4868	76·8242
Near Ogdensburg, N. Y.	P. B. M. 17.	79·0396	79·3770
Near Ogdensburg, N. Y.	P. B. M. 18.	75·8852	76·2225
Near Morristown, N. Y.	P. B. M. 19.	75·9763	76·3135
At Morristown N. Y.	P. B. M. A Morristown.	83·0911	83·4283
At Morristown, N. Y.	P. B. M. B Morristown.	82·6644	83·0016
At Morristown, N. Y.	P. B. M. C Morristown.	78·6136	78·9508
Near Morristown, N. Y.	P. B. M. 20.	74·8124	75·1495
Near Morristown, N. Y.	P. B. M. 21.	104·5325	104·8696
Near Oak Point Village, N. Y.	P. B. M. 22.	103·3738	103·7109
Near Oak Point Village, N. Y.	P. B. M. O. P.	103·1287	103·4657
Near Oak Point Village, N. Y.	P. B. M. 23.	79·2337	79·5706
Near Chippewa Village, N. Y.	P. B. M. 23A.	79·0388	79·3757
At Chippewa Village, N. Y.	P. B. M. C. V.	88·5812	88·9181
Near Chippewa Village, N. Y.	P. B. M. 24.	88·4697	88·8066
Near Chippewa Village, N. Y.	P. B. M. 25.	111·8810	112·2180
Near Alexandria Bay, N. Y.	P. B. M. 26.	101·7006	102·0374
Near Alexandria Bay, N. Y.	P. B. M. 27.	83·3501	83·6868
At Alexandria Bay, N. Y.	P. B. M. A Alexandria Bay.	78·9705	79·3068
At Alexandria Bay, N. Y.	P. B. M. B Alexandria Bay.	86·6145	86·9508
Near Alexandria Bay, N. Y.	P. B. M. 28.	88·0403	88·3765
Near Alexandria Bay, N. Y.	P. B. M. 29.	83·5998	83·9358
Near Clayton, N. Y.	P. B. M. 30.	80·5109	80·8468
At Clayton, N. Y.	P. B. M. A Clayton.	84·9608	85·2967
At Clayton, N. Y.	P. B. M. B Clayton.	80·5599	80·8958
At Clayton, N. Y.	P. B. M. C Clayton.	79·4175	79·7534
Near Clayton, N. Y.	P. B. M. 31.	111·1305	111·4663
Near Clayton, N. Y.	P. B. M. 32.	83·1491	83·4848
Near Dodges Bay, N. Y.	P. B. M. 33.	79·1653	79·5009
Near Cape Vincent, N. Y.	P. B. M. 34.	79·3159	79·6514
At Cape Vincent, N. Y.	P. B. M. A Cape Vincent.	77·4426	77·7779
At Cape Vincent, N. Y.	P. B. M. B Cape Vincent.	79·0658	79·4011
At Cape Vincent, N. Y.	P. B. M. C Cape Vincent.	82·9347	83·2700
At Tibbetts Point, N. Y.	P. B. M. 35.	80·4016	80·7369
At Dunkirk, N. Y.	598. Dunkirk, 1899.	182·4535	182·2327
At Dunkirk, N. Y.	Nelson Block.	179·3841	179·1633
At Forestville, N. Y.	871 D	265·6341	265·4146
Near Smith Mills, N. Y.	1097 D	334·7337	334·5153
At Dayton, N. Y.	1322 D	403·0863	402·8696
At Cattaraugus, N. Y.	1401 D	422·1824	421·9672
At Little Valley, N. Y.	1593 D	485·7545	485·5407
Near Salamanca, N. Y.	1413 D	430·7366	430·5238
At Salamanca, N. Y.	1391. Dunkirk, 1899.	423·9382	423·7259

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported.
		metres.	*metres.*
At Carrollton, N. Y.	1393 D	424·8983	424·6869
At Allegany, N. Y.	1408 D	429·2538	429·0437
At Olean, N. Y.	1450 D	442·3134	442·1044
Near Hinsdale, N. Y.	1508 D	459·8366	459·6289
Near Cuba, N. Y.	1515 D	462·1210	461·9143
At Friendship, N. Y.	1520 D	463·4030	463·1979
Near Belvidere, N. Y.	1351 D	411·9632	411·7591
At Belmont N. Y.	1416 D	431·9335	431·7299
At Wellsville, N. Y.	1519 D	463·2487	463·0464
Near Andover, N. Y.	1573 D	479·6127	479·4117
Near Andover, N. Y.	1675 D	510·6694	510·4694
At Alfred, N. Y.	1610 D	490·9429	490·7439
At Almond, N. Y.	1383 D	421·3013	421·1031
At Hornellsville, N. Y.	1141 D	348·0154	347·8183
Near Canisteo, N. Y.	1113 D	339·3631	339·1669
Near Adrian, N. Y.	1080 D	329·3329	329·1380
At Cameron, N. Y.	1048 D	319·4978	319·3036
At Rathbone, N. Y.	1006 D	306·7352	306·5425
At Addison, N. Y.	1021 D	311·4638	311·2721
At Painted Post, N. Y.	935 D	285·1422	284·9520
At Corning, N. Y.	City Hall.	285·3145	285·1248
Near Big Flats, N. Y.	899 D	274·3584	274·1700
At Horseheads, N. Y.	901 D	274·7547	274·5674
At Horseheads, N. Y.	Station.	274·1457	273·9584
At Elmira, N. Y.	857. Albany.	261·5010	261·3144
At Elmira, N. Y.	Erie Station.	260·2715	*260·0851
At Wellsburg, N. Y.	824 A	250·7031	250·7146
Near Chemung, N. Y.	804 A	244·5676	244·5799
At Waverly, N. Y.	840 A	255·6181	255·6317
Near Barton, N. Y.	798 A	242·8706	242·8855
At Owego, N. Y.	815 A	248·2064	248·2229
At Owego, N. Y.	812 A	247·1850	247·2024
Near Union, N. Y.	825 A	252·2650	252·2847
At Binghamton, N. Y.	867 A	263·7560	263·7769
Near Port Crane, N. Y.	959 A	291·9404	291·9621
Near Sanitaria Springs N. Y.	1126 A	342·8748	342·8976
Near Tunnel, N. Y.	1384 A	421·0803	421·1040
Near Harpersville, N. Y.	1051 A	319·5389	319·5639
At Afton, N. Y.	973 A	296·2977	296·3238
Near Bainbridge, N. Y.	978 A	297·7907	297·8176
Near Bainbridge, N. Y.	989 A	301·4496	301·4774
At Unadilla, N. Y.	1024 A	311·7080	311·7373
At Wells Bridge, N. Y.	1047 A	318·8220	318·8519
Near Otego, N. Y.	1051 A	319·8869	319·9178
At Oneonta, N. Y.	1232 A	375·2913	375·3235
At Oneonta, N. Y.	Oneonta.	330·9608	330·9930
At Colliers, N. Y.	1119 A	340·7235	340·7567
Near Maryland, N. Y.	1170 A	356·3786	356·4125
At Schenevus, N. Y.	1272 A	387·3291	387·3641
At Worcester, N. Y.	1311 A	399·1486	399·1845
Near East Worcester, N. Y.	1406 A	428·1201	428·1568
Near Richmondville, N. Y.	1224 A	372·6045	372·6425
Near Cobleskill, N. Y.	Cobleskill.	289·1410	289·1799
At Cobleskill, N. Y.	930 A	283·1603	283·1994
At Barnerville Crossing, N. Y.	Barnerville.	275·2980	275·3374
Near Howes Cave, N. Y.	731 A	222·5446	222·5846
Near Esperance, N. Y.	753 A	229·1650	229·2067
Near Duanesburg, N. Y.	681 A	207·3395	207·3815
Near Kelleys, N. Y.	410 A	124·4922	124·5354

* The corresponding elevation as reported on the line toward Greenbush = 260·2817.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported.
		metres.	*metres.*
At Schenectady, N. Y.	242 A	73·3447	73·3890
Near Cohoes, N. Y.	Mohawk Aqueduct.	59·1960	59·2398
At Cohoes, N. Y.	Mill Race.	48·4567	48·5151
At Erie, Pa.	B. M. I. (1873).	175·3416	175·1125
At Erie, Pa.	U. S. Engineer's B. M.	176·0122	175·7831
At Erie, Pa.	635. Pittsburg (1899).	193·9726	193·7435
At Erie, Pa.	685	209·0303	208·8012
Near Belle Valley, Pa.	1103. Pittsburg (1899).	336·2783	336·0524
Near Samson, Pa.	1214. Pittsburg (1899).	370·3862	370·1636
Near Samson, Pa.	P. R. R.	369·3953	369·1727
Near Samson, Pa.	P. R. R.	362·9990	362·7776
Near Lebœuff, Pa.	1193. Pittsburg (1899).	363·9825	363·7628
Near Millers, Pa.	1148. Pittsburg (1899).	349·9810	349·7642
Near Venango, Pa.	1128. Pittsburg (1899).	344·0393	343·8257
Near Saegerstown, Pa.	1109. Pittsburg (1899).	338·1073	337·8958
Near Meadville, Pa.	1071. Pittsburg (1899).	326·8009	326·5926
Near Cochranton, Pa.	1062. Pittsburg (1899).	323·8499	323·6461
At Utica, Pa.	1038. Pittsburg (1899).	316·5216	316·3211
Near Sugar Creek, Pa.	1013. Pittsburg (1899).	309·0021	308·8032
At Franklin, Pa.	989. Pittsburg (1899).	301·6054	301·4085
At Franklin, Pa.	987. Pittsburg (1899).	301·1287	300·9318
At East Sandy, Pa.	970. Pittsburg (1899).	295·9908	295·7956
Near Brandon, Pa.	957. Pittsburg (1899).	291·9755	291·7835
Near Kennerdell, Pa.	941. Pittsburg (1899).	287·3035	287·1136
Near St. George, Pa.	925. Pittsburg (1899).	282·3718	282·1835
Near Rockland, Pa.	919. Pittsburg (1899).	280·7302	280·5440
Near Dotter, Pa.	905. Pittsburg (1899).	276·2644	276·0802
Near Emlenton, Pa.	898. Pittsburg (1899).	274·1208	273·9395
At Parker, Pa.	883. Pittsburg (1899).	269·5327	269·3526
At Monterey, Pa.	869. Pittsburg (1899).	265·2775	265·0994
Near Lower Hillville, Pa.	885. Pittsburg (1899).	261·1178	260·9422
At East Brady, Pa.	852. Pittsburg (1899).	259·9813	259·8069
At Red Bank, Pa.	844. Pittsburg (1899).	257·5787	257·4063
Near Rimerton, Pa.	820. Pittsburg (1899).	250·2865	250·1166
At Mosgrove, Pa.	806. Pittsburg (1899).	246·1521	245·9854
At Kittanning, Pa.	803. Pittsburg (1899).	245·0201	244·8555
Near Rosston, Pa.	786. Pittsburg (1899).	239·9766	239·8144
At West Penn Junction, Pa.	788. Pittsburg (1899).	240·4834	240·3249
At West Penn Junction, Pa.	P. R. R. No. 26.	240·4776	240·3191
At Edgecliff, Pa.	764. Pittsburg (1899).	232·8295	232·6759
At Blacks Run, Pa.	770. Pittsburg (1899).	235·1781	235·0278
At Wildwood, Pa.	P. R. R.	228·3571	228·2109
Near Brilliant, Pa.	745. Pittsburg (1899).	227·2897	227·1517
At Pittsburg, Pa.	P. R. R. No. 99.	226·8012	226·6665
At Pittsburg, Pa.	738. Pittsburg (1899).	225·1617	225·0270
Near Valley Falls, W. Va.	986. Pittsburg (1899).	300·4447	300·4356
Near Powells, W. Va.	899. Pittsburg (1899).	274·0647	274·0548
At Benton Ferry, W. Va.	885. Pittsburg (1899).	269·8171	269·8061
Near Fairmont, W. Va.	885. Pittsburg (1899).	269·8018	269·7891
Near Catawba, W. Va.	873. Pittsburg (1899).	266·0163	266·0025
Near Little Falls, W. Va.	859. Pittsburg (1899).	261·8282	261·8118
At Uffington, W. Va.	828. Pittsburg (1899).	252·3944	252·3770
At Morgantown, W. Va.	821. Pittsburg (1899).	250·2591	250·2410
At Morgantown, W. Va.	U. S. E. B. M.	250·2563	250·2382
Near Van Vorhis, W. Va.	815. Pittsburg (1899).	248·5389	248·5198
Near Point Marion, Pa.	813. Pittsburg (1899).	247·8263	247·8059
Near Outcrop, Pa.	1084. Pittsburg (1899).	330·4229	330·4008
At Fairchance, Pa.	1065. Pittsburg (1899).	324·7403	324·7169

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.	Elevation as reported.
		metres.	*metres.*
At Uniontown, Pa.	999. Pittsburg (1899).	304·5201	304·4952
Near Upper Middletown, Pa.	920. Pittsburg (1899).	280·4037	280·3775
Near Tippecanoe, Pa.	868. Pittsburg (1899).	264·4862	264·4587
Near West Brownsville, Pa.	778. Pittsburg (1899).	237·0915	237·0632
Near West Brownsville, Pa.	P. R. R. No. 54.	237·0900	237·0617
Near Woods Run, Pa.	764. Pittsburg (1899).	232·9498	232·9204
Near Charleroi, Pa.	760. Pittsburg (1899).	231·0496	231·0187
At Lock No. 4, Pa.	Lock No. 4.	226·7613	226·7302
At Baird, Pa.	755. Pittsburg (1899).	230·2065	230·1741
Near River View, Pa.	753. Pittsburg (1899).	229·6386	229·6051
Near Peters Creek, Pa.	740. Pittsburg (1899).	225·4873	225·4525
Near Coal Valley, Pa.	P. R. R. No. 19.	224·5309	224·4951
Near Thomson, Pa.	767. Pittsburg (1899).	233·8550	233·8177
Near Thomson, Pa.	P. R. R. No. 11.	232·9342	232·8969
Near Bessemer, Pa.	760. Pittsburg (1899).	231·6040	231·5665
At Braddock, Pa.	P. R. R. No. 88.	252·7108	252·6730
At Homewood, Pa.	P. R. R. No. 92.	281·5408	281·4989
Near Benvenue, Pa.	818. Pittsburg (1899).	249·4834	*249·4391
At Harrisburg, Pa.	P. R. R. No. 1.	† 97·5692	
At Harrisburg, Pa.	P. R. R. No. 2.	†102·7852	
At Harrisburg, Pa.	364. Harrisburg (1899).	110·9356	
At Harrisburg, Pa.	P. R. R. No. 4.	101·1699	
Near Harrisburg, Pa.	P. R. R. No. 5.	106·5070	
Near Harrisburg, Pa.	P. R. R. No. 6.	106·5436	
Near Perdix, Pa.	P. R. R. No. 7.	105·3098	
At Perdix, Pa.	P. R. R. No. 8.	106·1273	
Near Perdix, Pa.	P. R. R. No. 9.	105·2161	
Near Perdix, Pa.	P. R. R. No. 10.	106·2768	
Near Perdix, Pa.	P. R. R. No. 11.	105·8076	
At Cove Creek, Pa.	P. R. R. No. 12.	107·1976	
At Shermans Creek, Pa.	P. R. R. No. 13.	108·3224	
At Duncannon, Pa.	P. R. R. No. 14.	111·9314	
At Juniata Bridge, Pa.	P. R. R. B.	109·5512	
Near Juniata Bridge, Pa.	P. R. R. No. 15.	110·6729	
Near Aqueduct, Pa.	P. R. R. No. 16	113·7026	
At Aqueduct, Pa.	P. R. R. No. 17.	113·1754	
At Alters Run Bridge, Pa.	P. R. R. No. 18.	115·0196	
At Loshs Run Bridge, Pa.	P. R. R. No. 19.	113·8402	
Near Loshs Run, Pa.	P. R. R. No. 20.	117·6076	
At Bailey, Pa.	P. R. R. No. 22.	117·2542	
Near Bailey, Pa.	P. R. R. No. 23.	120·5341	
At Trimmers Rock, Pa.	P. R. R. No. 24.	119·6717	
Near Newport, Pa.	P. R. R. No. 25.	120·1505	
At Newport, Pa.	P. R. R. No. 26.	120·7968	
Near Newport, Pa.	P. R. R. No. 27.	120·9524	
Near Newport, Pa.	P. R. R. No. 28.	122·4278	
Near Old Ferry Station, Pa.	P. R. R. No. 29.	122·1232	
At Millerstown, Pa.	P. R. R. No. 31.	124·7540	
Near Durward, Pa.	P. R. R. No. 32.	125·0864	
At Durward, Pa.	P. R. R. No. 33.	128·8782	
Near Durward, Pa.	P. R. R. No. 34.	128·4455	
At Thompsontown, Pa.	P. R. R. No. 35.	128·0861	
Near Thompsontown, Pa.	P. R. R. No. 36.	127·6748	
Near Thompsontown, Pa.	P. R. R. No. 37.	128·1230	
At Vandyke, Pa.	P. R. R. C.	129·7874	
Near Vandyke, Pa.	P. R. R. No. 39.	129·8362	

* The elevation of "738 Pittsburg 1899" as reported on this line = 225·1157.

† In deriving the correction to the Penn. R. R. elevations at Harrisburg a mean was taken of the several corrections at No. XXIX, P. R. R. No. 1, and P. R. R. No. 2.

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Tuscarora, Pa.	P. R. R. No. 40.	131·1196
At Mexico, Pa.	P. R. R. No. 41.	130·8302
Near Port Royal, Pa.	P. R. R. No. 42.	131·9338
At Port Royal, Pa.	P. R. R. No. 43.	134·4333
Near Mifflin, Pa.	P. R. R. No. 45.	134·9274
At Mifflin, Pa.	P. R. R. No. 46.	135·5889
Near Mifflin, Pa.	P. R. R. No. 47.	136·2778
At Denholm, Pa.	P. R. R. No. 49.	138·3354
Near Denholm, Pa.	P. R. R. No. 50.	141·9659
Near Narrow, Sta., Pa.	P. R. R. No. 51.	142·1037
Near Narrow Sta., Pa.	P. R. R. No. 52.	144·4081
At Bixler Water Sta., Pa.	P. R. R. No. 53.	145·2098
At Lewistown Junc., Pa.	P. R. R. No. 54.	151·9644
At Mayes Bridge, Pa.	P. R. R. No. 57.	152·3426
At Granville, Pa.	P. R. R. No. 58.	150·5598
At Anderson, Pa.	P. R. R. No. 59.	150·2858
Near Longfellow Sta., Pa.	P. R. R. No. 61.	151·6180
Near Horingford Sta., Pa.	P. R. R. No. 62.	152·4900
Near Horingford Sta., Pa.	P. R. R. No. 63.	159·6348
At McVeytown, Pa.	P. R. R. No. 64.	160·2262
Near McVeytown, Pa.	P. R. R. No. 65.	154·2950
Near McVeytown, Pa.	P. R. R. No. 66.	154·3744
Near Ryde, Pa.	P. R. R. No. 67.	155·7522
At Ryde, Pa.	P. R. R. No. 68.	157·1208
At Overhead Bridge, Pa.	P. R. R. No. 69.	162·6134
At Manayunk Bridge, Pa.	P. R. R. No. 70.	164·1590
Near Vineyard Sta., Pa.	P. R. R. No. 71.	171·6969
Near Vineyard Sta., Pa.	P. R. R. No. 72.	178·2502
Near Newton Hamilton, Pa.	P. R. R. No. 73.	179·8964
At Newton Hamilton, Pa.	P. R. R. No. 74.	182·7068
Near Mount Union, Pa.	P. R. R. No. 75.	183·4232
At Mount Union, Pa.	P. R. R. No. 76.	183·0882
Near Mount Union, Pa.	P. R. R. No. 77.	177·6354
At Jackstown, Pa.	P. R. R. No. 78.	181·0524
At Mapleton, Pa.	P. R. R. No. 79.	182·0462
At Vandevanders Bridge, Pa.	P. R. R. No. 80.	183·2382
At Bridgeport, Pa.	P. R. R. No. 81.	183·2260
At Mill Creek, Pa.	P. R. R. No. 82.	184·9452
At Mill Creek, Pa.	P. R. R. No. 83.	183·3298
Near Mill Creek, Pa.	P. R. R. No. 84.	183·6714
At Ardenheim, Pa.	P. R. R. No. 85.	183·9824
Near Ardenheim, Pa.	P. R. R. No. 86.	189·2952
At Huntingdon, Pa.	P. R. R. No. 87.	190·3898
At Huntingdon, Pa.	P. R. R. No. 88.	190·4296
Near Warrior Ridge, Pa.	P. R. R. D	203·7374
At Warrior Ridge, Pa.	P. R. R. No. 90.	205·9900
Near Petersburg, Pa.	P. R. R. No. 91.	205·9658
At Petersburg, Pa.	P. R. R. No. 92.	207·5418
Near Petersburg, Pa.	P. R. R. No. 93.	211·1142
Near Petersburg, Pa.	P. R. R. No. 94.	211·4801
Near Petersburg, Pa.	P. R. R. No. 95.	213·3180
Near Barree, Pa.	P. R. R. No. 96.	219·6397
Near Barree, Pa.	P. R. R. No. 97.	222·2520
At Tunnel, Pa.	P. R. R. No. 98.	231·4418
At Tunnel, Pa.	P. R. R. No. 99.	232·0210
Near Union Furnace, Pa.	P. R. R. E	238·6780
Near Union Furnace, Pa.	P. R. R. No. 101.	239·7693
At Union Furnace, Pa.	P. R. R. No. 102.	243·5459
Near Union Furnace, Pa.	P. R. R. No. 103.	250·4132

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Shoenberger, Pa.	P. R. R. No. 104.	255·5948
Near Birmingham, Pa.	P. R. R. No. 105.	261·5904
At Birmingham, Pa.	P. R. R. No. 106.	264·1904
Near Birmingham, Pa.	P. R. R. No. 107.	270·6888
Near Tyrone, Pa.	P. R. R. No. 108.	271·5150
At Tyrone, Pa.	P. R. R. No. 109.	273·1306
At Tyrone, Pa.	P. R. R. No. 110.	277·6448
Near Tyrone, Pa.	P. R. R. No. 111.	281·1014
Near Tyrone, Pa.	P. R. R. No. 112.	284·8018
Near Grazierville, Pa.	P. R. R. F	287·5024
Near Grazierville, Pa.	P. R. R. No. 113.	289·8310
At Tipton, Pa.	P. R. R. No. 114.	302·8218
Near Fostoria, Pa.	P. R. R. No. 115.	313·2554
At Bellwood, Pa.	P. R. R. No. 116.	323·8018
Near Bellwood, Pa.	P. R. R. No. 117.	322·6194
At Elizabeth Furnace, Pa.	P. R. R. No. 118.	327·8620
Near Elizabeth Furnace, Pa.	P. R. R. No. 119.	335·3084
At Blair Furnace, Pa.	P. R. R. No. 120.	340·8378
At Red Bridge, Pa.	P. R. R. No. 121.	345·3214
At Haggerty Run, Pa.	P. R. R. No. 122.	348·1987
At Altoona, Pa.	P. R. R. No. 123.	354·0357
At Altoona, Pa.	P. R. R. No. 124.	354·4747
At Altoona, Pa.	P. R. R. No. 125.	356·7090
At Altoona, Pa.	P. R. R. No. 126.	360·0832
At Altoona, Pa.	P. R. R. No. 127.	363·3600
At Kittanning Point, Pa.	P. R. R. No. 2.	495·7539
At Allegrippus, Pa.	P. R. R. No. 3.	589·9984
At Bennington, Pa.	P. R. R. No. 4.	619·0309
At Allegheny Tunnel, Pa.	P. R. R. No. 5.	648·2035
At Gallitzin, Pa.	P. R. R. No. 6.	659·8624
At Cresson, Pa.	P. R. R. No. 7.	616·3190
Near Lilly, Pa.	P. R. R. No. 8.	594·5658
At Lilly, Pa.	P. R. R. No. 9.	575·8206
At Portage, Pa.	P. R. R. No. 12.	514·3550
Near Portage, Pa.	P. R. R. No. 13.	494·9059
At Wilmore, Pa.	P. R. R. No. 14.	476·4077
Near Wilmore, Pa.	P. R. R. No. 15.	475·2315
Near Ehrenfeld, Pa.	P. R. R. No. 16.	476·3167
At Ehrenfeld, Pa.	P. R. R. No. 17.	463·1312
Near Ehrenfeld, Pa.	P. R. R. No. 18.	452·4054
At Conemaugh Viaduct, Pa.	P. R. R. No. 20.	444·3832
At Mineral Point, Pa.	P. R. R. No. 21.	431·6396
Near Mineral Point, Pa.	P. R. R. No. 22a.	414·9124
Near Mineral Point, Pa.	P. R. R. No. 23.	404·4426
Near Conemaugh, Pa.	P. R. R. No. 24.	399·6178
At Conemaugh, Pa.	P. R. R. No. 26.	374·0420
At Woodvale, Pa.	P. R. R. No. 27.	361·3747
At Johnstown, Pa.	P. R. R. No. 28.	362·0820
At Johnstown, Pa.	P. R. R. No. 28a.	359·8478
Near Sang Hollow, Pa.	P. R. R. No. 30a.	349·9881
At Sang Hollow, Pa.	P. R. R. No. 31.	348·9243
Near Big Spring Run, Pa.	P. R. R. No. 34.	343·4961
At Big Spring Run, Pa.	P. R. R. No. 36.	333·6513
At Piney Run, Pa.	P. R. R. No. 36a.	332·8195
Near New Florence, Pa.	P. R. R. No. 36b.	329·5036
Near New Florence, Pa.	P. R. R. No. 37.	327·2238
At New Florence, Pa.	P. R. R. No. 37a.	329·3636
Near Lockport, Pa.	P. R. R. No. 40.	317·8700
Near Lockport, Pa.	P. R. R. No. 41.	320·3999

Corrected elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Corrected elevation.
		metres.
At Lockport, Pa.	P. R. R. No. 42.	321·6282
At Bolivar, Pa.	P. R. R. No. 43.	314·9474
At Bolivar, Pa.	P. R. R. No. 44.	315·7034
At Bolivar, Pa.	P. R. R. No. 44a.	315·8192
Near Bolivar, Pa.	P. R. R. No. 45.	330·9192
At Pack Saddle, Pa.	P. R. R. No. 46.	337·0032
At Pack Saddle, Pa.	P. R. R. No. 46a.	337·5277
At Blairsville, Pa.	P. R. R. No. 47.	341·4110
Near Blairsville, Pa.	P. R. R. No. 48.	339·5884
At Millwood, Pa.	P. R. R. No. 51.	355·3838
Near Millwood, Pa.	P. R. R. No. 52.	350·7326
At Derry, Pa.	P. R. R. No. 53.	356·3380
At Derry, Pa.	P. R. R. No. 54.	360·4132
At Bradenville, Pa.	P. R. R. No. 56.	331·1314
At Bradenville, Pa.	P. R. R. No. 56a.	330·8602
At Loyalhanna, Pa.	P. R. R. No. 57.	316·8973
At Latrobe, Pa.	P. R. R. No. 58.	307·4944
At Latrobe, Pa.	P. R. R. No. 58a.	301·5051
Near Latrobe, Pa.	P. R. R. No. 59.	324·3502
At Beatty, Pa.	P. R. R. No. 60.	328·4468
At Carney, Pa.	P. R. R. No. 61.	351·5601
Near Carney, Pa.	P. R. R. No. 62.	368·7967
At George, Pa.	P. R. R. No. 63.	365·6697
At Greensburg, Pa.	P. R. R. No. 65.	331·0902
At Greensburg, Pa.	P. R. R. No. 66.	339·5151
At Radsbaugh, Pa.	P. R. R. No. 67.	354·3104
At Radsbaugh, Pa.	P. R. R. No. 68.	355·1121
At Radsbaugh, Pa.	P. R. R. No. 68a.	352·9358
At Radsbaugh, Pa.	P. R. R. No. 69.	349·7537
At Radsbaugh, Pa.	P. R. R. No. 69a.	347·8336
Near Grapeville, Pa.	P. R. R. No. 70.	336·3548
At Grapeville, Pa.	P. R. R. No. 71.	323·0688
At Penn, Pa.	P. R. R. No. 72.	296·8653
Near Penn, Pa.	P. R. R. No. 72a.	300·0048
Near Manor, Pa.	P. R. R. No. 73.	288·8126
At Irwin, Pa.	P. R. R. No. 76a.	268·0652
Near Larimer, Pa.	P. R. R. No. 77a.	262·9022
At Adara, Pa.	P. R. R. No. 78.	254·7916
At Moss Side, Pa.	P. R. R. No. 81.	232·7395
At Wall, Pa.	P. R. R. No. 82.	229·1461
At Turtle Creek, Pa.	P. R. R. No. 84.	228·4635
At Brinton, Pa.	P. R. R. No. 85.	229·3660
At Brinton, Pa.	P. R. R. No. 86.	230·7409

DESCRIPTIONS OF BENCH MARKS.

GENERAL NOTES DESCRIBING IN DETAIL DIFFERENT FORMS AND MARKINGS OF BENCH MARKS CONNECTED WITH THE LEVEL NET.

NOTE 1.—A bench mark described as a copper bolt and referred to this note is a piece of round copper ½ inch by 2 inches, leaded horizontally into a masonry wall. A vertical and a horizontal line cut on the end form, by their intersection, the bench mark.

NOTE 2.—A bench mark referred to this note is lettered as follows:

N		N
U. S. C. & G. S.	or	B □ M
B □ M		U. S. C. & G. S.
1881		1878

The letter at the top being changed to correspond with that of the bench mark and the date to agree with the year when established. The bottom surface of the square cut is always taken as the bench mark.

NOTE 3.—Stone posts referred to this note are in general 6 inches square, about 4½ feet long, and set with 4 feet below the ground. The top surface is marked:

U S
□
B M

The bottom of the square cut is always taken as the bench mark.

NOTE 4.—Bench marks referred to this note are lettered as follows:

L
B □ M
U. S. C. S.
1878

The letter at the top being changed to correspond with that of the bench mark and the date to agree with the year when established. The bottom surface of the square cut is always taken as the bench mark.

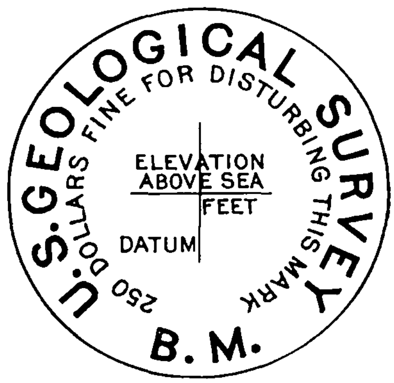
NOTE 5.—A bench mark described as a brass bolt and referred to this note is 3 inches long, cut from round brass rod three-eighths inch in diameter, and leaded horizontally into vertical face of masonry, with its outer end setting slightly back of surface and marked horizontally across its center by an indentation cut with a cold chisel, and lettered as follows:

U S C
⊖
& G S

NOTE 6.—A bench mark cut in masonry and referred to this note is the horizontal bottom surface of a square cut about 1 inch on a side and three-eighths inch deep, and is lettered as follows:

U S C
□
& G S

NOTE 7.—Bench marks of the United States Geological Survey referred to this note consist of hollow wrought-iron posts 4 feet 6 inches in length, 3½ inches in outer diameter, split at the bottom and expanded to 12 inches, so as to prevent either the easy subsidence of the post or its being maliciously pulled out of the ground. Into the top of this post is riveted a bronze tablet 3½ inches in diameter and one-fourth inch thick, appropriately lettered as shown, and the iron is heavily coated with hot asphalt. These posts are buried in the earth, with only 1 foot of their length projecting above the surface. The surface of the cap at the intersection of the cross is taken as the bench mark.



NOTE 8.—All bench-mark monuments referred to this note consist of pieces of limestone 46 centimetres square and 15 centimetres thick, marked

U S
○
B M

with spherical-headed copper bolts leaded in upper faces, and buried 1·2 metres under ground, access being given through 12-centimetre iron pipes set on top. Each pipe has a cast-iron cover, fastened by a horizontal bolt through cap and pipe. The cap has a small boss and the letters

U S E
○
B M

raised on top. Elevations will apply to the top of the bolt in the underground stone. Elevation of boss of pipe cap can be found in any case by adding 1·24 metres to elevation of copper bolt.

NOTE 9.—A bench mark consisting of a stone post and referred to this note is 5 inches square by 2 feet 6 inches in length and is buried usually with 3 inches projecting. The top is dressed and lettered as follows:

U S
B □ M
1880

The bottom of the square cut is always the bench mark.

NOTE 10.—Stone post bench marks referred to this note are duplicates of those described in Note 9, except that the date is 1881.

NOTE 11.—Stone post bench marks referred to this note are 8 by 8 inches and 30 inches long, rough, except 6 inches at the top, which is dressed to 6 by 6 inches. It is lettered on its top surface thus:

U S
□
B M

The stones are in general set with 3 inches projecting above the surface, and the bottom of the square cut is the bench mark.

NOTE 12.—Stone post bench marks referred to this note are similar to those described in Note 11, except that they are 36 inches in length and set with 6 inches projecting above the surface.

NOTE 13.—Stone post bench marks referred to this note are 8 by 8 inches in cross section and 3 feet long and usually buried with 6 inches projecting above the surface. The top of the post is lettered thus:

U S
□
B M

and the bottom of the square cut at the center is the bench mark.

NOTE 13a.—A P. B. M. referred to this note consists of a piece of copper rod three-eighths inch in diameter and 3 inches long, upset at the inner end and leaded either horizontally or vertically, and is always marked, when possible,

U S
⊙
P B M

by letters 1½ inches high, about ¼ inch heavy, and $\frac{3}{16}$ inch deep, cut in the stone. When set horizontally, the outer end of the bolt stands about one-fourth inch back of the face of the stone and the indentation of a "center punch" is made in the center of this end, the center of which is the point of reference. When set vertically, the top of the copper bolt, which is the point of reference, projects above the surface of the stone about 0·003 foot.

NOTE 14.—A P. B. M. or permanent bench mark referred to this note, is set with special care so as to be practically permanent; those described as a tile and pipe consist of a vitrified tile 18 by 18 by 4 inches, in the center of which is set vertically with lead a ⅜-inch copper bolt, the upper end being a little above the upper surface of the tile. Surrounding the bolt on the surface of the tile is the inscription "Mississippi River Commission, 1898, U. S., P. B. M." This tile is buried in the ground from 3 to 3½ feet beneath the surface. On top of the tile is placed a 4-inch wrought-iron gas pipe 4 feet long concentric with the copper bolt; the lower end of the pipe is split into quarters and spread out to prevent the pipe from heaving by frost or being pulled up. A cast brass cap fits over the top of the pipe, and is riveted thereto. The cap has the following inscription in sunken letters, "Mississippi River Commission, $250 fine for disturbing this mark. 1898. P. B. M., U. S. Latitude. Longitude. Elevation above sea." The elevation of the top of the cap is determined; the structure has thus two bench marks. All witness trees are blazed with a △ facing the bench mark.

NOTE 15.—A P. B. M. when referred to this note is the top of copper bolt set in the regulation "B. M." stone 18 by 18 by 4 inches thick, 3½ feet under ground, over and concentric with which is set an iron pipe, 4 feet long, provided with a flange at the bottom 10 inches in outer diameter, and cap at top terminating in a rounded knob, which is also taken as a P. B. M.

The top surface of flat stone is marked "B. M." and the cap surmounting pipe is molded with the inscription "Missouri River Commission."

NOTE 16.—A P. B. M. referred to this note is the center of punch mark in copper bolt leaded horizontally into the masonry of structures, or into natural ledges, about ⅛ inch deeper than the surface of rock; or the top of copper bolt set vertically into the masonry of structures, or into natural ledges, projecting about 0·002 foot above the surface, and in both cases all have the letters

U S
⊙
P B M

cut into the rock of size and depth to be readily seen and to last many years.

DESCRIPTIONS OF BENCH MARKS SANDY HOOK TO DOBBS FERRY.

Sandy Hook to Red Bank, N. J.

T. H.—A heavy line on the northwest corner post, inside the tide house at *Sandy Hook.* It is the first or starting mark to which the average height of the ocean has been referred.

A and B.—*Sandy Hook, N. J.* Are cedar posts 8 feet long and 8 inches in diameter, sunk in the ground with ends projecting about 4 inches. In the center of each post is a copper nail surrounded by five others in form of a pentagon. These posts are 12 metres apart and bear ENE. from the steamer landing and nearly northeast from the tide house, and are distant from the latter about 500 metres. They are also 95 metres NW. of the railroad red engine house, and are in the edge of the cedars, where the ground is elevated a few feet above the marsh.

C.—Copper bolt (see note 1, page 548,) in the wall of the main light-house tower at *Sandy Hook.* It is a few inches west of the northwest angle of the tower and 9¼ inches above the sloping ledge near its base.

No. II.—A heavy granite post, which projects about 2 feet above the surface of the ground, on the east side of the track of the New Jersey Southern Railroad, about three-quarters of a mile north of *Highland* Station.

No. V.—A square cavity cut on the south pier of the Oceanport Drawbridge, about 1½ miles north of the *Branchport* Station, New Jersey Central Railroad.

E.—*Red Bank, N. J.* A marble post near the southeast corner of the house of Rev. B. F. Leipser. The house stands on the southwest corner of Monmouth and Pearl streets.

Since the establishment of the bench mark in 1881 the property changed ownership, and now belongs to Mr. Van Dyke Reed. The new porch, resting on a brick foundation, is flush with the east edge of the bench mark and covers about one-third of it; the bricks of the foundation do not rest on the marble post, which is over 5 feet long and projects above the ground about 5 inches.

T of 1886.—A marble post, about 4 feet long, the upper part dressed, and the letters "U. S. C. S." carved in the upper surface; in the center of the face there is a small cavity, about half an inch in dimensions. This mark is on the western slope of the high ridge at *Sandy Hook*, just east of the New Jersey Southern Railroad wharf. It is below the crest of the ridge, sheltered by vegetation, and 375 feet west of the western corner of the round house of the railroad, and 2 feet 7½ inches WSW. of bench mark A of 1881 (described above), and is also 41 feet WNW. of bench mark B of 1881.

U of 1886.—A copper nail in the top of the highest horizontal brace of the platform upon which the house containing the self-registering tide gauge of 1886 at *Sandy Hook* is erected. The copper nail is surrounded by a circlet of nine copper tacks; the bench is 4 feet 1½ inches east of the eastern edge of the door of tide house and south and east of the tide-gauge walk. A tide staff is near the mark.

Red Bank, N. J., to South Amboy, N. J.

S.—At *Port Monmouth*. Established July 29, 1887; is a cross on a brick whose upper surface was the tidal bench mark established in 1886. The brick is in the highest course of the pier which supports the northeast corner of the piazza of Captain Bowman's house. On its east face is a small cross, and the center of this cross is the bench mark. This mark is 0·0216 metre lower than the upper surface of the brick.

Port Monmouth tidal.—Was established by Assistant H. L. Marindin in 1886. It is on the top of the brick foundation (northeast corner) of the wooden piazza of Captain Bowman's frame house. The top of the brick pier is the bench mark.

R.—*Keyport, N. J.* Established July 14, 1887; is situated on the east end of stone doorsill of the First National Bank. The mark is the center of a cross cut in the east corner of the sill.

Conaskonk Point tidal.—Was established by Assistant Marindin in 1886. The mark is the top of a nail driven in a silver poplar tree near the Monmouth House.

No. VI.—*Matawan, N. J.* First established in July, 1870. In 1881 was supposed by Assistant Braid to have the appearance of having been slightly disturbed. The mark is the center of a triangle cut on a flagstone in front of Benjamin Tuttle's house on Main street.

Tidal.—*South Amboy, N. J.* Was established in 1886 on the slip in the Pennsylvania coal yard. The bench mark is the top of the great sill upon which the uprights rest that carry the rails along the side of the slip. It is on the east side of the yard. The foot of the upright just at the bench mark has a small three-sided piece cut out of it and three nails are driven in the sill. A copper nail in the center of this triangle is the mark. The letters "B. M." are cut on the upright.

No. VIII.—Near *South Amboy*. The center of a triangle cut on stone wall at crossing of Camden and Amboy branch of Pennsylvania Railroad and of New Jersey Central Railroad.

F.—*Raritan Bay*. The bottom surface of a square cavity cut on the pier at the north end of drawbridge between South Amboy and Perth Amboy.

South Amboy, N. J., to Fort Wadsworth, Staten Island.

State Geological Survey.—*Perth Amboy, N. J.* A granite post located in a triangular grass plot in the public park in the center line of High street, 97.75 feet southwesterly from its intersection with the center line of Market street. (See description in Report of State Geologist for 1886.)

N.—*Staten Island.* Is situated on a rock a little south of *Gifford* station on the Staten Island Railroad, on the west side of the track, about 125 metres from the station. It was established June 10, 1887.

O.—*Staten Island.* Is situated on a rock at *Great Kills*, and is a cross cut on a large stone in the bottom course of rough sea wall in front of Fitzgerald's Hotel. The stone is the second one inland from the southeast corner of the wall. Mark established June 13, 1887.

Great Kills tidal.—*Staten Island.* The bench mark is on the post that supports the northeast corner of the barn at *Great Kills* belonging to Mr. Fitzgerald. The post is at the extreme corner, and about 1 foot above the ground. The east side is flattened and the middle of the line joining the flattened side with the bevel running to the round portion is the datum line. The letters "B. M." are cut above this line. Established in 1886.

M.—*Fort Wadsworth, Staten Island.* Is situated on the top layer of granite masonry which surrounds gun No. 5, water battery, a little south of the fort. The bench mark is a small black spot near the corner of the stone, nearly under gun No. 5, or the second one south of the embankment. Established June 7, 1887.

Quarantine Dock.—*Staten Island.* A cross cut on the upper surface of the coping on the north end of the old sea wall and about forty paces south of the Quarantine boathouse. The letters U. S. C. & G. S. are cut near it.

Constables Hook, N. J.—At the crude-oil docks of the Standard Oil Company on *Constables Hook, Kill Van Kull.* The bench mark is the top of the southeast corner of a stringer upon which the one-story brick warehouse of the company is built; the brick above the mark has a rude cross scratched in its face.

P.—*Constables Hook, N. J.* A copper bolt (see note 1, page 548) in a brick at the cooper workshops of the Standard Oil Company. This brick is on the second buttress east of the door on the south side of the shop. The shop is just in the rear of the covered dock called Crude-Oil Dock No. 3.

Q.—*Bergen, N. J.* A cross and cavity cut in the upper surface of a large granite stone forming the south end of the top course of masonry in the west abutment of small iron bridge of the Central Railroad of New Jersey, crossing the Morris Canal. The mark is on the southeast corner of the stone and shows the letters U. S.

Tidal.—*Elm Park, Staten Island.* The mark is a small cross cut on a stone in the foundation wall of the house attached to the Elm Park cottage. The horizontal line marks the reference plane. This stone is the second from the top and the second from the north face of the wall; the cross is near the lower left-hand edge of the stone.

Tidal.—*Elizabeth, N. J.* Is a cross cut in a brick at the southeast corner of Worrall & Co.'s foundry at *Elizabeth.* It is in the seventh course of brick from the ground and marked U. S. Established in 1886.

Narrows to Hunters Point, Long Island, N. Y.

L.—*Fort Hamilton, Long Island, N. Y.* A cross cut in the granite stone on the northwest corner of the wall on its west side and near the gate for wagon-road entrance opposite the Ocean House. It is about 1½ feet above the ground and 4 inches from the high offset of the retaining wall. Established in May, 1887.

Tidal.—*Locust Grove, Bath Beach, Long Island.* This bench mark is the corner of a granite stone in the revetment wall, marked just below the corner with an indistinct cross. The mark is on the left-hand side in going out on the pier. Established in 1886.

K.—*Bath Beach.* The mark is situated on the north side of the second house (chalet style) from the corner of Bay Thirteenth street on Coopsy avenue, Bath Beach. The mark is a copper bolt (See note 1, page 548) in the fifth brick above window ledge and on the north side of the window, east side of the house. Established in May, 1887.

No. 25.—*Bay Ridge, Long Island.* The mark is situated in Bay Ridge at the southeast corner of Fourth avenue and Sixty-seventh street, two blocks below the Brooklyn city line. It is a granite post 6 by 6 inches, with about 3 inches projecting above ground; it is marked by a square and cross on its upper surface. The stone is inside the sidewalk at the northwest corner of Lumbey's lot. Established in April, 1887.

Tidal.—*Bay Ridge, Long Island.* The mark is the northwest corner of the blue-stone slab forming the top of the lowest step leading from Mr. Langley's place to the bay shore. A flight of six stone steps comes down to the iron gate; on the lowest step a rude cross marks the bench. Established by Assistant Marindin in 1886; mark 9·521 feet above the zero of the gauge.

J.—*Bay Ridge, Long Island.* The mark or cross is situated on coping stone on top of and at north corner of the tunnel of the Manhattan Beach Railroad under Second avenue and between Sixty-fifth and Sixty-sixth streets, just outside the Brooklyn city limits. Established in May, 1887.

A.—*Brooklyn, N. Y.* Is situated on the stone step at the door at the southeast corner of St. Michael's school on Fourth avenue, just north of Forty-third street, Brooklyn. It is a cross cut in the northwest corner of the large step. Established in May, 1887.

G.—*Atlantic Dock, Brooklyn.* Is situated on the seaward face of one of the stone store buildings on Atlantic Dock and facing Buttermilk Channel. It is a cross cut on the south end of the fourth stone above the foundation in the space between the two iron doors of store No. 22, and directly under the number. Established in May, 1887.

Hydrographic marks, corner of driveway and of ordnance building, *Governors Island.*—The marks were established in 1873 by Assistant Marindin and by Lieutenant Handy, U. S. N., in 1875. The first mark is on the northeast face of the retaining wall of the terrace or driveway in front of headquarters, and the lower edge of the rectangular notch is the mark called B. $M._1$. The mark is 2·4 feet above the ground. On August 28, 1875, B. $M._2$ was established on the southeast corner of the underpinning to the ordnance building. The letters U. S. are cut into the stone below the mark.

H.—*Governors Island.* The bench mark is the extreme northeast corner of the large stone having a ringbolt in the top and forming part of the coping of the sea wall in front of Castle William. A cross was cut in the stone. Established in 1886.

I.—*Governors Island.* Is situated on the south end of doorsill, entrance into Castle William. It is a cross cut in the sill on the left of main entrance.

C.—*Hall of Records, Brooklyn.* Is on the east side of Kings County Hall of Records, facing Boerum Place. The granite foundation of this building consists of two courses; the lower course projects beyond the upper one about 2 inches, thus forming a ledge which slopes from the inner edge; the mark is on the top of this ledge, about 5½ feet from the corner of the building. Established in May, 1887.

D.—*Brooklyn Navy-Yard.* This bench mark is situated on the south front of the United States machine shop No. 28 (in 1870) in the navy-yard, close to the gate on Flushing avenue. It is a square cavity of 1 inch side and of half an inch depth, cut in the stone sill of the double door at south end of building. It is about 1 foot from the front edge of the sill, and the bottom of the cavity is the mark. Established in May, 1887.

F.—At the gas company's warehouse, used for storage of coal, foot of Hudson avenue and west of the Navy-Yard. The bench mark is on the north side of the stone building on the east face of the fourth buttress from the northeast corner and consists of a cross cut on the fourth course of stone above the foundation. Established in May, 1887.

E.—*Corlears Hook, New York City.* This mark is situated on the southwest corner of Coe's bonded warehouse, corner of Water and East streets, Corlears Hook. It consists of a cross cut in the granite door jamb, first door from the southwest corner and about 5 feet from the ground. Established in May, 1887.

Tidal.—*Corlears Hook, N. Y.* Established by Assistant Marindin in October, 1886. The bench mark is the edge of stone sill belonging to the door of Coe's warehouse nearest to Corlear street. The door jambs are each monoliths, and where the foot of the western jamb meets the stone sill is the level of the bench.

Tidal.—*Hunters Point, East River.* Established in October, 1886. The bench mark was taken on the curbing in the west side of Front street. It is at the extreme southeast end of the fence that surrounds the triangular space between the building, Long Island News Company's office, and the Annex pier. It is also described as B. M. No. 8.

B.—*Hunters Point.* This mark is established on the large brick building known as Miller's Long Island City Hotel, corner of Borden avenue and Front street. The entrance to building is at the southwest corner, there being a triangular space or vestibule before the door. The bench mark is a cross cut in the northwest corner of this space, about 1 inch from the outer edge of the sill and about 4 inches from where the brick wall ends. The sill is of North River bluestone. Established in May, 1887.

Hunters Point, Long Island, to New York City and Dobbs Ferry, Hudson River.

No. 7.—*Ravenswood, Long Island.* The mark is on the lowest step of the entrance to A. Fischer's garden on Webster avenue, and is a small square cut on the flagstone top.

No. 6.—*Astoria, Long Island.* This bench mark is a triangle cut into the top of the curbstone on the corner of Fulton street and Perot avenue. It is about 2½ feet from the lamp-post and 7½ feet from the fire plug.

No. 4.—*Near Astoria Dock.* Is a triangle cut into the wooden stringer forming part of the sea wall or bulkhead. An iron nail was driven into each corner of the triangle and the letters "U. S." were cut on one side.

No. 1.—*Pot Cove, Long Island.* The bench mark is a triangle cut into the stringer above the tide gauge of 1886. An iron nail was driven in each corner of the triangle.

No. 2.—*Pot Cove, Long Island.* The bench is a small cross on the coping of the wall that divides the properties of Messrs. Morrison and Whittemore at Pot Cove. An iron fence comes to an end at the place selected for the bench.

No. 4a.—*Polhemus Dock, Long Island.* A triangle cut into the top stone of the northeast corner of the Polhemus dock, which is at the intersection of River road and Wolcott avenue. The bench is 10.308 feet above the zero of the gauge of 1886.

No. 5.—*New York City, foot of Eighty-fourth street.* This bench is on the sea wall in process of construction on the East River, foot of Eighty-fourth street. It is the extreme southeast end of the sea wall, River View Park (at the Eighty-fourth street end of it), and is the upper surface at the corner marked by a square. It was the intention of the park commissioners to put on top of the stone selected for the bench mark a course of dressed granite coping, which may now be in place. Established in 1886.

Tidals 1886 and 1885, foot of Forty-second street.—*New York City, Hudson River.* The 1886 bench mark is a small cross made on the new brick pilaster that supports the iron arch leading to the gas company's wharf and in line with the end of the coal shed. It is on the thirty-second brick, counting from the level of the dock up; the horizontal line on the brick is the datum line. The 1885 bench mark established on the wall of the same building (gas company's) in connection with the gauge of 1885 is a cross on the brick wall having the letters "U. S. C. S." marked upon it; this mark is about 48 meters from the mark of 1886 and on the side of the wall facing the paved roadway from the entrance of the works to the pier.

Tidal.—*Dobbs Ferry, Hudson River.* Established in 1885. This mark consists of a cross with the letters U. S. C. S. cut in the brick wall of S. Taylor's lumber office, near the wharf. It is on the west side of the southeast corner of the two-story brick building, about 2 feet from the corner and 2½ feet above the surface of the ground. The horizontal cut of the cross is the point of reference.

V.—*Dobbs Ferry.* Established in August, 1887. It is on the same brick building as above. The mark consists of a copper bolt leaded horizontally in middle of brick in the first course below bench mark of 1885; it is the sixth brick from extreme southeast corner of building. The center of the head of the bolt is the bench mark.

Hunters Point, Long Island, to Willets Point, Long Island.

All the bench marks in this section were established in 1886, or refer to that year, and served for the hydrographic survey of the East River.

No. 9.—*Borden Avenue Bridge, Long Island City, N. Y.* Is a triangle cut in the extreme southern end of the coping of the south abutment of the wagon bridge where Borden avenue crosses arm of Newtown Creek.

No. 10.—*In Flushing*, on Lawrence street. Is a small square cut into a sandstone sidewalk flag, near J. Milnor Peck's lumber yard.

No. 11.—*At College Point.* Is a small (1½-inch) square cut into the northeast corner of the granite stone covering the catch-basin at the intersection of Nineteenth street and Fifth avenue. The middle of the square is the point of reference.

Tidal Station No. 68.—*College Point.* Is the horizontal line of a cross cut into a granite stone of the foundation wall of a house at the ferry yard, foot of Third avenue, College Point.

No. 12.—Is the middle of a square cut on the southwest corner of the top stone of the bridge culvert about 700 feet beyond the *College Point* Station of the Long Island Railroad, north division, in the direction toward Whitestone.

No. 105.—*At Willets Point.* A square cut on the stringer of the long dock at Willets Point, immediately over the Coast and Geodetic Survey gauge of 1886. The United States Engineers also have a bench mark at this place; it is a cross made in a stone of the retaining wall, on the left when coming from the dock into the post grounds. The zero of the Engineers' gauge is 2.139 feet above the zero of the Coast and Geodetic Survey gauge, and the Engineers' bench mark is (above the zero of the Engineers' gauge) 18.056 feet (October 9, 1886).

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN SANDY HOOK, N. J., AND HAGERSTOWN, MD.

T. H.—See page 552.

No. I.—The center of the inner edge of the second embrasure, southwest corner of the fort at *Sandy Hook.*

A and B.—See page 552.

C.—See page 552.

No. II.—See page 552.

No. III.—*Navesink Highlands.* A mark on top of a heavy granite post, 13 metres south of the southernmost light-house tower.

D.—*Navesink Highlands* light-house. The bottom surface of a square cavity cut on the sloping ledge at the southeast corner of the base of the southernmost tower.

No. IV.—*Seabright, N. J.*—The bottom surface of a square cavity cut on the north wing wall of the west abutment of the bridge over South Shrewsbury River.

No. V.—See page 552.

E.—See page 552.

No. VI.—See page 553.

No. VII.—*Morgan* Station, New Jersey Central Railroad, N. J. The center of a triangle cut on the southeast pier of the drawbridge over Cheesequake Creek.

No. VIII.—See page 553.

F.—See page 553.

No. IX.—A slight circular concavity, bounded by a triangle, cut on the west end of the south wall of stone bridge near *Metuchens* Tank Station of Lehigh Valley Railroad. By means of this bridge the Pennsylvania Railroad crosses the Lehigh Valley Railroad.

No. X.—A square cavity marked thus: B□M, cut on stone abutment at the northwest corner of a small iron railroad bridge, about 150 metres east of *South Plainfield* Station, Lehigh Valley Railroad.

No. XI.—Cut on northeast corner of stone abutment of railroad bridge (New Jersey Central Railroad), about one-fourth mile east of *Bound Brook, N. J.* It is marked thus: B□M.

No. XII.—Cut on the south end of a small railroad bridge, about three-fourths mile west of *New Market* Station, Lehigh Valley Railroad. It is marked thus:

B□M
XII

No. XIII.—A square cavity cut on top of the west end of the north abutment of road bridge over Raritan River and Canal at *Bound Brook*, *N. J.* It is marked thus: B□M.

No. XIV.—The bottom surface of a circular cavity in top of a granite monument (true meridian monument of the State survey) in the grounds of the court-house at *Somerville*, *N. J.*

G.—A square cavity cut in the stone at the base of the easternmost pillar of the court-house front at *Somerville*, *N. J.* See note 2, page 549.

No. XV.—Cut on the southwest corner of the railroad bridge over the north branch of the Raritan River, near *North Branch* Station, New Jersey Central Railroad. It is marked the same as No. XII.

No. XVI.—Cut on projecting stone near the center of the north abutment wall of overhead bridge, about 1 mile east of *Annandale*, *N. J.*

No. XVII.—One-fourth mile west of *Bloomsbury*, *N. J.*, on the northwest corner of a stone bridge (New Jersey Central Railroad) over wagon road. It is marked thus:

B□M
1881

No. XVIII.—Cut on coping stone at east end of the north parapet of New Jersey Central Railroad Bridge over the Delaware and Lackawanna Canal, 1½ miles east of *Phillipsburg*, *N. J.* It is marked the same as No. XVII.

No. XIX.—*Easton*, *Pa.* Cut on one of the central piers of the railroad bridge across the Lehigh River. It is marked thus:

U. S.
B□M
XIX.

No. XX.—Cut on foundation stone at the west corner of the jail at *Easton*, *Pa.* It is marked the same as No. XIX.

H.—*Easton*, *Pa.* The sill of a blind window on east side of the court-house. (See note 2, page 549.)

I.—*Allentown*, *Pa.* Cut on the sill of a basement window on the south side of the front entrance of the jail. (See note 2, page 549.)

No. XXI.—About 1½ miles west of *Allentown*, *Pa.* It is cut on the northeast corner of a bridge (Philadelphia and Reading Railroad) over a wagon road. It is marked B □ M.

No. XXII.—Cut on the top stone of the middle of the north side of a bridge (Philadelphia and Reading Railroad) over a small run about one-half mile west of *Macungie* Station. It is marked thus:

XXII
B □ M
1881.

J.—*Reading*, *Pa.* Cut on the coping stone of the eastern abutment of the northeasternmost railroad bridge at the railroad depot. (See note 2, page 549.)

No. XXIII.—About one-fourth mile east of *Shamrock* Station, Philadelphia and Reading Railroad. Cut on the southeast corner of a railroad bridge. It is marked thus: B □ M.

No. XXIV.—About one-eighth mile east of *Robesonia* Station, Philadelphia and Reading Railroad. Cut on a pier of a small bridge. It is marked the same as No. XXII.

No. XXV.—Cut at the east end of the base of the north wall of an overhead bridge about 1½ miles west of *Womelsdorf* Station, Philadelphia and Reading Railroad. It is marked the same as No. XXII.

No. XXVI.—The center of the cross on a white marble block built into the front wall of Saint Mary's Catholic Church, at *Lebanon*, *Pa.*, at the south side of the southernmost front entrance.

K.—Marble post (see note 3, page 549) in the grounds of Mr. P. L. Weiner, southeast corner of Eighth and Church streets, *Lebanon*, *Pa.* Its south face bears the letter K.

No. XXVII.—At the southwest corner of the bridge (Philadelphia and Reading Railroad) over "Joe Crider's Dam," about 1¼ miles west of *Annville*, *Lebanon County*, *Pa.* It is marked the same as No. XXII.

No. XXVIII.—Cut on stone parapet of the bridge over Swatara River and Canal, between *Beaver* and *Hummelstown* Stations (Philadelphia and Reading Railroad). It is marked the same as No. XXII.

No. XXIX.—*Harrisburg*, *Pa.* The center of the top surface of the monument (in the Capitol grounds) marking the astronomical station of the Coast and Geodetic Survey.

L.—Cut at the base of the pillar at the southeast corner of the Capitol building, *Harrisburg*, *Pa.* (See note 2, page 549.) Reported in 1899 as destroyed.

M.—*Carlisle*, *Pa.* Cut on the base of the column at the west side of the jail entrance. (See note 2, page 549.)

No. XXX.—*Shippensburg*, *Pa.* Cut on the water table of the house and store of Mr. C. J. Reddig, northwest corner of Main and Railroad streets. It is marked thus: B □ M.

N.—Cut on the pedestal at base of the northernmost pillar of the front of the court-house at *Chambersburg*, *Pa.* (See note 2, page 549.)

No. XXXI.—*Greencastle*, *Pa.* The center of a cross cut in a stone in the front wall of the Philadelphia and Reading Railroad depot. It is south of the entrance and 7 inches above the level of the sidewalk.

A.—*Hagerstown*, *Md.* Cut on the water table of the court-house, which stands at the corner of Washington and Jonathan streets. The bench mark is on the Jonathan street side. (See note 2, page 549.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN HAGERSTOWN, MD., AND GRAFTON, W. VA.

A.—See above.

Nos. I, II, IV, and V.—Cut on top of mileposts 1, 2, 4, and 5 on the turnpike between *Hagerstown* and *Williamsport*. These probably can not be depended upon as permanent.

B.—A square cavity cut on the top surface of the stone on the west side of the aqueduct of Chesapeake and Ohio Canal over the Conococheague River at *Williamsport, Md.* (See note 4, page 549.)

C.—About 7 miles west of *Williamsport, Md.* Cut on the coping stone of Dam No. 5, Potomac River. (See note 4, page 549.)

No. VI.—About 7¾ miles west of *Williamsport, Md.* Square cut on top layer of stone of the second canal lock (Chesapeake and Ohio Canal) above Dam No. 5.

D.—Nine and one-fourth miles west of *Williamsport, Md.* Square cut on the top layer of stone at west end of the sixth lock above Dam No. 5.

No. VII.—Square cut on the coping stone at the upper end of "overflow" at "Big Pool," Chesapeake and Ohio Canal. It is about 13⅛ miles west of Williamsport, Md., and nearly opposite *Cherry Run* Station of Baltimore and Ohio Railroad.

E.—Cut on the coping stone of the aqueduct (Chesapeake and Ohio Canal) over Licking Creek, about 8 miles east of *Hancock, Md.* (See note 4, page 549.)

No. VIII.—Square cut on the coping stone at the southeast end of Lock No. 52, Chesapeake and Ohio Canal, and is about 1 mile east of *Hancock, Md.*

F.—Cut on the coping stone on the middle of the north side of the Chesapeake and Ohio Canal aqueduct at *Hancock, Md.* (See note 4, page 549.)

No. IX.—Square cut on the coping stone of Lock No. 53, Chesapeake and Ohio Canal, and is about 6 miles west of *Hancock, Md.*

G.—Cut on the coping stone of Lock No. 55, Chesapeake and Ohio Canal, at Dam No. 6, and about 10 miles west of *Hancock, Md.* (See note 4, page 549.)

No. X.—Square cut on the coping stone at the north end of Lock 56, Chesapeake and Ohio Canal, about 12¼ miles west of *Hancock, Md.*

No. XI.—Square cut on the top of the wing wall at the south side and east end of Lock No. 57, Chesapeake and Ohio Canal. It is about 15¼ miles west of Hancock and 4¾ miles east of *Little Orleans, Md.*

No. XII.—*Little Orleans, Md.*—Square cut on the coping stone of the aqueduct (Chesapeake and Ohio Canal) over Fifteen-mile Creek.

No. XIII.—About 3 miles west of *Little Orleans, Md.* Square cut on the coping of Lock No. 58, Chesapeake and Ohio Canal.

H.—About 12 miles west of *Little Orleans, Md.*, and 2 miles east of the canal tunnel. It is cut on the coping of Lock No. 61. (See note 4, page 549.)

No. XIV.—At the north end of the canal tunnel. It is a square cut on the stone foundation, a short distance below the level of the towpath.

No. XV.—Square cut on the coping stone of Lock No. 67, Chesapeake and Ohio Canal, and is about 5 miles east of *Oldtown, Md.*

No. XVI.—Square cut on the coping stone of Lock No. 72, Chesapeake and Ohio Canal, and is about 9¼ miles east of *Cumberland, Md.*

I.—*Cumberland, Md.*—Cut on the coping stone of the feed lock, at the western terminus of the Chesapeake and Ohio Canal. (See note 4, page 549.)

No. XVII.—Cut on the abutment of a small drain on the Baltimore and Ohio Railroad, about 5½ miles west of *Cumberland, Md.* It is marked thus: B □ M

No. XVIII.—Cut on the foundation stone, at the southwest angle of a drain on the Baltimore and Ohio Railroad, about 12 miles west of *Cumberland, Md.* It is marked thus: B □ M.

J.—Cut on the top of the middle pier of Baltimore and Ohio Railroad bridge, over a small drain about one-fourth of a mile east of *Keyser*, *W. Va.* (See note 4, page 549.)

No. XX.—Cut on the top step at the northwest corner of the Baltimore and Ohio Railroad bridge over the Potomac River at *Bloomington*, *Garrett County*, *Md.* It is also about 2 miles west of Piedmont, W. Va., and is marked thus: B □ M.

No. XXI.—About 1 mile west of *Oakland*, *Md.* Square cut on a large rock beside the track of the Baltimore and Ohio Railroad.

No. XXII.—About 3 miles east of *Oakland*, *Md.* Cut on the west abutment of a small bridge, Baltimore and Ohio Railroad, and is marked thus: B □ M.

No. XXIII.—Cut on top stone of a cattle guard, a short distance north of *Deer Park*, *Garrett County*, *Md.* It is marked thus: B □ M.

No. XXIV.—Near *Huttons Switch* Station, *Md.* (Baltimore and Ohio Railroad). Square cut on the abutment of a bridge over a small run.

No. XXV.—Cut on the abutment of a small bridge (Baltimore and Ohio Railroad) about 10¾ miles west of *Bloomington*, *Md.* It is marked thus: B □ M.

K.—Cut on the abutment, southwest corner of Baltimore and Ohio Railroad bridge over the Youghiogheny River. It is about 1¼ miles west of *Oakland*, *Md.* (See note 4, page 549.)

No. XXVI.—Two miles east of *Cranberry Summit* Station of Baltimore and Ohio Railroad, Preston County, W. Va. Square cut on southeast corner of railroad bridge over a small stream.

No. XXVII.—Cut on the coping stone, near the middle of the slide wall (Baltimore and Ohio Railroad), about 1½ miles west of *Cranberry Summit*, and is marked thus: B □ M.

L.—Cut on the coping stone of abutment at northwest corner of the Baltimore and Ohio Railroad bridge over Salt Lick Creek, 4 miles east of *Rowlesburg*, *W. Va.* (See note 4, page 549.)

No. XXVIII.—*Rowlesburg*, *W. Va.*—Cut at the base of the center pillar at the west end of Baltimore and Ohio Railroad bridge over Cheat River. It is marked thus: B □ M.

No. XXIX.—Cut on top of the "Buckhorn Wall," about 40 metres from its eastern end. It is about 3¼ miles west of *Rowlesburg*, *W. Va.*, and is marked thus: B □ M.

No. XXX.—Square cut on corner stone of abutment of a small bridge, Baltimore and Ohio Railroad, about 2 miles east of *Grafton*, *W. Va.*

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN GRAFTON, W. VA., AND ATHENS, OHIO.

M.—*Grafton*, *W. Va.*—Cut on top of the north side of the central pier of the Baltimore and Ohio Railroad bridge over Taggarts Valley Creek, a branch of the Monongahela River. (See note 4, page 549.)

No. XXXI.—About 5½ miles west of *Grafton*, *W. Va.* Cut on corner stone of the east end of a trestle which is numbered 2½ (B. and O. R. R., Parkersburg branch). It is marked thus: B □ M.

No. XXXII.—Cut on corner stone of the west abutment of the Baltimore and Ohio Railroad bridge east of *Bridgeport*, *Harrison County*, *W. Va.* It is marked thus: B □ M.

No. XXXIII.—About 2 miles east of *West Union*, *Doddridge County*, *W. Va.* Cut on top of the pier at the west end of Baltimore and Ohio Railroad bridge No. 21, over Middle Island Creek. It is marked thus: B □ M.

N.—About one-fourth mile east of *West Union*, *W. Va.*, and is cut on the top of the southwest corner of the pier of Baltimore and Ohio Railroad bridge No. 23, over Middle Island Creek. (See note 2, page 549.)

No. XXXIV.—Cut on the southeast corner stone of the pier of bridge No. 26 (B. and O. R. R.), about 10 miles west of *West Union*, *W. Va.*, and is marked thus: B □ M.

No. XXXV.—Cut on the coping stone of the eastern abutment of Baltimore and Ohio Railroad bridge No. 31, over Bonds Creek, about one-fourth mile east of *Cornwall* Station. It is marked thus: B □ M.

No. XXXVI.—Cut on the eastern abutment of Baltimore and Ohio Railroad bridge No. 35, over Bonds Creek, 1 mile east of *Cairo*, *Ritchie County*, *W. Va.* It is marked thus: B □ M.

No. XXXVII.—Cut on the west abutment of Baltimore and Ohio Railroad bridge over Goose Creek, about 200 metres east of *Petroleum*, *W. Va.* It is marked thus: B □ M.

No. XXXVIII.—Cut on the northeast corner stone of abutment of Baltimore and Ohio Railroad bridge No. 44, about 1 mile west of *Petroleum*, *W. Va.* It is marked thus: B □ M.

No. XXXIX.—Square cut on the foundation at northwest corner of Baltimore and Ohio Railroad bridge No. 52, 2 miles east of *Parkersburg*, *W. Va.*

O.—At *Parkersburg*, *W. Va.*—Cut on the water table, south front, near western corner of the post-office and court-house. (See note 2, page 549.)

No. XL.—*Belpre*, *Ohio.*—Cut on the wing wall of the second pier from west end of Baltimore and Ohio Railroad bridge, which crosses the Ohio River at this point. It is marked thus: B □ M.

No. XLI.—Cut on southwest corner of abutment of Marietta and Cincinnati Railroad bridge over Little Hocking Creek, near its junction with the Ohio River, and at *Little Hocking* Station. It is marked thus: B □ M.

No. XLII.—About one-half mile east of *Coolville* Station, Marietta and Cincinnati Railroad. Cut on coping of abutment of a railroad bridge, and is marked thus: B □ M.

No. XLIII.—About 3¾ miles west of *Coolville*, *Athens County*, *Ohio.* Cut on east abutment of a small railroad bridge, and is marked thus: B □ M.

No. XLIV.—About 1 mile west of *Guysville*, *Ohio*, and is cut on the eastern abutment of Marietta and Cincinnati Railroad bridge, and marked thus: B □ M.

No. XLV.—Cut on the west abutment of Marietta and Cincinnati Railroad bridge over Little Hocking River, about 2½ miles west of *Guysville*, *Ohio*, and is marked thus: B □ M.

No. XLVI.—Cut on the west abutment of a small bridge (Marietta and Cincinnati Railroad), about 150 metres east of Canaan Chapel, *Canaanville*, *Athens County*, *Ohio.* It is marked thus: B □ M.

No. XLVII.—About three-fourths of a mile west of *Stewart*, *Athens County*, *Ohio.* Cut on the west abutment of Marietta and Cincinnati Railroad bridge over Little Hocking River. It is marked thus: B □ M.

No. XLVIII.—One and one-fourth miles east of *Stewart*, *Athens County*, *Ohio.* Cut on top of the wall of the west abutment of Marietta and Cincinnati Railroad bridge, and is marked thus: B □ M.

No. XLIX.—Cut on the coping of a railroad culvert, about 1½ miles west of *Canaanville*, *Athens County*, *Ohio*, and is marked thus: B □ M.

No. L.—Cut on the south abutment (east side and fourth step from top) of road bridge over Marietta and Cincinnati Railroad and the Hocking River at *Athens*, *Ohio*. It is marked thus: B □ M.

P.—*Athens*, *Ohio*. Cut on top of the pier of the bridge over the Marietta and Cincinnati Railroad and the Hocking River. (See note 4, page 549.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ATHENS, OHIO, AND MITCHELL, IND.

P.—See above.

No. LI.—At *Moonville*, *Ohio*. Cut on the eastern abutment of Marietta and Cincinnati Railroad bridge over Raccoon Creek, and is marked thus: B □ M.

No. LII.—One mile south of *Zaleski*, *Ohio*. Cut on south abutment of Marietta and Cincinnati Railroad bridge over Raccoon Creek, and is marked thus: B □ M.

No. LIII.—Cut on the coping of a small drain or culvert, about one-half mile east of *Hamden* Station, Marietta and Cincinnati Railroad. It is marked thus: B □ M.

No. LIV.—Cut on the east abutment of Marietta and Cincinnati Railroad bridge over Big Salt Creek, about 1½ miles east of *Londonderry* Station, and is marked thus: B □ M.

No. LV.—One and one-half miles east of *Schooleys* Station, Marietta and Cincinnati Railroad. Cut on the eastern abutment of railroad bridge over Walnut Creek, and is marked thus: B □ M.

Q.—Cut on the pedestal of the lamp-post which stands on the north side of the steps of the front entrance of the court-house at *Chillicothe*, *Ohio*. (See note 2, page 549.)

No. LVI.—Cut on the west abutment of Marietta and Cincinnati Railroad bridge over branch of Paint Creek, about 1¼ miles east of *Musselmans Junction*, *Ross County*, *Ohio*. It is marked thus: B □ M.

No. LVII.—Cut on the east abutment of Marietta and Cincinnati Railroad bridge over branch of Paint Creek, about one-fourth mile west of *Musselmans Junction*, *Ross County*, *Ohio*. It is marked thus: B □ M.

No. LVIII.—Cut on the eastern abutment of Marietta and Cincinnati Railroad bridge, about 1 mile east of *Lyndon* Station, and is marked thus: B □ M.

No. LIX.—Cut on the eastern abutment of Marietta and Cincinnati Railroad bridge, at *Martinsville*, *Clinton County*, *Ohio*. It is marked thus: B □ M.

No. LX.—Cut on the east abutment of Marietta and Cincinnati Railroad bridge, about three-tenths mile east of *Clinton Valley* Station, and is marked thus: B □ M.

No. LXI.—Cut on the west abutment of Marietta and Cincinnati Railroad bridge, about 3¼ miles east of *Loveland*, *Ohio*, and is marked thus: B □ M.

R.—*Loveland*, *Ohio*. Cut on the east abutment of Marietta and Cincinnati Railroad bridge over the Little Miami River. (See note 2, page 549.)

No. LXII.—Cut on the pier of the Marietta and Cincinnati Railroad bridge over

Sycamore Creek, a short distance west of *Remington* Station, and is marked thus: B □ M. Reported in 1899 as destroyed.

No. LXIII.—Cut on the west abutment of Marietta and Cincinnati Railroad bridge, a short distance west of *Cumminsville*, *Hamilton County*, *Ohio*. It is marked thus: B □ M. Reported in 1899 as destroyed.

No. LXIV.—Cut on the south abutment of Marietta and Cincinnati Railroad bridge over Gest street, suburb of *Cincinnati*, *Ohio*. It is marked thus: B □ M. Reported in 1899 as destroyed.

S.—Cut on the west abutment of Marietta and Cincinnati Railroad bridge over Mill Creek, at Eighth Street Station, *Cincinnati*, *Ohio*. (See note 2, page 549.) Reported in 1899 as destroyed.

T, or City B. M. No. 1.—Highest point of a copper bolt projecting 1½ inches from the masonry on the west side of the courthouse, in *Cincinnati*, *Ohio*. It is on the south face of pillar at south side of main entrance on Main street, and 3 inches above the flagging. On the flat surface which surrounds the bench mark is inscribed, "B M No. 1 115·25."

No. LXV.—A square cavity cut in top of a stone monument, about 46 metres west of *Delhi* Station of Ohio and Mississippi Railroad (*Hamilton County*, *Ohio*). Reported in 1899 as destroyed.

No. LXVI.—Hamilton County, Ohio. Cut on a pier (first pier from Ohio side of river) of Ohio and Mississippi Railroad bridge over Miami River, near its junction with the Ohio River. It is about 2 miles east of *Lawrenceburg*, *Ind.*, and is marked thus: B □ M. Reported in 1899 as destroyed.

U.—*Lawrenceburg*, *Ind.* Cut on the water table of the court-house front, under center of second window from the east corner. It is marked thus:

1879
U S C & G S
B □ M
U

No. LXVII.—Cut on the east abutment of Ohio and Mississippi Railroad bridge No. 11, over South Hogan Creek, about 3½ miles west of *Cochran* Station, *Dearborn County*, *Ind.* It is marked thus: B □ M.

No. LXVIII.—Cut on the east abutment of Ohio and Mississippi Railroad bridge over Greasy Run, a short distance east of *Delaware*, *Ripley County*, *Ind.* It is marked thus: B □ M.

No. LXIX.—Cut on the east abutment of Ohio and Mississippi Railroad bridge over north fork of Vernon River, about three-fourths mile east of *North Vernon*, *Jennings County*, *Ind.* It is marked thus: B □ M.

V.—Cut on the west abutment of Ohio and Mississippi Railroad bridge over east fork of White River, about 2 miles east of *Medora*, *Jackson County*, *Ind.* (See note 2, page 549.)

No. LXX.—Cut on the coping stone of arch (Ohio and Mississippi Railroad) over wagon road, about 200 metres east of *Fort Ritner* Station, *Lawrence County*, *Ind.* It is marked thus: B □ M.

W.—Cut on the eastern abutment of Ohio and Mississippi Railroad bridge over east fork of White River, about one-third mile east of *Scottville*, *Lawrence County*, *Ind.* (See note 2, page 549.)

X.—Cut on the sill of window near the west corner of the south face of M. N. Moore's store, at *Mitchell*, *Ind.* (See note 2, page 549.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN MITCHELL, IND., AND ST. LOUIS, MO.

X.—See above.

Y.—The center of a cross, cut on the face of the stone cap of a basement window on the northwest side of the courthouse at *West Shoals*, *Martin County*, *Ind.* It is marked thus:

Y
B + M

Z.—Cut on the sill of a basement window at southeast corner of court-house at *Washington*, *Daviess County*, *Ind.* (See note 2, page 549.)

A_3.—Cut on the stone ledge on the northwest front of the courthouse at *Vincennes*, *Ind.* (See note 2, page 549.)

No. I.—The center of the top surface of the easternmost stone pier of the Coast and Geodetic Survey astronomical observatory, in the grounds of the *Vincennes* court-house.

B_3.—Cut at the base of one of the columns of the north face of the court-house at *Olney*, *Richland County*, *Ill.* (See note 2, page 549.)

No. II.—Near the southeast corner of the grounds of the public school at *Olney*, *Ill.*, on the monument marking the end of the United States Engineers' base line.

The top of the monument bears the inscription "U. S.," and the bench mark is the center of the space inclosed by the lower curve of the S.

No. III.—Cut on the eastern abutment of Ohio and Mississippi Railroad bridge over Little Wabash River, about 1½ miles east of *Clay City*, *Ill.*, and is marked thus: B □ M.

C_3.—Cut on a front basement window, near southeast corner of the public school building at *Flora*, *Clay Co.*, *Ill.* (See note 2, page 549.)

No. IV.—Cut on the west abutment of Ohio and Mississippi Railroad trestle over Skillet Fork of Little Wabash River, about 2½ miles east of *Iuka*, *Ill.* It is marked thus:

B □ M
IV

D_3.—The center of a cross, cut on the southwest corner of the courthouse at *Salem*, *Ill.* (See note 2, page 549.)

No. V.—Cut on the coping stone, at the east end of a long arched culvert, at *Odin* Station of Ohio and Mississippi Railroad. It is marked thus:

B. M. V.
□

No. VI.—Cut on the west abutment of Ohio and Mississippi Railroad trestle, about 2½ miles west of *Sandoval, Ill.* It is marked thus:

U. S.
B ☐ M
VI.

No. VII.—Cut on the west abutment of Ohio and Mississippi Railroad culvert, about one-fourth mile east of *Collins* Station, and is marked the same as No. IV.

E_3.—About one-fourth mile east of *Carlyle, Ill.* Cut on a pier of the Ohio and Mississippi Railroad bridge over the Kaskaskia River. (See note 2, page 549.)

F_3.—Cut on the station ledge under the windows of the east face of the courthouse at *Carlyle, Ill.* (See note 2, page 549.)

No. VIII.—Cut on west abutment of Ohio and Mississippi Railroad bridge over Sugar Creek, about 1 mile west of *Ariston, Ill.* It is marked the same as No. VI.

G_3.—Cut on the sill of a basement window on the east face of the public school building at *Lebanon, St. Clair County, Ill.* (See note 2, page 549.)

No. IX.—Cut on the east abutment of Ohio and Mississippi Railroad bridge, about one-fourth mile east of *Caseyville, St. Clair County, Ill.* It is marked the same as No. IV.

H_3.—The center of the head of the copper bolt inserted in the stone monument marking the north end of the American Bottom Base.

I_3.—A mark on a large bronze plate inserted in the south face of the eastern land pier of the Great Bridge at *East St. Louis, Ill.*

The plate bears the inscription:

U. S.
Coast & Geodetic Survey
Bench Mark
1882

J_3.—A similar plate inserted in the western land pier of the Great Bridge at *St. Louis, Mo.* Bench marks I_3 and J_3 were placed as nearly as possible on the same level as the St. Louis (so-called) "City Directrix" described below.

K_3.—Known at *St. Louis* as the "City Directrix." It has been in use for many years, and was originally the top surface of the pedestal of a monument which stood on Front street, near Market. The monument shaft was destroyed at the time of the great fire in that locality, but the pedestal remained. It is now level with the curbstone and forms a part thereof. A T mark has since been cut to indicate the point used for a bench mark.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ST. LOUIS AND ETLAH, MO.

K_3.—See above.

No. X.—Is cut on the upper surface of the middle top stone of the south side of the east abutment of railroad bridge (Missouri Pacific) at *St. Paul, Mo.* It is marked thus: B. ☐ M.

No. XI.—Is cut on top of the south side of the west abutment of the Missouri Pacific Railroad bridge at *Allenton, Mo.* It is marked thus: B ☐ M.

No. XII.—Is a cross on the head of a copper bolt inserted in the face of a perpendicular rocky bluff about three-eighths of a mile west of *South Point* Station (Mo. Pac. R. R.). The bolt was inserted by the United States Engineers at work on improvement of Missouri River, and is the same as P. B. M. 49.

L_3.—Is cut on the horizontal surface of the stone ledge under the windows of the east face of the German Catholic Church at *Washington, Mo.* It is marked thus:

U. S. C. & G. S.
L_3
1882

M_3.—Is cut on the northeast corner of the building occupied by the New Haven Merchandise Company, at *New Haven, Mo.* The building stands a short distance south of the Missouri Pacific Railroad track and west of the railroad station. The B. M. is marked as follows:

U. S. C. & G. S.
B. + M.
M_3
1882

No. XIII.—Is cut on the north side of the east abutment of railroad culvert (Mo. Pac. R. R.), about one-eighth mile west of *New Haven, Mo.* It is marked thus: B. □ M.

No. XIV.—Is cut on the top surface of the north end of the east abutment of a small railroad bridge or culvert (Mo. Pac. R. R.) about one-fourth mile east of *Etlah* Station, *Mo.* It is marked thus:

U. S.
B. □ M.
XIV.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ETLAH, MO., AND VICINITY OF JEFFERSON CITY, MO.

No. XV.—*Berger, Franklin County, Mo.* A limestone post 1·7 feet long, rough at the bottom and dressed to 6 by 6 inches at the top to a depth of 6 inches, and buried 1·5 feet in the ground. It is on the west side of Mrs. M. M. Schaub's house, close to the wall of the foundation and 3·3 feet from the southwest corner of the house. This house is quite close to the track of the Missouri Pacific Railroad (50 feet), just north of the point where the main street of the village crosses it. Both corners of the stone on the south side are chipped off, and the stone appears to be rather soft.

N_3.—The center of a cross cut on the northeast corner (east side) of the stone foundation of the White House hotel, at *Hermann, Gasconade County, Mo.* The cross is 1·24 feet south of the corner and 1·26 feet above the surface of the ground. It is marked as follows:

U S
+
B M
N_3
1888

No. XVI.—Five kilometres from *Gasconade, Gasconade County, Mo.* The bottom of a square cut in the top of the stone abutment to the iron bridge on the Missouri

Pacific Railroad across Coles Creek. The bridge rests on a portion of the abutment which is about 4 feet lower than that portion where the bench is cut.

It is on the east side of the creek and is north of the railroad. The bench is marked as follows:

U S
□
B M

No. XVII.—*Gasconade, Mo.* The bottom of a square cut in the top of the middle stone pier of the Missouri Pacific Railroad bridge over the Gasconade River. It is 6 inches from south end of pier and south of the track. It is marked the same as No. XVI.

No. XVIII.—*Gasconade County, Mo.* The bottom of a square hole cut in the center of the top of a limestone post which was set in the ground in the yard of Mr. J. Wolter's dwelling and storehouse at *Gasconade* station. The post is about 0·7 metre from the southeast corner of the house, which is situated about 100 feet south of the Missouri Pacific Railroad and about 200 feet west of the railroad station house. The post is dressed to 6 by 6 inches at the top and is 18 inches long, buried 15 inches in the ground. It is marked on top the same as No. XVI.

No. XIX.—*Gasconade County, Mo.* The bottom of a small square cut in the top of the stone foundation to H. Binkholter & Co.'s grain elevator at *Morrison* Station, Missouri Pacific Railroad. The building is about 6 inches inside the outer face of the foundation, and the mark is on this ledge, near the northeast corner of the building, which is situated quite near the track, on the south side. The stone is soft and the letters are roughly cut; the bottom of the hole is smooth. It is marked the same as No. XVI.

O_3.—*Chamois, Osage County, Mo.* The bottom of a square cut in the top of the stone across the bottom of the side door to the two-story brick saloon on the northwest corner of Main and Pacific streets. This door is on the Pacific street side and faces the railroad. The bench is near the west side of the door and is marked as follows:

U S
□
B M
O_3
1888

No. XX.—*St. Aubert, Osage County, Mo.* The bottom of a square cut in the top of the stone abutment of the Missouri Pacific Railroad bridge No. 25, opposite the village of St. Aubert. The bench is on the east abutment, and is south of the track. The letters are very roughly cut. The bridge is about one-fourth mile west of the depot. It is marked the same as No. XVI.

No. XXI.—Near *St. Aubert, Osage County, Mo.* Is on the north side of east abutment of the first trestle west of milepost 106 on the Missouri Pacific Railroad, and about 1 mile west of St. Aubert Station and between it and Isbell Station. The B. M. is a spot surrounded by a square trench (about an inch square), with the letters rudely and slightly cut:

U S
□
B M

No. XXII.—*Isbell, Osage County, Mo.* The bottom of a square cut in the top of the stone abutment of the Missouri Pacific Railroad bridge over Loose Creek. It is on the east abutment, and is north of the track. Reported in 1892 as destroyed.

P_3.—At *Bonnot's Mill, Osage County, Mo.* On the northwest corner of a brick building used as a store and owned by Mrs. L. Bonnot, and is on the limestone block forming the corner stone, which is about 8 inches square at the end and projects some 4 inches. The mark is the bottom of a square cavity in center of projection, and has on upper surface U. S. □ B. M. and on western face P_3. 1888. The stone is 35 paces south of railroad.

No. XXIII.—The surface of the stone inside a square (□) cut on top of the fourth pier (from east bank) of the Missouri Pacific Railroad bridge over the Osage River at *Osage, Mo.* It is under the center of the track and about the center of the top of the pier.

No. XXIV.—The bottom of a square cut in the top of a limestone post in the southwest corner of Mrs. Rassler's boarding house yard at *Osage, Mo.* It is dressed to 6 by 6 inches at the top and projects above ground about 3 inches. The top of the post is lettered as follows:

U S
□
B M

No. XXV.—The bottom of a square cut in the capstone on south end of west abutment of first trestle east of milepost 119 on the Missouri Pacific Railroad, between the Osago River and the Moreau Creek. The letters are placed thus, indistinctly and roughly cut:

U S
□
B M

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN JEFFERSON CITY, MO., AND HOLLIDAY, KANS.

No. XXV.—See above.

Old B. M. 90 (85).—Established by the Missouri River Commission, and called in 1892 P. B. M. 106. Horizontal furrow in head of copper bolt, leaded into rock of river-ward cut face of Capitol Hill, *Jefferson City, Mo*

The hill on the north side has been cut away to permit the construction of the Missouri Pacific Railroad and presents about 30 feet of rock above the bench mark. The bolt is about 3½ feet above the ground and 35 paces west of east end of rock cut. It projects 1 inch outside the face of the bluff, and is bent slightly downward. It is not firmly fixed in position, as it can be moved a little up and down with the fingers. Two and a half feet above and a little to the left of the bench mark the smooth surface of the rock is marked as follows:

U S B M ↘
185

No. XXVII.—The bottom of a square cut in the coping to the stone wall around the Capitol grounds at *Jefferson City, Mo.* It is a short distance north of the east entrance to the grounds. The wall is level on top north of the entrance as far as the bench mark and then descends the side of the hill by slopes and benches. It is marked as follows:

U S
C & □ G S
B M

No. XXVIII.—The intersection of two lines forming a cross in the face of the east or front wall of the Capitol building at *Jefferson City*, *Mo.*, at its northeast corner, about 8 or 10 inches south of the corner and 2 feet above the ground. The stone on which it is cut is the corner stone of the building. There is an offset in the wall a few inches below the bench mark, and on the upper surface of this offset letters were cut as follows:

+
U S C & G S B M

No. XXIX.—The bottom of a square hole cut in the top of the abutment to the iron railroad bridge over Gray's Creek near *Cole* Station, Missouri Pacific Railroad. It is on the stone on which the end of the iron truss rests, just inside the southeast corner of the truss. It is about 1 metre from south end of abutment and about the middle east and west. It was roughly lettered as follows:

U S
□
B M

No. XXX.—The bottom of a square cut in the stone abutment to the iron railroad bridge over Grays Creek at *Scott* Station, Missouri Pacific Railroad. On the abutment on the west bank of the creek, and south of the track on the stone on which the end of the iron truss rests. It is 1½ metres from south end of abutment, and 0·3 metre from its inner face on line with south face of highest part of the abutment. It is roughly lettered the same as No. XXIX.

No. XXXI.—The bottom of a square cut in the top of stone foundation to the brick residence of George Elston, at *Elston* Station, *Cole County*, *Mo.* It is at an angle in the wall just outside the south end of the porch on the front or west side of the house.

No. XXXII.—The bottom of a square cut in the top of the stone foundation to the brick store at *Center Town*, *Cole County*, *Mo.* (owned by W. S. Freshoar). The store is south of the railroad and west of the railroad station. The bench mark is in the opening for the north window in the front of the store and is near the north side of this opening. It was marked the same as No. XXIX.

M. P. R. R. No. 114.—Marked thus: B + M. On top of the foundation stone at the southwest corner of the water tank at *Center Town* Station, *Mo.*

No. XXXIII.—The intersection of two lines forming a cross (+) cut in the face of the raised stonework at the west end of the stone steps to the brick courthouse at *California*, *Moniteau County*, *Mo.* The steps lead to the entrance on the south side of the building. It was lettered as follows: U S + B M.

M. P. R. R. No. 122.—Marked thus: B + M. On top of foundation on north side of water tank 200 feet east of *California* Station, *Mo.*

No. XXXIV.—A copper bolt (see note 1, page 548) in the front of a one-story brick building at *Clarksburg* post office (Moniteau Railroad Station). The building is owned by Mr. G. L. Fowler and occupied by him as a drug store. It is next door to the bank and nearly opposite the railroad station, north of the track. The bolt is in the fourth course above the iron door and window sill, and in the middle brick of the east side wall of the building.

No. XXXV.—The bottom of a square cut in the stone window sill to the City Drug Store at *Tipton, Moniteau County, Mo.* The drug store is in the corner room of the City Hotel, a three-story brick building, south of the track and nearly opposite the railroad station, owned by Mr. Redmond, the proprietor of the drug store. The bench mark is on the sill of the window east of the east door to the drug store, about in the middle of the exposed portion of the stone window sill. The following letters were roughly cut: U S□B M.

No. 14.—On the northwest corner of the one-story concrete building owned and occupied by Mr. P. D. Gunter, at *Fortuna, Mo.* It is the highest point within a triangle rudely marked on the top of the corner stone.

Versailles North Base △.—The top of copper bolt in surface stone marking the trigonometrical station in the yard of Mr. Moses H. Tipton, about 5 miles northeast of Versailles, Mo. The stone is 0·65 by 0·65 by 0·27 metre, set in concrete, and lettered on its top surface as follows:

U S C & G S
O
1897

Hunter △.—The top of copper bolt in surface stone marking the trigonometrical station 4 miles east of Versailles, Mo., on land belonging to the estate of D. C. Dale. The stone is 0·65 by 0·65 by 0·24 metre and is lettered the same as Versailles North Base.

No. XXXVI.—The center of a square cut on the iron door and window sill to the brick building at *Syracuse, Morgan County, Mo.* The building is owned by D. Crowe and is south of the track, nearly opposite the railroad station. It is rented and occupied as a store by A. S. Thomson. The bench mark is on the sill of the west window about 6 inches east of the west side of the window, near the northwest corner of the building.

No. XXXVII.—A copper bolt (see note 1, page 548) in the front wall of the brick drug store at *Otterville, Mo.*, owned by J. H. Potter. Mr. Potter's son, R. E. Potter, is the proprietor of the store. The bolt is in the fourth course above the sidewalk and in the third brick from the south side of the window south of the front entrance.

M. P. R. R. No. 143.—Marked thus: B + M. On top of second course of masonry from the top, at the northeast corner of bridge, 900 feet west of *Otterville* Station.

No. XXXVIII.—The bottom of a square cut in the top of the stone foundation to the brick store at *Smithton, Mo.*, occupied by Hair & White. The building is south of the railroad and nearly opposite the railroad station. The foundation projects outside the brick wall, and the bench mark is on top of this projection on the east side of the building, near the northeast corner.

M. P. R. R. No. 152.—Marked thus: B + M. On top of the northwest corner of basement entrance on north side of railroad office building, about 1 mile east of *Sedalia* station. This bench mark is almost flush with the surface of the ground.

No. XXXIX.—The bottom of a square cut in the top of the coping to the stone wall around the basement entrance to the courthouse at *Sedalia*, *Pettis County*, *Mo.* It is north of the west entrance to the courthouse (the basement entrance being immediately under the entrance to first floor) and near the wall of the main building. It is lettered as follows:

U S C & G S
□
B M

No. XL.—The bottom of a square cut in the top of the stone pier on the west bank of Mud Creek (Pettis County, Mo.) which supports the iron railroad bridge (Missouri Pacific). The end of the bridge north of the track rests on the stone in which the square is cut, this portion of the pier being smaller and about 3 feet higher than the main pier. The bench mark is near the northwest corner of this raised portion. It is roughly lettered the same as No. XXIX.

No. XLI.—A copper bolt (see note 1, page 548) in the front wall of the brick block at *Lamonte*, *Mo.*, owned by White & Bramley. It is in the eighth course above the foundation and in the second brick from the northwest corner, in the front or west wall of the building. The building is near the railroad track just east of the railroad station.

No. XLII.—The bottom of a square cut in the top of the stone doorsill to the side entrance of the private office back of the Bank of Knobnoster, owned by C. B. Littlefield, at *Knobnoster*, *Mo.* It was lettered the same as No. XXXV. The steps have been removed from this door, and it is not used as an entrance.

M. P. R. R. No. 169.—Marked thus: B + M. On top of stone at northwest corner of culvert, 3,600 feet west of *Knobnoster* station. Bench mark is 8 feet north of north rail.

No. XLIII, or M. P. R. R. No. 171.—Is a cross cut in the top of one of the stones of the west abutment to the small wooden railroad bridge 500 feet east of the railroad station at *Montserrat*. It is north of the track. The rod was held on the intersection of the two lines forming the cross (+). It is lettered as follows: B + M.

No. XLIV, or Normal △.—Is in the grounds of the Missouri State Normal School, at *Warrensburg*, *Johnson County*, *Mo.*, near the southeast corner of the extension to the main building. It is a sandstone post 6 inches square, with two lines cut in the top, forming a cross at its center, and the intersection of these lines is the bench mark. Two other sandstone posts are placed 5 feet from this center stone, one north and one south. The center stone is marked as follows, and its top is nearly even with the ground:

U	S
C	S

No. XLV.—A copper bolt (see note 1, page 548) in one of the stones of the basement story of the State Normal School at *Warrensburg*, *Mo.* The bolt is on the south side of the main building, near the southeast corner, just to the left of a blind window. The basement story is built of sandstone.

No. XLVI.—A mark made on top of the sandstone pillar under the northwest corner of the corrugated-iron warehouse at *Center View, Johnson County, Mo.* The top edge of this pillar is beveled, and this bevel was cut so as to form a flat bench at the northwest corner of the pillar, and the surface of this bench is the bench mark. The warehouse is owned by Porter & Delany. It is south of the track and west of the railroad station.

No. XLVII.—At *Holden, Mo.* This bench mark was destroyed.

No. XLVIII, or M. P. R. R. No. 188.—Is marked thus: B + M, 1 foot west of the northwest bridge seat over Little Pine Oak Creek 1 mile west of *Holden* Station. The line forming the west side of the cross was found broken, and a square hole was cut in the top of the stone bridge pier at this point for the bench mark. The bench mark is on the pier on the west bank of the creek, and is north of the track. The bottom of the square hole is the bench mark.

No. XLIX.—A copper bolt (see note 1, page 548) in the front wall of the brick building at *Kingsville, Mo.*, known as "Isley's Hall." The building is owned by B. F. Metzler. The bolt is in the fourth course above the iron window sill, and in the third brick from the northwest corner.

No. L.—The bottom of a square cut in the top of the stone pier to the iron railroad bridge about 500 metres east of *Strasburg, Mo.* It is on the pier on east bank of the creek, and is north of the track, near northwest corner of the pier. It was roughly lettered the same as No. XXIX.

No. LI.—A copper bolt (see note 1, page 548) in the face of the south wall to the Atlantic Hotel, at *Pleasant Hill, Cass County, Mo.* It is below and about halfway between the second and third windows from the southeast corner of the building, in the eighth course above the porch and in the fifth brick from the west side of the first recess in the wall from the southeast corner.

M. P. R. R. No. 201.—Marked thus: B + M. On top of northeast corner of culvert 1 500 feet west of *Pleasant Hill* Station.

No. LII.—The bottom of a square cut in the top of the stone pier under the east end of the iron railroad bridge, three-fourths of a mile west of *Pleasant Hill, Mo.* The bench mark is south of the track and quite near the end of the iron superstructure of the bridge. It is roughly lettered the same as No. XXIX.

M. P. R. R. No. 206.—Marked thus: B + M. On top of bridge seat at southeast corner of bridge No 63, 2 feet therefrom and one-half mile west of *Greenwood* Station.

No. LIII.—The bottom of a square cut in the stone pier under the east end of the iron railroad bridge (No. 63) a half mile west of *Greenwood, Mo.* It is north of the track and near the northeast corner of the pier. A railroad bench mark is quite near it, marked B + M. It was roughly lettered the same as No. XXIX.

No. LIV.—The bottom of a square cut in the top of the stone foundation to the brick building at *Lees Summit, Jackson County, Mo.*, owned by W. B. Howard. The corner store is occupied by J. R. Spencer as a drug store. The building is at the northeast corner of the intersection of the street parallel to the railroad and the first street south of the railroad station. The bench mark is near the southwest corner of the building, on the front, where there is an entrance to the basement. It was roughly lettered the same as No. XXIX.

No. LV.—The bottom of a square cut in the top of the stone pier under the north end of the iron railroad bridge over Little Blue Creek, about one-fourth mile south of

Little Blue Station, *Jackson County*, *Mo.* It is near the southeast corner of the large stone which supports the bridge, on the east side of the track. It was roughly lettered the same as No. XXIX.

No. LVI.—The bottom of a square cut in the stone abutment to the Missouri Pacific Railroad bridge at the Chicago and Alton Railroad crossing. It is east of the Missouri Pacific track and on the north side of the Chicago and Alton track. An attempt was made to cut letters but the stone chipped too much to allow success. This crossing is about 2 miles south of *Independence*, *Mo.*

No. LVII.—The bottom of a square cut in the top of the stone coping to the paved entrance to the courthouse at *Independence*, *Jackson County*, *Mo.* This entrance is on the south side of the old building, and the bench mark is between the last column on the left as you enter the building and the corner of the building itself on the left of the entrance. The stone forms a portion of the building. It was lettered as follows:

U S
C & G S
□
B M

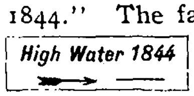
Independence City Directrix.—Is the top of a granite post buried in the courthouse yard near the southwest corner of the courthouse (new building) at *Independence*, *Jackson County*, *Mo.* The top of the post is cut in the form of a sphere and polished. The bench mark is the highest point of the sphere. It is marked "Elevation $326\frac{74}{100}$ ft."

No. LVIII.—The bottom of a square cut in the top of the abutment to Missouri Pacific Railroad bridge over *Big Blue* River. The end of the bridge rests on a bench several feet below. The bench mark is south of the track and at the southwest (upper) corner of the east abutment. It was roughly lettered the same as No. XXIX.

Old M. R. C. B. M. 241.—Cross (+) cut into top of stone foundation at northeast corner of four-story brick grist mill, called "Zenith Mills," 1 mile below *Kansas City* Bridge. The cross is very faintly cut and there are no letters near it. A two-story extension to the Zenith Mills has been built since the bench mark was established.

Old M. R. C. B. M. 243.—Horizontal furrow in head of copper bolt leaded into north face, near east end, of south abutment of *Kansas City* Bridge.

Old M. R. C. B. M. 244.—The point of arrowhead engraved on south side of first pier north of south abutment of *Kansas City* Bridge, and marked (erroneously) "High water of 1844." The face of one of the stones in the pier is dressed and lettered as follows:



M. R. C. $\frac{73}{1}$—Top of cap.—On right bank at *Kansas City*, *Mo.*, 50 feet east of shore pier of Hannibal Bridge, and 10 feet from river bank. It was called P. B. M. 230 in 1892 and is the usual form of Missouri River Commission P. B. M. (See note 8, page 550.)

Old M. R. C. B. M. 245.—A cross (+) cut into top of foundation at northwest corner of Union Elevator, *Kansas City*, *Mo.*

• No. LIX.—The bottom of a square cut in the top of the stone abutment to the Atchison, Topeka and Santa Fe Railroad bridge No. 2, about 2 miles west of *Kansas City*. The bridge is a small one in Johnson County, Kans., and is about one-half mile east of the first wagon bridge across the Kansas River above Kansas City. The bench mark is on the east abutment and is north of the track. It was roughly lettered the same as No. XXIX.

No. LX.—The bottom of a square cut in the top of the stone foundation to one of the iron columns supporting the road bridge over the Atchison, Topeka and Santa Fe Railroad yard at *Argentine, Johnson County, Kans.* The bridge is a short distance west of the railroad station at Argentine, and the bench mark is on the foundation to the first column south of the main track on the west side of the bridge. It was roughly lettered the same as No. XXIX.

No. LXI.—The bottom of a square cut in the top of the coping to the stone culvert under the Atchison, Topeka and Santa Fe Railroad about one-half mile east of *Holliday, Johnson County, Kans.* The bench mark is south of the track and near the southeast corner of the culvert. It was roughly lettered the same as No. XXIX.

No. LXII.—The bottom of a square cut in the top of a stone pier under the east end of the iron railroad bridge over Mill Creek about one-half mile west of *Holliday, Johnson County, Kans.* It is north of the track and near the northeast corner of the pier. It was roughly lettered the same as No. XXIX.

No. LXIII.—The bottom of a square cut in the top of the stone pier under the west end of the iron railroad bridge over Mill Creek about one-half mile west of *Holliday, Johnson County, Kans.* It is north of the track near the north end of the pier. It was roughly lettered the same as No. XXIX.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN HOLLIDAY AND SALINA, KANS.

No. LXIII.—*Holliday, Kans.* (See above.)

A.—The bottom of a square cut in the stone abutment to the iron railroad bridge (No. 19) over Cedar Creek, three-fourths of a mile east of *Cedar Junction, Johnson County, Kans.* It is on the west abutment, north of the track, about the center of the stone forming the top, at the northeast corner. The following letters were roughly cut:

U S
□
B M

B.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge one-fourth of a mile east of *Desoto, Johnson County, Kans.* It is on the east abutment, north of the track and near the center of the stone forming the top of northwest corner. It is lettered the same as A.

C.—A copper bolt (see note 1, page 548) in the brick flour mill at *Desoto, Kans.* The mill is a three-story brick building owned by J. M. Hadley. The bolt is in the west (front) wall, in the second course above the stone foundation, and in the second brick from northwest corner.

D.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge (No. 29) one-half mile east of *Weaver, Douglas County, Kans.* It is on the east abutment, in the middle (near west end) of the stone forming the top of the northwest corner of the abutment. It is roughly lettered the same as A.

E.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge over Wakarusa Creek, one-half mile west of *Eudora, Douglas County, Kans.*

It is on the west abutment, north of the track and near the middle and east end of the stone forming the top of the northeast corner. It is roughly lettered the same as A.

F.—The bottom of a square cut in the stone doorsill to the door in the east end of the Atchison, Topeka and Santa Fe Railroad depot at *Lawrence*, *Douglas County*, *Kans.* The bench mark is near the south end of the sill and near the front edge. The stone is very hard and the hole was not cut deep. The building is of brick, with stone trimmings.

G.—The bottom of a square cut in the top of the stone retaining wall at the entrance of the mill race at *Lawrence*, *Kans.* It is at the rounded portion of the wall on the shore side of the race at its entrance. It is roughly lettered the same as A.

H.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge over Mud Creek, one-half mile east of *Club House*, *Douglas County*, *Kans.* The bench mark is on the east abutment, north of the track and near the middle and west end of the stone forming the top of the northwest corner. It is roughly lettered the same as A.

I.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge one-half mile east of *Lecompton*, *Douglas County*, *Kans.* It is on the west abutment, north of the track and near the middle and east end of the stone forming the top of the northeast corner. It is roughly lettered the same as A.

J.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge (No. 47) over Coon Creek, 1 mile west of *Lecompton*, *Douglas County*, *Kans.* It is on the west abutment, south of the track and near the middle and east end of the stone forming the top of the southeast corner. It is roughly lettered the same as A.

K.—The bottom of a square cut in the top of the stone abutment to the railroad bridge (No. 55), 1¼ miles east of *Grover*, *Douglas County*, *Kans.* It is on the west abutment, south of the track, and in the middle (near east end) of the stone forming the top of the southeast corner. It is roughly lettered the same as A.

L.—The bottom of a square cut in the top of the abutment to the iron railroad bridge one-half mile east of *Tecumseh*, *Shawnee County*, *Kans.* It is north of the track, on west abutment, and near middle and east end of the stone forming the northeast corner of its top. It is roughly lettered the same as A.

M.—The bottom of a square cut in the upper surface of a stone projecting from the wall of the paint shop of the Atchison, Topeka and Santa Fe Railway repair shops at *Topeka*, *Kans.* It is on the south wall, near the southwest corner of the building, in a slight recess formed by two offsets in the wall running up like columns from the stone on which the bench mark is cut. One of these columns forms the southwest corner of the building. No letters were cut.

N.—The bottom of a square cut in the top of the stone supporting the south end of the iron railroad bridge (Atchison, Topeka and Santa Fe) over the Kansas River at *Topeka*, *Kans.* It is east of the track on the south bank of the river and on the south side of the street which goes under the bridge. It is near the northeast corner of the stone. It is roughly lettered the same as A.

B. M. Jennings.—A cross cut on the west end of the stone forming the third step above the pavement at the entrance to the Columbian Building at *Topeka*, *Kans.* It was established by Mr. Jennings, the United States Weather Service observer, and his barometer is referred to it. The Columbian Building is on Sixth street, between Kansas avenue and Jackson street. The cross is close to the wall, and the surface of the stone at the south end of the cross is the bench mark.

O.—A smooth place is dressed on the face of the second stone (sandstone) above the pavement on the west side of the entrance to the Columbian Building, Sixth street, between Kansas avenue and Jackson street, *Topeka, Kans.*, and a V-shaped line is nicely cut horizontally across this space. The bottom of the cut forming this line, at its middle point, was used as the bench mark. It is lettered as follows: $\frac{\text{945 B. M. feet}}{\text{above sea level}}$ and was established by the owner of the building.

P.—The bottom of a square cut in the top of the stone window sill to the brick building at *Silver Lake, Shawnee County, Kans.*, used as the post office. The building (owned by P. H. Butler) is south of the track, nearly opposite the railroad station, on south side of the main street and on the northwest corner of a block. The bench mark is about the middle of the window sill of the west window in the front (north) face of the building. It is roughly lettered the same as A.

Q.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge one-fourth mile west of *Rossville, Shawnee County, Kans.* It is north of the track on east abutment and about the middle of exposed portion of the stone supporting the end of the bridge. It is roughly lettered the same as A.

R.—The intersection of two lines forming a cross (+) cut on the stone coping of the foundation to the brick building used as an infirmary at St. Mary's College (Jesuit), *St. Marys, Pottawatomie County, Kans.* On the west face of the building, on the third stone from southwest corner, and about under the center of the space between the second and third windows from southwest corner. The following letters were roughly cut:

U S
+
B M

S.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge over Vermilion River, about 2 miles west of *Belvue, Pottawatomie County, Kans.* It is north of the track on west abutment and about the center of the exposed portion of the stone supporting the end of the bridge. It is roughly lettered the same as A.

T.—The bottom of a square cut in the top of the stone window sill to the two-story stone building at the northwest corner of Lincoln avenue and Third street, *Wamego, Pottawatomie County, Kans.* The building is owned by Hecker Bros. and used as a dry goods store. The bench mark is on the sill of the show window on the left of the entrance in the vestibule at the corner (Third street side). The following letters were poorly cut:

U S
C & □ G S
B M

U.—The bottom of a square cut in the stone window sill to the brick store at *St. George, Pottawatomie County, Kans.*, owned by J. D. Robertson. It is on the sill to the east window in the front (south) end of the building, on the right of the door as you enter. The following letters were roughly cut: U S □ B M.

V.—The bottom of a square cut in the top of the stone abutment to the iron railway (Union Pacific) bridge over Big Blue River at *Manhattan*, *Kans.* It is north of the track and on the west abutment. It is cut on the step in the abutment on which the end of the iron superstructure rests and is on the outer top stone. It is roughly lettered the same as A.

W.—The intersection of a cross cut on the east (front) face of the public school building (stone) at *Ogden*, *Riley County*, *Kans.* It is at the northeast corner of the building, on the east end of the stone forming the corner and on the fifth stone above the ground. It is roughly lettered the same as R.

X.—The intersection of a cross cut in the smooth surface of the water table of the railroad station (stone building) at *Fort Riley*, *Riley County*, *Kans.* It is on the east end near the southeast corner. The building is of stone, roughly dressed, and the sloping water table is the only portion dressed to a smooth surface. The following letters were roughly cut: U S + B M.

Y.—The intersection of a cross cut on the east end of the railroad station, Union Pacific (stone building), at *Junction City*, *Riley County*, *Kans.* It is on the eighth stone from the northeast corner of the building, in the first course above the brown stone foundation showing above the platform. It is on the right of the door to the express storeroom in this end of the station. It is roughly lettered the same as R.

Z.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge over Chapman Creek, one-half mile east of *Chapman*, *Dickinson County*, *Kans.* It is on the west abutment, south of the track, and on the offset on which the end of the iron superstructure rests. It is roughly lettered the same as A.

A_1.—The bottom of a square cut in the top of the stone step at the entrance to the County High School at *Chapman*, *Dickinson County*, *Kans.* This step leads to the entrance at the east end of the building in the front or south side (not main entrance). It is on the second step above the ground, near its west end. It is roughly lettered the same as A.

B_1.—The bottom of a square cut in the stone doorsill to the west entrance to the courthouse at *Abilene*, *Dickinson County*, *Kans.* It is on the upper surface and near the north end of the sill. The building is a brick structure. It was lettered the same as T.

C_1.—The intersection of a cross (+) cut in the face of the dressed stone water table of the rough-stone railway station (Union Pacific) at *Solomon*, *Dickinson County*, *Kans.* It is on the west end of the building, between the two windows and about the center of the outer face of the fourth stone from the southwest corner of the building. It is roughly lettered the same as R.

D_1.—The bottom of a square cut in the stone doorsill to the building at *New Cambria*, *Saline County*, *Kans.*, used as a store and railway station (Union Pacific). The bench mark is near the west end of the sill to the east door in the front of the building, which is owned by S. P. Dowmyer. It is roughly lettered the same as A.

E_1.—The bottom of a square cut in the top of the stone pier to the iron railroad bridge (Union Pacific) over Smoky Hill River one-half mile west of *New Cambria*, *Saline County*, *Kans.* The bench mark is west of the river, north of the track, and on top of the small pier under the end of the wooden trestlework of the bridge. This small pier is built on top of a larger pier which supports the iron bridge. It is roughly lettered the same as A.

Salina East Base △.—The top of copper bolt in limestone block 30 inches square and 15 inches high, set in concrete, which marks the station at the surface. It is 1 mile west of *New Cambria, Kans.*, on land owned by Mrs. Mary Marlin, of Salina. It is 35·05 feet north of the second telegraph pole along the Union Pacific Railroad west of the gate entrance to Marlin's farm. Lettered thus:

U S C & G
18 ○ 96
SURVEY

Salina West Base △.—The top of copper bolt in limestone block 30 inches square and 15 inches high, set in concrete, which is the surface mark of the station. It is in the northeast part of *Salina, Saline County, Kans.*, east of the tanks of the Standard Oil Company. It is 42·75 feet north of the line of telegraph poles which parallel on the north side the Union Pacific Railroad track, and 10 feet east of the north and south fence bounding the land of the Standard Oil Company. It is lettered in the same way as Salina East Base.

F_1.—The intersection of two lines forming a cross (+) cut in the face of the stone window sill to the Missouri Pacific Railway station at *Salina, Saline County, Kans.* The bench mark is under the window in the west side of the bow window in front of the building, which is constructed of rough stone. The following letters were cut:

U. S.
C. & + G. S.
B. M.

G_1.—The bottom of a square cut in the upper surface of the stone coping to the vestibule in front of the brick building at *Salina, Kans.*, owned and occupied by the H. T. Lee Mercantile Company. The bench mark is on top of the vestibule floor, at the left side of the steps to the main entrance on Santa Fe street. It is lettered the same as F_1.

H_1.—The intersection of two lines forming a cross (+) cut in the outer face of the dressed stone coping to the stone foundation of the brick public school building on Elm street, one block west of Santa Fe street, *Salina, Kans.* The bench mark is on the east wall and near the southeast corner of the building. It is lettered the same as F_1.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN SALINA AND ELLIS, KANS.

G_1.—*Salina, Kans.* (See above.)

H_1.—*Salina, Kans.* (See above.)

I_1.—The intersection of a cross cut on the limestone window sill to the window in the east end of the stone building at *Bavaria, Saline County, Kans.*, used as a railroad station. The cross is in the outer face of the window sill. The following letters were cut:

U S
+
B M

J_1.—The intersection of a cross cut in the limestone coping to the foundation of the stone public school building at *Brookville*, *Saline County*, *Kans.* It is on the east (front) side of the building, about 1·4 metres from the northeast corner. The cross is in the outer face of the coping, and is lettered the same as I_1.

K_1.—The bottom of a square cut in the upper surface of the stone foundation to one of the iron supports to the railroad water tank 1 mile east of *Terra Cotta* switch. The bench mark is on the west one of the two supports under the north side of the tank. The following letters were cut:

U S
□
B M

L_1.—The intersection of two lines cut in the end of a copper bolt that is leaded in the front (north) wall of the three-story brick hotel building at *Kanopolis*, *Ellsworth County*, *Kans.* The bolt is in the fifth course above the limestone foundation and in the second brick from the northeast corner of the building. The building stands on the southwest corner of Ohio and Kansas avenues.

M_1.—The intersection of two lines cut in the end of a copper bolt that is leaded in the stone foundation to the courthouse at *Ellsworth*, *Kans.* The bolt is in the front (east) wall in the second course above the ground and in the third stone from the southeast corner of the building. The bench mark is about 25 centimetres above the top of the basement window sill (stone).

N_1.—The bottom of a square cut in the top of the marble slab set in the top of the concrete pier marking the telegraphic longitude station at *Ellsworth*, *Kans.* The edge of the square hole is about 0·01 metre north of the small round hole marking the station and the square hole is not cut deep. The pier is in the yard of the public school building and two sandstone posts project from its top some distance above the ground. These posts are marked "U. S. Coast and Geodetic Survey."

Water gauge B. M.—Established by the United States Geological Survey in connection with a water gauge near it in the Smoky Hill River. It is a small knob cut on the root of a box elder tree at the south end of the iron road bridge over the river at *Ellsworth*, *Kans.* The tree is east of the bridge, between the stone abutment and the river bank. Two iron nails are driven in the top of this knob and the rods were held on top of the north nail. The bench mark is about 0·4 metre above the ground.

O_1.—The bottom of a square cut in the top of the stone window sill in front of the two-story stone building (with iron front to first story) at *Wilson*, *Ellsworth County*, *Kans.*, owned by J. F. Tampier, and used as a general store. The bench mark is under the window east of the door. The building fronts north, faces the track, and is opposite the railroad station. It is lettered the same as K_1.

P_1.—The intersection of a cross cut in the iron front to the two-story stone building at *Wilson*, *Ellsworth County*, *Kans*, owned by J. F. Tampier. The cross is on the iron column west of the west window in the front of the building between two square projections near the bottom of the column.

Q_1.—The bottom of a square cut in the top of the stone foundation under one of the iron supports to the railroad water tank at *Dorrance*, *Russell County*, *Kans.* The bench mark is on the foundation under the west one of the two supports under the north side of the tank and is north of the iron support. It is lettered the same as K_1.

R_1.—The intersection of a cross cut in the front (east) face of the two-story stone Masonic Hall building at *Bunker Hill*, *Russell County*, *Kans.* The cross is cut in the third course above the stone sidewalk and in the second stone from the northeast corner of the building, which is owned by the Masonic fraternity. It is lettered the same as I_1.

S_1 or Bunker Hill △.—The top of the marble post marking *Bunker Hill* triangulation station. It is situated in the south portion of the town bearing the same name, in *Russell County*, *Kans.* The top of the post is divided into four sections by two lines cut in the top, intersecting at the center. The bench mark is the surface of the stone at the southwest corner of the northeast section.

T_1 or Russell Southeast Base △.—The top of the sandstone post marking the station. It is in *Russell County*, *Kans.*, near *Homer* railroad station. The top of the post is divided into four sections by two lines cut in the top, intersecting at the center. The bench mark is the surface of the stone at the southwest corner of the northeast quarter.

U_1.—The intersection of a cross cut in the west end of the stone railroad station at *Russell*, *Russell County*, *Kans.* The cross is cut in the stone at the southwest corner of the building and in the fourth course above the platform. It is lettered the same as I_1.

V_1.—The intersection of a cross in the end of a copper bolt in the front (north) face of the Union Hotel at *Gorham*, *Russell County*, *Kans.* The hotel is a two-story stone building owned by J. W. Ginther. The bolt is in the sixth course above the ground and in the stone forming the northwest corner about the middle of its north face.

W_1.—The intersection of a cross in the end of a copper bolt in the north wall of the two-story stone building at *Walker*, *Ellis County*, *Kans.* The building is owned by the Catholic Church and stands south of the railroad track and east of the station. The bolt is in the sixth course above the ground and in the stone forming the northwest corner.

X_1.—The intersection of a cross in the end of a copper bolt in the front (north) wall of the two-story stone railroad station at *Victoria*, *Ellis County*, *Kans.* The bolt is in the second course above the platform and in the second stone from the northeast corner of the building.

Y_1.—The bottom of a square cut in the upper surface of the stone forming the lower step to the First National Bank building at *Hays*, *Ellis County*, *Kans.* The entrance to the bank is at the southeast corner of the building, and the bench mark is at the left-hand end of the lower step as you enter the building. It is lettered the same as K_1.

Z_1.—The intersection of a cross in the end of a copper bolt in the east side of the stone building at *Ellis*, *Kans.*, used as a railroad station and hotel. The bolt is in the third course above the sidewalk and in the second stone to the left (south) of the door, as you enter the building.

A_2.—The intersection of a cross in the end of a copper bolt in the front face of the stone wall to the one-story business building owned and occupied by Thomas Daly, at *Ellis*, *Kans.* The bolt is in the west side wall, in the second course above the foundation, and about the center of the stone forming the course.

B_2.—The intersection of a cross in the end of a copper bolt in the front face of the east side wall to the two-story stone business building owned and occupied by R. McCloud, at *Ellis*, *Kans.* The bolt is in the second course above the foundation and about the middle of the stone forming the course.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ELLIS, KANS., AND HUGO, COLO.

A_2.—*Ellis, Kans.* (See page 582).

B_2.—*Ellis, Kans.* (See page 582).

C_2.—The intersection of a cross in the end of a copper bolt in the east front face of the two-story stone building at *Ogallah, Kans.*, owned by William Baldwin and used as a store and post office. The bolt is in the fourth course above the foundation and in the stone forming the northeast corner.

D_2.—The bottom of a square cut in the stone doorsill to the entrance to the court-house at *Wakeeney, Kans.* The building fronts west and the bench mark is at the north or left side of the door as the building is entered. The following letters were cut:

U S
□
B M

E_2.—The intersection of a cross cut in the end of a copper bolt in the front (west) face of the stone pump house to the railroad water tank at *Collyer, Kans.* The bolt is on the right of the door as the building is entered, in the fifth course above the ground and is in the stone forming the southwest corner. The following letters were cut:

U S
O
B M

F_2.—The intersection of a cross in the end of a copper bolt in the north wall to the two-story brick schoolhouse at *Quinter, Kans.* The building is about 500 metres south of the railroad. The bolt is in the sixth course of brick above the stone foundation and in the second brick from the northeast corner.

G_2.—The intersection of a cross in the end of a copper bolt in the east wall of the stone pump house at the west end of the railroad station platform at *Buffalo Park, Kans.* The bolt is in the second course above the platform and in the stone forming the south-east corner. It is lettered the same as E_2.

H_2.—The intersection of two lines forming a cross in the iron front to the two-story brick building (called the Opera House) at *Grainfield, Kans.* The building fronts east and the mark is near the southeast corner. The maker's mark is on the iron in raised letters and the cross is placed as follows: $\frac{\text{Mesker \& Bros.,}}{\text{St. + Louis, Mo.}}$. The letters U S B M were cut in the iron immediately below the cross.

I_2.—The intersection of a cross in the end of a copper bolt in the east wall of the stone pump house to the railroad water tank at *Grinnell, Kans.* The bolt is in the ninth course above the foundation and in the stone forming the northeast corner of the building.

J_2.—The intersection of a cross in the end of a copper bolt in the east wall to the stone pump house to the railroad water tank at *Oakley, Kans.* The bolt is in third course above the ground and in the stone forming the southeast corner of the building. The following letters were cut: U S O B M.

K_2.—The intersection of a cross in the end of a copper bolt in the front south wall of the stone basement to the one-story frame dwelling house at *Monument, Kans.*, owned by Thomas Handley. The house is north of the railroad and about 800 metres east of the railroad station. The bolt is at the west side of the east window in the second course above the ground and in the stone forming the west side of the window. It is lettered the same as J_2.

L_2.—The surface of the iron at the intersection of a cross in the upper surface of the pedestal to the iron monument marking the end of the bonded portion of the Union Pacific Railway. The monument stands north of the track about 2½ kilometres west of *Page City, Kans.* The cross is at the southeast corner, and the following letters were cut: U S + B M.

M_2.—The bottom of a square cut in the upper surface of the stone foundation supporting one of the iron columns under the railroad water tank at *Winona, Kans.* The hole is in the southeast stone of the four supporting the central group of columns and on its south sloping face. The following letters were cut: U S □ B M.

N_2.—A square cut in the top of a granite post (see note 3, page 549) at *McAllaster, Kans.*, between the railroad track and switch, near the southeast corner of the platform around the railroad station.

O_2.—A square cut in the top of a granite post (see note 3, page 549) at *Turkey Creek, Kans.*, on the railway right of way between the track and the telegraph pole used as the 414-milepost.

P_2.—The bottom of a square cut in the top of the sandstone post forming the west support of the transit at the telegraph longitude station at *Wallace, Kans.* The station is in the northeast corner of the inclosure east of the stone house formerly used as the office of the division superintendent of the Union Pacific Railway. It is lettered the same as D_2.

Q_2.—The bottom of a square cut in the upper surface of the stone foundation under one of the iron columns supporting the railroad water tank, 3½ miles west of *Wallace, Kans.* The hole is in the southwest stone of the four supporting the central group of columns, and near its south side. It is lettered the same as D_2.

R_2.—The intersection of a cross in the end of a copper bolt in the stone foundation under the east front wall of a one-story business building at *Sharon Springs, Kans.* The building is on the west side of the main street and is owned by Colonel Woodhouse. The bolt is in the stone forming the southeast corner of the foundation and projects a little outside the stone.

S_2.—A square cut in the top of a granite post (see note 3, page 549) on the railway right of way about 10 feet south of the station sign at *Monotony, Kans.*

T_2.—The intersection of a cross in the end of a copper bolt in the front (east) wall of the stone pump house to the railway water tank at *Weskan, Kans.* The bolt is in the second course below the top of the wooden door casing, and in the third stone from the southeast corner of the building.

U_2.—The surface of the iron at the intersection of two lines cut in the upper surface of the pedestal to the iron monument marking the *Kansas-Colorado State line.* The monument is north of the track on the railway right of way. The cross is at the southwest corner between the round hole and the corner. The following letters were cut:

U S
+
B M

A.—A square cut in the top of a granite post (see note 3, page 549) in the southeast corner of the yard around the railway section house at *Arapahoe, Cheyenne County, Colo.*

B.—The bottom of a square cut in the limestone window sill to the brick railway roundhouse at *Cheyenne Wells, Cheyenne County, Colo.* The bench mark is about the middle of the sill to the window on the left of the door as you enter the roundhouse from the main track. It is lettered the same as D_2.

C.—A square cut in the top of a granite post (see note 3, page 549) in the yard to the railway station (and dwelling of the agent) at *First View, Cheyenne County, Colo.*, about the middle of the south side, just inside the fence.

D.—The intersection of a cross in the end of a copper bolt in the front (east) wall of the stone pump house to the railway water tank at *Kit Carson, Cheyenne County, Colo.* The bolt is in the fourth course above the ground in the stone forming the southeast corner.

E.—The bottom of a square cut in the top of the coping to the stone retaining wall of the culvert 1 mile east of *Wildhorse, Cheyenne County, Colo.* The hole is north of the track, at the west angle in the wall. It is lettered the same as D_2.

F.—A square cut in the top of a granite post (see note 3, page 549) near the east end of the railway section house at *Aroya, Cheyenne County, Colo.*

G.—A square cut in the top of a granite post in the southeast corner of the yard to the railway section house at *Boyero, Lincoln County, Colo.*

H.—The intersection of a cross in the end of a copper bolt in the brick pump house to the railway water tank at *Mirage, Lincoln County, Colo.* The bolt is in the eighth course above the stone foundation and in the sixth brick to the right of the door as you enter.

I.—A square cut in the top of a granite post (see note 3, page 549) in the yard to the county jail at *Hugo, Lincoln County, Colo.*, east of the building. Destroyed in 1898.

J.—The intersection of a cross in the end of a copper bolt in the stone water table to the brick jail building at *Hugo, Lincoln County, Colo.* The bolt is in the front wall near the southeast corner of the building, and on the right of the door as you enter the jail.

K.—The intersection of a cross in the end of a copper bolt in the stone water table to the brick jail building at *Hugo, Lincoln County; Colo.* The bolt is in the front wall near the southwest corner of the building, and on the left of the door as you enter the jail.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN HUGO AND COLORADO SPRINGS, COLO.

I.—*Hugo, Colo.* Destroyed.

J.—Hugo, Colo. (See above.)

K.—*Hugo, Colo.* (See above.)

L.—The bottom of a square cut in the top of the stone wing wall to the railroad culvert nearly opposite milepost 544 near *Lake, Lincoln County, Colo.* The bench mark is south of the track and near the western edge of the wall on the stone forming the corner. It is lettered thus:

U S
□
B M

M.—The intersection of a cross in end of a copper bolt, in the east (front) wall of the stone pump house to the railroad water tank at *Lake*, *Lincoln County*, *Colo.* The bolt is in the fourth course above the ground and in the third stone from the southeast corner of the building.

N.—A square cut in the top of a granite post at *Limon* Station, *Lincoln County*, *Colo.* It is situated in the northeast corner (near front fence) of the yard to the public school at Limon. (See note 3, page 549.)

O.—The bottom of a square offset cut in the sloping top to the artificial stone foundation under one of the supports to the Chicago, Rock Island and Pacific Railroad water tank at *Limon* Station, *Lincoln County*, *Colo.* The mark is on the foundation under the north one of the two western supports (nearest the track), is south of the support and near the southeast corner of the stone.

P.—The bottom of a square offset cut in the sloping top to the artificial stone foundation under one of the supports to the Chicago, Rock Island and Pacific Railroad water tank at *Limon*, *Lincoln County*, *Colo.* The mark is on the foundation under the northwest one of the central group of supports (4) and is near the northwest corner of the stone.

Q.—A limestone post in the northeast corner of the yard to the railroad section house at *Resolis*, *Elbert County*, *Colo.* (See note 3, page 549.)

R.—The bottom of a square offset cut in the sloping surface of the stone under one of the wooden posts supporting the railroad water tank at *Mattison*, *Elbert County*, *Colo.* The stone is under the north one of the two western supports under the tank, and is at northeast corner of the stone. It is lettered the same as L.

S.—A square cut in the top of a limestone post buried in the southeast corner of the yard to the railroad section house at *Ramah*, *El Paso County*, *Colo.* (See note 3, page 549.)

T.—The bottom of a square offset in the upper surface of the stone foundation supporting one of the wooden uprights under the railroad water tank at *Calhan*, *El Paso County*, *Colo.* The mark is on the stone under the east one of the two uprights at the north side of the tank, and it is near the northwest corner of the stone. It is lettered the same as L.

U.—The intersection of a cross in the end of a copper bolt in the stone foundation to the Russel Gates Mercantile Company's store at *Peyton*, *El Paso County*, *Colo.* The bolt is in the upper stone of the foundation, on the south side, at the southeast corner of the building, at the west end of the steps leading to the front porch.

V.—The bottom of a square offset in the top of the stone under one of the supports to the Chicago, Rock Island and Pacific Railroad water tank at *Falcon*, *El Paso County*, *Colo.* The bench mark is on the stone under the east one of the two supports under the south side of the tank, and it is at the southeast corner of the stone. It is lettered the same as L.

W.—The bottom of a square cut in the top of one of the stones forming the abutment to the Union Pacific, Denver and Gulf Railway bridge over the Chicago, Rock Island and Parific Railroad at *Falcon*, *El Paso County*, *Colo.* The bench mark is on the west abutment, at the north end, on top of the stone forming the third course above the Chicago, Rock Island and Pacific Railroad track and the first of the series of steps or offsets leading to the top of the abutment. It is lettered the same as L.

X.—The bottom of a square offset cut in the top of one of the artificial stones under the supports to the railroad water tank at *Elsmere*, *El Paso County*, *Colo.* The bench mark is on the stone under the south one of the two supports under the east side of the tank, and it is at the southwest corner of the stone. It is lettered the same as L, but the stone crumbles easily, and both mark and letters are roughly cut.

Y.—The bottom of a square cut in the upper surface of the stone forming the first step or offset in the stone abutment to the Atchison, Topeka and Santa Fe Railway bridge over the Chicago, Rock Island and Pacific Railway, near *Roswell*, *El Paso County*, *Colo.* The mark is on the abutment north of the Chicago, Rock Island and Pacific Railway track at the east end. It is lettered the same as L.

Z.—The bottom of a square cut in the upper surface of a stone window sill to a window in the roundhouse (stone) of the Chicago, Rock Island and Pacific Railway at *Roswell*, *El Paso County*, *Colo.* There is one window and a door in the south end of the roundhouse, and the bench mark is cut in the sill to this window. It is lettered the same as L.

A_1.—The bottom of a square hole in the top of the stone abutment to the Denver and Rio Grande Railroad bridge over Monument Creek, about 800 metres north of the railroad station at *Colorado Springs*, *El Paso County*, *Colo.* The bench mark is west of the track, on the north abutment, and on the second stone from the end where the offsets begin. It is lettered the same as L.

B_1.—The intersection of a cross in the end of a copper bolt in the wall of the Denver and Rio Grande passenger depot at *Colorado Springs*, *El Paso County*, *Colo.* The bolt is in the third course above the platform and in the second stone from the southwest corner of the building, in the east wall.

City.—The surface of the stone door sill of the north door (west side) of the Denver and Rio Grande Railroad passenger station at *Colorado Springs*, *El Paso County*, *Colo.* It is near the front edge and the north end of the sill. There is no mark, and its location was pointed out by the city engineer. Its elevation has been determined by the railroad company.

North Mast.—This bench mark is on an unusually tall telegraph pole in *Colorado Springs*, *Colo.* It is about 20 inches in diameter and is the nearest to the Denver and Rio Grande Railroad station of two such poles which are on the railway right of way. This pole is about 34·8 metres from the middle of the west window in the south face of the passenger station. The bench mark is the top of the black band about the base of the pole.

South Mast.—This bench mark is an unusually large (in height and girth) telegraph pole near the passenger station of the Denver and Rio Grande Railway in *Colorado Springs*, *El Paso County*, *Colo.* There are two of these poles along the railway right of way—south mast is the southern one; it is also the most western pole of a long line of similar poles extending from the railroad line to the central telegraph office in Colorado Springs. It is about 46 metres south of North Mast bench mark, and 80·2 metres distant from the middle of the west window in south face of railway station. South mast is about 20 inches in diameter. The bench mark is the top of the black band about the base of the pole.

Nail.—The head of a nail which was driven in South Mast on a level with the center of the vertical circle when mounted near Denver and Rio Grande Railway passenger depot at time observations for vertical angles on Pikes Peak and surrounding points were made in 1895.

Reference.—This bench mark is center of sill of west window in south face of Denver and Rio Grande Railroad passenger station, *Colorado Springs*, *Colo.* The upper part of front of sill has a sloping face and the bench mark is where this sloping face intersects the perpendicular front of the sill.

V. C. Post.—The top of a wooden post, 8 by 8 inches in cross section, and about 4 feet above surface of ground. It is 1 metre west of South Mast bench mark, in *Colorado Springs*, *El Paso County*, *Colo.* The post was used as a support for vertical circle in 1895, when vertical angles were measured on Pikes Peak and surrounding points by Assistant Eimbeck.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN COLORADO SPRINGS AND DENVER, COLO.

Z.—*Roswell*, *Colo.* (See page 587.)

C_1.—The bottom of a square cut in the top of the stone abutment to Denver and Rio Grande Railroad culvert near the sign "One mile to *Pike View*," north of that station. It is east of the track and on the second stone from the south end of the abutment, near the middle of its upper surface. It is lettered thus:

U S
□
B M

D_1.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge (Denver and Rio Grande No. 65A) near mile post 66, at *Edgerton*, *El Paso County*, *Colo.* It is west of the track, on the stone forming the north end of the north abutment. It is lettered the same as C_1.

E_1.—The bottom of a square cut in the top of one of the stones forming the north abutment of railroad bridge No. 63A, about 1¼ miles south of *Husted*, *El Paso County*, *Colo.* It is opposite the dwelling of Mr. E. P. Moon. It is on the second step or offset from the top of the abutment and is east of the track. It is lettered the same as C_1.

F_1.—The bottom of a square cut in the upper surface of the stone foundation under the Denver and Rio Grande Railroad water tank at *Husted*, *El Paso County*, *Colo.* The tank is supported by wooden posts, and the bench mark is on the foundation under the northern tier (farthest from the track) and at its eastern end. It is lettered the same as C_1.

G_1.—The bottom of a square cut in the upper surface of the foundation under the Denver and Rio Grande Railroad station building (wood) at *Monument*, *El Paso County*, *Colo.* It is on the foundation under the front of the building, near the southwest corner where the foundation shows above the platform. Lettered: U S □ B M.

H_1.—The bottom of a square cut in the top of the stone wall around the Denver and Rio Grande Railroad turntable at *Palmer Lake*, *El Paso County*, *Colo.* It is on the east side nearest the railroad station and is between the track and the main line. It is lettered the same as C_1.

I_1.—The bottom of a square cut in the top of the stone under one of the iron supports to the Atchison, Topeka and Santa Fe Railroad bridge over the Denver and Rio

Grande Railroad, about 2 miles north of *Palmer Lake, El Paso County, Colo.* It is east of the track and near the southeast corner of the stone. It is lettered the same as C_1.

J_1.—The intersection of a cross in the end of a copper bolt in the brick foundation to the Greenland Farm Ranch House, at *Greenland, Douglas County, Colo.* The bolt is in the foundation under the north side of the house (back building) in the fourth course above the ground and in the third brick from the northeast corner of the building.

K_1.—The bottom of a square cut in the stone abutment of the Denver and Rio Grande Railroad bridge south of *Larkspur, Douglas County, Colo.* The bench mark is west of the track and on the north side of the stream on the stone forming the top of the abutment. It is lettered the same as C_1.

L_1.—The bottom of a square cut in the stone abutment to the Denver and Rio Grande Railroad bridge north of *Douglas, Douglas County, Colo.* The bench mark is west of the track and at the north end of the bridge on the stone forming the second step or offset in the abutment below the top. It is lettered the same as C_1.

M_1.—The intersection of a cross in the end of a copper bolt in the east (front) wall of the stone courthouse at *Castle Rock, Douglas County, Colo.* The bolt is in the fifth course above the ground, in the second stone on the left of the door as you enter, and near the south end of the stone.

N_1.—The bottom of a square cut in the top of the stone retaining wall to the Denver and Rio Grande Railroad culvert at the north end of the side track at *Plateau, Douglas County, Colo.* The bench mark is west of the track at the south end of the culvert. It is lettered the same as C_1.

O_1.—The bottom of a square cut in the sandstone abutment to the Atchison, Topeka and Santa Fe Railroad bridge at *Sedalia, Douglas County, Colo.* It is east of the Atchison, Topeka and Santa Fe track and west of the Denver and Rio Grande track, on top of the second step or offset above the Denver and Rio Grande track. It is lettered the same as C_1.

P_1.—The bottom of a square cut in the stone abutment of the Denver and Rio Grande Railroad bridge about 1 mile north of *Toluca, Douglas County, Colo.* It is on the north abutment east of the track and on the second step or offset from the top. The bridge is numbered 19 A. It is lettered the same as C_1.

Q_1.—The bottom of a square cut in the top of the retaining wall to the railroad culvert about half a mile north of *Acequia, Douglas County, Colo.* The bench mark is east of the track and near the north end of the wall. It is lettered the same as C_1.

R_1.—The bottom of a square cut in the top of the retaining wall to the Denver and Rio Grande Railroad culvert at *Wolhurst, Douglas County, Colo.* The bench mark is east of the track and near the north end of the wall. It is lettered the same as C_1.

S_1.—The intersection of a cross in the end of a copper bolt in the stone railway station (Denver and Rio Grande) at *Littleton, Arapahoe County, Colo.* The bolt is in the south end of the building in the third course above the platform and in the third stone from the southeast corner.

T_1.—The bottom of a square cut in the stone abutment to the Denver and Rio Grande Railroad bridge about 1 mile north of *Petersburg, Arapahoe County, Colo.* The bench mark is on the north abutment east of the track and on the second step or offset from the top. It is lettered the same as C_1.

U_1.—Established by the United States Geological Survey in *Denver, Colo.*, and is described by them as follows: "State Capitol grounds, southeast corner of; aluminum tablet let into top of stone post, azimuth station, near steps, marked 5275." The surface of the metal at the intersection of two lines forming a cross was used.

V_1.—Established by the United States Geological Survey in *Denver, Colo.*, and is described by them as follows: "State Capitol grounds, in steps at northeast corner of; bronze tablet, also used as azimuth mark, marked 5275." The surface of the metal, at the intersection of two lines forming a cross was used.

W_1.—Established by the United States Geological Survey in *Denver, Colo.*, and is described by them as follows: "State Capitol grounds, east front of; on lower pedestal southeast corner of steps. $\frac{\text{U S}}{\text{B M}}$ cut on top of granite block." The surface of the stone between the letters was used.

X_1.—Established by the United States Geological Survey, and is described by them as follows: "Union Depot (*Denver, Colo.*), east front of; on north side of main entrance, 2 feet above pavement, bronze tablet marked 5184." When examined this tablet was found to move slightly in azimuth, but apparently did not change its height. The tablet is set in the face of the wall, and the intersection of the two lines cut in the tablet, forming a cross, was used as the bench mark.

Y_1.—Used by the United States Geological Survey, and is described by them as follows: "City Datum (*Denver, Colo.*), cross in floor main entrance, east front Union Depot." The cross is on the right hand as you enter and close to the wall. The surface of the stone at the intersection of the cross was used as the bench mark.

Z_1.—The bottom of a square cut in the top of the sandstone window sill to the brick building on the southeast corner of Thirty-ninth avenue and High street, *Denver, Colo.* The building is occupied by A. Kraus as a saloon. It is on the sill under the second window from the corner on the High street side.

A_2.—The bottom of a square cut in the upper surface of a stone window sill to the brick machine shop (Union Pacific Railway shops) at *Jersey, Colo.* It is on the sill under the first window from the southeast corner in the south end of the building. Lettered U S □ B M.

B_2.—The bottom of a square cut in the upper surface of a stone window sill to the brick planing mill (Union Pacific Railway shops) at *Jersey, Colo.* It is on the sill under the second window from the southwest corner in the south end of the building. Lettered U S □ B M.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN LIMON AND DENVER, COLO.

P.—*Limon, Colo.* (See page 586.)

O.—*Limon, Colo.* (See page 586.)

N.—*Limon, Colo.* (See page 586.)

River Bend N_2.—A square cut in the top of a granite post at *River Bend, Elbert County, Colo.* It is in the southeast corner of the yard to the railroad section house. (See note 3, page 549.)

M_2.—A square cut in the top of a granite post at *Godfrey, Elbert County, Colo.* It is in the northwest corner of the yard to the railroad section house. (See note 3, page 549.)

L_2.—The intersection of a cross in the end of a copper bolt at *Agate*, *Elbert County*, *Colo*. The bolt is in the south (front) wall of the stone pump house to the railroad water tank, in the sixth course above the ground and in the second stone from the southwest corner, on the left of the door as you enter. (See note 3, page 549.)

K_2.—A square cut in the top of a granite post at *Lowland*, *Elbert County*, *Colo.*, near and north of the station sign at Lowland. (See note 3, page 549.)

J_2.—A square cut in the top of a granite post at *Deer Trail*, *Arapahoe County*, *Colo*. It is in the southeast corner of the yard to the railroad section house. (See note 3, page 549.)

I_2.—The bottom of a square offset in the sloping surface of a stone, under one of the iron supports to the Union Pacific Railroad water tank at *Byers*, *Arapahoe County*, *Colo*. It is on the stone under the south one of the two supports under the eastern side of the tank. It is lettered:

U S
□
B M

H_2.—A square cut in the top of a granite post at *Bennett*, *Aparahoe County*, *Colo*. It is in the southwest corner of the yard to the railroad section house.. (See note 3, page 549.)

G_2.—Established by the United States Geological Survey, and is described by them as follows: "Watkins, 0·2 mile east of, iron post, 180 feet north of track (K. P. R. R.), in sec. 36, T. 3 S., R. 66 W., marked 5513." At *Watkins*, *Arapahoe County*, *Colo*. (See note 7, page 549.)

F_2.—Established by the United States Geological Survey, and is described by them as follows: "Behrens Ranch, 1·1 miles southeast of; 50 feet south of track (K. P. R. R.), 60 feet east of bridge No. 803, T. 3 N., R. 66 W., sec. 36. Iron post marked 5484." It is 6 miles east of *Magnolia*, *Arapahoe County*, *Colo*. (See note 7, page 549.)

E_2.—Established by the United States Geological Survey, and described by them as follows: "Crippen's Ranch, one-fourth mile south of; 100 feet north of track Kansas Pacific Railroad, T. 2 S., R. 66 W. Iron post marked 5400." Two miles east of *Magnolia*, *Arapahoe County*, *Colo*. (See note 7, page 549.)

D_2.—Established by the United States Geological Survey, and described by them as follows: "Magnolia, one-fourth mile east of; 40 feet north of track, T. 3 S., R. 67 W., sec. 25. Iron post marked 5333." At *Magnolia*, *Arapahoe County*, *Colo*. (See note 7, page 549.)

C_2.—Established by the United States Geological Survey, and described by them as follows: "*Denver*, 6½ miles east of; 0·2 mile south of Sand Creek slaughterhouse, 14 feet south of K. P. R. R. main track. Iron post marked 5275." It is 1·5 metres west of warning post at Sand Creek slaughterhouse road crossing. (See note 7, page 549.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN BILOXI, MISS., AND MOBILE, ALA.

I_1, or P. B. M. 18.—At *Biloxi*, *Miss.*, on the building on the southwest corner of Back Bay road (or Mule street) and Jackson street. The center of head of copper bolt leaded horizontally into the center of the second brick from the southeast corner of the fourteenth course above the sidewalk, in the east wall.

H_1, or P. B. M. 19.—Two hundred and twenty-five metres west of the west end of *Biloxi Bay Bridge, Miss.*, and 30 metres south of center of track of the Louisville and Nashville Railroad. The bench mark is a cross cut on the top of the marking stone (the copper bolt has been destroyed) set in the ground. Pine trees near the stone are marked with five narrow blazes.

G_1, or P. B. M. 20.—Near the west end of *Biloxi Bay Bridge, Miss.*, on the Louisville and Nashville Railroad. The bench mark is the head of a copper bolt leaded vertically in the top of marking stone set in the ground 4 metres north of center of track and 114 metres west of the west end of the bridge. The letters "U S" are cut upon the top of the stone.

F_1, or P. B. M. 21.—On the north side of the drawbridge pier of the *Biloxi Bay Bridge, Miss.*, on the Louisville and Nashville Railroad. The top of a copper bolt leaded vertically in the concrete inside of the iron caisson. The bolt is about halfway between cogwheels and extreme north point of iron caisson. It is 16 inches to extreme north edge of caisson and 18 inches to cogwheels. The caisson is 30 feet in diameter, filled with concrete, and rests on top of piles in 12 feet of water.

E_1.—Near the east end of *Biloxi Bay Bridge.*, *Miss*, and about 68 metres south of the Louisville and Nashville Railroad track, in the yard of and near the northwest corner of the frame house owned and occupied by the Rev. J. B. Walker. The bench mark is the bottom of the square cut in the top of a marble stone, 6 by 4 inches on top and about 2½ feet long, projecting about 1 inch above ground, and has the letters "U S C S" cut upon the top. Distance from center of bench to brick pier under northwest corner of house, 0·8 metre.

D_1.—At *Ocean Springs, Jackson County, Miss.*, in chimney on west side of storehouse owned and occupied by A. Franco. It is the center of head of copper bolt 0·0125 metre in diameter, leaded horizontally into the middle brick in the twenty-first layer above the ground.

C_1.—At *Scranton, Jackson County, Miss.*, on the north face and near the northeast corner of the court-house. It is the center of head of copper bolt 0·0125 metre in diameter, leaded horizontally in the middle of the tenth brick above water table.

B_1.—At *Grand Bay, Mobile County, Ala.*, on the Louisville and Nashville Railroad. It is on the north side of the chimney at the east end of the frame dwelling owned by Mr. Oscar Cassebry, and is the center of the head of a copper bolt, 0·0125 metre in diameter, leaded horizontally into the eighth layer of bricks above the ground and near the middle of the third brick from the north end of the chimney.

A_1.—At *St. Elmo* station, *Mobile County, Ala.*, on the Louisville and Nashville Railroad, in the yard of and in the northwest angle of the house occupied by Mr. Adams. The bench mark is the bottom of the square cavity cut in the top of the marble stone marking the point. The stone is 6 by 4 inches on top and about 2½ feet long, and has the letters "U S C S" cut upon the top.

A.—At *Mobile, Ala.*, on the sill of the window on the north front and near the east end of the custom-house. It is the bottom of a square cut in the stone. It is 0·215 metre from extreme north edge of sill, 0·143 metre from south wall, 0·145 metre from east wall, and 1·155 metres below the window.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN MOBILE, ALA., AND MERIDIAN, MISS.

A.—*Mobile, Ala.* (See page 592.)

Astronomical Station.—At *Mobile, Ala.* Old hydrographic bench mark at old astronomical station in Bienville Park.

B.—At *Citronelle, Ala.* The center of cross on head of copper bolt leaded horizontally in the south chimney of the cottage belonging to the Mobile and Ohio Railroad. The bolt is in the middle of the brick in the fourth layer from the ground, three bricks from east edge of chimney and three from the west edge.

E_2.—At milepost 38 of the Mobile and Ohio Railroad, in *Washington County, Ala.* The bottom of square cut in top of marking stone in the ground on the east side of the track, 7·78 metres from the center of track and 0·81 metre from the wire fence. The stone is of white marble. (See note 3, page 549.)

F_2.—At *Deer Park, Washington County, Ala.* The bottom of a cavity, 1 inch square and one-half inch deep, in a white marble block set in the front yard of Mr. James B. Rawls's residence. This marble block is between the schoolhouse and well, and projects 1 inch above the ground. (See note 3, page 549.)

G_2.—At *Escatawpa, Washington County, Ala.* The center of a horizontal cut on copper bolt leaded horizontally into the south chimney of Dr. W. H. Boykin's house, on Main street. This bolt is in the center of the middle brick in the eleventh layer above the water-table course.

H_2.—At mile-post 58 of the Mobile and Ohio Railroad in *Alabama.* The bottom of cavity, 1 inch square and one-half inch deep, cut in a white marble block set on the top of a small hill on the east side of track. Distance of stone from center of track, at right angles, is 30·9 metres and 27·5 metres from the milepost. It projects about an inch above the ground. (See note 3, page 549.)

I_2.—At *State Line, Wayne County, Miss.* Center of cross on head of copper bolt leaded horizontally into west side of the south chimney of Mr. E. A. Lister's house. This house is on the east side of the Mobile and Ohio Railroad, just opposite the water tank, and is the next one north of Mr. B. A. Cragin's house. The bolt is in the center of the middle brick in the tenth course above the ground.

J_2.—At *Bucatunna, Wayne County, Miss.* Center of cross on head of copper bolt leaded horizontally in south chimney of house belonging to Mr. F. H. Hooge. This house is on the west side of the Mobile and Ohio Railroad, about 50 metres south of railroad station. The bolt is in the center of the middle brick in the thirteenth course above the water-table course.

K_2.—At *Winchester, Wayne County, Miss.* Bottom of cavity 1 inch square and one-half inch deep, cut in white marble block set in the front yard near the gate of Mr. A. J. Henderick's house. This marble block projects about 4 inches above the ground. (See note 3, page 549.)

L_2.—At *Waynesboro, Wayne County, Miss.* Center of cross on head of copper bolt leaded horizontally into a brick on the front side of Mr. J. P. Turner's store on the northeast corner of Car and Station streets. The bolt is in the center of the fifth brick from the south wall and in the twelfth course above the foundation.

M_2.—At milepost 89 of the Mobile and Ohio Railroad in *Mississippi*. Bottom of cavity 1 inch square and one-half inch deep, cut in white marble block set on east side of track. This stone is 11·1 metres, at right angles, from the center of track. It projects about 3 inches above the ground. (See note 3, page 549.)

N_2.—At *Shubuta, Clarke County, Miss.* Center of cross on head of copper bolt leaded horizontally into the front wall of Mr. M. Greenhood's store, a one-story brick building on the north side of Occutta street, west of the Mobile and Ohio Railroad. The bolt is in the center of a brick, 2½ bricks east of store door and 2½ west of west side of window, in the fourteenth course above the foundation and two courses above lower sill of window.

O_2.—Near railroad station of the Mobile and Ohio Railroad at *De Soto, Clarke County, Miss.* Bottom of cavity 1 inch square and one-half inch deep, cut in marking stone set in the ground 0·38 metre north of north wall of station and 1·45 metres west of the east wall. This stone is a white marble block projecting about 3 inches above the ground. (See note 3, page 549.)

D_2.—Near Mobile and Ohio Railroad station at *Quitman, Clarke County, Miss.* Bottom of square cavity cut in the top of marking stone set in the front yard, on the left side of the gate (as you go in) of Dr. Jere. Sander's hotel. (See note 3, page 549.)

C_2.—On courthouse at *Quitman, Clarke County, Miss.* Center of cross cut on head of copper bolt leaded horizontally in the middle of a brick, on the west face and near the northwest corner of the court-house. The brick is in the fourth layer above the water table, and second one from north end of pillar at corner of building.

B_2.—At *Enterprise, Clarke County, Miss.* Center of head of copper bolt, 0·0646 metre in length and 0·0132 metre in diameter, leaded horizontally in the middle of a brick in the north face of Chickasawhay Mills. The brick is in the tenth course above the ground, about halfway between the two main doors of brick structure.

C.—On courthouse at *Meridian, Lauderdale County, Miss.* A cross cut on the iron doorsill at the north entrance. Is near the east edge of the sill and measures, from its center to the extreme north edge of sill, 0·32 metre and 0·0445 metre from the east door jamb. Marked thus: X.

DESCRIPTIONS OF PERMANENT BENCH MARKS FROM MERIDIAN TO CORINTH, MISS.

C.—*Meridian, Miss.* (See above.)

D.—At *Meridian, Lauderdale County, Miss.* Is the upper part of the last stroke in the last "N" in the name of John Stinson inscribed on the granite block placed in the northeast corner of the courthouse. This block bears the names of the board of supervisors. In 1897 reported as no longer accessible.

E.—At *Scooba, Kemper County, Miss.* Center of copper bolt leaded horizontally in the south side of the chimney at the west end of J. H. Duke's store. The bolt is almost in the center of the brick in the eighteenth course from the ground and one brick from the west end of chimney.

F.—Near *Macon, Noxubee County, Miss.*, on the Mobile and Ohio Railroad. The center of a cross on the southeast corner of the coping on the south abutment of bridge over Nuxubee River. Center of cross measures 0·250 metre from extreme south edge of stone and 0·220 metre from iron wall plate resting on stone.

No. 96.—Near Mobile and Ohio Railroad station at *Macon*, *Noxubee County*, *Miss.* A cross on the end of a brick in the south pier of the water tank. Center of cross is 0·0035 metre from extreme south end of pier and 0·0435 metre from extreme east end.

G.—At *Artesia*, *Lowndes County*, *Miss.* Center of cross on copper bolt leaded horizontally into a brick in the southwest pier of the hotel at Artesia. The brick is in the third course from the top and one brick from the north end of pier.

H.—At *West Point*, *Clay County*, *Miss.* Bottom of square cavity cut in brick in the top of offset on the east front of the Jackson House. Center of bench to extreme east edge of brick measures 0·012 metre.

I.—On court-house at *West Point*, *Clay County*, *Miss.* A point on the granite block or tablet bearing the inscription of Cannon Lodge, No. 159, situated in the northeast corner of the courthouse. There is a horizontal line near the middle of this tablet and the bench is the point directly below the letter "A."

L.—At Mobile and Ohio Railroad station at *Okolona*, *Chickasaw County*, *Miss.* Center of copper bolt leaded horizontally into a brick in the southwest pier of the station. The brick is the middle one on the west side of the pier, and in the seventh course from the ground.

K.—On cotton warehouse at *Okolona*, *Miss.* Center of bolt leaded horizontally in a brick on the east front and near the south end of the warehouse occupied by C. R. Smith. The brick is the thirteenth one south of door and in the twenty-second course from the ground.

M.—On the Mobile and Ohio Railroad bridge over *Tubby Lubby Creek.* The bottom of a square cut in the capstone of the pier on the north bank of the creek. It is west of the track and is roughly lettered:

U S
□
B M

N.—At *Shannon*, *Lee County*, *Miss.* The center of a cross in end of a brass bolt leaded horizontally into a brick in the east wall of R. B. Clark & Co.'s store. The brick is in the sixth row above the foundation, and is the sixth one from the north end of wall.

O.—At *Verona*, *Lee County*, *Miss.* The center of a cross in end of a brass bolt leaded horizontally into a brick in the south front of R. L. Trice & Son's store. The brick is in the sixth row above the foundation, and is the third one from the west side.

P.—At *Tupelo*, *Lee County*, *Miss.* The center of a cross in end of a brass bolt leaded horizontally into a brick in the front wall of Fulton Hotel. The brick is in the twenty-first course above the ground, and is the second one from the southeast corner.

Q.—At *Saltillo*, *Lee County*, *Miss.* A square cut in a limestone block in the front yard of James R. Boling's house, near the northwest corner of the brick flower pit on the south side of the house. (See note 3, page 549.)

R.—At *Guntown*, *Lee County*, *Miss.* The center of a cross in end of a brass bolt leaded horizontally into a brick in the chimney on the north end of J. W. Kernodle's house. The brick is in the twelfth course above the ground, and is the second one from the outer face of chimney on the side toward the front of the house.

S.—At *Baldwyn*, *Lee County*, *Miss.* A square cut in a limestone block in the southwest corner of the yard to the Bucey Hotel. (See note 3, page 549.)

T.—At *Booneville*, *Prentiss County*, *Miss.* The center of a cross in end of a brass bolt leaded horizontally into a brick in the east front of the courthouse. The brick is in the eighteenth course below the window sill, and is the second one from the northeast corner.

U.—At *Rienzi*, *Alcorn County*, *Miss.* The center of a cross in end of a copper bolt leaded horizontally into a brick in the outer face of the north chimney on the east side of Taylor's Hotel. The brick is in the fifteenth course above the ground, and is the third one from the north side of chimney.

V.—At *Corinth*, *Alcorn County*, *Miss.* The center of a cross in end of a brass bolt leaded horizontally into a brick in the east wall of a store on Waldren street. The building is opposite the courthouse, and is used as the city hall. The brick is in the third course above the sill of the window, near the north end of the building, and is the fourth one south of this window.

W.—At *Corinth*, *Miss.* The center of a cross in end of a brass bolt leaded horizontally into a brick in the west wall of the courthouse. The brick is in the fourteenth row below the line of window sills, and in the fifth one south of the fifth cellar ventilator, counting from the northwest corner of the building.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN CORINTH, MISS., AND CAIRO, ILL.

X.—At *Ramer*, *McNairy County*, *Tenn.* The center of a cross cut in a brass bolt leaded horizontally into a brick in the pier under the southwest corner of the Mobile and Ohio Railroad station. The brick is in the fourth course from the top of pier, and is the one on the southeast corner. The end of the bolt is about one-fourth inch below the outer face of the brick.

Y.—At *Falcon*, *McNairy County*, *Tenn.* A brass bolt leaded horizontally into a brick in the chimney on the south end of a house owned by the Mobile and Ohio Railroad Company, standing a short distance north of the railroad station, on the west side of track. The brick is the second one from the southeast corner of the chimney, in the sixth course above the foundation, on the side fronting the railroad track.

Z.—At *Bethel Springs*, *McNairy County*, *Tenn.* The surface inclosed between two file marks, about 1 inch apart, on one of the raised portions of the corrugated iron door sill of Stovall, Epps & Hendrix Co.'s brick storehouse. The mark is 5½ inches from the front edge of the sill and 5½ inches from the wall forming the south side of the building.

No. XXVII.—At *McNairy*, *McNairy County*, *Tenn.* The bottom of a square cut in the rock foundation of the chimney at the south end of E. W. Sheffield's house, near the southeast corner of the chimney. The house is on the west of and fronts the railroad, about one-fourth mile south of the station.

No. XXVI.—At *Henderson*, *Chester County*, *Tenn.* The center of a cross in end of a brass bolt leaded horizontally into a brick in the south wall of J. F. Hamlett's storehouse. The house is west and a short distance north of the railroad station, facing the railroad track. The brick is in the fifth course above the ground, and is the sixth one from the southwest corner of the building.

No. XXV.—At *Pinson*, *Madison County*, *Tenn.* The center of a cross in end of a brass bolt leaded horizontally into a brick in the front of M. M. Robin's store. The house is west and a short distance north of the railroad station, facing the track. The brick is in the eleventh course above the sidewalk, and is the second one from the northeast corner of the building.

No. XXIV.—About 2½ miles south of *Jackson, Tenn.* The bottom of a square cut in the stone coping of the brick pier at the north end of the Mobile and Ohio Railroad bridge over Forked Deer River. The mark is west of the track near the lower chord of bridge, and about 13 inches from the north edge of stone.

No. XXIII.—At *Jackson, Tenn.* The bottom of a square cut in the capstone of the retaining wall in front of one of the basement windows of the Federal Building, corner of Market and Baltimore streets. The window is just north of the Market-street entrance. The stone is marked thus:

U S
□
B M

No. XXII.—At *Jackson, Tenn.* The bottom of a square cut in the capstone of the brick pier at the west end of the Illinois Central Railroad bridge over Market street. It is south of the track, and lettered the same as No. XXIII.

No. XXI.—At *Oakfield, Madison County, Tenn.* The bottom of a square cut in a limestone block in the southwest corner of the front yard of R. Daniel's house, which stands just north of the store and post office. (See note 3, page 549.)

No. XX.—At *Medina, Gibson County, Tenn.* A square cut in a limestone block in the northwest corner of W. A. House's front yard. (See note 3, page 549.)

No. XIX.—At *Milan, Gibson County, Tenn.* A square cut in a limestone block in the front yard of Dr. M. D. L. Gordon's house, on Main street, near the public school. The stone is north of the house, near the back fence. (See note 3, page 549.)

No. XVIII.—At *Milan, Tenn.* The center of a cross in the end of a brass bolt leaded horizontally into a brick, in the north wall of the building on the southwest corner of Front and Main streets. The brick is in the seventh course above the pavement, and is the sixth one east of the second doorway from the west end of the building.

No. XVII.—At *Bradford, Gibson County, Tenn.* A square cut in a granite block set in the southwest corner of the front yard of J. T. Cain's house, which stands southeast of the railroad station, fronting on the track. (See note 3, page 549.)

No. XV.—At *Greenfield, Tenn.* A small hole in a brass bolt leaded horizontally into a brick in the front wall of Darling Jones's storehouse. The brick is in the eighth course above the pavement, and is the third one from the northwest corner of the building.

No. XIV.—At *Sharon, Weakly County, Tenn.* The center of a cross cut in a brass bolt leaded horizontally into a brick in the chimney at the north end of Lloyd Dodd's house. The brick is in the twenty-fourth course above the ground, near the middle of the chimney. The mark is roughly lettered thus:

U S
⊙
B M

No. XIII.—At *Martin, Weakly County, Tenn.* A small hole in a brass bolt leaded horizontally into a brick in the west side of the bank building owned by J. R. Lovelace.

The brick is in the tenth course above the ground, and is the fourth one from the northwest corner.

No. XII.—At *McConnell, Obion County, Tenn.* A square cut in a limestone block set in the northeast corner of the yard of W. B. Smith, agent for the Illinois Central Railroad. (See note 3, page 549.)

No. XI.—At *Fulton, Fulton County, Ky.* A hole in a brass bolt leaded horizontally into a brick in the east wall of E. C. Reed's livery stable. The brick is in the nineteenth course from the ground, and is the fifteenth one from the northeast corner of the stable. It is lettered the same as No. XIV.

No. X.—At *Alexander, Fulton County, Ky.* A square cut in a limestone block set near the northwest corner of J. M. Cashon's frame house, on the east side of the railroad track, near the station. (See note 3, page 549.)

No. IX.—At *Clinton, Hickman County, Ky.* The bottom of a square cut in the stone doorsill at the south entrance of the courthouse. It is lettered thus:

U S
□
B M

No. VIII.—At *Arlington, Carlisle County, Ky.* A square cut in a limestone block set in the southwest corner of the back yard of Thomas G. Edward's house, near the railroad station. (See note 3, page 549.)

No. VII.—At *Bardwell, Carlisle County, Ky.* The bottom of a square cut in the south end of the stone doorsill at the west entrance to the courthouse. It is marked the same as No. IX.

No. VI.—On the Illinois Central Railroad bridge over *Mayfield Creek*, which is the boundary between Ballard and Carlisle counties, *Ky.* The bottom of a square cut on the stone coping of the brick pier on the north bank of creek. It is west of the track, just outside of the bridge, and lettered the same as No. IX.

No. V.—At *Fort Jefferson, Ballard County, Ky.* A square cut in a limestone block set in the northeast corner of J. M. Vance's yard, across the street from J. C. Depoyster's store. (See note 3, page 549.)

No. IV.—At *Wickliffe, Ballard County, Ky.* A square cut in a limestone block set near the northwest corner of the Elliott House, close to the brick wall on the street. (See note 3, page 549.)

No. III.—At *East Cairo, Ballard County, Ky.* The bottom of a square cut in a limestone block set in the top of the levee protecting the Mobile and Ohio Railroad yard, just back of the yardmaster's office. The block is 6 inches square, projects 2 inches from the ground, and is lettered thus:

U S
C □ S
B M

P. B. M. 3.—At *Cairo, Ill.* Established by the United States Engineers and described by the Mississippi River Commission as follows: "Is hole in copper bolt set in southeast end of Illinois Central Railroad freight depot, at junction of Fourteenth street and Ohio River. It is 0·49 metre southwest of the east corner and is marked with the letters U. S. B. M. cut in stone near bolt." When visited in 1888, some of the lead had been picked from around the bolt, but the bolt was still firm. The arches of the building were cracked, as if it had settled.

P. B. M. 2.—At *Cairo, Ill.* Established by the United States Engineers and described by the Mississippi River Commission as follows: "Is hole in copper bolt set horizontally in east side of building containing offices of the trustees of Cairo city public property. It is 4·44 metres from southeast corner and 1·12 metres below lower surface of water table. Marked with the letters U. S. B. M. cut in stone near bolt. The building fronts on Washington avenue, and is between Eighteenth and Nineteenth streets." The mark was found undisturbed in 1888.

P. B. M. 1.—At *Cairo, Ill.* Established by the United States Engineers and described by the Mississippi River Commission as follows: "Is small hole in center of copper bolt set horizontally in northwest side of custom-house. It is 7·18 metres from northwest corner and 0·37 metre below the junction of the sandstone and limestone, and 0·93 metre above surface of cement walk. Marked with the letters U. S. B. M. cut in stone near bolt. The custom-house is in the square bounded by Fourteenth and Fifteenth and Poplar streets and Washington avenue." It was found undisturbed in 1888.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN CAIRO AND ODIN, ILL.

No. II.—On one of the abutments of the Illinois Central Railroad bridge over Cash Creek, near *Mound City Junction, Ill.* The bottom of a square cut in the abutment at the south bank of the creek, on the east side of the track, and marked thus:

U S
□
B M

No. I.—At *Mound City Junction, Alexander County, Ill.* A square cut in a limestone block set in the yard of the Illinois Central Railroad section house. It is near the front fence just north of the gate, near lone tree. (See note 3, page 549).

Z_3.—At *Villa Ridge, Pulaski County, Ill.* The center of a brass bolt leaded horizontally into a brick in the chimney at the east end of the Stoddard House. The brick is in the twenty-second course above the ground and is the fifth one from the south end of chimney.

Y_3.—At *Villa Ridge, Ill.* Top of a railroad spike driven in the root on the east side of a large beech tree which stands east of the railroad track and nearly opposite the 12-mile post. It is lettered thus:

(U. S. B. M.
"Y")

No. XII_a.—South of the 14-mile post on the Illinois Central Railroad. The bottom of a square cut near the center of south abutment of small railroad bridge No. 8. It is near *Villa Ridge, Ill.*

No. 139.—About 523 metres south of the 17-mile post on the Illinois Central Railroad. The bottom of a square cut in the capstone of the middle pier of small railroad bridge No. 12. It is east of the track and is marked thus:

(□)

X_3.—Near *Ullin Station*, *Pulaski County*, *Ill.* The bottom of a square cut on the northeast corner of the north abutment of bridge No. 15, over the Cache River. It is marked thus:

U S
□
B M

W_3.—At *Anna*, *Union County*, *Ill.* The bottom of a square cut in the stone sill of window on southwest front of Otrich's drug store, under the Otrich House. It is about 0·10 metre from west end of iron jamb and 0.06 metre from south edge of sill. It is marked thus:

(□)

V_3.—About 1 mile north of *Makanda*, *Jackson County*, *Ill.*, and 50 metres south of the 50-mile post on the Illinois Central Railroad. The bottom of a square cut in the southeast capstone of south abutment of iron bridge No. 87, over Drury Creek. It is marked thus:

(□)

T_3.—At *Carbondale*, *Jackson County*, *Ill.* The bottom of a square cut in the stone sill under the east front window of Jacob Beard's brick store. The store is on the west side of the railroad track at the north end of public park. The cavity is marked thus:

(□)

U_3.—In *Jackson County*, *Ill.*, about 2 miles south of *De Soto*. The bottom of a square cut in the west end of the south abutment of Illinois Central Railroad bridge over Big Muddy Creek. It is about 1 metre west of track and 0·3 metre from north edge of abutment, and is marked thus:

(□)

R_3.—At *Duquoin*, *Perry County*, *Ill.* The bottom of a square cut in corner of the stone sill at the main door of the Duquoin Bank building, opposite the Illinois Central Railroad depot. The cavity is marked thus:

(□)

S_3.—About 2 miles south of *Radom* Station, *Washington County*, *Ill.* The bottom of a square cut in the northeast corner of the north abutment of the stone-arch bridge over Little Muddy Creek on the Illinois Central Railroad. It is marked thus:

(□)

Q_3.—Near *Ashley*, *Washington County*, *Ill.* The bottom of a square cut in the capstone of the southeast wing wall of small culvert, No. 212, on the Illinois Central Railroad, about 175 metres south of the 99-mile post. The cavity is about 2 metres east of the track, and is marked thus:

(□)

P_3.—About 1 mile north of *Richview* Station, *Washington County*, *Ill.* The bottom of a square cut in the southeast corner of the capstone on the east end of a stone culvert on the Illinois Central Railroad, 409 metres south of the 103-mile post. The cavity is marked thus:

(□)

N_3.—At *Centralia*, *Marion County*, *Ill.* The bottom of a square cut in the stone sill of the south window of J. J. Pfaff & Co.'s drug store, marked thus:

(□)

O_3.—About 2 miles north of *Centralia*, *Ill.* The bottom of a square cut in the capstone at the east end of the north abutment of the Illinois Central Railroad bridge over Crooked Creek. The cut is about 3 metres from the iron footplate of bridge, and is marked thus:

(□)

M_3.—At *Odin*, *Marion County*, *Ill.* The bottom of a square cavity cut in a stone in the top layer of the foundation, at the southeast corner of Craig's brick store. It is about 1 foot above the ground, and is marked thus:

(□)

No. V.—*Odin*, *Ill.* (See page 566.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN BILOXI, MISS., AND CARROLLTON, LA.

I_1, or M. R. C. P. B. M. 18.—*Biloxi*, *Miss.* (See page 591.)

J_1, or P. B. M. 17.—At *Beauvoir* Station, *Miss.*, on the Louisville and Nashville Railroad. The bench mark is the top of a copper bolt leaded vertically into the top of the marking stone, set in the ground near the west end of the depot platform and 11 metres south of center of track. The letters U. S. are cut upon the top of the stone.

K_1, or P. B. M. 16.—At *Mississippi City*, *Harrison County*, *Miss.*, in the west wall of the county jail. The bench mark is the center of a copper bolt leaded horizontally into the center of the fifth brick of the fifteenth course above the water table. The bricks are counted from the northwest corner of the building. The letters U. S. are cut over and B. M. under the bolt.

L_1, or P. B. M. 15.—About 552 metres west of the New Orleans 66-mile post and 24 metres north of the center of track of the Louisville and Nashville Railroad. The bench mark is the top of the marking stone, set in the ground, and which has the letters U. S. cut upon the top. Three pine trees, each marked with 5 blazes, are near the stone.

M_1, or P. B. M. 14.—One hundred and ninety-one metres east of the New Orleans 62-mile post and 8 metres north of the center of track of the Louisville and Nashville Railroad, *Mississippi*. The bench mark is the top of head of copper bolt leaded vertically in top of marking stone, set in the ground, with the letters U. S. cut upon the top.

N_1, or P. B. M. 13.—At *Pass Christian* Station, on the Louisville and Nashville Railroad, *Mississippi*. The bench mark is the top of head of copper bolt leaded in top of marking stone, set in the ground between the pump house and water tank. It is a little inside of the north line of pump house and tank and about 3 metres from west side of pump house. The pump house is about 9 metres south of track. The letters U. S. are cut upon the top of the stone.

O_1, or P. B. M. 12.—At *Hendersons Point*, *Miss.* The bench mark is the top of head of copper bolt, leaded in the top of marking stone set in the ground within the northwest corner of fence surrounding plot of ground on which the tool house of Louisville and Nashville Railroad, section No. 9, is situated. The stone is about 32 metres west of west side of house and 8 metres south of center of track. The letters U. S. are cut upon the top of the stone.

P_1, or P. B. M. 11.—At *Bay St. Louis, Miss.* The bench mark is the top of head of copper bolt leaded in the top of marking stone set in the ground by the northeast corner of fence surrounding southwest plot of land at the intersection of the Louisville and Nashville Railroad track and Front street. It is 12 metres south of center of track and about 51 metres west of west end of bridge over Bay St. Louis. The letters U. S. are cut upon the top of the stone.

Q_1, or P. B. M. 10.—At *Bay St. Louis, Miss.* The bench mark is the center of head of copper bolt leaded horizontally into the face of the southern brick wall of the vestibule of the Catholic Church, about halfway between side entrance of vestibule and main front wall and about 1 metre above the ground.

R_1, or P. B. M. 9.—At *Waveland* Station, *Miss.*, on the Louisville and Nashville Railroad. The bench mark is the top of marking stone set within the southeast corner of fence surrounding the land of Henderson Winfield. The corner is at the intersection of Waveland road and lane between the lands of Mr. Shaw and Mr. Winfield. The stone is about 32 metres south of the southeast corner of station house, and has the letters U. S. cut upon the top.

S_1, or P. B. M. 8.—At *Toulmé* Station, Louisville and Nashville Railroad, *Mississippi*. The bench mark is the top of the marking stone set in the ground in the northwest corner of the front yard in which the section house is situated. The stone is about 10 metres south of center of main track and has the letters U. S. cut upon the top.

T_1, or P. B. M. 7.—Near *Claiborne* Station, Louisville and Nashville Railroad, *Mississippi*. The bench mark is the center of small cross cut in top of marking stone set in the ground just north of north fence of house lot of Pat. Terril. It is 18 metres south of center of main track, 12 metres east of east end of station house, the distance of 12 metres being measured parallel to the railroad track. The letters U. S. are cut upon the top of the stone.

U_1, or P. B. M. 6.—On the high point of ground, just east of *East Pearl River, Miss.*, by the fence in front of land of Mrs. Sarah Selph, 200 metres east of the eastern pier of the iron truss bridge over the East Pearl River, on the Louisville and Nashville Railroad, and 27·2 metres south of center of main railroad track. The bench mark is the top of a copper bolt leaded in the top of the marking stone, set to within 0·25 foot of its top in the highest point of ground. The stone has the date 1882, and the letters P. B. M. cut upon the top.

V_1, or P. B. M. 5.—The top of a copper bolt leaded vertically in the concrete pier projecting above main pier of old drawbridge and a little southwest of center of pier, just north of the iron truss bridge over the *Rigolets* on the Louisville and Nashville Railroad, *Louisiana*. The bolt has the letters U. S. P. B. M. cut around it.

W_1, or P. B. M. 4.—On *Fort Macomb, Chef Menteur, La.* The bench mark is the center of head of copper bolt leaded horizontally in a brick in the wall at the right-hand side of the entrance to the fort, and has cut around it the letters and date

U S
18 ⊙ 82
P B M

X_1, or P. B. M. 3.—At the Gentilly gate on the east side of the fair grounds at *New Orleans, La.* The bench mark is the center of head of a copper bolt leaded horizontally in the east face of the middle brick gatepost, in the fifth course of bricks above the ground, and is marked with the letters U ⊙ S

Y_1, or P. B. M. 2.—At drawbridge across Bayou St. John, on the Esplanade road, *New Orleans, La.* The bench mark is the center of head of copper bolt leaded horizontally into the middle brick in the eleventh course above the ground in the northwest face of the south one of two abutments at the northwest end of drawbridge, and is marked with the letters

U S
P B M

Z_1, or P. B. M. 1.—At the white bridge crossing the new canal, on the Carrollton road, near *New Orleans, La.* The bench mark is the top of a copper bolt leaded vertically in the top of the northwest portion of drawpier of bridge. It measures 0·90 metre to the extreme northwest edge of pier from center of bench mark and 0·5155 metre to edge of iron track that the bridge turns on. It is marked the same as Y_1.

P. B. M. Carrollton.—At *Carrollton, La.*, on north face of masonry of northwest corner pillar of old courthouse, in the middle, about 0.03 foot from water table of pillar, and about 2.5 feet above ground, being the center of a small hole in the center of a copper bolt leaded horizontally. The letters U S P B M are cut near the bolt.

No. I.—On the seventh district Babcock engine house at *Carrollton, La.* The engine house is at the corner of Madison and St. Charles streets. The bench mark is the center of a small cross cut on the west end of iron doorsill of walled-up door near the northwest corner of the engine house; it is 0·124 metre to extreme west edge of sill, and 0·185 metre to north door jamb. The engine house is adjoining the New Orleans and Carrollton Railroad depot. It is lettered thus:

U S C S
B×M
1875

Old Hampson (Williams).—At *Carrollton, La.*, near corner of Madison street and River road. The bench mark is a spike driven in the wall of blacksmith shop of Carrollton and New Orleans Railroad, at northwest corner of shop. The spike is now about 6 inches below the surface of the ground, between the nineteenth and twentieth courses of bricks below the window sill, and reported loose in 1880.

New Hampson (Howell).—At *Carrollton, La.*, near corner of Madison street and River road. The bench mark is a spike driven in the wall of blacksmith shop of Carrollton and New Orleans Railroad, at northwest corner of shop. The spike is between the twenty-first and twenty-second courses of bricks below the window sill.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN CARROLLTON AND SMITHLAND, LA.

No. I.—At *Carrollton, Jefferson Parish, La.* (See above.)

Old Hampson (Williams).—*Carrollton, La.* (See above.)

No. II.—At Twelve Mile Point, 5 miles above *Carrollton, La.* A cement post (formed by boring a hole in the ground and filling with cement) in front of Mr. Soniat's house on Carrollton road, about 25 paces south of the gateway.

The bench is the bottom of a slight depression in the surface of the cement, and is marked thus:

U S
B □ M
1880

No. III.—At *Kennerville, Jefferson Parish, La.* The bottom of a square depression in the top of a granite block buried in the yard of Dr. Gustine about 26 metres south of the house, near a date-palm tree. It is marked thus:

U S
B M

No. IV.—On Longue's Plantation, St. Charles Parish, about 4 miles above *Kennerville.* The head of an iron bolt (about 4 inches long) embedded in a cement post sunk in the levee, nearly in front of Noibert Longue's house. The post is placed between two large oaks, the second and third from the road on the eastern side of the avenue leading to the river.

No. V.—On *Destréhan Plantation, St. Charles Parish, La.* The stone sill of the footway on the western side of the main entrance, the particular spot being indicated by a groove and the letters U. S. B. M. The plantation belongs to Judge Post.

No. VI.—On *Prospect Plantation, St. Charles Parish, La.* The upper surface of the square pedestal of the pillar on the eastern side of the front steps of Mr. Sarpy's house. The pedestal is of brick, covered with hard stucco. The bench is the square spot surrounded by a groove and marked U. S. B. M., 1880. The plantation is owned by Leon Sarpy, and is nearly opposite *Hahnville.*

No. VII.—On the estate of Mr. Ambruster, St. Charles Parish, La. The head of an iron bolt in a cement post at the foot of a large pecan tree in front of the house. The hole above the bench was filled with fragments of brick and covered with earth. The place is about a half mile below the Gypsy Plantation, owned by Mr. Labranche, which is at the bend of the river below *Bonnet Carré* Crevasse.

No. VIII.—Near *Bonnet Carré* post-office, *St. John the Baptist Parish, La.* The head of a long iron bolt embedded in a cement post in the yard of Mr. Adam Lasseigne, just above the post office.

No. IX.—On Terre Haute Plantation, St. John the Baptist Parish, La. The upper (horizontal) edge of a triangular groove cut in the brick wall of the plantation store, on the west side and at the southwest corner. It is marked U. S. B. M., 1880, No. IX. The plantation is just above the settlement at *Bonnet Carré* and belongs to Mr. James W. Godberry.

No. X.—On *Mount Airy Plantation, St. John the Baptist Parish, La.* The upper surface of the granite sill at the foot of the iron stairway in front of the house. The particular spot is surrounded by a groove and marked U. S. B. M., 1880. Plantation extends to the boundary of St. James Parish and belongs to Mr. Joseph Lebourgeois.

No. XI.—On *Belle Alliance Plantation, St. James Parish, La.* The upper edge of the groove or triangle cut in the west side of a small brick pier supporting the southwest corner of a wooden warehouse, which stands upon the levee nearly in front of the house. It is designated U. S. B. M., 1880—XI. Plantation belongs to Mr. Wallis.

No. XII.—On *Belmont Plantation, St. James Parish, La.* The bottom of a square cut in the corner of the cement pedestal of the column at the southwest corner of the house, and designated U.S.B.M. House and plantation belong to Mr. Louis Lebourgeois.

No. XIII.—At College Point, just below *St. Michaeltown*, *St. James Parish*, *La.* A horizontal line cut in the iron post on the south side of the Jefferson College front gateway. Designated XIII—U.S.B.M., 1880, the bench being the line just above the letters B.M.

No. XIV.—At the *Convent of the Sacred Heart*, *St. James Parish*, *La.* The bottom of a shallow square cut in the granite step of the most southern door on the west side of the convent, marked U. S. B.M.

No. XV.—On Mr. Colomb's house, *St. James Parish*, *La.* The upper surface of the stone pedestal of the first pillar on the right-hand side as you ascend the steps to the piazza. The particular spot is surrounded by a groove and designated U.S. B. M.—XV.

No. XVI.—On Mrs. Hagan's house, 6 miles below *Donaldsonville*, *St. James Parish*, *La.* The surface of a limestone slab on the left-hand side as you ascend the piazza steps. Particular spot marked by a groove and the letters U. S. B. M.

No. XVII.—Near Mr Heath's house, about a mile above *Donaldsonville*, *Ascension Parish*, *La.* A granite post buried in the yard, near large pecan tree.

No. XVIII.—At Mr. V. P. Mirre's house, *Ascension Parish*, *La.* A granite post with cement around it buried in the front yard. Place is about 4 miles above *Donaldsonville* and formerly belonged to Mr. E. Dicharry.

No. XIX.—On *Ashland Plantation*, *Ascension Parish*, *La.* A cross cut on the head of an iron bolt in the north end of the brick warehouse at *Ashland Landing*. The bolt is carried entirely through the wall, has a nut screwed on the inner end, is 4.8 feet above the ground, and in the middle of the wall. Designated U. S. B. M., 1880—XIX.

No. XX.—On *Southwood Plantation* (formerly called "Hard Times"), situated at the extreme upper end of *Ascension Parish*, *La.* A point on the upper surface of the projecting brick foundation running around the house. A square opening was cut through the stucco covering, and the bench is the surface of the brick. Marked U. S. B. M.—1880.

No. XXI.—On *Indian Camp Plantation*, *Iberville Parish*, *La.* A granite post placed near the house in the angle formed by the central portion of the house and a wing. Plantation belongs to Mrs. Buddington.

No. XXII.—On Leach, Seaward & Thompson Plantation, about a mile above *Bayou Goula*, *Iberville Parish*, *La.* A granite post sunk in the ground near the oak tree by the house, which is a low, frame building.

No. XXIII.—At *St. Gabriel*, *Iberville Parish*, *La.* A granite post in the front yard of Julian Grassin, next to St. Gabriel's Church. Plantation formerly belonged to Dr. Pritchard, and is 4 or 5 miles above Bayou Goula.

No. XXIV.—On *Anger's Plantation*, *Iberville Parish*, *La.* A granite post near the corner of the yard of Mr. Daigre, the overseer. His house is the second one below the *Forlorn Hope* post office, and just above the bend in the road.

No. XXV.—On Anger's Plantation, 5 miles above *Plaquemine*, *Iberville Parish*, *La.* A granite post in the northeast corner of the yard of Mr. Walter Humble, on the plantation. The house is a short distance west of the road which runs across the point to Forlorn Hope post office.

No. XXVI.—On Hollywood Plantation, *East Baton Rouge Parish*, *La.* A granite post, 8 metres from the fence at the side of the road and on the line of a row of old fig trees, 23 metres east of the house. Plantation belongs to Mr. H. Vonpuhl, is 12 miles below Baton Rouge, and a half mile above *Manchac* post office.

No. XXVII.—On *Cottage Plantation*, *East Baton Rouge Parish*, *La.* A granite post buried close to the front gate of the inner yard of Mr. Conrad's house. Plantation is on the point 8 miles below Baton Rouge and belongs to Mr. Conrad.

No. XXVIII.—On Arlington Plantation, *East Baton Rouge Parish*, *La.* A granite post placed in the front yard, close to an old brick pier or horse block near the house. Plantation belongs to Mr. Shannon, and is 4 miles below *Baton Rouge*.

No. XXIX.—At South Base, East Baton Rouge Parish, *La.* A point surrounded by a shallow groove, upon the top of the limestone monument at the south end of the Coast Survey base line, just below *Baton Rouge*.

No. XXX.—At North Base, East Baton Rouge Parish, La. The surface of the limestone monument at the north end of the *Baton Rouge* Base.

No. XXXI.—On State House, *Baton Rouge*, *La.* A bench mark of the United States Engineers. The edge of one of the foundation courses of the tower on the north side of the western entrance to the building. It is marked U. S. E.

No. XXXII.—On Mr. J. H. Gay's plantation, West Baton Rouge Parish, La. A granite post buried in the flower garden in front of the house. Plantation is directly opposite the city of *Baton Rouge* and just below the ferry landing.

No. XXXIII.—On *Belmont Plantation*, *West Baton Rouge Parish*, *La.* A granite post buried in front of the pillar at the northwest corner of the house. Plantation belongs to Mr. A. Guesnard.

No. XXXIV.—Near *Grossman's Landing*, *West Baton Rouge Parish*, *La.* A granite post in front of house of Mr. W. B. Chamberlain, jr. House is located about a half mile above Lobdell's store, at Grossman's Landing.

No. XXXV.—At the Kelson Store, opposite the upper part of *Profit Island*, *West Baton Rouge Parish*, *La.* A granite post placed in the back corner of the inclosure around the store. Store belongs to Capt. J. J. Brown and land (with exception of store lot) to S. Stirling, of West Feliciana Parish.

No. XXXVI.—On Sans Souci Plantation, near *Hermitage Landing*, *West Baton Rouge Parish*, *La.* A granite post placed in front of the house of Mr. C. Devall. House fronts on a bayou, the remains of the old river channel, and is on the road leading directly back from the landing.

No. XXXVII.—At *Waterloo*, *Pointe Coupee Parish*, *La.* The upper edge of a mark cut on the front of the St. Claude store, and marked U. S. B. M., 1880. Store is of brick, and belongs to a Mr. Robin.

No. XXXVIII.—At South Base, *Pointe Coupee Parish*, *La.* The top of the copper bolt in the limestone monument at the south or lower end of the Coast Survey base-line, which is nearly opposite Bayou Sara.

No. XXXIX.—At North Base, *Pointe Coupee Parish*, *La.* The top of copper bolt in limestone monument at north or upper end of above base.

No. XL.—On Poydras Plantation, *Pointe Coupee Parish*, *La.* A granite post placed on the left-hand side as you ascend the front steps of the house. Place belongs to Colonel Claiborne, and is about a half mile above the new road leading to the courthouse at False River. This part of the parish is known as "*Pointe Coupee Settlement.*"

No. XLI.—On *Morrison Plantation*, *Pointe Coupee Parish*, *La.* A granite post placed beside the front steps (on the left hand as you ascend) of the house. Plantation belongs to Mr. Morrison's heirs, and is just below the McRae place.

No. XLII.—At *Morganzia*, *Pointe Coupee Parish*, *La.* A granite post, 3 inches below the surface at the junction of the Grand Levee, and a diagonal branch levee running toward the Government light at Morganzia Landing. The spot is about half a mile below the hamlet called Morganzia.

No. XLIII.—At *Raccourci Landing*, *Pointe Coupee Parish*, *La.* A granite post in front of the house on Mr. Edward Lacour's premises.

No. XLIV.—On *Bella Vista Plantation*, on Old River, *Pointe Coupee Parish*, *La.* A granite post on the left hand as you ascend the front steps of the house. Plantation belongs to Dr. A. A. Batchelor.

No. XLV.—Near *Smithland* post office, at Hog Point Landing, *Pointe Coupee Parish*, *La.* A granite post placed in Mr. Archie Smith's yard near the landing.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN SMITHLAND AND BIELAS LANDING, LA., OPPOSITE RODNEY, MISS.

No. XLVI.—On *Angola Plantation*, *West Feliciana Parish*, *La.* On the top of the circular wall forming the mouth of a cistern, just back of the house. The bench is the upper surface of the brick exposed by cutting a square aperture through the cement. Marked U. S. B. M. Plantation is nearly opposite the mouth of Red River.

No. XLVII.—On *Tarbert Plantation*, *Wilkinson County*, *Miss.* A granite post placed close to the back fence of the yard and by a small building. Plantation is owned by Mr. Jenkins, of Natchez, Miss., and lies between Angola and Langside plantations, extending beyond the State line.

No. XLVIII.—At *Clarksville Landing*, *Wilkinson County*, *Miss.* A granite post buried at the southeast corner of Lehman & Lauenburgh's store, back of an old cotton gin, a short distance above the landing.

No. XLIX.—At *Fort Adams*, *Wilkinson County*, *Miss.* A granite post buried at the southwest corner of Mr. J. R. Mathew's house. The house is just above the "corners" at the upper end of the village.

No. L.—At southwest base, *Lums Point*, *Concordia Parish*, *La.* The top of the copper bolt in the stone post (10" x 10" on top), marking the southwest end of Lum's Point Coast Survey base line. Situated on the place owned by Mr. Lum, of Vicksburg, and nearly opposite Fort Adams, Miss.

No. LI.—At northeast base, *Lums Point*, *Concordia Parish*, *La.* The top of a copper bolt in the stone post marking the northeast end of above base. Situated on the Point Breeze Plantation, owned by Mr. Trager.

No. LII.—On *Ballamagan Plantation*, *Concordia Parish*, *La.* A cut in the brick top of the cistern, near the engine house and about 500 metres south of Mr. E. Pullen's (the lessee) son's residence. This cistern is on the right of the road leading from Point Breeze to Black Hawk, about 3 miles from the latter place. The bench mark is marked U. S. B. M. □ *LII.*

No. LIII.—At *Black Hawk* Post Office, *La.* A granite post on the right of the steps leading to the entrance on the east front of Mr. Ed. Pullen's residence. (See note 9, page 550.)

No. LIV.—On Ashland Plantation, near *Bougére* Post Office, *La.* A granite post on the left of the steps leading to the front entrance of Mr. W. G. Walton's residence. (See note 9, page 550.)

No. LV.—On Brabston Plantation, near *Fairview* Post Office, *La.* A white marble post on the right of the steps leading to the front entrance of the residence owned by Mr. W. G. Walton. (See note 9, page 550.)

No. LVI.—About 3½ miles below B. M. LVII. The center of the top of a 6 by 6 inch marble block (a triangulation stone), marked on side facing river U. S. C. & G. S.

No. LVII.—On *Deer Park Plantation, Concordia Parish, La.*, about 24 miles (by river) below Vidalia. A marble post on the right of the steps leading to the front entrance of the agent's (Mr. James Pipes in 1880) house. This house is about one-fourth mile back from the river bank and just to the southward of the main road leading to Vidalia. (See note 9, page 550.)

No. LVIII.—On *Ashley Plantation, Concordia Parish, La.*, about 2 miles below Morville Landing. A granite post marking the station "Ashley" in Assistant Boyd's triangulation 1879-80. It is situated near the river bank close to an old cistern, and is marked U. S. C. & G. S. The center of the top of the post is the bench.*

No. LIX.—On *Moro Plantation, Concordia Parish, La.* Center of top of granite post marking the station "Moro" in Assistant Boyd's triangulation. It is situated about a mile above Morville Landing and about half a mile below Mr. A. Crother's (owner of plantation) residence. Marked U. S. C. & G. S.

No. LX.—On *Moro Plantation, Concordia Parish La.* A marble post on the right of the steps leading to the front entrance of Mr. A. Crother's house. (See note 9, page 550.)

No. LXI.—About a mile below *Vidalia, Concordia Parish, La.* The intersection of the cross lines on the top of an iron screw pile used as a triangulation station. It is situated in an open field near the road to Vidalia, on the right-hand side, and marked U. S. C. S. G. P.—1875.†

No. LXII.—At *Vidalia, La.* A marble post on the right of the steps leading to the front entrance of Judge W. H. Hough's residence. (See note 9, page 550.)

No. LXIII.—At east base, near *Vidalia* courthouse. The center of cross on bolt in granite monument, 14 by 14 inches on top, projecting about 14 inches above the ground, situated in the lot immediately back of the courthouse and jail and marking the east end of the Vidalia base. Lot is owned by Mr. J. Conti, of Natchez, Miss., and stone is marked U. S. C. S.—1878.

No. LXIV.—At *Palo Alto, Concordia Parish, La.*, about a mile north of *Vidalia.* The center of cross on top of iron screw pile marking Boyd's triangulation station, Palo Alto. On the property of Mrs. Kate Minor, of Natchez, on the left of the road from Vidalia about 250 metres. Marked U. S. C. S. G. P.—1875.†

*Assistant Boyd in describing this station states that water was found 3 feet under surface and the post was supported by chips, bricks, etc.

†This is probably the date when the castings were *made*, as they were *set* in 1879. G. P. stands for Geodetic Point.

No. LXV.—In levee, about 4½ miles above *Vidalia, La.* A square cut in marble post set in levee near old brick wall. (See note 10, page 550.)

No. LXVI.—On *Bullits Bayou Plantation, Concordia Parish, La.* A square cut in top of marble post set on right of steps leading to the front entrance of Mr. E. W. Wall's residence at Bullits Bayou Landing, next to the plantation store. (See note 10, page 550.)

No. LXVII.—At *Gibsons Landing, Concordia Parish, La.* A square cut in marble post set at the northeast corner of Stanton & Brandon's store. (See note 10, page 550.)

No. LXVIII.—On Agnasco (Morland estate) Plantation, about half a mile below *L'Argent Landing.* A cross cut on top of cistern about 51 metres southwest of Mrs. Moreland's house. Marked U. S. B. M.

No. LXIX.—At Duncan, a triangulation point about half a mile above *L'Argent, Tensas Parish, La.* The head of copper tack in 4 by 4 inch post marking the above triangulation point. Is on S. B. Duncan's plantation, near the end of old levee and about 300 metres from the junction of the old and new levees.

No. LXX.—About 3 miles below *Waterproof, Tensas Parish, La.* A cross on top of cistern about 50 metres from the main levee between L'Argent and Waterproof and 190 metres from junction of old and new levees. Marked U. S. B. M.—1881.

No. LXXI.—At *Waterproof, La.* A square cut in marble post on the left of steps leading to the front entrance of Mr. A. P. Martin's residence. (See note 10, page 550.)

No. LXXII.—At *Kemps Landing, Tensas Parish, La.* A square cut in marble post on the right of steps leading to the front entrance of Mr. W. H. Goldman's residence. (See note 10, page 550.)

No. LXXIII, or No. 297.—On *Villa Clara Plantation, Tensas Parish, La.*, opposite Rodney, Miss. A square cut in marble post on the left of steps leading to the front entrance of Capt. E. L. Whitney's residence. Bielas Landing is on Villa Clara Plantation, and Captain Whitney's residence is about one-half mile distant from it and about 6 miles below St. Joseph. (See note 10, page 550.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN BIELAS LANDING, LA., OPPOSITE RODNEY, MISS., AND MILLIKENS BEND, LA.

LXXIII or 297.—*Villa Clara Plantation, La.* (See above.)

No. 291.—On *Duck Pond Plantation, Tensas Parish, La.* The center of head of copper bolt leaded horizontally in north face of brick chimney of ginhouse. Is in the seventh course below the projecting course and fifth brick from northeast edge of chimney.

No. 286.—On *Panola Plantation, Tensas Parish, La.* The center of head of copper bolt in brick chimney of ginhouse. Is in the twenty-third course from ground and fourth brick from northeast corner.

No. 280.—On *Waveland Plantation, Tensas Parish, La.* The center of head of copper bolt in southeast face of brick chimney of ginhouse. Is in the middle brick of tenth course from foundation.

No. 272.—On *Hard Times Plantation, Tensas Parish, La.* The top of copper bolt embedded vertically in a block of cement 8 inches in diameter, set about 50 metres south of the bank of Lake St. Joseph, near a cabin.

No. 262.—On *Riverside Plantation*, *Tensas Parish*, *La.* The center of head of copper bolt in middle brick of twelfth course from foundation, in south face of east chimney of dwelling on plantation.

No. 258.—On *Point Pleasant Plantation*, *Tensas Parish*, *La.* The center of head of copper bolt in brick 4 feet from the ground and in middle of north face of north chimney of dwelling.

No. 246.—On *Sargents Point Plantation*, *Madison Parish*, *La.* The top of copper bolt embedded in a block of cement 8 inches in diameter, set near cabins surrounded by water oaks and pecans, about 600 metres from channel of river.

No. 243.—At *Kelloggs Landing*, *Madison Parish*, *La.* The center of head of copper bolt in brick 15 inches from ground and in middle of south face of southeast chimney of Kellogg's post office building.

No. 232.—On *Crystal Springs Plantation*, *Madison Parish*, *La.* The center of head of copper bolt in brick of twelfth course from ground and second one from southeast edge of east chimney of dwelling.

No. 225.—On *Point Place Plantation*, *Madison Parish*, *La.* The center of head of copper bolt in middle brick of tenth course from the ground of second pillar from southeast corner of dwelling house. Plantation is opposite Warrenton, Miss.

No. 215.—In *Delta*, *Madison Parish*, *La.*, opposite Vicksburg, Miss. The end of vertical ray of five-rayed cast-iron star, used as a tie plate, in south end of parish clerk's office near courthouse. Is about 4 feet from ground and 3 from southeast corner of building. Reported as loose in 1896.

No. 211.—On Willow Glenn Plantation, *Madison Parish*, *La.* The center of cross in head of copper bolt in middle brick of eighth course from ground of second pillar from southeast corner of dwelling-house porch. It is about 2 miles above *Delta*, *La.*

No. 207.—On *Elcho Plantation*, *Madison Parish*, *La.* The center of head of copper bolt in brick in twenty-first course from ground, and third one from southeast edge of south chimney of dwelling house.

No. 197.—On *Duck Port Plantation*, *Madison Parish*, *La.* The center of head of copper bolt in middle brick of third course from top of third pillar from northeast corner of dwelling-house porch.

No. 188.—On *Cabin Teele Plantation*, *Madison Parish*, *La.* The center of head of copper bolt in brick in east face of brick pillar supporting the northeast corner of dwelling house.

DESCRIPTIONS OF PERMANENT BENCH MARKS FROM MILLIKENS BEND, LA., TO GREENVILLE, MISS.

No. 188.—*Cabin Teele Plantation*, *Madison Parish*, *La.* (See above.)

No. 184.—On *River View Plantation*, *Madison Parish*, *La.* The center of head of copper bolt in brick pillar supporting northeast corner of porch of dwelling house belonging to Citizens' Bank of Louisiana. Situated about 1¼ miles below Millikens Bend.

No. 179.—On English Field Plantation, three-fourths mile above *Millikens Bend*, *La.* The center of copper bolt in sixth brick from top of foundation and third one from northwest corner of Mr. H. P. Morancy's dwelling house.

No. 171.—On Ditchley Plantation, one-fourth mile above *Omega* post office, *Madison Parish, La.* The center of head of copper bolt in brick chimney on north face and near northeast edge of Mrs. Sarah A. Nutt's dwelling house.

No. 162.—On Henderson Plantation, one-eighth mile above *Henderson Landing, East Carroll Parish, La.* The center of head of copper bolt in west face of pillar of dwelling house owned by Mrs. Emma E. Peck.

No. 161.—On Henderson Plantation, three-fourths mile above *Henderson Landing.* The center of head of copper bolt in east face of chimney of cabin opposite old ginhouse. Marked U. S. B. M.

No. 153.—On Tennessee Plantation, 3½ miles above *Ingomar* post office, *Issaquena County, Miss.* The center of head of copper bolt in brick chimney of cotton gin. Marked U. S. B. M.

No. 150.—On Forest Home Plantation, about 4 miles above *Ingomar* post office. The center of head of copper bolt in southwest face of chimney of dwelling house.

No. 140.—On *Shiloh Plantation*, near landing, *Issaquena County, Miss.* The center of head of copper bolt in north face of brick chimney of cotton gin. Marked U. S. B. M.

No. 137.—On Elliston Plantation, near *Hays* post office, *Issaquena County, Miss.* The center of head of copper bolt in brick pillar (second one from southwest corner) supporting dwelling house porch.

No. 128.—On Lockwood Plantation, one-third mile above *Tallulah Landing, Issaquena County, Miss.* The center of head of copper bolt near southeast corner of brick foundation of dwelling house.

No. 124.—Two miles above *Tallulah Landing, Issaquena County, Miss.* The center of head of copper bolt in brick foundation of *Tallulah* post office, or better known as "Old Tallulah Courthouse."

No. 112.—On *Ben Lomond Plantation, Issaquena County, Miss.* The center of head of copper bolt in west face of chimney of ginhouse just back of Ben Lomond post office.

No. 105.—On *Reserve Plantation, Issaquena County, Miss.* The center of head of copper bolt in west face of brick chimney of ginhouse, about one-fourth mile from levee and 3½ above Ben Lomond post office.

No. 95.—On Wade Lawn Plantation, one-fourth mile below *Mayersville, Issaquena County, Miss.* The center of head of copper bolt in west face of brick chimney at north end of dwelling house.

No. 90.—On Glen Annie Plantation, about 2 miles above *Mayersville, Issaqnena County, Miss.* The center of head of copper bolt in front face of brick pillar supporting the southwest corner of portico of Col. H. B. Keep's house.

No. 83.—On *River Dale Plantation*, opposite Arkansas line, *Issaquena County, Miss.* The center of head of copper bolt in second brick pillar south from north corner of dwelling house.

No. 70.—On *Palmetto Plantation, Washington County, Miss.* The center of head of copper bolt in brick pillar at northwest corner of dwelling house.

No. 65.—On Albemarle Plantation, about a mile below *Leota, Washington County, Miss.* The center of head of copper bolt in front face of dwelling house, in second brick below water sill and about the middle of large brick column on left-hand side of entrance to house.

No. 62.—On Maryland Plantation, back of *Leota*, *Washington County*, *Miss.* The center of head of copper bolt in second brick below wood sill, about the middle of north face of dwelling house.

No. 56.—On D. M. Hill's plantation, near *Lake Washington Landing*, *Washington County*, *Miss.* The top of copper bolt in a block of cement set in the ground about 53 feet back of the levee and 100 feet north of road from Landing to Lake Washington.

No. 46.—On *Longwood Plantation*, *Washington County*, *Miss.* The center of head of copper bolt in west face of ginhouse chimney. Marked U. S. B. M.

No. 42.—On *Glenora Plantation*, *Washington County*, *Miss.* The center of head of copper bolt in west face of ginhouse chimney.

No. 39.—On *Auburn Plantation*, *Washington County*, *Miss.* The center of head of copper bolt in north face of ginhouse brick chimney on Buckner's estate. Marked U. S. B. M.

No. 33.—On *Wayside Plantation*, near the banks of *Lake See*, *Washington County*, *Miss.* The center of head of copper bolt in brick foundation on right of porch in front side of dwelling house.

No. 22.—At *Refuge*, *Washington County*, *Miss.* The center of head of copper bolt in second pier on northwest side of Mr. Richardson's store.

No. 19.—On *Refuge Plantation*, *Washington County*, *Miss.* The center of head of copper bolt in ginhouse chimney, about 3 feet above ground.

No. 11.—On *Highland Plantation*, *Warfield Point*, *Washington County*, *Miss.*, about 6 miles below Greenville. The top of copper bolt in block of cement placed about 70 feet north of Mr. Warfield's house, near large cottonwood tree.

No. 8.—On Richardson's plantation, about 2 miles above *Warfield Point*. The top of an iron spike on a stump 8 feet in diameter and 8 feet high in a cypress swamp.

No. 5.—About 2¼ miles below *Greenville* and abreast of La Grange landing. The top of an iron spike driven vertically into large cottonwood tree near foot of eastern slope of levee.

No. 2.—Near *Greenville*. *Miss.* The center of head of copper bolt in fourteenth course above water sill of C. P. Huntington's gin-house chimney. Marked U. S. B. M.

Greenville No. 1.—At *Greenville*, *Miss.* On corrugated iron doorsill on north side, near northwest corner of building known as the "Bank Building." The precise point is not marked, but can be defined as the point near the back side and west end of sill, $32^{cm}.0$ from front face, $5^{cm}.5$ from doorstrip, and $9^{cm}.0$ from west door jamb.

DESCRIPTIONS OF BENCH MARKS BETWEEN WILKERSONS LANDING, MISS., AND LITTLE ROCK, ARK.

P. B. M. No. 84.—*Wilkersons Landing*, *Miss.* (See page 696.)

F.—At *Arkansas City*, *Desha County*, *Ark.* The bottom of a square cut in the top of an 8 by 8 inch granite post set in the ground about 2 metres south of west corner of small house, which is occupied by the engineers of the Little Rock, Mississippi River and Texas Railroad; this house is the first one southwest of the railroad station. It is lettered thus:

U S
□
B M

G.—At *McGehee Station, Desha County, Ark.* The center of cross in the head of copper bolt leaded horizontally into a brick of the chimney on the north side of a small whitewashed house west of the line of the Little Rock, Mississippi River and Texas Railroad. The brick is in the ninth course from the ground; the house may also be described as the first one south of the road crossing, south of trestle No. 575, and the seventh one north of A. McGehee's store, used as the station and post office. Reported in 1897 as disturbed.

H.—At *Tillar, Drew County, Ark.* The center of cross on head of copper bolt leaded horizontally into a brick of the chimney at the back of H. L. Henry & Bro.'s store. The brick is the eleventh one from the ground and third one east of side of house.

I.—At *Walnut Lake, Desha County, Ark.* The center of cross on a 2½-inch copper bolt leaded horizontally into a brick on the west side of the chimney on the north end of Mr. R. A. Picken's dwelling house. The brick is in the eighteenth course from the ground.

J.—At *Varner, Lincoln County, Ark.* The bottom of a square cut in top of granite post set about 2 feet west of the extreme east corner of the front yard of Mr. R. R. Rice's residence. The house is a large white frame structure about 200 yards southeast of Varner station. It is lettered the same as F.

K.—At *Noble Lake, Jefferson County, Ark.* The bottom of a square cut in top of a 6 by 6 inch granite post set at the southeast corner of the north extension of the platform of the Little Rock, Mississippi River and Texas Railroad station. It is lettered the same as F.

N.—At *Pine Bluff, Jefferson County, Ark.* Is the bottom of a square cut in top of a 6 by 6 inch granite post, which is set in the front yard, at the southeast corner, of a house belonging to Mr. John Bell, this house being at the intersection of Oak street and West Fourth avenue and is No. 803 on West Fourth avenue. It is lettered the same as F.

L.—At *Pine Bluff, Jefferson County, Ark.* Center of cross cut on head of copper bolt leaded, horizontally, into a brick on the south side of the State Branch Normal School. The brick is in the fourth course below the sill of the first window east of the piazza. The school is situated just west of the city limits.

E.—Near milepost 85 of the Little Rock, Mississippi River and Texas Railroad. Is the bottom of a square cavity cut in the top of a granite post set about 6 metres west of the track of the Little Rock, Mississippi River and Texas Railroad, and about 23 metres south of the second telegraph pole on the west side of the track south of milepost 85. The post is dressed down to 6 by 6 inches and is lettered the same as F.

D.—At *Redfield, Jefferson County, Ark.* Is the bottom of a square cut in the top of a 6 by 6 inch granite post set in the northeast corner of a small front yard between J. Converse's blacksmith shop and store. The post projects about 4 inches above the ground and its top is marked the same as F.

C.—At *Wrightsville, Pulaski County, Ark.* The bottom of a square cut in limestone block which is set in the ground near the southeast end of the platform at the Little Rock, Mississippi River and Texas Railroad station. The stone is just west of the flight of stairs leading up to the platform from the south; the top is beveled and is lettered the same as F.

No. II.—Between *Sweet Home* and *Wrightsville, Pulaski County, Ark.* Is the top of a brass nail almost in the center of an equilateral triangle formed by three copper nails in the top of the southwest block which supports the platform immediately in front of section house No. 2 of the Little Rock, Mississippi River and Texas Railroad. This section house is between mileposts 106 and 107 and is the one occupied by the section foreman.

No. I or 3.—At *Little Rock, Pulaski County, Ark.* Is the bottom of a square cut in the stone doorsill of the middle door, at the west end of it, of the brick building occupied by Whittemore & Gordon, pork brokers, at the foot of Commerce street on the bank of the Arkansas River.

A.—At *Little Rock, Pulaski County, Ark.* The center of cross in the granite substructure of the east face of the United States custom-house and post office. It is beneath the water-table course of masonry and its center is about 13¾ inches north and about 5½ inches above the upper corner of the north line of the basement window nearest to Second street.

B.—At *Little Rock, Ark.* A rectangular cut on the north side of the granite coping of wall inclosing the small sunken area immediately in front of the basement window referred to above. Lettered the same as F.

O.—At *Little Rock, Pulaski County, Ark.* Bottom of a square cut in the top of a 6 by 6 inch granite post set near the main entrance of the State capitol. This post is about 29½ inches south and about 33½ inches west of the southwest corner of the stone porch.

West Base.—On the north bank of the Arkansas River, near the east end of *Argenta, Pulaski County, Ark.* A square cut on the extreme south end of the west monument of the United States Engineers' base line, and is marked U. S.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN LITTLE ROCK AND FORT SMITH, ARK.

West Base.—*Argenta, Ark.* (See above.)

No. I.—A granite post on the north side of the Little Rock and Fort Smith Railroad, between mile posts 4 and 5 (from *Little Rock*), 4 metres from the track and 1.6 metres west of sixth telegraph pole west of trestle No. 12. (See note 11, page 550.)

No. II.—A granite post in the southwest corner of the yard in front of Mr. Charles Chonoski's residence at *Marche, Pulaski County, Ark.* This house joins the store and post office. (See note 11, page 550.)

No. III.—A granite post in the west end of the yard owned by Daniel Chism, postmaster at *Palarm, Faulkner County, Ark.*, and close to the line of the fence, about 10 metres north of the building containing the post office. It is also on a line with the south end of the platform of the railroad station. It is like the marks described in note 11, page 550, except that four lines form the square and the bench mark is the surface in the center of this square.

No. IV.—A granite post in the southwest corner of the yard in front of a house belonging to Mr. J. R. Miller, at *May Flower, Faulkner County, Ark.* (L. R. and Ft. S. R. R). This house is almost due east of the station. It is the same as No. III.

No. V.—A granite post in the west end of the yard owned by J. W. Austin, at

Preston, *Faulkner County*, *Ark.*, close to the line of the fence and on line with the north end of the building containing the post office and store. (See note 11, page 550.)

No. VI.—On top of the stone foundation at the southwest corner of the brick record vault of the courthouse at *Conway*, *Faulkner County*, *Ark.* It is the bottom of a square cut in a flat stone of the foundation, and is roughly marked as follows: U S □ B M

No. VII.—A granite post near the fence to yard in front of the house where the railroad section hands live, and is nearly opposite section house No. 5 on the Little Rock and Fort Smith Railroad, near *Conway*. (See note 11, page 550.)

No. VIII.—The bottom of a square cut in the top of the stone abutment to the railroad bridge over Cadron Creek, on the Little Rock and Fort Smith Railroad, near *Menifee*. It is on the abutment on the east bank of the creek and north of the track, and is roughly marked as follows: U S □ B M

No. IX.—A granite post at *Menifee*, *Conway County*, *Ark.*, a few feet west of the storehouse used as a post office, and on line with the front of this building. An old well is quite near the bench mark. (See note 11, page 550.)

No. X.—A granite post in the southeast corner of the yard to the Sims Hotel, at *Plumerville*, *Conway County*, *Ark.* (See note 11, page 550.)

No. XI.—The bottom of a square cut in the top of the upper step (stone) to the west entrance of the courthouse at *Morrillton*, *Conway County*, *Ark.* It is near the south end of the step, and marked as follows:

U S
□
B M

No. XII.—A granite post in the southeast corner of the yard to the Little Rock and Fort Smith Railroad section house No. 7, at *Germantown*, *Conway County*, *Ark.* (See note 11, page 550.)

No. XIII.—A granite post in the southwest corner of the yard to W. R. Jones's house at *Blackville*, *Ark.* (See note 11, page 550.)

No. XIV.—The bottom of a square cut in the southwest corner of the stone doorsill at southwest corner of the brick building owned by E. A. Darr, at *Atkins*, *Pope County*, *Ark.* The building is at the northeast corner of Railroad avenue and Dover street. It is lettered the same as No. XI.

No. XV.—A granite post in the northeast corner of the yard to the large frame house owned by J. Potts and T. H. Ragsdale, at *Galla Creek*, *Pope County*, *Ark.* (See note 11, page 550.) The bottom of the square cut is not even and the rod was held at the lowest point, which is slightly below the general surface of the bottom.

No. XVI.—The bottom of a square cut in the stone foundation to the main entrance to the courthouse at *Russellville*, *Pope County*, *Ark.* It is on the right of the entrance going into the building and is marked the same as No. XI.

No. XVII.—A granite post in the southwest corner of the yard to the dwelling attached to the Onita Coal Company's store near *Onita* Station, *Pope County*, *Ark.* (See note 11, page 550.)

No. XVIII.—The bottom of a square cut in the top of the stone abutment of the Little Rock and Fort Smith Railroad bridge over *Illinois Creek*. It is on the abutment on the west side of the creek and is north of the track. It is roughly marked the same as No. XI.

No. XIX.—The bottom of a square cut in the top of the stone abutment to the Little Rock and Fort Smith Railroad bridge over Mill Creek, near *Mill Creek* Station. It is on the abutment on the west side of the creek and north of the track, and roughly marked the same as No. XI.

No. XX.—A granite post in the northeast corner of the yard to Mrs. Sarah Battenfield's house at *London*, *Pope County*, *Ark.* (See note 11, page 550.)

No. XXI.—The bottom of a square cut about one-half inch deep in the upper surface of the stone forming the top of the stone pier of the Little Rock and Fort Smith Railroad bridge over Piney Creek. It is north of the track, and on the pier on the east bank of the creek. It was roughly marked, the same as No. XI. The bridge is about one-quarter mile west of *Berlin* post office (Piney station), on the Little Rock and Fort Smith Railroad.

No. XXII.—The center of a cross cut in one of the stones forming the foundation to the chimney on the west side of Dr. R. M. Osborn's residence at *Knoxville*, *Johnson County*, *Ark.* The cross is 1 foot 10½ inches above the ground, 10½ inches from the outside face of the chimney, and on the side next to the railroad, on which the house fronts. The house is a small frame structure, and is west of the station house, near the railroad track. The stone is roughly marked as follows:

U S
+
B M

No. XXIII.—The center of cross in end of a copper bolt in the south face of the brick chimney on the west side of the City Hotel at *Lamar* post office (Cabin Creek station), *Johnson County*, *Ark.* The bolt is in the third row of brick from the ground and in the second brick from the outside face of the chimney. The house is one of the oldest in the town, according to information given by a bystander.

No. XXIV.—The bottom of a square cut in the top of the stone pier of the Little Rock and Fort Smith Railroad bridge over Spadia Creek, *near Clarksville*, *Johnson County*, *Ark.* The pier is on the west bank of the creek, and the bench mark is north of the track, near the western face of the pier. It is roughly marked the same as No. XI.

No. XXV.—The north monument of the meridian line established in the court-house yard at *Clarksville*, *Johnson County*, *Ark.*, by the State geological survey. This monument is a stone, roughly dressed at the top to 6 by 6 inches for 6 inches below the top, planted in the northeast corner of the yard. It has a hole in the center of the top, filled with lead, into which a small brass pin is driven, and the top of this pin is the bench mark. The top of the lead is even with the upper surface of the stone, and the stone seems firmly set.

No. XXVI.—The south monument of the meridian line established in the court-house yard at *Clarksville*, *Johnson County*, *Ark.*, by the State Geological Survey. This monument is a stone roughly dressed at the top to 6 by 6 inches for 6 inches below the top, planted near the southeast corner of the yard, just outside the iron fence. It has a hole in the center of the top, filled with lead, into which a small brass pin is driven, and the top of this pin is the bench mark. The top of the lead is about even with the upper surface of the stone, and the stone seems firmly set.

No. XXVII.—A stone post in the southeast corner of the yard to J. Siegel's store at *Spadra, Johnson County, Ark.* It is 22 metres east of the store, about 50 metres north of the railroad and 150 metres east of the railroad station. This stone differs from those described in note 11, page 550, only in having 1889 cut on one face, and the S on top is backward.

No. XXVIII.—The center of a cross cut on the stone chimney on the east end of the house owned by John Durham, at *Hartman, Johnson County, Ark.* The house is about one-third of a mile west of the railroad station, and the cross is on the side of the chimney facing the railroad and on the fourth stone from the ground. The house stands about 150 metres north of the railroad. The stone is very hard, and the cross and letter are roughly cut, as follows:

U S
+
B M

No. XXIX.—The bottom of a square cut in the stone foundation to the stone chimney of the kitchen to the Central Hotel, at *Coal Hill, Johnson County, Ark.* The hotel is quite near the railroad station, and the kitchen is behind the main building and built as an extension to it. The bench mark is about the center of the outer east face of the chimney and 3 inches above the ground. It was roughly lettered the same as No. XI.

No. XXX.—The center of a cross in end of copper bolt leaded in the brick chimney on south side (next to railroad) of the large boarding house just west of the railroad station at *Altus, Franklin County, Ark.* The house is owned by F. W. Hammond and is north of the track. The bolt is in the eighth course from the stone foundation and the third brick from the east side of chimney. It was roughly lettered as follows:

U S
⊕
B M

No. XXXI.—The center of a cross in end of copper bolt leaded in the east side of the brick courthouse (near the southeast corner) at *Ozark, Franklin County, Ark.* The bolt is in the sixth row above the foundation and in the third brick from the southeast corner.

No. XXXII.—The bottom of a small hole roughly cut in the stone foundation to the stone chimney on the east end of J. H. Bronte's house at *Poepping, Franklin County, Ark.* This is the only house at the station, which is nothing more than a switch. The bench mark is only a few inches above the ground, at the northeast corner of the chimney.

No. XXXIII.—The bottom of a square cut about one-half inch deep in the stone foundation to the stone chimney on the east end of Dr. W. W. Rambo's house at *White Oak, Franklin County, Ark.* The house is about 20 metres north of the railroad and a short distance west of the station sign. The doctor's office is in the corner of the yard, near the house. The bench mark is roughly marked, the same as No. XI, and is only a few inches above the ground.

No. XXXIV.—The bottom of a square cut in the top of the stone pier to the Little Rock and Fort Smith Railroad bridge over Little Mulberry Creek. It is on the pier at the east bank of the creek and south of the track, inside the outer line of the superstructure of the bridge. This bridge is one-third of a mile west of the railroad station at *Mulberry*, *Franklin County*, *Ark.* It is roughly marked the same as No. XI.

No. XXXV.—The bottom of a square cut in the stone foundation to a stone chimney on the east side of a house belonging to W. W. Lane at *Dyer*, *Crawford County*, *Ark.* The bench mark is only a few inches above the ground. The house is opposite the cotton platform at this station and about 80 metres north of the track.

No. XXXVI.—The center of a cross in end of copper or brass bolt (one-half inch in diameter), leaded in the north wall of a brick store, at *Alma*, *Crawford County*, *Ark.*, belonging to Mr. L. C. Locke. The bolt is in the fifth brick from the northeast corner of the building and in the seventeenth course from the foundation. The building is opposite the railroad station and directly south of it.

No. XXXVII.—A stone post in the south corner of the court-house yard at *Van Buren*, *Crawford County*, *Ark.* (See note 11, page 550.) In addition "1889" was roughly cut on one side of the stone. Reported in 1893 as destroyed.

No. XXXVIII.—The center of a cross in end of copper bolt leaded in the west wall of the brick courthouse at *Van Buren*, *Crawford County*, *Ark.* The bolt is in the second course from the foundation and in the second brick from the south corner of the building. The brick cracked when the bolt was driven in.

No. XXXIX.—The bottom of a square cut in the stone abutment to the iron railroad bridge over the Arkansas River at *Van Buren*, *Ark.* It is east of the track and on that part of the abutment on which the end of the bridge rests, on the north bank of the river. It is marked the same as No. XI.

No. XL.—The bottom of a square cut in the stone abutment to the iron railroad bridge over the Arkansas River at *Van Buren*, *Ark.* It is east of the track and on that portion of the abutment on which the end of the bridge rests, on the south bank of the river. It is marked the same as No. XI.

No. XLI.—The center of cross in end of copper bolt leaded in the west wall of the United States jail (brick) at *Fort Smith*, *Ark.* The bolt is in the first course above the limestone base stone and about 1 metre above the ground. It is in the fifth brick from the jamb formed by the side of the building and the brick ventilator. The jail is a new pressed-brick addition, with stone trimmings, to the old United States building. The letters "U. S. B. M." were cut in the base stone immediately below the bolt.

No. XLII.—The bottom of a square cut in the edge of the stone door-sill to the back door of the brick building on the northeast corner of Garrison avenue and First street at *Fort Smith*, *Ark.* The building is owned by Mr. Thomas Rogers and used as a saloon. It is diagonally across the street from the Little Rock and Fort Smith Railroad passenger station. The letters U. S. B. M. were cut immediately below the hole in the door-sill. Reported in 1893 as destroyed.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN VAN BUREN, ARK., AND BOSTON, MO.

No. XXXVII.—*Van Buren*, *Ark.* (See above.)

No. XXXVIII.—*Van Buren*, *Ark.* (See above.)

No. XXXIX.—*Van Buren*, *Ark.* (See above.)

No. XLIII.—The bottom of a square cut in the top of the stone pier on the south bank of Clear Water Creek under the railroad bridge one-half mile south of *Lillie*, *Crawford County*, *Ark*. It is west of the track and about the center of the west capstone to the pier. The following letters were roughly cut:

U S
□
B M

No. XLIV.—The bottom of a square cut in the top of a stone pier under the railroad bridge over Clear Water Creek, about 2 miles north of *Rudy*, *Crawford County*, *Ark*. The pier is at the south end of the iron part of the bridge and about 100 metres from south end of the trestle. It is about the center of the second capstone from the west end of the pier and is west of the track. It is roughly lettered the same as No. XLIII.

No. XLV.—The bottom of a square cut in the top of a stone pier under the railroad bridge over Clear Water Creek, about one-half mile south of *Lancaster*, *Crawford County*, *Ark*. It is west of the track on the third pier from south end of bridge and about the center of the second capstone from the west end of the pier. It is roughly lettered the same as No. XLIII.

No. XLVI.—The bottom of a square cut in the top of a stone pier under the railroad bridge over Clear Water Creek, three-fourths mile south of *Mountainburg*, *Crawford County*, *Ark*. It is on the second pier from south end of the bridge, east of the track, and about the middle of the triangular capstone at the east end of the pier. It is roughly lettered the same as No. XLIII.

No. XLVII.—The bottom of a square cut in the top of the stone supporting the north end of the iron superstructure to the railroad bridge over Clear Water Creek, 1 mile south of *Chester*, *Crawford County*, *Ark*. It is east of the track. Two limestones are placed on top of the sandstone pier on the north bank of the creek and the bench mark is on the upper one. It is roughly lettered the same as No. XLIII.

No. XLVIII.—The center of a cross cut in the end of a copper bolt leaded in the front wall of the Chester Hotel, at *Chester*, *Crawford County*, *Ark*. This is a two-story brick building facing the railroad station and is east of the track. The bolt is in the fourteenth course above the ground and in the second brick from the southwest corner of the hotel, in the front or west wall.

No. XLIX.—The bottom of a square cut in a marble post, 8 by 8 by 36 inches, buried 32 inches in the ground. It is in the southwest corner of the yard at the south side of the Chester Hotel at *Chester*, *Crawford County*, *Ark*. The top of the post is lettered as follows:

U S
C & □ G S
B M

No. CXXVIII.—A limestone post in the front yard to the dwelling of Mr. R. F. Kidd, at *Porter*, *Crawford County*, *Ark*. The stone is near the front fence on the right of the gate as you enter the yard. Mr. Kidd's house is west of the track and one-fourth mile south of the railroad station. (See note 12, page 551.)

No. CXXVII.—A limestone post in the front yard to the Summit Hotel on top of the Boston Mountain, one-half mile south of *Winslow*, *Washington County*, *Ark*. The stone is near the front fence and on the left of the gate as you enter the yard. (See note 12, page 551.)

No. CXXVI.—The bottom of a square cut in the top of the stone forming the first offset in the retaining wall to the entrance to the tunnel one-half mile south of *Winslow*, *Washington County*, *Ark.* It is at the north end of the tunnel and east of the track. The retaining wall goes up in a series of steps or offsets, and the bench mark is on top of the first offset above the track. It is roughly lettered the same as No. XLIII.

No. CXXV.—A limestone post in the yard to the railroad section house at *Brentwood*, *Washington County*, *Ark.*, near the front fence and on the left of the gate as you enter. The section house is west of the track and south of the railroad station. (See note 12, page 551.)

No. CXXIV.—The bottom of a square cut in the top of the stone pier to the iron railroad bridge over a branch of West Fork of White River, about one-fourth mile south of *Woolseys*, *Washington County*, *Ark.* It is on the pier under the north end of the bridge and is east of the track. There is a trestle outside the bridge at each end. It is roughly lettered the same as No. XLIII.

No. CXXIII.—The center of a cross in end of a copper bolt leaded in the north side wall of the brick building at *West Fork*, *Washington County*, *Ark.*, owned by J. B. Parks. It is occupied by Langston, Oldham & Co. as a general store, is west of the track, and faces it a short distance south of the station. The side wall is on the street. The bolt is in the third course above the rock foundation and in the third brick from the stone under the northeast corner of the building.

No. CXXII.—A limestone post in the front yard to the dwelling of Mr. Linn Clive, at *Greenland*, *Washington County*, *Ark.* It is near the front fence just to the left of the gate as you enter the yard. The yard adjoins the store and post office, which is east of the track and opposite the railroad-station platform. (See note 12, page 551.)

No. CXXI.—The center of a cross cut on the south side of the main entrance to the Arkansas State University building at *Fayetteville*, *Washington County*, *Ark.* The cross (+) is cut on the dressed surface of a large limestone about 2 feet above the ground. The stone was lettered as follows:

U S
C & + G S
B M

No. CXX.—A limestone post in the front yard to the dwelling of Mr. R. M. Licklyter, at *Johnson*, *Washington County*, *Ark.* The stone is near the front fence between the two gates. The dwelling is west of the track and a short distance south of the station platform. (See note 12, page 551.)

No. CXIX.—The center of a cross in the center of a copper bolt leaded in the front wall of the brick canning factory at *Springdale*, *Washington County*, *Ark.* The building faces the railroad and is about one-fourth of a mile north of the station. The bolt is in the first course above the stone foundation and in the third brick from the northeast corner.

No. CXVIII.—A limestone post in the southeast corner of the front yard to the residence of Dr. W. F. Greene, at *Lowell*, *Benton County*, *Ark.*, just north of the store which stands in the corner of the yard. (See note 12, page 551.)

No. CXVII.—The center of a cross cut in the end of a copper bolt leaded in the front wall of the brick engine house, or city hall, at *Rogers*, *Benton County*, *Ark.* The building fronts on the railroad and the bolt is in the twelfth course above the ground and in the first brick from the southeast corner.

No. CXVI.—A limestone post in the yard of the two-story frame dwelling at *Avoca*, *Benton County*, *Ark.*, owned by Andrew Lynch. The building is east of the track, a short distance south of the railroad station. (See note 12, page 551.)

No. CXV.—The bottom of a square cut in the top of the stone abutment to the iron railway bridge over Sugar Creek, at *Brightwater*, *Benton County*, *Ark.* It is on the north abutment west of the track and quite near the west edge of the abutment. The following letters were roughly cut: U S □ B M.

No. CXIV.—A limestone post in the southeast corner of the yard to the dwelling owned and occupied by Mrs. Martha Jackson, at *Garfield*, *Benton County*, *Ark.* The house is north of the track and about one-fourth of a mile west of the railroad station. (See note 12, page 551.)

No. CXIII.—The center of a cross in end of copper bolt leaded in the west side wall of the brick building at *Seligman*, *Barry County*, *Mo.*, owned and occupied by A. J. Dean, M. D. The building is east of the track and at the corner of Main and Seventh streets. The bolt is in the sixth course above the foundation and in the second brick from the northwest corner.

No. CXII.—The center of cross in end of copper bolt leaded in the front wall of the brick building at *Washburn*, *Barry County*, *Mo.*, owned by D. G. Reese. The building is west of the track opposite the railroad station. The bolt is in the seventh course above the pavement and in the second brick from the northeast corner.

No. CXI.—The center of a cross in end of copper bolt leaded in the front wall of Lucky Brothers' brick building at *Exeter*, *Barry County*, *Mo.* The building fronts west and is nearly opposite the railroad station. The bolt is in the tenth course above the iron window sill and in the second brick from the northwest corner.

No. CX.—The surface of the iron window sill to a brick store at *Purdy*, *Barry County*, *Mo.* The building is at the northeast corner of Commercial street and Bear avenue, and is owned by Swiger & Haddock. The bench mark is on the front edge of the window sill to the west window (in the front of the store) at its center. Four lines were cut in the iron, forming a space about an inch square, and the surface of this space is the bench mark. It was lettered as follows: U S □ B M:

No. CIX.—The bottom of a square cut in the top of the stone foundation to the brick building at the northeast corner of Broadway and Third street, *Monett*, *Barry County*, *Mo.* It is under the first window (north of corner) on Third street, the main entrance being at the corner, and the building is occupied by the Commercial Bank. The following letters were cut:

U S
□
B M

No. CVII.—The bottom of a square cut in the stone doorsill of the brick building at *Pierce City*, *Lawrence County*, *Mo.*, owned by A. Pfaff. The building is about the center of the block, east of the railroad station, and is used as a dry-goods store. The rear of the building faces the railroad track and the bench mark is in front of the west door in the rear of the building. It is lettered the same as No. CIX.

No. CVI.—The bottom of a square cut in the stone window sill to the Maulty & Leak brick block at *Wentworth*, *Newton County*, *Mo.* The building fronts west and the bench mark is under the north window in the front of the building. It is lettered the same as No. CIX.

No. CV.—The bottom of a cut in the upper surface of the lower stone step to the brick building at *Sarcoxie*, *Jasper County*, *Mo.*, owned and occupied by the Bank of Sarcoxie. The building is on the southeast corner of a block and is opposite the northeast corner of the public square. The letters U. S. B. M. surround the mark and "U. S. C. & G. Survey" and "Altitude above Gulf of Mexico, 1088 feet," were also cut in the stone step.

No. CIV.—A point on the iron window sill of the brick building (one story) at *Reeds*, *Jasper County*, *Mo.*, owned by J. D. Davis. The point is under the north window in the front of the building, a little north of the middle point. The building is some distance south of the railroad and is occupied as a general store. The letters U S B M were cut in the iron around the bench mark, which is the surface of the iron between the letters.

No. CIII.—One of the Carthage City bench marks is a limestone post 6 by 6 inches, dressed and rounded one way at the top, buried in the ground at the southwest corner of Main and Limestone streets at *Carthage*, *Jasper County*, *Mo.* It is on the inside line of the sidewalk, 2·3 feet west from the inside line of the west sidewalk on Main street, and is on Limestone street. The letters B M are cut on top of the stone. The highest part of the rounded surface was used as the bench mark.

No. CII.—The bottom of a square cut in the top of the stone pier under the west end of the iron railroad bridge (Mo. Pac. Ry.) over the North Branch of Spring River, about 1 mile north of *Carthage.* It is on the north pier west of the track and near the north edge of the pier. It is roughly lettered the same as No. CIX.

No. CI.—The bottom of a square cut in the top of the stone abutment to the iron railroad bridge over Buck Branch of Spring River, 3 miles north of *Carthage*, *Mo.* It is east of the track and inside the superstructure of the bridge, near the inside edge of the pier under the south end of the bridge. It is roughly marked the same as No. CIX.

No. C.—The bottom of a square cut in the top of the stone abutment of the iron railroad bridge over Dry Fork of Spring River, one-fourth mile north of *Carytown*, *Jasper County*, *Mo.* It is west of the track and inside the superstructure of the bridge, near the inside edge of the pier under the south end of the bridge. It is roughly lettered the same as No. CIX.

No. XCIX.—A limestone post in the northwest corner of the public park at *Jasper*, *Jasper County*, *Mo.* This park is south of the principal street of the town and east of the railroad, adjoining the right of way. (See note 12, page 551.)

No. XCVIII.—A limestone post in the southeast corner of the yard around the residence of Mr. W. D. Hastings, at *Boston*, *Barton County*, *Mo.* The house is a two-story frame house, painted white, and faces the railroad. It is west of the track and a short distance south of the railroad station. (See note 12, page 551.)

No. XCVII.—The bottom of a square cut in the stone abutment to the Missouri Pacific Railway bridge over the North Fork of Spring River, about 1 mile north of

Boston, *Barton County*, *Mo.* The mark is near the southeast corner of the stone supporting the south of the superstructure of the bridge on the west side of the track, on its upper surface.

No. XCVI.—The bottom of a square cut in the stone abutment to the Missouri Pacific Railway bridge over the North Fork of Spring River, about 1 mile north of *Boston*, *Barton County*, *Mo.* The mark is near the southwest corner of the stone supporting the south end of the superstructure of the bridge on the east side of the track, on its upper surface. It is roughly lettered the same as No. CIX.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN BOSTON AND PLEASANT HILL, MO.

No. XCVII.—Near *Boston*, *Mo.* (See page 622.)

No. XCVI.—Near *Boston*, *Mo.* (See above.)

No. XCV.—The bottom of a square cut in the top of the sandstone foundation to the standpipe of the *Lamar* (*Barton County*, *Mo.*) waterworks. The standpipe is west of the railroad and about half a mile north of the Missouri Pacific Railway station. It is on the north side of the standpipe, and the stone was roughly lettered as follows:

U S
□
B M

No. XCIV.—The bottom of a square cut in the top of the sandstone abutment to the Missouri Pacific Railway bridge over the North Fork of Spring River about 2 miles north of *Lamar*, *Barton County*, *Mo.* The mark is near the northeast corner of the stone supporting the north end of the superstructure of the bridge on the west side of the track. It was roughly lettered the same as No. XCV.

No. XCIII.—A limestone post in the northeast corner of the yard to the Irwin House (hotel), at *Irwin*, *Barton County*, *Mo.*, which is owned by Mr. Griffith, of Lamar Mo. The house is west of the railway and a short distance north of the railroad station. (See note 12, page 551.)

No. XCII.—The bottom of a square cut in the sandstone doorsill to a brick store at *Sheldon*, *Vernon County*, *Mo.* This store is on the north side of the principal street and is owned by Mr. E. Pollard. It is occupied as a harness store by Mr. M. M. Wilson. The bench mark is near the west end of the doorsill and is roughly lettered the same as No. XCV.

No. XCI.—A limestone post in the yard to the residence of Mr. J. H. Lloyd, at *Milo*, *Vernon County*, *Mo.*, and is in front of his house near the fence on the side of the yard. The post is east of the railroad track and north of the principal street of the town. The post office is next to Mr. Lloyd's house. (See note 12, page 551.)

No. XC.—The bottom of a square cut in the top of the first stone step (above the platform) to the entrance to the gentlemen's waiting room to the Missouri, Kansas and Texas Railway station at *Nevada*, *Vernon County*, *Mo.* The building is of brick, with one-half story of stone and stone trimmings, and the mark is on the first step to the entrance next the track. The following letters were cut near the bench mark:

U S
C & □ G S
B M

No. LXXXIX.—The bottom of a square cut in the top of the stone abutment to the Missouri Pacific Railway (L. and S. Division) bridge over *Marmiton Creek*, in *Vernon County, Mo.* The bench mark is on the south abutment near the outer (north) edge, east of the track and between it and the superstructure of the bridge. It is roughly lettered the same as No. XCV.

No. LXXXVIII.—The center of a cross in the end of a copper bolt leaded in the front of the brick store at *Horton*, *Vernon County*, *Mo.* The building is owned by Mr. Perry Hutchinson, and is occupied by Rowen & Son. The bolt is in the front face of the north wall to the right in entering the doorway leading to the second story. It is west of the track and opposite the railroad station. The bolt is in the fourteenth course above the ground and in the corner brick at the northeast corner of the building.

No. LXXXVII.—The bottom of a square cut in the top of the stone abutment to the Missouri Pacific Railway (L. and S. Division) bridge over Little Osage River, in *Vernon County*, *Mo.* It is about 1½ miles south of *Arthur*, *Mo.*, and is on the north abutment, west of the track and between it and the superstructure of the bridge. It is near the inner (north) edge of the abutment. It is roughly lettered the same as No. XCV.

No. LXXXVI.—The bottom of a square cut in the sandstone window sill to the Bank of Rich Hill, at *Rich Hill*, *Bates County*, *Mo.* It is near the east end of the window sill to the east window on the north side of the building and about 3 feet above the sidewalk.

No. LXXXV.—The bottom of a square cut in the stone doorsill to the entrance to the Bank of Rich Hill, at *Rich Hill*, *Bates County*, *Mo.* The mark is near the end of the doorsill on the left hand in entering the bank. The bank building is a substantial brick building, with stone trimmings, at the northwest corner of a square on the principal street of the town, two blocks west of the Missouri Pacific Railway.

No. LXXXIV.—The bottom of a square cut in the top of the stone abutment to the Missouri Pacific Railway (iron) bridge over the Marias de Cygne River. This bench mark is south of the river and east of the track on the southwest corner of the stone supporting the south end of the iron superstructure. It is roughly lettered the same as No. XCV.

No. LXXXIII.—The bottom of a square cut in the stone abutment to the Missouri Pacific Railway (iron) bridge over Miami Creek. It is north of the creek and east of the track on the northwest corner of the stone supporting the north end of the iron superstructure of the bridge. Roughly lettered the same as No. XCV.

No. LXXXII.—The bottom of a square cut in the limestone doorsill to the main entrance of the public school building at *Butler*, *Bates County*, *Mo.* The building faces east and the bench mark is near the left side of the door in entering. This school building is at the west end of Ohio street. It is lettered the same as No. XC.

No. LXXXI.—A limestone post in the northeast corner of the yard to the residence of Mr. T. J. Davis, at *Passaic*, *Bates County*, *Mo.* The yard is on the south side of the street, east of the railroad, and next to the only store (post office) in the place. (See note 12, page 551.)

No. LXXX.—The bottom of a square cut in the sandstone window sill to the brick building at *Adrian*, *Bates County*, *Mo.*, owned and occupied by the Adrian Banking Company. The mark is in front of the middle window of the three on the south front of the building. It is about 18 inches from the west side of this window sill and about

5 inches from the outer edge of the stone and is one-eighth inch deep. No letters were cut, but the letter P is just above and a little to the right of the bench mark.

No. LXXIX.—The bottom of a square cut in the stone abutment to the Missouri Pacific Railway bridge (No. 30) over Mormon Branch of Grand River, about 2¾ miles south of *Archie, Mo.* The mark is on the abutment south of the stream, on its upper surface near the south edge, and between the superstructure and the track, on the west side of the track. It is roughly lettered the same as No. XCV.

No. LXXVIII.—The center of a cross in end of copper bolt leaded in the face of the rear wall to the brick bank building at *Archie, Cass County, Mo.* This wall is on the side next the railroad and faces east. The building is nearly opposite the railroad station and is owned and occupied by the Bank of Archie. The bolt is in the twelfth course above the ground and in the second brick from the southeast corner.

No. LXXVII.—The bottom of a square cut in the southwest corner of the stone supporting the south end of the iron superstructure to the Missouri Pacific Railway bridge over Grand River. This bridge is about 2 miles north of *Archie*. The bench mark is south of the river, east of the track, and is roughly lettered the same as No. XCV.

No. LXXVI.—A limestone post in the yard to the residence of Mr. Henry Hoye, at *Lone Tree, Cass County, Mo.* The stone is in the northeast corner of the yard, which is west of the railroad track and about one-fourth mile north of railroad station. (See note 12, page 551.)

No. LXXV.—The bottom of a square cut in the stone abutment to the Missouri Pacific Railway bridge over the roadway at *Harrisonville, Cass County, Mo.*, about one-half mile south of the railroad station. It is on the abutment south of the road on the west side of the track and on the fourth offset from the top. It is roughly lettered the same as No. XCV.

Big Creek.—The bottom of a square cut in the abutment to iron railroad bridge (No. 2, Mo. Pac. Rwy.) over Big Creek. This bridge is about 3½ miles south of *Pleasant Hill, Cass County, Mo.* The bench mark is under the center of the track, on top of the abutment on north side of the creek and near its inner face. It is roughly lettered the same as No. XCV.

No. LXXIV.—The center of a cross in end of copper bolt leaded in the wall of the old creamery building (brick) at *Harrisonville, Cass County, Mo.* The building is near the Missouri Pacific Railway, east of the track and about one-fourth mile north of the railroad station and belongs to the Harrisonville Banking Company. The bolt is in the tenth course above the stone foundation and in the third brick from the northwest corner, in the wall on the north side. There is a hole in the wall a little above the bolt where the first attempt to insert it was made.

No. LII.—*Pleasant Hill, Mo.* (See page 574.)

No. LI.—*Pleasant Hill, Mo.* (See page 574.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN HARRISONVILLE, MO., AND HOLLIDAY, KANS.

No. LXXIII.—A limestone post at *Kimpton, Cass County, Mo.*, owned by Mr. J. S. Powell. It is near the wooden building (stone foundation), on the north side, between the door and the northeast corner. (See note 12, page 551.)

No. LXXII.—A limestone post in the yard to the residence of Mr. J. B. Ingels, at *Coleman, Cass County, Mo.* The stone is near the northwest corner of the house, on the front (north) side. The house is south of the track and about one-half mile west of the railroad station. (See note 12, page 551.)

No. LXXI.—A limestone post in the yard to the residence of Mr. R. C. Simeral, at *Raymore, Cass County, Mo.* The post is in the southeast corner of the yard, near the fence on the south side and about 20 feet from the hedge on the front (east) side. The top is dressed to 6 by 6 inches and is lettered as follows:

U □ S
□
B M

The center of the square, formed by cutting four lines in the top of the stone, is the bench mark, the rod being held on the upper surface of the stone. The square cut in the top of the post was not used, as it was found impracticable to make it level and smooth. Mr. Simeral's house is south of the railroad and about one-half mile west of the railroad station.

No. LXX.—The bottom of a square cut in the stone doorsill to the brick building used as a post office in *Belton, Cass County, Mo.* The building faces the railroad and forms the northern end of the brick block on the street just west of the railroad station. The mark is on the left end of the doorsill as you enter the building. It was roughly lettered as follows:

U S
□
B M

No. LXIX.—The bottom of a square cut in the top of the stone abutment to the Kansas City, Clinton and Springfield Railroad bridge over Big Blue Creek, near *Newington, Kans.* It is on the abutment on the west bank of the creek, north of the track, between the superstructure and the north rail. It was roughly lettered the same as No. LXX. This bench mark is about 75 metres west of the State line where it crosses the railroad track.

No. LXVIII.—A limestone post in the yard to the residence of N. J. McKitrick, at *Morse, Johnson County, Kans.* It is south of the house and about 5 feet from the bay window, nearly opposite the east side. (See note 12, page 551.)

No. LXVII.—The center of a cross in end of copper bolt leaded in the front or east wall of the Avenue Hotel (three-story brick) at *Olathe, Johnson County, Kans.* The bolt is in the fourteenth course above the stone foundation and in the fourth brick from the northeast corner. The hotel is across the street west of the courthouse. The bolt turned a little in driving it in, and consequently the lines of the cross are not horizontal and vertical, as they should be.

No. LXVI.—The bottom of a square cut in the upper surface of the stone coping to basement entrance of the courthouse at *Olathe, Johnson County, Kans.* This basement entrance is on the north side of the building, under the north entrance, and the bench mark is on the coping just east of the stone wall supporting this entrance. It was lettered as follows:

U S
C & □ G S
B M

No. LXV.—A marble post in the northwest corner of the courthouse yard at *Olathe, Johnson County, Kans.*, 10 paces from the fence on the north side and 2 paces from the fence on the west side. (See note 12, page 551.) This post was reported in 1893 to have been disturbed, and the post was then removed.

No. LXIV.—The bottom of a square cut in the top of the stone abutment to the Atchison, Topeka and Santa Fe Railroad (Emporia branch) bridge over Mill Creek, about 1 mile south of *Holliday, Johnson County, Kans.* The mark is on the abutment under the north end of the bridge, and is east of the track, near the southeast corner of the highest portion of the abutment. It was roughly lettered the same as LXX.

No. LXIII.—*Holliday, Kans.* (See page 576.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN WASHINGTON, D. C., AND HAGERSTOWN, MD.

Navy-Yard.—*Washington, D. C.* On the southwest corner of the upper surface of the iron plate of the brick column under the southwest corner of the porch around the commandant's office.

Capitol.—*Washington, D. C.* The top of a bronze bolt in the middle of a bronze plate 5 inches square, placed vertically in the granite water table under the first window west of the southeast corner of the Senate wing of the Capitol. The plate was placed in position June, 1884, and is inscribed "Capitol Bench Mark, U. S. Coast and Geodetic Survey, 1884."

Monument.—*Washington, D. C.* The top of a brass bolt, marked O, placed vertically in a stone on the southwest corner of the top layer of the foundation of the monument. It was established and used by the Army Engineers in the erection of the monument. The aluminum point of the pyramidion is said to be 555 feet 4½ inches above this bolt.

National Museum.—*Washington, D. C.* The center of a cross cut on the granie sill of the outer door of the main entrance, north side, to the main building. It is 5 feet from the east and the same from the west side of the door, 10½ inches from the north edge of the sill, and about 10 feet from the inner door leading to the Museum.

No. XI.—*West Washington (Georgetown), D. C.* The bottom of a square cut in the northwest coping stone of the north abutment of the Aqueduct Bridge over the Potomac River. It is marked thus: ⊠.

F.—*Great Falls, Md.* The bottom of a square cut marked thus ⌖ cut on the capstone of the south wall, near its west end, of lock 20, Chesapeake and Ohio Canal. It is 0·200 metre from extreme north and 0·450 metre from extreme east edge, and 1·65 metre from west gate of lock.

E.—*Seneca, Md.* The bottom of a square cut marked thus ⊠ cut on the southeast side of capstone on southwest end of the Aqueduct Bridge. It is 0·165 metre from the iron guard rail, 0·397 metre from extreme east edge of capstone, and 0·06 metre from end of lower wooden beam of guard rail crossing the bridge.

No. V.—*Whites Ferry, Montgomery County, Md.* A square cut on the south edge of capstone of culvert under Chesapeake and Ohio Canal, about 20 metres east of the bridge crossing the canal. It is on the south bank, and 0·178 metre from extreme south edge of capstone.

D.—*Point of Rocks, Md.* The bottom of a square cut marked thus ⌖ cut on the foundation of the north abutment of the bridge crossing the Chesapeake and Ohio Canal. It is 0·047 metre from extreme south edge of stone.

C.—*Weverton, Md.* A square cut marked thus ⌖ cut on northeast corner of southwest capstone on south wall of lock No. 31, Chesapeake and Ohio Canal. It is 0·355 metre from extreme east and 0·335 metre from extreme north edge.

B.—One-half mile south of *Keedysville*, *Washington County*, *Md.* A cross cut on northwest corner of west capstone on south abutment of Bridge No. 26 of Baltimore and Ohio Railroad.

A.—*Hagerstown*, *Md.* (See page 560.)

DESCRIPTIONS OF PERMANENT BENCH MARKS ON THE LINE OF LEVELS BETWEEN RICHMOND, VA., AND WASHINGTON, D. C.

O.—At *Richmond*, on freight depot of the Richmond, Fredericksburg and Potomac Railroad. It is on the granite doorsill of the second door on the west side and near the north end of the depot. The mark is the bottom of a square cut in the granite sill (thus □); it is 0·150 metre from the extreme west edge of the door and 0·654 metre from the north side of it to the center of the mark.

N_1.—*Laurel*, *Henrico County*, *Va.* The bottom of a square cut in the granite door sill of the south door on the east side of the brick workshop of the Reform School. It is on the upper (outer) edge of the sill, 0·15 metre from the south end.

N.—*Ashland*, *Va.* The bottom of a square cut in the sill of the southeast door of the Duncan Memorial Chapel adjoining Randolph-Macon College. It is marked thus ⌖, and is 0·15 metre from the south edge of the sill, 0·155 metre from the east side of the brick wall, and 0·184 metre from the door jamb.

M.—One and one-fourth miles south of *Doswell*, *Va.*, at Bridge No. 37 of the Richmond, Fredericksburg and Potomac Railroad, about 1¼ miles below the Chesapeake and Ohio junction. It is the bottom of a square cut in the southwest corner of the south abutment of the wooden bridge. The center of the hole is 0·17 metre from the extreme north edge of the rock in which it is cut, and is 0·46 metre from the extreme west edge.

K_3.—*Rutherglen*, *Caroline County*, *Va.* The center of a cross in end of copper bolt leaded in the west wall of the brick railroad section house. It is in the twelfth course from the ground and in the third brick from the northwest corner, in the right side of the wall as one enters the door.

K_2.—*Penola*, *Caroline County*, *Va.* The center of a cross in end of copper bolt leaded in the west face of the brick chimney at the back of the house and store owned by Mrs. A. B. De Jarnett and facing the railroad track. It is in the seventeenth course above the brick foundation to the house and in the second brick from the northwest corner.

K_1.—*Milford*, *Caroline County*, *Va.* The center of a cross in end of copper bolt leaded in the front of the brick section hands' house of the Richmond, Fredericksburg and Potomac Railroad, about 100 yards north of the railroad station. It is in the ninth course above the ground and in the fifth brick north of the front or east door.

I_2.—One mile south of *Guinea*, *Caroline County*, *Va.* The bottom of a roughly cut square hole in the stone retaining wall to a brick culvert 100 metres north of milepost 48. It is on the west side of the track and north side of the culvert, on the third step from the top and near the center of the exposed portion of the stone.

I_1.—One-half mile south of *Summit*, *Spottsylvania County*, *Va*. The bottom of a square cut in the sandstone coping at the end of the brick culvert 200 metres south of milepost 53. It is on the east side of the track and the north stone of the coping, being lettered as follows:

U S
□
B M

I.—*Fredericksburg*, *Va*. The bottom of a square cut in the doorsill of the Princess Anne street door to the library in the courthouse, being near the northwest corner of the building. It is 0·051 metre from the extreme east edge of the sill and 0·11 metre from the south side of the door.

H.—*Fredericksburg*, *Va*. The bottom of a square cut in the northwest corner of the stone coping of the west abutment of the bridge of the Richmond, Fredericksburg, and Potomac Railroad over the Rappahannock River. It is below the top of the abutment and 0·181 metre from the extreme east edge of the stone in which it is cut, 0·056 metre from the extreme north edge, and 0·084 metre from the abutment wall.

G_8.—Near *Potomac Run* Station, *Stafford County*, *Va*. The bottom of a square cut in the stone abutment of the iron railroad bridge over Potomac Run. It is on the north side of the run, west of the track, and at the end of the ironwork of the bridge.

G_7.—*Brooke*, *Stafford County*, *Va*. The bottom of a square cut in the top of the sandstone coping to the retaining wall of a brick culvert under the railroad. It is east of the track, near the south end of the wall, above the arch. The culvert is a short distance south of the railroad station. It is lettered the same as I_1.

G_6.—One-half mile south of *Widewater*, *Stafford County*, *Va*. The bottom of a square cut in the top of the retaining wall to a brick culvert under the railroad. It is east of the track and near the north end of the wall, above the arch. It is lettered the same as I_1.

G_5.—*Quantico*, *Prince William County*, *Va*. The center of a cross in end of copper bolt leaded in the side wall of a brick building owned by Max Lansburgh, opposite to the railroad station, being east of the track. It is in the twelfth course above the ground and in the third brick from the northwest corner.

G_4.—One-half mile north of *Woodbridge*, *Prince William County*, *Va*. The bottom of a square roughly cut in the top of a large granite block set in the red sandstone of the first pier from the north end of the bridge over Occoquan River. The stone is under the end of the iron superstructure; it is east of the track and the mark is at the northwest corner of the granite stone.

G_3.—*Pohick Creek*, *Fairfax County*, *Va*. The surface of an offset cut in the edge of the capstone to the north abutment of the iron bridge of the Richmond, Fredericksburg and Potomac Railroad. It is east of the track and on the southeast corner of the abutment.

G_2.—One-fourth mile north of *Accotink*, *Fairfax County*, *Va*. The bottom of a square cut in the north abutment to the small wooden railroad bridge No. 20. It is west of the track, on the offset below the top, on which the end of the bridge rests.

G_1.—*Cameron Run*, 3 miles south of *Alexandria*, *Va*. The bottom of a square hole cut in the top of the third step (down) of the granite abutment to the iron railroad bridge of the Baltimore and Potomac, over Cameron Run. It is east of the track, on the north abutment, and is lettered the same as I_1.

G.—*Alexandria, Va.* A mark, thus (□), near the middle of the sill of the northwest window of the custom-house. It is 0·12 metre from the extreme west edge of the sill and 0·115 metre from the extreme east edge.

No. XI.—*West Washington, D. C. (Georgetown).* See page 627.

DESCRIPTIONS OF PERMANENT BENCH MARKS ON LINE OF LEVELS BETWEEN OLD POINT COMFORT AND RICHMOND, VA.

Old Tidal.—*Old Point Comfort Light-House, Virginia.* It is on the southwest side of the light-house at Fort Monroe—a figure, thus U.S.C.S., cut in the stone about 1½ feet from the ground. The reference point is the middle of the lower horizontal edge of the indenture. The cut in the stone has the following dimensions: Top 0·161 metre long, bottom 0·185 metre, height at centre 0·0675 metre, and height at ends, respectively, 0·0675 metre north and 0·060 metre south. This mark was established in August, 1852, and was originally "a *line* cut in the wall."

U.—*Old Point Comfort, Va.* It is on the southwest side of the light-house at Fort Monroe—the center of a copper bolt leaded horizontally into the stone, directly beneath the "Old Tidal B. M." and 0·215 metre above the ground. The bolt is 0·0125 metre in diameter and 0·055 metre in length.

[N. B.—There is also a bench mark at the doorsill on the west side of the light-house, made by J. B. W. in 1884, and known as T, and another one, lozenge-shaped, established by Lieut. M. L. Wood in 1888.]

Fort.—*Fort Monroe, Va.* It is on the outer wall of the fort, close to and on the right-hand side of the postern gate. It is a cross (+) cut in the second granite block from the gate, being in the eleventh course of stone.

S.—*Newport News, Va.* It is on the stone doorsill on the south side of the Lafayette House, near the middle of the house, being the bottom of a square cut in the stone thus (□), at a distance of 0·055 metre from the south edge of the sill and 0·1663 metre from the extreme west edge.

R_3.—*Morrison, Warwick County, Va.* The centre of a cross in end of copper bolt leaded into the brick chimney of a one-story frame house in the yard of D. H. Jones's residence. The bolt is in the tenth course from the ground, on the north side of the chimney, and in the second brick from the outer or northeast corner.

R_2.—*Lee Hall, Warwick County, Va.* The centre of a cross in end of copper bolt leaded in the west wall of a two-story brick outhouse in the yard of E. C. Madison's residence. The bolt is in the seventh course above the ground and in the third brick from the southwest corner, on the west side of the house.

R.—*Williamsburg, Va.* The center of a copper bolt 0·058 metre long and 0·0125 metre in diameter, leaded horizontally in the north side of the courthouse, near the east end. The bolt is in the eleventh layer of bricks above the watershed of the building, and in the third brick from the corner of the north wing.

Q_4.—*Toano, James City County, Va.* The bottom of a square cut in the top of the brick foundation under the railroad water tank. It is in the top of the third sill from the track, 3½ inches from the west end and 2 inches from the north side of the foundation.

Q_3.—*Diascond, James City County, Va.* The intersection of a cross in end of copper bolt leaded in the brick chimney of the frame dwelling house owned by John Gordon and occupied by J. C. Glasebrook. The bolt is in the east side of the chimney, in the eleventh course of bricks above ground, and in the third brick from the northeast corner.

Q_2.—Near *Lanexa, New Kent County, Va.* The bottom of a square cut in the top of the raised portion of the brick culvert under the Chesapeake and Ohio Railway, just above the station. It is at the north end of the culvert and 0·5 metre from its west side. It is roughly lettered thus: U S □ B M.

Q.—*Providence Forge, New Kent County, Va.* The center of a copper bolt 0·058 metre long and 0·0125 metre in diameter, leaded horizontally in the north side of the chimney at the north end of Mr. Townsend's dwelling house. The bolt is in the eighth course of bricks from the ground and in the eighth brick from the north end of the chimney.

P_5.—*Roxbury, Charles City County, Va.* The intersection of a cross in end of copper bolt leaded in the brick chimney at the west end of T. L. Walker's residence. The bolt is in the tenth course of bricks from the ground and in the third brick from the west side of the chimney.

P_4.—One and a half miles easterly from *Richmond, Va.* The bottom of a square hole cut in the top of the stone coping to the brick culvert under the Chesapeake and Ohio Railroad, 140 metres east of milepost 81. It is on the south end of the culvert and on the eastern or largest stone of the coping on the raised part of the culvert at this end. It is roughly lettered thus:

U S
□
B M

P_3.—*Richmond, Va.*; corner of Seventeenth street and Winston alley. The bottom of a square cut in the top of the stone door and window sill (on which the iron columns in front of the building rest) of the brick building owned by Davenport & Morris and occupied by the Union Brokerage, Commission, and Warehouse Company. It is at the northeast corner of the building and is nearly on a level with the pavement. It is lettered thus:

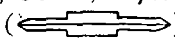
U. S.
C. & G. S.
□
B. M.

P_2.—*Richmond, Va.*, corner of Seventeenth and Dock streets. A cross (+) cut in the granite window sill of the window at the right-hand corner (as one faces the front of the building), on the front of the brick building owned and occupied by Davenport & Morris. It is lettered thus:

U. S.
C. & G. S.
+
B. M.

New City Hall.—*Richmond, Va.* The flat surface of an offset on the granite base to the lamp-post on the left of the steps leading to the west entrance to the new city hall. No marks were made. The stone is 30 by 30 inches; the reference point is the center of the square offset, size 2½ by 2½ inches, on the corner nearest the entrance and inside toward the steps. The city engineer's department knows and preserves the point.

P.—*Richmond, Va.;* Richmond College, at the head of Grace street. The bottom of a square cut in the granite sill of the east front door of the college, near the south end of the sill. It is 0·142 metre from the extreme east edge of the sill and 0·174 metre from the south edge of the door.

City B. M.—A stone post about 15 by 15 inches planted at the intersection of Poplar and Ash streets, *Richmond.* An iron plate is set in the side of the post facing the river and is inscribed as follows: "High-water line, 24 ft. 1·8 inch above ordinary high tide, Oct. 1, 1870." The mark is the middle line of a raised horizontal arrow on the plate ().

O.—*Richmond, Va.* (See page 628.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ST. AUGUSTINE AND CEDAR KEYS, FLA.

Fairfield.—Is about 6 inches from the east and south edges of the granite coping to the sea wall at the corner of the entrance to the basin opposite the plaza at *St. Augustine, Fla.*, and is supposed to be very nearly the same as the one used in 1854, although the coping is slightly out of position.

Hitchcock.—Established at *St. Augustine, Fla.*, in 1870 or 1874, and recovered in 1892. Is a triangle with hole in center, cut in the vertical face of the sea wall about 1½ feet from its base and 28¼ feet south of the wharf; 5·84 feet above the bench mark is a similar triangle cut on the seventh stone from the wharf, on the top of the sea wall.

Tidal.—A piece of iron 1 inch square was driven into the face of the sea wall at *St. Augustine, Fla.*, a few feet south of B. M. A, and 1·9 metres below the top of the wall. It is painted white and projects about 6 inches. The bench mark is the upper surface of the rod, just inside a line filed across it.

A.—The bottom of a square cut in the top of the granite coping to the sea wall at *St. Augustine, Fla.* The mark is about the center of the top of the wall, 3 feet south of the south side of the basin opposite the plaza. It was lettered as follows:

U S
C & □ G S
B M

B.—The surface of a smooth place 2 by 2 inches in the granite coping to the sea wall at *St. Augustine, Fla.* It is near the southwest corner of the sixty-seventh stone south of the south side of the basin opposite the plaza. It is lettered as follows:

U S
□
B M

It is 107 metres south of basin.

C.—The bottom of a square cut in the top of the marble post marking the south-east corner of the United States reservation just west of the plaza at *St. Augustine*, *Fla.* The post office and custom-house stand on this reservation. The edges of the top of the post are broken off in an irregular manner. The post is marked:

□
U S

D.—The bottom of a square cut at the center of a marble post 8 by 8 inches by 3 feet, buried in the ground 30 inches, in the United States reservation at *St. Augustine*, *Fla.* It is just west of the west end of the custom-house and is quite near the building. The top of the post is marked as follows:

U S
C & □ G S
B M

E.—An artificial stone post in the yard to the residence of Mr. H. Wood at *Tocoi Junction*, *St. Johns County*, *Fla.*, near the southeast corner of the house. (See note 13, page 551.)

F.—An artificial stone post in the southwest corner of the front yard to residence of Philip Weedman at *Middleton*, *St. Johns County*, *Fla.* It is quite near the fence on both sides. (See note 13, page 551.)

G.—A marble post in the yard of Mr. Thomas H. Hastings, at *Hastings*, *St. Johns County*, *Fla.*, near the back steps to the veranda on the west side of the house. (See note 13, page 551.)

H.—An artificial stone post at the northeast corner of the railroad station platform at *Buena Vista*, *St. Johns County*, *Fla.* There are no other buildings near the station and no inclosures. (See note 13, page 551.)

I.—The bottom of a square cut in top of an 8 by 8 by 18 inch marble post buried 16 inches in the ground. A quantity of sand and cement was mixed to form a mortar in which to set the post to make it more solid. It is in the front yard to the residence of Mr. J. E. Gould, at *East Palatka*, *St. Johns County*, *Fla.* The top of the post is marked as follows:

U S
□
B M

J.—The bottom of a square cut in the granite doorsill to the north door on west side of Florida Southern Railroad offices at *Palatka*, *Putnam County*, *Fla.* It is near the south side of the door. It was roughly lettered the same as B. The building is a two-story brick, near the St. Johns River, at the west end of the Jacksonville, St. Augustine and Halifax Railroad bridge over the river.

Francis.—The bottom of a square cut in the top of an artificial stone post 8 by 8 by 36 inches buried 30 inches in the ground. It is in the southwest corner of the yard to a small dwelling house, at *Francis*, *Putnam County*. *Fla.*, which belongs to R. D. Howell. The house is north of the track, faces the railroad, and is the second house west of the railroad station. The top is lettered the same as A.

K.—An artificial stone post the same as B. M. Francis, in the southwest corner of the yard to the dwelling house of Mr. T. W. Ralp, at *Hollister*, *Putnam County*, *Fla.* This house faces the railroad and is a short distance west of the railroad station, north of the track.

L.—An artificial stone post the same as B. M. Francis, in the small triangular inclosure in front of Mr. James M. Earskine's feed store, at *Interlacken, Putnam County, Fla.* This store is opposite the railroad station on the north side.

M.—An artificial stone post the same as B. M. Francis, in the inclosure just north of L. J. Stokes' store, at *McMeekin, Putnam County, Fla.* The store is north of the track, a short distance west of the railroad station.

N.—The intersection of a cross in end of copper bolt leaded in the brick chimney on the south side (next to railroad track) of the one-story frame dwelling house belonging to W. T. Broswell, at *Hawthorn, Fla.* The house is north of the track, a short distance east of the railroad station. The bolt is in the eighteenth course above the ground and in the second brick from the southwest corner of the chimney.

O.—The intersection of a cross in end of copper bolt leaded in the brick chimney on the north end of the one-story frame dwelling house belonging to J. N. Craig, at *Hawthorn, Fla.* The house is north of the railroad track, about half a block from the railroad station. The bolt is in the eighteenth course above the ground and in the corner brick at the northeast corner of the chimney.

P.—An artificial stone post the same as B. M. Francis, at *Grove Park, Alachua County, Fla.* It is in the northeast corner of a lot owned by M. S. Spray, just across the street south of the railroad station. The corner lot next the bench mark is occupied by a frame building used as a store.

Q.—The intersection of a cross in end of copper bolt leaded in the brick chimney at the north end of the one-story frame dwelling house at *Rochelle, Alachua County, Fla.*, owned by J. W. Phifer. The bolt is in the fifteenth course above the ground and in the brick which extends to the northwest corner of the chimney. The bolt is in the west side of the chimney. The brick is very soft.

R.—The bottom of a square cut in the top of an 8 by 8 by 26 inch marble post, buried 24 inches in the ground, in the southwest corner of the court-house yard at *Gainesville, Fla.* An iron fence surrounds the yard. Several inches of concrete were placed under the post. It was lettered the same as A.

S.—The middle of the smooth band on the outer edge of the iron doorsill to the door leading to the second story of the brick Barnett Block at *Gainesville, Alachua County, Fla.* The building faces the courthouse square and is south of its southwest corner. The iron band is raised slightly above the rest of the sill. No mark was made on it. The bench mark is in the middle of the doorway on the surface of this smooth band. The door is in the middle of the front of the building and the rooms on either side are used as stores.

T.—The bottom of a square cut in the upper surface of the first step above the ground on the right of the steps leading to the west entrance to the brick courthouse, at *Gainesville, Alachua County, Fla.* The steps are of artificial stone and the bench mark is on the lowest step on the right hand as you enter the building and near the wall. It was lettered the same as A.

U.—The bottom of a square cut in the top of a piece of artificial stone 8 by 8 by 14 inches buried with its upper surface 10 inches beneath the surface of the ground, at *Arredonda, Alachua County, Fla.* It is in the corner of an orchard belonging to D. G. Harvard and is 0·9 metre from the nearest corner post. The rest of the post, 22 inches long, broken off in transportation, was left lying on the ground near the bench mark. The top of the post is lettered the same as A.

V.—The bottom of a square cut in the top of one of the stones forming the foundation to the brick chimney at the west end of a small house at *Palmer*, *Alachua County*, *Fla.* Neither the foundation nor chimney is very substantial, but it was the only available place for a bench mark. The stone is on the top of the foundation at the northwest corner, about 2 feet above the ground. On the rough face of the stone under the bench mark the letters U S B M were roughly cut. The house is north of the track, a little west of the railroad station and belongs to C. E. Farrer.

Archer.—The intersection of a cross in end of a copper bolt leaded in the brick chimney on the south side of Mr. C. W. Banknight's house, at *Archer*, *Alachua County*, *Fla.* The house is a short distance north of the track and nearly opposite the old freight depot of the Florida Central and Peninsular Railroad. The bolt is in the ninth course above the ground and in the second brick from the southwest corner of the chimney. The brick is very soft, and the end of the bolt is about one-fourth inch inside the outer surface.

Albion.—The bottom of a square cut in the top of the corner brick (northwest) to the foundation to the small new chimney at the west side of the frame building north of the railroad station at *Albion*. This building is at present used as post office, express office, etc. This bench mark was established at the request of a civil engineer who is in charge of one of the phosphate mines in the vicinity.

W.—The intersection of a cross in end of a copper bolt leaded in the south side of the brick chimney at the west end of Mrs. L. E. Taylor's house, at *Bronson*, *Levy County*, *Fla.* The house is north of the track and nearly opposite the railroad station. The bolt is in the ninth course above the ground and in the second brick from the southwest corner of the chimney. The chimney is a new one and may possibly settle, but it was the only available place for a bench mark.

Otter Creek.—The intersection of a cross in end of a copper bolt leaded in the south side of the brick chimney on the east end of the two-story frame house at *Otter Creek*, *Levy County*, *Fla.* The bolt is in the eighteenth course above the ground and in the second brick from the southeast corner of the chimney. The house belongs to J. B. Coarsey and is rented and used as a boarding house.

X.—An artificial stone post, the same as B. M. Francis, in front yard of a house at *Ellzey*, *Levy County*, *Fla.* The house is occupied (1892) by J. A. Williams, railroad agent and postmaster, and is a small, one-story frame, south of the track and west of the railroad station. The stone is in the northeast corner of the front yard.

Rosewood.—An artificial stone post, the same as B. M. Francis, near the front of the store and post-office at *Rosewood*, *Levy County*, *Fla.* The land belongs to the estate of C. B. Dibble, and the store is the only one in the place. The post is just inside the fence, near the west side of the front porch.

Tidal.—An iron rod, 6 feet long and 1 inch in diameter, with head 2 by 2 inches, was driven in the sand, with the head a little below the surface, at the southwest corner of a carpenter's shop at the south end of D street, *Cedar Keys*, *Fla.* It can be reached in one station from the tide staff. The upper surface of the head of the rod is the bench mark.

Perkins.—Inquiry was made for the house described below, and one at northwest corner of B and Second streets was pointed out as having been built in 1877. The point used as this bench mark was the lower edge of the wooden window sill 0·2 metre from its east end. The window sill is well preserved and is apparently undisturbed. "Bench mark is the under edge of the sill of the front window at the southeast corner of the new concrete store, built in 1877 by Thomas Barnes."

Y.—The intersection of a cross (+) cut in the south face of the north iron pier of the Transit of Venus station, at *Cedar Keys, Fla.* There are two iron piers and one brick pier standing in the park at the east end of the town of Cedar Keys, and this bench mark is on the north iron pier. The cross is in the surface of the round pier 0.73 metre below the top. It was roughly marked as follows:

U S
+
B M

Z.—The upper surface of the bottom of a square opening in the south side of the south iron pier used at the Transit of Venus station at *Cedar Keys.* There are two iron piers and one brick pier standing in the park at the east end of the town, and this bench mark is on the south pier. The opening cut in the side of the pier is rectangular, 0·10 metre wide and 0·15 metre high. The bench mark is the surface of the iron at the center of the opening where a small cut is made. It was marked U S B M below the opening. Both iron piers are round.

Transit.—The intersection of a cross in end of a copper bolt leaded in the south face of the brick transit pier of the Transit of Venus station at *Cedar Keys.* The bolt is in the sixth course above the ground and in the second brick from the southwest corner of the pier.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN VICKSBURG AND MERIDIAN, MISS.

No. 211.—*Willow Glen Plantation, near Delta, La.* (See page 610.)

S. W. Base.—The top of the copper bolt leaded in the top of the 14 by 14 inches limestone post marking the south end of the Delta base line. The stone stands just south of the Vicksburg, Shreveport and Pacific Railway in the south edge of the village of *Delta, Madison Parish, La.*, and is apparently undisturbed. It is east of the road which forms the main street of the village.

N. E. Base.—The bottom of a square cut in the top of the 14 by 14 inches limestone post marking the north end of the Delta base line. The stone stands in the cotton field near the switch of the Vicksburg, Shreveport and Pacific Railway above the incline leading to the transfer crossing on the Louisiana bank. The stone is firmly fixed in position, but its top is about 0·2 metre below the surface of the ground (November, 1896). The copper bolt has been disturbed, and the square cut is 0·01 metre north of the copper bolt.

B.—The intersection of a cross in end of a copper bolt leaded in the north end of the brick pumping station of the Vicksburg waterworks. The building is on the flat bank of the river under the hills and about 1·6 kilometres south of the city limits of

Vicksburg, Miss. The bolt is in the first course above the water table and in the third brick from northwest corner of building.

M. R. C. $\frac{101}{1}$.—Established by the Mississippi River Commission, at *Kleinston, Miss.*, and is one of their "Stone Line" bench marks. It is a granite post, 6 by 6 inches, planted in the ground just inside the track of the Vicksburg, Shreveport and Pacific Railway, leading to the incline of the transfer crossing on the Mississippi side. The stone is north of and quite near the main road leading to the steamboat and ferry landing. The top of the copper bolt leaded in the top of the post is the bench mark. The top of the post is marked U. S. A wooden post and a portion of a railroad rail are planted near the stone to protect it from passing wagons.

A.— *Vicksburg, Miss.* Established by Maj. J. H. Willard, Corps Engineers, U. S. A., who described it as follows: "B. M. A is top of permanent cap on iron pipe planted on downstream edge of crown of second piece of old levee directly across the road from and back of B. M. $\frac{101}{1}$ about 180 feet, (about 5 feet 9 inches higher than $\frac{101}{1}$)." The top of the cap just off the slight ridge across the top was used as the bench mark. This distance from B. M. $\frac{101}{1}$ is 106 metres, instead of 180 feet, as stated above.

Cistern.—The intersection of a cross cut on the iron top to a cistern in the railroad yard of the Alabama and Vicksburg Railway, at *Vicksburg, Miss.* This cistern is between the railroad tracks just north of the freight depot of the railroad, west of Washington street. It is the same point used by the railroad engineers and by the United States engineers.

C.—A marble post, buried 1·2 metres in the ground in the southwest corner of the park west of the Alabama and Vicksburg Railway passenger station at *Vicksburg, Miss.* The stone is dressed on top to 0·250 by 0·175 metre, and the bottom of a square, cut in the top at its center 0·009 metre deep, is the bench mark. The top projects 0·25 metre above the surface of the ground and is lettered as follows:

U S
C & □ G S
B M

D.—An iron pipe driven in the ground in the railroad yard in front of the passenger station of the Alabama and Vicksburg Railway at *Vicksburg, Miss.* It is about 1·2 metres south of the base of the vertical face of the deep cut forming the north line of the yard. A cross cut on the permanent cap of the pipe at its north edge is the bench mark. This pipe has a circular disk about 0·15 metre in diameter attached to it near the bottom.

E.—An iron pipe driven in the ground just inside the right of way fence of the Alabama and Vicksburg Railway about 100 metres east of the first overhead (road) bridge (over railroad) about 2 kilometres east of *Vicksburg*. The bench mark is south of the track near the fence and on the slope leading out of the first depression east of said bridge, 6 metres west of second telegraph pole east of bridge. A cross cut in the top of the permanent cap at its north edge is the bench mark.

F.—An iron pipe driven in the ground just inside the right of way fence of the Alabama and Vicksburg Railway about 3 kilometres east of *Vicksburg*. Bench mark is 10 metres west of fourth telegraph pole west of second overhead (road) bridge east of

Vicksburg, on south side of track. The top of the cap on the pipe is divided into four sections by lines cut into it intersecting at the center. The surface of the cap at the inner corner of the southwest quarter was used as the bench mark.

G.—The intersection of a cross in end of copper bolt leaded in the brick chimney to the residence of J. A. Newman, at *Newman's* Station, *Miss.* Bolt is in north face of the chimney on west end of house, in the twelfth course above the ground, and in second brick from northwest corner. There is a crack across the back of the chimney.

H.—The intersection of a cross in end of copper bolt leaded in the front (south) wall of the brick building just east and north of the railroad station at *Bovina, Miss.* The building is owned by the district school and is used as a store. The bolt is in the twenty-second course above the ground (fifteenth course above the sidewalk) and in the second brick from the southwest corner of the building.

I.—The bottom of a square cut in the top of the stone supporting the end of the iron superstructure of the Alabama and Vicksburg Railway bridge over *Big Black River* The mark is on the west abutment of the bridge, south of the track and about 2 metres below the top of the rails. The following letters were cut:

U S
□
B M

J.—The bottom of a square cut in the top of the remains of the old stone pier to the old railway (A. and V.) bridge over *Big Black River.* The old pier is on the east bank of the river between the two iron piers under the new bridge. The bench mark is on the southwest corner of the old pier, and is lettered the same as I.

K.—The surface at the intersection of a cross cut on top of a piece of railroad iron buried firmly in the ground. The iron marks the northeast corner of a lot at *Smith's* Station, owned by John Fleckenstein. It is south of the track and east of the cottonseed warehouse of Mississippi Cotton Oil Company, Capital City Mill, and near the railway right of way.

L.—The intersection of a cross in end of a copper bolt leaded in the side (east) wall of the brick railroad station building at *Edwards, Miss.* The bolt is in the eleventh course above the ground and in the second brick from southeast corner of the building.

M.—The bottom of a square cut in the top of the stone pier under the railroad bridge over Bakers Creek, about 5½ kilometres east of *Edwards, Miss.* The pier is on the east bank under the trestle work just east of the end of the iron bridge and the bench mark is south of the track near the south edge of the pier. It is lettered the same as I.

N.—The bottom of a square cut in the top of the stone pier under the west end of the iron railroad bridge over Bakers Creek, about 1 kilometre west of *Bolton, Miss.* The pier is on the west bank of the creek and the bench mark is south of the track and near the south edge of the pier. This end of the pier is rounded. It is lettered the same as I.

O.—The bottom of a square cut in the top of the coping to the stone arch culvert about one-half kilometre west of *Clinton, Hinds County, Miss.* The mark is north of the track, a little west of the center of the arch. It is lettered the same as I.

P.—The bottom of a square cut in the stone water table to the stone basement of the United States courthouse and post office at *Jackson*, *Miss.* The bench mark is under the center of the east window in the north front of the building. The square cut is 6 millimetres deep and lettered:

U S
C & □ G S
B M

Q.—The bottom of a square cut in the top of one of the bricks in the retaining wall to the small culvert (earthenware pipe) under the railroad just west of the railroad water tank on west bank of Pearl River at *Jackson*, *Miss.* The bench mark is south of the track and on the brick at the west end of the third course above the earthenware pipe.

R.—The bottom of a square cut in the top of the brick retaining wall to the culvert (large iron pipe) under the railroad 200 metres east of *Pearsons*, *Rankin County*, *Miss.* The bench mark is on the top course of brick just east of the one which is above the center of the pipe and is south of the track. It is lettered the same as I.

S.—The bottom of a square cut in the top of the brick retaining wall to the culvert (small earthen pipe) under the railroad at *Greenfield* post office, *Rankin County*, *Miss.* The mark is north of the track and near the outer edge of the wall. The culvert is at the west end of the switch. It is lettered the same as I.

T.—The bottom of a square cut in the top of the brick retaining wall to the culvert under the railroad just west of the railroad station at *Brandon*, *Rankin County*, *Miss.* The bench mark is north of the track on the third row of bricks back from the face of the wall and west of the center of the culvert. It is lettered the same as I.

U.—The bottom of a square cut in the top of one of the stones forming the foundation under one of the supports to the railroad water tank at *Rankin*, *Rankin County*, *Miss.* The bench mark is on the southwest corner of the stone under the south one of the two most westerly supports. It is lettered the same as I.

W.—The intersection of a cross in end of copper bolt leaded in the front wall of the Lessel House at *Pelahatchie*, *Rankin County*, *Miss.* This hotel is a two-story brick building north of the track opposite the railroad station. The bolt is in the bottom course of fire brick (with which the front wall is faced) and in the second brick from the southeast corner of the building.

X.—The bottom of the square cut in the upper surface of the large earthenware pipe used as a railroad culvert just west of *Clarksburg*, *Rankin County*, *Miss.* The bench mark is south of the track on the highest part of the pipe, which projects 0.25 metre outside the brick retaining wall. It is lettered the same as I.

Y.—The central surface inside four lines forming a square, cut in the upper surface of the large iron pipe used as a culvert under the railroad at *Morton*, *Scott County*, *Miss.* The bench mark is at the north end of the pipe (north of the track) and at the highest point of the upper surface, just inside the enlarged portion at the edge. The following letters were cut:

U S □ B M

The culvert is a short distance west of the railroad station.

Z.—The intersection of a cross in end of copper bolt leaded in the county jail building (brick) at *Forest*, *Scott County*, *Miss.* The bolt is in the front (east) wall in the third course above the corner stone and in the third brick from the northeast corner of the building.

A_1.—The intersection of a cross in end of a copper bolt leaded in a brick chimney at *Lake*, *Scott County*, *Miss.* The bench mark is in the east side of the east chimney on the south end of a dwelling house owned by Mrs. Prestridge. The house is north of the track and about 200 metres west of the railroad station. The bolt is in the third course above the ground and the second brick from the southeast corner of the chimney.

B_1.—The intersection of a cross in end of a copper bolt leaded in the front (east) wall of a brick store at *Newton*, *Newton County*, *Miss.* This building belongs to T. J. Bingham and stands south of the track on the west side of the main street of the town, with its south wall just outside the railroad right of way. The bolt is in the fifth course above the sidewalk and in the second brick from the southeast corner of the building.

C_1.—The intersection of a cross in end of copper bolt leaded in the chimney on the east end of the dwelling house of A. E. Gray, at *Hickory*, *Newton County*, *Miss.* The house is south of the track and immediately west of the Hanner House. The chimney is on the east end of the house, and the bolt is in the north face in the nineteenth course above the ground and in the second brick from the northeast corner.

D_1.—The bottom of a square cut in the cement covering the top of the brick retaining wall to the small culvert at *Chunkey*, *Newton County*, *Miss.* The culvert is near the railroad station, on the east side, and the bench mark is north of the main track, between it and the switch.

E_1.—The top of an iron bolt of the railway bridge (iron) over Chunkey River (second crossing east of *Chunkey* station). The bolt is set in the stone pier under the west end of the bridge and helps to hold the iron plate under the west end of the superstructure in position. It is south of the track, at the west end of the plate, and inside the superstructure. The top of the bolt was hammered to a level surface and the rod held upon it. The stone of which the pier is composed is soft and irregular.

F_1.—The surface at the intersection of a cross cut in the top of the elbow on top of the 2½-inch pipe of the small artesian well in the yard of W. J. Graham, at *Graham* station, *Lauderdale County*, *Miss.* The pipe extends 20 feet into the ground and has been in position for several months. There is a large artesian well in the yard, near the small one. The following letters were cut:

U S
+
B M

G_1.—The bottom of a square cut in the upper surface of the brick lining to the railroad tunnel 8 miles west of *Meridian*, *Miss.* The bench mark is at the west entrance to the tunnel in the fifth course above the end of the ties, counting around the lining, and in the third brick from the west end of the tunnel. The following letters were cut:

U S
B □ M

The bench mark is north of the track.

C.—*Meridian*, *Miss.* (See page 594.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN CORINTH, MISS., AND MEMPHIS, TENN.

V.—*Corinth, Alcorn County, Miss.* (See page 596.)

W.—*Corinth, Alcorn County, Miss.* (See page 596.)

L.—*Chewalla, McNairy County, Tenn.* The intersection of a cross in end of copper bolt leaded in the side face of brick chimney on east end of frame house occupied by F. S. McCallar, railroad agent, at Chewalla. The bolt is in the fourteenth course above the ground and in the second brick from the end of the house, and in the side of the chimney toward the front of the house. The house is north of the track and east of the public road.

M.—*Cypress Creek, Tennessee.* The bottom of a square cut in the top of the stone pier of the iron railroad bridge over Cypress Creek. It is on the pier on the east bank of the creek and is south of the track, outside of the superstructure of the bridge, near the outer edge of the pier. The letters U. S. B. M. were roughly cut near it.

N.—*Pocahontas, Tenn.* The intersection of a cross in end of copper bolt leaded in the front face of the Brick Hotel. The bolt is in the twelfth course above the ground and in the third brick from the southwest corner of the building. The hotel is north of the track and nearly opposite the railroad station. It is kept by Mr. Seay, the railroad agent.

O.—*Middleton, Hardeman County, Tenn.* The intersection of a cross in end of copper bolt leaded in the face of the west side wall to the brick store just west of the hotel. The building faces the railroad and is quite near it. The bolt is in the fourth course below the front doorsill and in the second brick from the northwest corner of the building.

P.—*Saulsbury, Hardeman County, Tenn.* The intersection of a cross in end of copper bolt leaded in the face of the west side wall to the brick store owned and occupied by R. M. Wright. The bolt is near the southwest corner, in the twenty-first course above the ground, and in the fifth brick from the southwest corner.

R.—*Grand Junction, Tenn.* The intersection of a cross in end of copper bolt leaded into the face of the front wall to the brick store owned and occupied by W. R. Robinson. The store is north of the track and a short distance east of the railroad crossing. The bolt is near the southeast corner of the building, in the fourth course above the front porch, and in the second brick from the southeast corner.

I.—*La Grange, Fayette County, Tenn.* The bottom of a square cut in the top of the stone abutment to the railroad bridge over Main street. The abutment is on the east side of the street and is north of the track.

K.—*La Grange, Fayette County, Tenn.* The bottom of a square cut in the top of the stone abutment to the railroad bridge over Main street. The abutment is on the west side of the street and is south of the track.

H.—*Moscow, Fayette County, Tenn.* The bottom of a square cut in the rough face of one of the stones in the foundation of the railroad water tank. This mark is on the south face (next to the track) of the foundation, and 6·2 feet from the southwest corner.

G.—*Wolf River* railroad bridge. The bottom of a square cut in the top of the stone pier to the iron railroad bridge over Wolf Creek. It is on the pier on the east bank of the creek, on the inner side of the raised portion on the north end of the pier, and 1·5 feet from its eastern face. It was roughly lettered:

U S B M
□

F.—*Rossville*, *Fayette County*, *Tenn.* The bottom of a square cut about one-fourth inch deep, in the top of a ledge in the stone foundation of the railroad water tank. The mark is only a few inches above the ground, and is 2 feet north of the southeast corner of the foundation, and is on the east side of the tank.

E.—*Collierville*, *Shelby County*, *Tenn.* The intersection of a cross in end of copper bolt (five-eighths inch in diameter) leaded in the front of Duloney & Patrick's brick storehouse, which faces the public square and is on the east side, a short distance from the railroad. The bolt is in the eleventh course above the ground and in the third brick from the southwest corner of the building.

D.—*Bailey* Station, *Shelby County*, *Tenn.* The intersection of a cross in end of copper bolt leaded in the brick chimney on the west end of J. W. Brown's residence. The bolt is in the corner brick on the south or front face of the chimney and in the twenty-second course above the ground.

C.—*Germantown*, *Shelby County*, *Tenn.* The bottom of a square cut about one-fourth inch deep in the northwest corner of the upper surface of the stone cap to the brick pier, under the northwest corner of the platform to the railroad station.

B.—*White* Station, *Shelby County*, *Tenn.* The bottom of a square cut in the stone foundation to the railroad water tank. It is on the top of the offset, at the southwest corner of the tank, about 18 inches above the ground, and is marked as follows:

U S
□
B M

the letters being rudely cut in the limestone.

A.—*Buntyn*, *Shelby County*, *Tenn.* The upper surface of the first brick offset above the ground on the west side of the entrance to the Methodist Church. Three lines were cut in the brick, forming a square with the outer edge, and the bench mark is the upper surface of the brick within this square. It is on the third brick from the west side of entrance. This church is a substantial brick building.

P. B. M. Memphis.—*Memphis*, *Tenn.* Is the center of a hole in head of copper bolt leaded horizontally in face of subsill of first basement window from southwest corner, on west side of new custom-house. It is marked

U S
⊙
B M

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ANNAPOLIS, MD., AND WASHINGTON, D. C.

a.—Perkins's tidal bench mark at *Annapolis*, *Md.* On southwest corner of stone doorsill of Moss's chandler store, No. 23 (now No. 2) Market Space. Top of step.

Wood's.—A horizontal line directly below bench mark *a*. On side of step 0·158 metre below it. Marked U. S. C. & G. S.—M. L. W. '88.

b.—At *Annapolis, Md.* On granite block in foundation at northwest corner of brick building designated "D. M. Sprogle's Lumber, Brick and Lime Yard." Building torn down between 1876 and 1880.

5 S. R.—On front doorsill of house No. 5, Stribling Row, 7¾ inches from west door frame, 2 inches from edge of step, and 14 inches from west end of step. Naval Academy, *Annapolis, Md.*

1 S. R.—On projecting base, about 1 metre above ground, at northwest corner of house No. 1, Stribling Row, *Annapolis, Md.*

Obs.—On center of top of stone pier, 8 feet southwest of front of observatory building. *Annapolis, Md.*

Hern.—On northeast side of base of Herndon Monument, midway of length, about 2 inches out from face of shaft, and about 3 feet above ground. *Annapolis, Md.*

Taylor.—A trigonometrical station. On top of the hill where signal stood; exact point not recovered.

No. XIII.—At *Annapolis, Md.* On southwest corner of fourth granite block supporting iron fence around the governor's house, counting northeast from southwest corner. Marked by a cross cut in stone.

No. XII.—At *Annapolis, Md.* A cut in east corner of west doorsill of church on West street, opposite Washington Street Market.

No. VII.—On sill of danger signal at *Bowie* Station, Baltimore & Potomac Railroad, *Maryland.*

No. IV.—On west side of arch culvert near pump house, at *Wilson* Station, *Maryland.* Marked thus: ⊗.

Hill.—At trigonometrical station, near *Washington, D. C.*

No. II.—On northeast corner of curbstone of Navy-Yard Bridge, at east end of, and north side, *Washington, D. C.*

No. I or 5.—A cross on stone around Navy-Yard flagstaff near entrance gate, Washington, D. C.

New Coast Survey Office.—The center of central square in vestibule of main entrance. Building on New Jersey avenue near B street South, Washington, D. C.

Capitol B. M.—*Washington, D. C.* (See page 627.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN DENVER, COLO., AND ROCK CREEK, WYO.

A_2.—*Jersey, Colo.* (See page 590.)

B_2.—*Jersey, Colo.* (See page 590.)

N_2.—Established by the United States Geological Survey and described by them as follows: "Hotel Model, 1 mile north of; 18 feet northwest of U. P. R. R. track, on south side of highway, in sec. 6, T. 3 S., R. 67 W. Iron post marked 5131." (See note 7, page 549.) It is near *Denver, Colo.*

O_2.—Established by the United States Geological Survey and described by them as follows: "*Hazeltine*, 1·2 miles southwest of; 41 feet northwest of U. P. R. R. track, on north side of highway, 200 yards north of mile board 10, in sec. 16, T. 2 S., R. 67 W. Iron post marked 5090." (See note 7, page 549.)

P_2.—Established by the United States Geological Survey and described by them as follows: "*Henderson*, one-half mile northwest of; 196 feet northwest of main track of U. P. R. R. and on north side of highway, in sec. 35, T. 1 S., R. 67 W. Iron post marked 5033." (See note 7, page 549.)

Q_2.—Established by the United States Geological Survey near *Brighton*, *Colo.*, and described by them as follows: "School house No. 10, Arapahoe County, about one-fourth mile west of; 23 feet west of U. P. R. R. track, on north side of highway, 22 miles south of Greeley, in sec. 13, T. 1 S., R. 67 W. Iron post marked 5005." (See note 7, page 549.)

R_2.—Established by the United States Geological Survey and described by them as follows: "*Brighton*, about 1 mile north of; 24 feet west of U. P. R. R. track on south side of highway known as 'Base Line road.' Iron post marked 4966." (See note 7, page 549.)

S_2.—Established by the United States Geological Survey near *Lupton*, *Colo.*, and described by them as follows: "Bryan's ranch, 200 yards west of; 40 ft. west of U. P. R. R. track, on north side of public highway, in sec. 17, T. 1 N., R. 66 W. Iron post marked 4936." (See note 7, page 549.)

T_2.—Established by the United States Geological Survey at *Lupton*, *Colo.*, and described by them as follows: "Fort Lupton school grounds, northwest corner of; 190 feet west of U. P. R. R. track, in sec. 5, T. 1 N., R. 66 W. Iron post marked 4904." (See note 7, page 549.)

U_2.—Established by the United States Geological Survey near *Lupton*, *Colo.*, and described by them as follows: "Knowlton's ranch, one-fourth mile east of; 26 feet west of U. P. R. R. track, on south side of public highway, in sec. 20, T. 2 N., R. 66 W. Iron post marked 4869." (See note 7, page 549.)

V_2.—Established by the United States Geological Survey near *Platteville*, *Colo.*, and described by them as follows: "Cheese's ranch, one-fourth mile west of; 60 feet south of mile board 32, 31 feet west of U. P. R. R. track, on south side of public highway, about 300 feet east of main road between Platteville and Fort Lupton, in sec. 6, T. 2 N., R. 66 W. Iron post marked 4837." (See note 7, page 549.)

W_2.—Established by the United States Geological Survey and described by them as follows: "*Platteville*, one-half mile south of; 30 feet west of U. P. R. R. track, in sec. 19, T. 3 N., R. 66 W. Iron post marked 4819." (See note 7, page 549.)

X_2.—Established by the United States Geological Survey near *Platteville*, *Colo.*, and described by them as follows: "Moerhle's ranch, one-fourth mile south of; 36 feet west of U. P. R. R. track, on north side of public highway, in sec. 6, T. 3 N., R. 66 W., about 2.2 miles north of *Platteville* station. Iron post marked 4795." (See note 7, page 549.)

Y_2.—Established by the United States Geological Survey near *Nantes*, *Colo.*, and described by them as follows: "Lucerne's ranch, one-fourth mile northeast of; 20 feet west of U. P. R. R. track, on south side of public highway, about one-fourth mile east of northwest corner of sec. 23, T. 4 N., R. 66 W. Iron post marked 4724." (See note 7, page 549.)

Z_2.—Established by the United States Geological Survey and described by them as follows: "*La Salle*, *Colo.*, three-fourths mile north of; 60 feet west of U. P. R. R. track, and about 200 feet south of old Pikes Peak road, sec. 32, T. 5 N., R. 65 W. Iron post marked 4650." (See note 7, page 549.)

A_3.—Established by the United States Geological Survey and described by them as follows: "*Greeley, Colo.*, Tenth st., 9 feet north of south line thereof; 17 feet west of most westerly track of U. P. R. R., and 12 feet south of warning post. Iron post marked 4651." (See note 7, page 549.)

B_3.—Established by the United States Geological Survey. It is an aluminum tablet set in the face of the stone foundation to the brick church at *Lucerne, Weld County, Colo.* The tablet bears the usual inscription, and the intersection of a cross at the center of the tablet was used as the bench mark. The tablet is in the west wall of the church about the middle of the north recess.

C_3.—The intersection of a cross in the end of a copper bolt in the south wall of the brick r lroad depot at *Eaton, Weld County, Colo.* The bolt is in the first course above the stone trimming under the windows and in the fifth brick from the southeast corner of the building.

D_3.—A square cut in the top of a granite post (see note 3, page 549) in the southwest corner of the yard to the railroad section house at *Pierce, Weld County, Colo.*

E_3.—A square cut in the top of a granite post in the southeast corner of the yard to the railroad section house at *Dover, Weld County, Colo.* (See note 3, page 549.)

F_3.—A square cut in the top of a granite post in the southwest corner of the yard to the railroad section house at *Carr, Weld County, Colo.* (See note 3, page 549.)

A.—A square cut in the top of a granite post set in the northeast corner of the yard to the railroad section house at *Athol, Laramie County, Wyo.* (See note 3, page 549.)

B.—The bottom of a square cut in the top of the stone foundation under one of the iron supports to the city viaduct across the Union Pacific Railroad yard at *Cheyenne, Wyo.* The mark is on the stone under the west support of the first pair inside the park north of the main track and at its southwest corner. The following letters were cut:

U S
□
B M

C.—The bottom of a square cut in the upper surface of the stone window sill to a window in the brick carpenter's shop (U. P. R. R. shops) at *Cheyenne, Wyo.* The mark is on the sill under the west window in the north side of the shop. It is lettered the same as B.

D.—The bottom of a square cut in the upper surface of the stone window sill under a window in the brick machine shop (U. P. R. R. shops) at *Cheyenne, Wyo.* The mark is on the sill under the west window in the north side of the shop. It is lettered the same as B.

E.—Established by the United States Geological Survey. It is a bronze plate set in the stone floor of the vestibule to the front (south) entrance to the State Capitol building at *Cheyenne, Wyo.* It is near the top of the steps between the west side wall and the first column. The surface of the plate at the intersection of a cross was used as the bench mark. The plate bears the usual inscription.

F.—A square cut in the top of a granite post near the southwest corner of the railroad section house at *Borie, Laramie County, Wyo.* (See note 3, page 549.)

G.—The bottom of a square cut in the upper surface of the stone under one of the iron supports under the railroad water tank at *Otto, Laramie County, Wyo.* It is on the stone under the north support on the east side of the tank. It is lettered the same as B.

H.—A square cut in the top of a granite post near the southwest corner of the railroad section house at *Granite Canyon, Laramie County, Wyo.* (See note 3, page 549.)

I.—The bottom of a square cut in the upper surface of a stone under one of the iron supports to the railroad water tank at *Sherman, Albany County, Wyo.* It is on the stone under the western of the two supports under the south side of the tank (nearest the track) at its southwest corner. It is lettered the same as B.

J.—The bottom of a square cut in the top of one of the foundation stones to the Ames monument at *Sherman, Albany County, Wyo.* This stone is on the east side of the monument near its northeast corner. It is about 4 feet long, projects about 2 feet beyond the edge of the monument, and its upper surface is about even with the ground. It is lettered the same as B.

K.—The bottom of a square cut in the top of a stone under one of the iron supports under the railroad water tank at *Dale Creek, Albany County, Wyo.* The mark is on the stone under the western support of the two under the north side of the tank (nearest the track) at the northwest corner of the stone. It is lettered the same as B.

L.—The bottom of a square cut in the top of the stone abutment to the *Dale Creek* (iron) railroad bridge, *Albany County, Wyo.* The mark is on the top of the abutment at the west end of the bridge and is south of the railroad track. It is lettered the same as B.

M.—The bottom of a square cut in the top of the stone foundation under the north end of the elevated railroad track running through the coal chutes at *Red Buttes, Albany County, Wyo.* The mark is at the east end of the stone foundation. It is lettered the same as B.

N.—The intersection of a cross in the end of a copper bolt in the stone wall of the basement to the courthouse at *Laramie, Albany County, Wyo.* The bolt is in the north wall in the stone forming the northwest corner of the building. The stone above is marked 1871 on its western face and the water table upon which the brick superstructure rests is one course above the bolt.

O.—The bottom of a square cut in the top of a stone pier under the iron railroad bridge over the Laramie River at *Laramie, Wyo.* The mark is on the pier on the south bank of the river is west of the track and between the iron superstructure and the west rail. It is lettered the same as B.

P.—A square cut in the top of a granite post set in the ground near the railroad section house at *Howell, Albany County, Wyo.* (See note 3, page 549.)

Q.—The bottom of a square cut in the upper surface of a stone under one of the iron supports to the railroad water tank at *Wyoming, Albany County, Wyo.* The mark is on the stone under the west one of the two supports under the north side of the tank (nearest the side track) near the northwest corner. It is lettered the same as B.

R.—The bottom of a square cut in the upper surface of one of the stones under the iron supports to the railroad water tank at *Coopers Lake, Albany County, Wyo.* The mark is on the stone base to the support nearest the track of the two supports under the west side of the tank. It is near the southeast corner of the stone supporting a stone on which the iron support rests. It is lettered the same as B.

S.—A square cut in the top of a granite post at *Lookout, Albany County, Wyo.* The post is on the railroad right of way just inside the fence, to the west of the public road, and is in front of the railroad station. (See note 3, page 549.)

T.—The surface of the iron base to the iron support under the railroad water tank at *Harper, Albany County, Wyo.* A cross (+) was cut on the iron base of the north one of the two supports under the west side (nearest the track) of the tank to indicate the position of the bench mark. It is on the flat projection nearest the track and is near the bolt which fastens down the column.

U.—The bottom of a square cut in the top of a stone pier under the Union Pacific Railroad bridge over Rock Creek, near *Rock Creek, Albany County, Wyo.* The mark is on the pier north of the creek and is east of the track. It is lettered the same as B.

V.—A square cut in the top of a granite post at *Rock Creek, Albany County, Wyo.* The post is in the front yard to the residence of William Taylor, just inside the front fence, and is in the northeast corner. There are two posts in the yard, and this bench mark is on the post to the south, or on the left as you face the house. (See note 3, page 549.)

W.—A square cut in the top of a granite post at *Rock Creek, Albany County, Wyo.* The post is in the front yard to the residence of William Taylor, just inside the front fence, and is in the northeast corner. There are two posts in the yard and this bench mark is on the post to the north, or on the right as you face the house. (See note 3, page 549.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ABILENE AND SOLOMON, KANS., AND NORFOLK, NEBR.

B_1.—*Abilene, Kans.* (See page 579.)

C_1.—*Solomon, Kans.* (See page 579.)

W_2.—A crystallized limestone post in the small park in front of Atchison, Topeka and Santa Fe Railroad station, and 4·6 metres south of the track in *Solomon, Dickinson County, Kans.* (See note 3, page 549.)

X_2.—A copper bolt (see note 1, page 548) in the east brick wall of the stone building belonging to the Masonic fraternity on the north side of Main street in *Solomon, Kans.* It is in the fourteenth course above the foundation and in the seventh brick from southeast corner.

Z_2.—A copper bolt leaded into the sandstone coping on the south side of the east abutment of the wagon bridge over Mud Creek, about a half mile west of the Union Pacific station in *Abilene, Dickinson County, Kans.* The bolt is set vertically 5½ feet from bridge and its top forms the bench mark.

Y_2.—A crystallized limestone post (see note 3, page 549) in the northwest angle made by the crossing of the Strong City branch of the Atchison, Topeka and Santa Fe Railroad with the Union Pacific Railroad at *Abilene, Kans.* It is 11·5 metres from the Union Pacific and 10·2 metres from the Atchison, Topeka and Santa Fe track.

A_3.—A crystallized limestone post (see note 3, page 549) south of the Atchison, Topeka and Santa Fe Railroad station at *Talmage, Kans.* It is 70·2 metres south of the north end of curve No. 73 and 2·05 metres east of track.

B_3.—The bottom of a square cut in the southwest corner stone of the abandoned foundation of the pumping station, now (1899) used as a cellar, in the town of *Man-*

chester, Dickinson County, Kans. It is 0·25 metre from west and 0·075 metre from south face of stone.

C_3.—A copper bolt (see note 1, page 548) in the foundation of the building belonging to the Salina Cement and Plaster Company at *Longford, Clay County, Kans.* It is 0·21 metre north of the doorway to the boiler room and 0·34 metre below the woodwork.

D_3.—A crystallized limestone post (see note 3, page 549) on the right of way of the Atchison, Topeka and Santa Fe Railroad between the station and the Santa Fe Hotel at *Oak Hill, Clay County, Kans.* It is in a group of three trees and 1·2 metres from the central one.

E_3.—A copper bolt (see note 1, page 548) in the largest stone in the southwest corner of the stone house owned by J. W. Catlin, and near south end of trestle No. 33 over Chapman Creek, in the township of *Catlin, Cloud County, Kans.* It is 0·21 metre from the corner and on the west face of building.

F_3.—The bottom of a square cut on the northwest of the twenty-one cubical sandstone blocks supporting the water tank of the Atchison, Topeka and Santa Fe Railroad at *Miltonvale, Cloud County, Kans.*

G_3.—A crystallized limestone post (see note 3, page 549) near the signpost of the flag station on the Atchison, Topeka and Santa Fe Railroad called *Sulphur Springs, Cloud County, Kans.* The public road crosses the track between the bench mark and the station sign. It is 14·5 metres north of sign and 4·6 metres east of track.

H_3.—A crystallized limestone post (see note 3, page 549) between the second and third trees in the park of the Atchison, Topeka and Santa Fe Railroad, just south of their station at *Aurora, Cloud County, Kans.*

I_3.—A crystallized limestone post (see note 3, page 549) east of the Atchison, Topeka and Santa Fe Railroad track and opposite the stock yards, 130 metres south of the depot at *Huscher, Cloud County, Kans.* It is 0·3 metre west of the east fence marking right of way.

J_3.—The bottom of a square cut on the limestone forming the north coping of the west porch of the courthouse in *Concordia, Cloud County, Kans.* It is lettered the same as the stone posts. (See note 3, page 549.)

Concordia City.—The southwest edge of the fourth and top iron step at the northwest corner of the First National Bank building at *Concordia, Cloud County, Kans.* It is the surface of the raised portion and is 0·036 metre from the iron casing and 0·12 metre from the stone work. Not marked.

K_3.—The bottom of a square cut on the northeast foundation stone of the water tank belonging to the Atchison, Topeka and Santa Fe Railroad Company, and about one-fourth mile north of their station at *Concordia, Cloud County, Kans.* It was lettered the same as the stone posts. (See note 3, page 549.)

L_3.—The bottom of a square cut on the capstone of a small stone culvert under the Missouri Pacific Railroad between the second and third telegraph poles southeast of *Hannum* switch of the Atchison, Topeka and Santa Fe Railroad.

M_3.—A copper bolt (see note 1, page 548) in the limestone foundation of the barn belonging to Mr. A. C. Nelson, northeast of the station *Oneonta*, on the Atchison, Topeka and Santa Fe Railroad, in *Cloud County, Kans.* It is in the southwest face of the barn, 1·29 metres north of the southwest window.

N_3.—A copper bolt (see note 1, page 548) in the stone foundation of the elevator leased by A. H. Poage, just southeast of the station *Kackley*, on the Atchison, Topeka and Santa Fe Railroad, in *Republic County*, *Kans.* It is on the north face and the top and eleventh stone from the northwest corner.

O_3.—A crystallized limestone post (see note 3, page 549) in the southwest angle formed by the crossing of the Atchison, Topeka and Santa Fe Railroad with the Chicago, Rock Island and Pacific Railroad and southwest of the signal tower at *Courtland*, *Republic County*, *Kans.* It is 12·7 metres from the Chicago, Rock Island and Pacific track and 13·9 metres from the Santa Fe on the right of way of the former.

P_3.—A crystallized limestone post (see note 3, page 549) 2 feet west of the shed just west of station *Lovewell*, on the Atchison, Topeka and Santa Fe Railroad, in *Jewell County*, *Kans.* It is 3 metres south of the north siding.

Q_3.—A crystallized limestone post (see note 3, page 549) opposite the north end of the Atchison, Topeka and Santa Fe Railroad station platform at *Webber*, *Jewell County*, *Kans.* It is 8 paces west of the siding.

R_3.—The bottom of a square cut on the receiving stone of the central pier of the Atchison, Topeka and Santa Fe Railroad bridge over the Republican River, in Kansas, about 2 miles south of *Superior*, *Nebr.* It is 0·088 foot east of the end pier of the second span from the north. It is lettered the same as the stone posts.

B.—A crystallized limestone post (see note 3, page 549) in the small park west of the Burlington and Missouri River Railroad station at *Superior*, *Nuckolls County*, *Nebr.* It is 3·8 metres from northwest corner and 1·2 metres from west side of depot.

Superior No. 2.—The usual form of Geological Survey bench mark. (See note 7, page 549.) It is 20 metres from river bank on north side and 3 metres west of west line of bridge, about 1 mile west of *Superior*, *Nuckolls County*, *Nebr.*

C.—A crystallized limestone post (see note 3, page 549) 13·1 metres west of Burlington and Missouri River Railroad station at *Bostwick*, *Nuckolls County*, *Nebr.*, and 4·8 metres north of track.

D.—The bottom of a square cut on the southwest corner of the Missouri sandstone step of the Bank of Guide Rock, at *Guide Rock*, *Webster County*, *Nebr.* It is lettered the same as the stone posts. (See note 3, page 549).

E.—A crystallized limestone post (see note 3, page 549) on the right of way of the Burlington and Missouri River Railroad, adjacent to the property of the Amboy Milling and Elevator Company, at *Amboy*, *Webster County*, *Nebr.* It is 4 rails north of highway and 4 metres east of track. It is in line with three large cottonwood trees.

F.—A crystallized limestone post (see note 3, page 549) in the park south of the station at *Cowles*, on the Burlington and Missouri River Railroad, *Webster County*, *Nebr.* It is in the center of a group of eight small trees about 11 metres south of the depot and 7 metres east of main track.

G.—A crystallized limestone post (see note 3, page 549) on the right of way of the Burlington and Missouri River Railroad, about 5½ miles south of *Blue Hill*, *Webster County*, *Nebr.* It is about one-half mile south of the house of Mr. Louis Smith and about 1¼ miles northwest of house of Mr. Johnson.

H.—The bottom of a square cut on the west corner of the foundation for water tower belonging to the city of *Blue Hill*, *Webster County*, *Nebr.* The foundation consists of two tiers of limestone, and the bench mark is on the lower tier, about 10 inches above the ground. It is lettered the same as the stone posts. (See note 3, page 549.)

Blue Hill △.—A Vermont marble post near the south center of sec. 24, T. 4 N., R. 11, *Webster County, Nebr.*, on land owned by Peter Paugh. It is about 2½ miles south and 3 miles west of town of *Blue Hill*. The top has two V-shaped grooves at right angles and the letters U S C S. The intersection of the grooves is the bench mark.

I.—A crystallized limestone post (see note 3, page 549) on the right of way of the Burlington and Missouri River Railroad and in the fenced park south of the station at *Ayr, Adams County, Nebr.*

J.—A crystallized limestone post (see note 3, page 549) on the right of way of the Burlington and Missouri River Railroad, at their siding, *Brickton, Adams County, Nebr.* It is about 100 metres south of elevator, 10 metres south of switch, and 0·3 metre east of fence marking the right of way of the railroad.

K.—The bottom of a square cut on the west coping of the railing of the south step of the courthouse in *Hastings, Adams County, Nebr.* The railing is of Missouri free-stone, lettered the same as the stone posts. (See note 3, page 549.)

Bank.—The bottom of a square cut on the east end of the fourth step, outside of railing of the steps to the First National Bank building, at *Hastings, Nebr.* It is lettered the same as the stone posts. (See note 3, page 549.)

Tower.—The bottom of a square cut on the northeast corner of the coping of the foundation of the water tower belonging to the city of *Hastings, Nebr.* It is about 8 inches from the ground. Lettered the same as the stone posts. (See note 3, page 549.)

L.—A crystallized limestone post (see note 3, page 549) on the right of way of the St. Joseph and Grand Island Railroad, opposite their station, *Hansen, Adams County, Nebr.* It is west of the track and in the line of the ash trees which parallel the track, 1 metre from the third and 1·5 metres from the fourth tree, counting from the north end.

M.—The bottom of a square cut (unlettered) on the stone foundation of the west side, near the northwest corner of the Bank of Doniphan, at *Doniphan, Hall County, Nebr.* It is 0·8 metre south of corner.

N.—A crystallized limestone post (see note 3, page 549) on the right of way of the St. Joseph and Grand Island Railroad, west of their station sign "*Rivers*," *Hall County, Nebr.*, 6 miles south of Grand Island. It is 0·3 metre east of the fence separating the right of way from the property of Mr. George Clousen and in line with the station sign.

O.—A copper bolt (see note 1, page 548) in the brick wall of the wash room of the Oxnard Beet Sugar Factory, about 1 mile west of *Grand Island, Hall County, Nebr.* It is on the east side, between two sets of windows, 4·15 metres from northeast corner and 1·4 metres from ground.

P.—The bottom of a square cut on the shoulder of the north column at the east and main entrance to the Security Bank building in *Grand Island, Nebr.* It is 0·8 metre from sidewalk and 1·3 metres from steps leading down into the Repu lican printing office. Lettered the same as the stone posts. (See note 3, page 549.)

Q.—An Indiana Bedford post (see note 3, page 549) in the northeast corner of the small park across the track from the office at the Union Pacific car shops, about one-half mile east of the Union Pacific station at *Grand Island, Nebr.* It is 1·07 metres from the east and 1·28 metres from the north fence bounding the park.

R.—The bottom of a square cut (unlettered) near the west edge of the west coping stone of the north end of a limestone culvert about 325 metres east of mile pole 160 along the Union Pacific Railroad west of *Grand Island, Nebr.* It is 0·32 metre from the west and 0·15 metre from the north edge of stone.

S.—The bottom of a square cut (unlettered) on the top surface of the second step from the bottom, and in about the largest stone visible in the south side of the west abutment of trestle No. 112 over Wood River. It is 400 metres east of milepole 165 along the Union Pacific Railroad west of *Alda, Nebr.* It is 0·21 metre from south edge and 0·27 metre from east edge of the stone.

T.—The bottom of a square cut on the south front of the brick store building owned by A. C. Murphy, in *Wood River, Nebr.* It is 0·13 metre from the west and 0·08 metre from the south edge of the sandstone doorstep on the south front of the building.

Shelton east base △.—The top of a copper bolt with cross lines in a limestone post. It is situated about one-half mile west of *Shelton* and 56·3 feet north of north rail of main track of the Union Pacific Railroad.

U.—A crystallized limestone post (see note 3, page 549) on the right of way of the Union Pacific Railroad, 6 metres south of track, and 0·55 metre north of station sign at *Lockwood, Merrick County, Nebr.*

V.—A copper bolt (see note 1, page 548) in the south front of the public school building (1888) at *Chapman, Merrick County, Nebr.* It is in the seventh course above the foundation and midway between the stone sills of the first and second windows from the southeast corner.

W.—A crystallized limestone post (see note 3, page 549) between the track of the Union Pacific Railroad and the signpost of their station *Paddock, Merrick County, Nebr.*

X.—A copper bolt (see note 1, page 548) in the north wall of the courthouse at *Central City, Merrick County, Nebr.* It is 9 centimetres from west edge of projecting front, 1·44 metres from west edge of main entrance, and 1·16 metres above stone coping. It is directly above the bench mark of the city, to which an arrow (cut in the stone coping) points.

Y.—A crystallized limestone post set between the Union Pacific track and the signpost of their station *Thummel, Merrick County, Nebr.*

Z.—The bottom of a square cut on the sandstone doorsteps of the south and main entrance to the brick schoolhouse in *Clarks, Merrick County, Nebr.* This large stone appears to have been broken soon after the building was erected. The cut is in the northwest corner and 6 inches from the woodwork either way.

A_1.—A crystallized limestone post (see note 3, page 549) on the right of way of Union Pacific Railroad, between the main track and the station post *Havens, Platte County, Nebr.*

B_1—A crystallized limestone post (see note 3, page 549) between the first and second trees east of the station at *Silver Creek, Merrick County, Nebr.*, 3½ metres from either tree, and 7·79 metres south from main track.

C_1.—An Indiana Bedford stone post (see note 3, page 549) in the park east of station at *Duncan*, *Platte County*, *Nebr*. It is in line with the row of trees in the park, 4·8 metres from east tree and 10·55 metres from track.

Columbus No. 2.—At the *Columbus* gauge station on the Loup River, of the U. S. Geological Survey (see note 7, page 549), placed 72 feet east of the gauge rod. The gauge is on the piling revetment, just upstream from the Union Pacific Railroad bridge, on left bank of stream. It is near the east tower of cable.

Columbus No. 3.—At the *Columbus* gauge station on the Platte River, of the U. S. Geological Survey (see note 7, page 549). It is located 44·5 feet east of the gauge, 60 feet north of the north end of north bridge truss, and 10 feet west of a cottonwood tree 6 inches in diameter. It is about 2½ miles south of *Columbus*, *Platte County*, *Nebr*.

D_1.—The bottom of a square cut in the northeast one of the 6 shoulders to the foundation of the water tower at *Columbus*, *Platte County*, *Nebr*. It is lettered the same as the stone posts. (See note 3, page 549.)

E_1.—The bottom of a square cut near the west end of the doorstep at the south entrance of the new high school building (1898) at *Columbus*, *Platte County*, *Nebr*. It is lettered the same as the stone posts. (See note 3, page 549.)

F_1.—A marble post (see note 3, page 549) on the right of way of the Union Pacific Railroad at the switch called Winstone, Platte County, Nebr., about half way between *Columbus* and *Oconee*. It is 1·3 metres east of the fence, 13·22 metres west of the track, and about 30 metres west of the stockyards.

G_1.—An Indiana Bedford stone post (see note 3, page 549) 4·4 metres north of Union Pacific station at *Oconee*, *Platte County*, *Nebr.*, and 9·2 metres east of main track.

H_1.—The bottom of a square cut on the southeast one of the eight cubical stones supporting the water tank at *Platte Center*, *Platte County*, *Nebr*. It is on the northwest corner of the stone, 6 centimetres from west edge and 15 centimetres from northwest corner of wooden column.

I_1.—An Indiana Bedford stone post (see note 3, page 549) 1·17 metres west of the station sign at *Tarnov*, *Platte County*, *Nebr*. It is 3·65 metres west of Union Pacific track and 1.64 metres from southwest corner of station platform.

J_1.—A copper bolt (see note 1, page 548) in the east face of the brick schoolhouse about 200 yards southwest from the large Catholic church at *Humphrey*, *Platte County*, *Nebr*. It is in the third tier of bricks above the stone coping and 40 centimetres from southeast corner of building.

K_1.—An Indiana Bedford stone post (see note 3, page 549) on the right of way of the Union Pacific Railroad, about half way between *Humphrey* and *Madison*, in *Madison County*, *Nebr*. It is 120 yards south of milepole No. 31, 12·83 metres west of track and 1·63 metres from fence.

NOTE.—Before this bench mark could be determined it had been partially destroyed. The square was recut, leaving the post itself in a damaged condition.

L_1.—A copper bolt (see note 1, page 548) in the south wall of the Madison State Bank building, in *Madison*, *Madison County*, *Nebr*. It is in the tenth course of brick from the line of the window sills and in the third brick west of the window casing in southeast corner. It is 1·235 metres above the sidewalk and 2·6 metres from southeast corner.

M_1.—An Indiana Bedford stone post (see note 3, page 549) on the right of way of the Union Pacific Railroad between *Madison* and *Warnerville*, *Madison County*, *Nebr.* It is 0·98 metre from fence on the west side, 13·52 metres from track, and 8.75 metres from railroad gate. The gate is across a private road leading to the house of Mr. J. B. Long, which is about one-fourth mile east.

N_1.—An Indiana Bedford stone post (see note 3, page 549) in the angle formed by the crossing of the Union Pacific Railroad and the Fremont, Elkhorn and Missouri Valley Railroad, about 1½ miles southwest of *Norfolk*, *Madison County*, *Nebr.* It is 11.8 metres north of the Fremont, Elkhorn and Missouri Valley track and 16.31 metres from northeast intersection of the two tracks.

O_1.—The bottom of a square cut on the doorstep to the west entrance of the high school building at *Norfolk*, *Nebr.* The building, erected in 1890, is at the intersection of Fifth street and Phillip avenue. It is 8 centimetres from outer edge of stone, 10 centimetres from west edge of entrance, and 23 centimetres from west woodwork. It is lettered the same as the stone posts. (See note 3, page 549.)

P_1.—A copper bolt (see note 1, page 548) in the north side of the Oxnard Hotel, at *Norfolk*, *Madison County*, *Nebr.* It is in the second tier of bricks above the large stone foundation, between the east entrance on the north side and the window just west of the entrance. The bolt faces east, but is in the west side of the entrance, about 5 inches from outer edge of bricks and 1¼ inches from the wookwork.

Norfolk No. 3.—At the *Norfolk* gauge station, on the Elkhorn River, of the United States Geological Survey (see note 7, page 549), located 35 feet west and 7 feet north of top of gauge and 15·5 feet west of ash tree, which has a small spike driven horizontally near the root. The elevation of this spike is 2·49 feet below the top of the United States Geological Survey bench mark. The gauge is about 2 miles south of the north line of Thirteenth street extended and about 300 yards east from the house of Burr Taft, observer.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN GIBRALTAR, MICH., AND CINCINNATI, OHIO.

Gibraltar 1877.—Is at *Gibraltar*, *Mich.*, in foundation wall of light-house tower—now (1899) abandoned and used as a dwelling—at its southeast corner, east face, in fourth course of masonry below the cut sandstone water table, being center of small hole in head of copper bolt leaded horizontally.

2 of 1875.—Is in *Gibraltar*, *Mich.*, on the same light-house as above—now (1899) used as a dwelling—on the southeast corner of the stone doorsill of the door in the southeast angle of the building, being marked by a right angle cut on the stone.

U. S. P. B. M. 1.—Is in *Gibraltar*, *Mich.*, in south part of the town, on lake front, in the rear of Mr. Edward Hall's dock and boathouse, 75 feet southwest of his house, in the northeast corner of stone milk house, in east face, 8 inches south from corner and 4 feet 4 inches above ground, being center mark of brass bolt leaded horizontally.

A.—Is in *South Rockwood*, *Mich.*, 17 feet west of center of Michigan Central track, 198 feet south of depot, on the southeast stone pillar of water tank on the northeast corner of stone, being bottom of a square cut 1 inch on a side and one-half inch deep.

B.—Is in *Newport*, *Mich.*, on line of Michigan Central track, about 360 feet above depot, in south abutment of bridge over Swan Creek, in end of north face, 3 feet above ground, being center of horizontal mark in brass bolt leaded horizontally.

C.—Is in *Monroe, Mich.*, on the west end of south pier of Michigan Central Railroad bridge over the Raisin River, on the west face of pier, 6 inches north of its south edge and about 4 feet above ground, being horizontal mark in brass bolt leaded horizontally.

D.—Is in *Monroe, Mich.*, on the south side of First street, 345 feet west of Kentucky avenue, on northwest corner of city fire-engine house, on northeast corner of pedestal stone just under brickwork, being bottom surface of a square cut 1 inch on side and one-half inch deep.

E.—Is 1½ miles below *La Salle* station, *Mich.*, on line of the Lake Shore and Michigan Southern Railroad, 115 metres below Lagerness road crossing, 3·38 metres east of east rail of track, on south side of open stone culvert, on top stone, 3½ feet above ground, and is a square cut. (See note 6, page 549.)

F.—Is at *Vienna* station, on Michigan Central and Lake Shore and Michigan Southern railroads, Erie Township, *Monroe County, Mich.*, 325 feet west of track on north side of road to Erie (on the section line E. W. of section 16), about 20 rods west of center of section, on southwest corner of Mrs. William McLain's house, in the east end of water-table stone of the south side of the building, about 2½ feet above ground, being a brass bolt. (See note 5, page 549.)

U.—Is in *Lucas County, Ohio*, at a place called *Alexis* (on time-table), being at the intersection of the Lake Shore and Michigan Southern and Ann Arbor, Detroit and Toledo roads, on the west side of the Lake Shore and Michigan Southern and on the northeast side of the Ann Arbor road, on west abutment south side of long culvert of very large stone, on the first step, below coping at its northwest corner, 5 inches from either face, and is a square cut. (See note 6, page 549.)

Toledo City No. 165.—Is in northern part of *Toledo*, near the Maumee River, on west side of Summit avenue and north corner of Columbus avenue, on frame building, being a copper nail on east side of sign.

Park △.—Is in *Toledo, Ohio*, on the north bank of the Maumee River, 106 metres above River Place, 1·35 metres south of south edge of flagging in River Park, being a stone triangulation monument set in the ground. The point taken is the east point of the triangle cut in the stone.

V.—Is in *Toledo, Ohio*, on the north bank of the Maumee River, on the north abutment of the Pennsylvania Railroad bridge, east side, on retaining wall, 15 inches west of the northwest corner of the bridge seat block and 3 feet above it, and is a square cut. (See note 6, page 549.)

Power House.—On the northeast corner of Water and Madison streets, *Toledo, Ohio*, on southwest corner of traction company's power house, on top of sandstone water table just where brick begins, about 3 feet above sidewalk, being marked by a square.

W.—Is in *Toledo, Ohio*, on the United States custom office building, on the southeast corner of Madison and St. Clair streets, 15 feet south of the south side of entrance on St. Clair street, on the south face of pilaster angle, 6 inches east of west face and 1½ metres above ground, being a brass bolt. (See note 5, page 549.)

Post Office.—Is on the northwest corner of custom-house building in *Toledo, Ohio*. A cross cut on the top of the granite water table just where sandstone begins, being the outer quarter of cross.

Toledo City No. 44.—Is on southwest corner of Madison and Summit streets, *Toledo*, *Ohio*. A cross cut on northeast corner of water table of Roberts's drug store.

Toledo City No. 296.—Is in *Toledo, Ohio*, on the easterly abutment of the Pennsylvania Railroad bridge over the Maumee River, north side of track, on coping stone, 9 inches north of north side of guard timber of track, being highest point at northerly part of a cross.

X.—Is in *Wood County*, *Ohio*, about 3 miles north of *Perrysburg*, on the road to Toledo (the electric line runs on this road), 480 feet north of August Broke's house, in west face of culvert under road, 26 inches north of the north spring of arch and 28 inches above top of arch (under side), being a brass bolt. (See note 5, page 549.)

Y.—Is in *Perrysburg*, *Wood County*, *Ohio*, 318 metres south of depot, on the west end of culvert, under the Cincinnati, Hamilton and Dayton track, 32 inches north of spring line and 18 inches above it, and 26 inches above ground, being a brass bolt. (See note 5, page 549.)

Z.—Is in *Roachton*, *Wood County*, *Ohio*, just north of the north line of Middleburg Township, about 300 feet west of the Cincinnati, Hamilton and Dayton track, in foundation of residence of W. C. Parrin, center of east side and in east face of bay window, 0·65 metre south of north angle and 0·55 metre above ground, in second brick below wooden water table, being horizontal line in brass bolt leaded horizontally.

A_1.—Is in *Hull Prairie*, *Wood County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, about 200 feet south of the depot, in the southeast quarter of stone culvert on the first step below the bridge seat, 5 inches east of east end of bridge seat course, and 4½ inches south of north face, being a square cut. (See note 6, page 549.)

B_1.—Is in *Haskins*, *Wood County*, *Ohio*, 250 metres west of the Cincinnati, Hamilton and Dayton Railroad track on Sugar street, in south face of public school building, in water table 4 feet 10 inches above ground, 1 foot 9 inches east of east side of entrance, being a brass bolt. (See note 5, page 549.)

C_1.—Is in the village of *Tontogany*, *Wood County*, *Ohio*, on the southeast corner of Main and Broad streets, at west side of entrance to Waltz store, "1894" in the northwest corner of iron plate under column, being top of a surface seven-eighths inch square marked by a cut of a cold chisel.

D_1.—Is in *Weston*, *Wood County*, *Ohio*, very near south center of section 35, about 150 feet east of Cincinnati, Hamilton and Dayton Railroad track on south side of Main street, at the east side of east entrance on northeast corner of iron pedestal, being the top of surface by a square cut with a cold chisel.

E_1.—Is in *Weston*, *Wood County*, *Ohio*, in the foundation of First Methodist church, erected in 1895, in north face of foundation, 3 feet and 10 inches west of the west face of belfry tower, in second course of masonry below the water table course, 2 feet above ground, being a brass bolt. (See note 5, page 549.)

Weston Village.—Is in *Weston*, *Ohio*, about 100 feet east of the Cincinnati, Hamilton and Dayton Railroad track, on the north side of Main street, at the northwest corner of the Citizens' Bank building, on top of corner stone just below brick.

F_1.—Is in the village of *Milton Center*, *Wood County*, *Ohio*, on the east side of Railroad street, at south side of east and west alley, in the stone building of John Biverstock, on north end of base stone below window, being a square cut. (See note 6, page 549.)

G_1.—Is in *Custar*, *Wood County*, *Ohio*, on the northwest corner of Superior and Linn streets, in the northeast corner of foundation of public school building, and 1 foot 10 inches west of east face, and 3 feet 8 inches above ground, being a brass bolt. (See note 5, page 549.)

H_1.—Is in the village of *Deshler*, *Henry County*, *Ohio*, on the northeast corner of Maple and Keiser streets, in the southeast corner of the main building, Presbyterian church, in the water table, east face, about 1 foot north of south corner and 3 feet above ground, being a brass bolt. (See note 5, page 549.)

I_1.—Is in the village of *Deshler*, *Henry County*, *Ohio*, on the north side of Main street about 175 feet east of Cincinnati, Hamilton and Dayton Railroad track, on the bank building owned by Mr. A. W. Lee, on west end of base stone, under window west of entrance, being a square cut. (See note 6, page 549.)

J_1.—Is in the village of *Belmore*, *Putnam County*, *Ohio*, on the northeast corner of Defiance and Walnut streets, in the east face of the foundation of the Starling building, 18 feet north of south corner of building and 8 inches below bottom of baseboard and 10 inches above ground, being intersection of two approximately horizontal and vertical chisel cuts in brass bolt leaded horizontally and lettered U. S. C. & G. S.

K_1.—Is in the village of *Leipsic*, *Ohio*, on the north side of Railroad street, about 126 feet east of Main street, on the top of foundation, northeast corner of the Lampe building, under the east end of the window, 11 inches west of the corner buttress, 1 foot above sidewalk, being a square cut. (See note 6, page 549.)

L_1.—Is in the village of *Leipsic*, *Putnam County*, *Ohio*, on the south side of Commercial street, 129 feet east from the east side of Main street, on the foundation at the northeast corner of the Heffler House, 6 inches west of east face and 35 inches above the flagging of the sidewalk, being a brass bolt. (See note 5, page 549.)

M_1.—Is in *Ottawa Township*, *Putnam County*, *Ohio*, on line of the Cincinnati, Hamilton and Dayton Railroad, about one-half mile below G. W. Miller's residence and 150 metres north of milepost 50 T, on southeast quarter of stone culvert No. 54, on bridge seat course, 6 inches north of east end of stone above, and 2 feet 10 inches east of wing angle, being a square cut. (See note 6, page 549.)

N_1.—Is in the village of *Ottawa*, *Putnam County*, *Ohio*, on the south side of Mainleron street, about 170 feet west of railroad, on the large stone step of foundation, 5 feet east of east side of east pillar of stairway entrance, being a square cut. (See note 6, page 549.)

O_1.—Is about 3 miles north of *Columbus Grove*, *Putnam County*, *Ohio*, 110 feet above milepost 56, on the southwest quarter of abutment to bridge 51, Cincinnati, Hamilton and Dayton Railroad, on the second step below the bridge seat course, about 6 inches from face and 6 inches from edge of stone, being a square cut. (See note 6, page 549.)

P_1.—Is in the village of *Columbus Grove*, *Putnam County*, *Ohio*, on the north side of Sycamore street, about 33 feet east of the Cincinnati, Hamilton and Dayton Railroad, on the A. H. Day building, at the left side of east entrance (now—1899—post office), on the southwest corner of iron plate under iron post, marked on corner by square cut with a cold chisel.

Q_1.—Is in the village of *Columbus Grove*, *Putnam County*, *Ohio*, on the Theodore Kunneke building, on the southwest corner of Sycamore and High streets, in the water table on the south side of Sycamore street, about 24 feet west of east corner, at head of stair descending into basement, being a brass bolt. (See note 5, page 549.)

R_1.—Is 2½ miles north of *Monroe*, *Allen County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, 50 feet below public road crossing, on the southeast quarter of culvert over Sycamore Run, on the southwest corner of second step, being a square cut. (See note 6, page 549.)

S_1.—Is in the village of *West Cairo*, *Allen County*, *Ohio*, 125 meters west of the Cincinnati, Hamilton and Dayton Railroad track, on south side of main cross street, on the northwest corner of foundation of dwelling of Charles Wallis, in north face near west angle of water table, being a brass bolt. (See note 5, page 549.)

T_1.—Is in *Bath Township*, *Allen County*, *Ohio*, midway between West Cairo and Lima, on the line of the Cincinnati, Hamilton and Dayton Railroad, at east and west road on section line between sections 17 and 18, in front of Henry Boose's residence, in the northeast quarter of viaduct arch, under track, on south end of seventh step from top, being a square cut. (See note 6, page 549.)

U_1.—Is in the city of *Lima*, *Allen County*, *Ohio*, on the depot building of the Cincinnati, Hamilton and Dayton Railroad, on the east side of building, in angle south of main structure, on the west end of doorsill stone, being at present (1899) entrance to train dispatcher's office, being a square cut. (See note 6, page 549.)

V_1.—Is in the city of *Lima*, *Allen County*, *Ohio*, on the southeast corner of High and Elizabeth streets, on the northeast corner of the post office building, in the water table, east face, 96 metres south of the north corner and 1·27 metres above the flagging, being a horizontal cut in the center of a 1-inch square cut, one-fourth inch deep, and marked U.S.C.& G.S.

Lima City.—Is in the city of *Lima*, *Allen County*, *Ohio*, on the southwest corner of High and Main streets, on the top of the north fireplug of city hydrant.

W_1.—Is 1¼ miles north of the village of *Cridersville*, *Allen County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, on the northwest quarter of abutment of bridge 46, over Little Haw Creek, on west end of bridge-seat course, 9 inches north of south face, being the highest point on rounding square 1¾ inches on a side, and lettered U.S.C.& G.S.

X_1.—Is in the village of *Cridersville*, *Auglaize County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, 66 feet west from main track and 45 feet north of north side of Main street, in the stone window sill of the Hover Bros.' block, being a brass bolt. (See note 5, page 549.)

Y_1.—Is one-fourth mile north of *Wapakoneta*, *Auglaize County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, in the northeast quarter of bridge 45 over the Auglaize River, in the bridge seat course on east part of receding angle, 1·9 metres below top of retaining wall; being a square cut. (See note 6, page 549.)

Z_1.—Is in the town of *Wapakoneta*, *Auglaize County*, *Ohio*, on the county courthouse building on the east face of the building, 17 feet from the northeast corner of the north pillar between basement windows, 3 feet above the ground, and 16 inches south of the north edge of pillar; being a brass bolt. (See note 5, page 549.)

A_2—Is in *Pushada Township*, *Auglaize County*, *Ohio*, on line of the Cincinnati, Hamilton and Dayton Railroad, 2 miles south of Wapakoneta, on southeast quarter of bridge No. 44 over Pushada Creek, on bridge seat course, 2 feet west of east end of shelf, 7 inches back from edge; being the elevated point circumscribed by square cut in stone lettered U. S. C. & G. S.

B_2—Is in the village of *Botkins*, *Shelby County*, *Ohio*, on north side of main cross street one-fourth mile east of the Cincinnati, Hamilton and Dayton Railroad, in top corner of stone foundation of public school building, in south face, 0·78 metre east of west corner, 0·72 metre above ground; being a brass bolt. (See note 5, page 549.)

C_2.—Is in the village of *Anna*, *Shelby County*, *Ohio*, on the First Methodist Church building, on the corner of Pike and Second streets, on the east side of small buttress north of east door, 0·75 metre above ground and 0·15 metre south of north edge of buttress; being a brass bolt. (See note 5, page 549.)

D_2.—Is one-half mile north of the village of *Swanders*, *Shelby County*, *Ohio*, on northeast quarter of stone culvert (dated 1892) under the Cincinnati, Hamilton and Dayton Railroad, in top of third step below coping, 5 inches from its south face and 5 inches from east face of next step above; being a square cut. (See note 6, page 549).

E_2.—Is in *Franklin Township*, *Shelby County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, half way between mileposts 101 and 102 from Cincinnati, on lowest point of grade, on southeast quarter of culvert on second step, about 1·3 metres below coping; being a square cut. (See note 6, page 549.)

F_2.—Is in the city of *Sidney*, *Shelby County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, at the southwest quarter of bridge No. 40 over the Cleveland, Cincinnati, Chicago and St. Louis Railroad, on the northwest corner of the bridge seat course, 6 inches from both north and west faces; being a square cut. (See note 6, page 549.)

Sidney City.—Is at the northwest corner of courthouse square, 48⅓ feet above the city zero point. The mark is made by burying a Dayton stone 20 inches square and 2 feet high with another stone of the same kind 2 feet high and 14 inches square on bottom and 3 inches square on top, set on top of the sandstone, and both firmly imbedded in the ground up to the top of the second stone. Above this is 4 inches of cement in which a cross is cut.

G_2.—Is in the city of *Sidney*, *Shelby County*, *Ohio*, on the county courthouse on west face of foundation of north vestibule 2 feet 1 inch south of north projecting edge of foundation and 3 feet 5 inches above ground; being a brass bolt. (See note 5, page 549.

H_2.—Is in *Clinton Township*, *Shelby County*, *Ohio*, 1¼ miles south of Sidney, on the line of the canal and Cincinnati, Hamilton and Dayton Railroad on the southwest quarter of bridge over canal, on the northwest corner of large bridge seat stone, 6 inches from each face; being a square cut. (See note 6, page 549.)

I_2.—Is in the village of *Kirkwood*, *Shelby County*, *Ohio*, on the schoolhouse (Pontiac School) on east face center of second pilaster from south end on water table, about 2 feet above ground; being a brass bolt. (See note 5, page 549.)

J_2.—Is in *Springcreek Township*, *Miami County*, *Ohio*, on line of Cincinnati, Hamilton and Dayton Railroad, midway between Kirkwood and Piqua, on bridge over Bush Creek, on east end of west abutment bridge seat course, 6 inches from both east and south faces; being a square cut. (See note 6, page 549.)

K_2.—Is in the city of *Piqua*, *Miami County*, *Ohio*, on line of Cincinnati, Hamilton and Dayton Railroad, on culvert No. 26, over Albino Pike, on northeast quarter on center of east stone of bridge seat course, being the highest point circumscribed by a 1-inch square and lettered U. S. C. & G. S.

Penn. R. R.—Is in the city of *Piqua*, *Miami County*, *Ohio*, on the line of the Pennsylvania Railroad, on north end of east abutment of bridge over Miami River, on top of bridge seat course, 14 inches north of truss and 8 inches back from the face; being highest point of square 4 inches on a side cut on a stone.

L_2.—Is in the city of *Piqua*, *Miami County*, *Ohio*, on the southwest corner of Downing street, and the Pittsburg, Chicago, Cincinnati and St. Louis Railroad, on the malt house of J. G. Schmidlapp (1889), on the northeast corner of building, on water table, 1·2 metres above the sidewalk and 1 metre south of corner; being a brass bolt. (See note 5, page 549.)

M_2.—Is in the village of *Farrington*, *Miami County*, *Ohio*, on line of Miami and Erie Canal, 3 miles south of Piqua, on lock built by Isaac Van Ness (1835), on west side of tumble on northwest corner of coping stone, 6 inches from either face; being a square cut. (See note 6, page 549.)

N_2.—Is in *Concord Township*, *Maimi County*, *Ohio*, on line of Miami and Erie Canal, on lock 2½ miles north of Troy, on east jaw of lock, on east coping stone of wall, 6 inches from south face and 18 inches from east end of wall; being a square cut. (See note 6, page 549.)

O_2.—Is in the town of *Troy*, *Miami County*, *Ohio*, on the line of the Miami and Erie Canal, on Troy lock, east jaw, on coping stone, west of east end of wall and 6 inches north of south face; being a square cut. (See note 6, page 549.)

P_2—Is in town of *Troy*, *Miami County*, *Ohio*, on courthouse, on southwest corner of building, on south face, 0·75 metre from west corner and 1·2 metres above ground; being a brass bolt. (See note 5, page 549.)

Troy City.—Is in town of *Troy*, *Miami County*, *Ohio*, on south side of Miami street, on first house west of Lutheran Church, at northeast corner of house, on the top of the water table.

Q_2.—Is in southern extremity of *Troy*, *Miami County*, *Ohio*, at the intersection of Miami and Erie Canal and Cleveland, Cincinnati, Columbus and St. Louis Railroad, on east abutment of railroad bridge over canal, on west face of abutment, 1·3 metres above ground and 2·5 metres north of south end of abutment; being a brass bolt. (See note 5, page 549.)

R_2.—Is in *Concord Township*, *Miami County*, *Ohio*, 1¼ miles south of Troy, on line of Miami and Erie Canal, on south end of lock, east side, 13 feet south of king-post at beginning of curve on northwest corner of coping stone; being surface circumscribed by square 1¼ inches on a side.

S_2.—Is in *Concord Township*, *Miami County*, *Ohio*, 70 feet below lock, 2½ miles south of Troy, on southwest quarter of masonry of feeder lock, on sixth step from top, on its northwest corner; being a square cut. (See note 6, page 549.)

T_2.—Is in the village of *Tippecanoe City*, *Miami County*, *Ohio*, on line of the Miami and Erie Canal, on Tippecanoe Lock, on the east side, on south end, on center coping stone of wing; being a square cut. (See note 6, page 549.)

U_2.—Is in the village of *Tippecanoe City*, *Miami County*, *Ohio*, on north side of Main street, on first building east of canal, on power house of Tippecanoe Electric Light and Water Company, on southeast corner of building on south face on water table, 5 inches below brick work and 7 inches north of corner; being a brass bolt. (See note 5, page 549.)

V_2.—Is in *Van Buren Township*, *Miami County*, *Ohio*, on line of Miami and Erie

Canal, 2½ miles below Tippecanoe City, on Picayune Lock, east jaw, on coping stone, 12 feet south of south king-post, and 6 inches east of edge of wall; being a square cut. (See note 6, page 549.)

W_2.—Is in the village of *Tadmor*, *Montgomery County*, *Ohio*, on line of Miami and Erie Canal, on east abutment of steel bowstring girder bridge over canal, northwest corner, on north face, 1 foot east of corner and 3½ feet above ground; being a brass bolt. (See note 5, page 549.)

X_2.—Is in *Butler Township*, *Montgomery County*, *Ohio*, on line of Cincinnati, Hamilton and Dayton Railroad, 2⅜ miles below Tadmor, on Bridge No. 8 over Poplar Creek, on west side of north abutment, on first step below bridge seat, 5 inches east of west face of stone and 7 inches north of south face; being a square cut. (See note 6, page 549.)

Y_2.—Is in *Harrison Township*, *Montgomery County*, *Ohio*, on line of the Cincinnati, Hamilton and Dayton Railroad, about 1 mile north of *Dayton* city limits, on north abutment of bridge over Miami River, west side of abutment, 6 inches south of north edge and 17 inches east of west edge, being a square cut. (See note 6, page 549.)

Z_2.—Is in the city of *Dayton*, *Montgomery County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, on Bridge No. 2, over Mad River, on south abutment of bridge, east end, 22 inches west of east end of stone and 6 inches south of north face, being a square cut. (See note 6, page 549.)

Dayton City.—Is in city of *Dayton*, *Montgomery County*, *Ohio*, on northwest corner of Main and Sixth streets (city workhouse), being point of pyramidal top of stone fence post, 3½ feet above sidewalk.

A_3.—Is in the city of *Dayton*, *Montgomery County*, *Ohio*, on southwest corner of South Main and West Fifth streets, on post office, at southeast corner of building, east face, on water table, 1·2 metres above the pavement and 0·3 metre north of corner, being a brass bolt. (See note 5, page 549.)

B_3.—Is in the city of *Dayton*, *Montgomery County*, *Ohio*, on line of the Cincinnati, Hamilton and Dayton Railroad, on bridge over Miami River, one-third mile south of Union Depot, on west pier, north end, on nose of coping stone of pier, midway between sides and 20 inches back from point, being a square cut. (See note 6, page 549.)

E_4.—Is in *Van Buren Township*, *Montgomery County*, *Ohio*, 2½ miles south of Dayton, on the line of the Cleveland, Cincinnati, Chicago and St. Louis Railroad, on viaduct bridge over highway, midway between Miami River bridge and canal bridge, on north abutment, on southeast corner of bridge-seat course, 9 inches from either face and 15 feet east of truss, being a square cut. (See note 6, page 549.)

C_3.—Is in *Montgomery County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, 4 miles south of *Dayton*, on southwest quarter of culvert No. 39, bridge-seat course, west end, 8 inches east of west end and 5 inches south of west face, being a square cut. (See note 6, page 549.)

D_4.—Is in *Miami Township*, *Montgomery County*, *Ohio*, on line of Cleveland, Cincinnati, Chicago and St. Louis Railroad, two-thirds mile south of *Alexandria*, 300 feet north of street-car power house, on pier of stone culvert over ditch, east end, 10 inches west of east face and 18 inches south of point, being a square cut. (See note 6, page 549.)

D_3.—Is in *Montgomery County*, *Ohio*, on line of Cincinnati, Hamilton and Dayton Railroad, three-fourths mile north of *Whitfield*, north abutment of Bridge No. 36 over

Parthin Creek, east end, on wing wall bridge-seat coping, 1½ metres east from chord and 9 inches from retaining wall, being a square cut. (See note 6, page 549.)

C_4.—Is in the village of *Carrollton*, *Montgomery County*, *Ohio*, on the line of the Miami and Erie Canal, on the tumble of lower Carrollton lock, west side, south end, on second step below coping, 4 inches north of south face and 6 inches west of east face of stone, being a square cut. (See note 6, page 549.)

B_4.—Is in the city of *Miamisburg*, *Montgomery County*, *Ohio*, on line of Cleveland, Cincinnati, Chicago and St. Louis Railroad, in north end of town, 500 feet north of Enterprise Carriage Works, on bridge No. 250, over Sycamore Creek, north abutment, west end, on retaining wall, second step below coping, 14 inches east of west face and 6 inches north of south face, being a square cut. (See note 6, page 549.)

E_3.—Is in *Montgomery County*, *Ohio*, on line of Cincinnati, Hamilton and Dayton Railroad, one-fourth mile north of *Miamisburg* depot, on east end of north abutment of bridge over Bear Creek on bridge-seat course at east end of wing wall, 6 inches from south face and 12 inches from east face, being highest point in rounded square, lettered U. S. C. & G. S.

F_3.—Is in the town of *Miamisburg*, *Montgomery County*, *Ohio*, on west abutment of road bridge over Miami River at Cincinnati, Hamilton and Dayton Railroad depot, on south face of retaining wall, 7 feet west of angle in eighth course of masonry below the coping, being a brass bolt. (See note 5, page 549.)

A_4.—Is in the city of *Miamisburg*, *Montgomery County*, *Ohio*, at south end of village, about 8 feet east of center of Third street, on north side of Smith street, 2·05 metres west of center of Cleveland, Cincinnati, Chicago and St. Louis track, 0·73 metre below top of rail on bridge-seat course of masonry, being a square cut. (See note 6, page 549.)

G_3.—Is in *Montgomery County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, about 2¼ miles south of *Miamisburg*, on culvert No. 32, northeast quarter, on fourth step below bridge-seat course, 3 inches west of east face and 6 inches north of south face, being a square cut. (See note 6, page 549.)

Z_3.—Is in *Montgomery County*, *Ohio*, on line of the Cleveland, Cincinnati, Chicago and St. Louis Railroad, 2 miles north of *Franklin*, on culvert No. 223 over race from lock, on south abutment, second stone from east end of bridge-seat course, 7 inches south of north face and 6 inches west of east face, being a square cut. (See note 6, page 549.)

H_3.—Is in *Warren County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, one-half mile north of *Carlisle*, on culvert No. 31 over creek, north abutment, east end, on bridge-seat course, 6 inches from east face, 12 inches north of south face, being a square cut. (See note 6, page 549.)

I_3.—Is in the town of *Franklin*, *Warren County*, *Ohio*, on plant of Franklin Water Works, on northwest corner of Sixth street and Cleveland, Cincinnati, Chicago and St. Louis Railroad, on southeast corner of water table, being highest point of rounding square exactly in angle.

J_3.—Is in *Warren County*, *Ohio*, on line of Cincinnati, Hamilton and Dayton Railroad, 2¼ miles south of *Carlisle*, on bridge No. 30 over Big Twin Creek, on south of two piers on east end, center of nose, 15 inches back from point, being a square cut. (See note 6, page 549.)

Y_3.—Is in *Miami County, Ohio*, on line of Cleveland, Cincinnati, Chicago and St. Louis Railroad, 1 mile south of depot at *Franklin*, on bridge No. 254 over Clear Creek, south abutment, west side on second course below top of retaining wall, 3 feet above bridge-seat course, 5 inches from both west and north faces, being a square cut. (See note 6, page 549.)

K_3.—Is in *Butler County, Ohio*, on line of Cincinnati, Hamilton and Dayton Railroad, one-half mile south of *Poast Town*, on bridge No. 26 over Brown Run, on east end of wing wall, north abutment, first step below bridge-seat course, southeast corner of stone, being a square cut. (See note 6, page 549.)

X_3.—Is in *Butler County, Ohio*, on the line of the Cleveland, Cincinnati, Chicago and St. Louis Railroad, 2¾ miles north of *Middletown*, on culvert No. 270, south abutment, east end of bridge-seat course, 13 inches south of north face and 10 inches west of east face, being a square cut. (See note 6, page 549.)

L_3.—Is in the village of *Heno*, *Butler County, Ohio*, on line of Cincinnati, Hamilton and Dayton Railroad, 400 feet north of *Middletown* depot, on north abutment of culvert No. 21, east end, on first step below bridge-seat course, 6 inches west of east face and 6 inches north of south face, being a square cut. (See note 6, page 549.)

M_3.—Is in the city of *Middletown, Hamilton County, Ohio*, in eastern part of city, about 120 metres west of Cleveland, Cincinnati, Chicago and St. Louis Railroad track, on southwest corner of Third and Grimes streets, on east face of Kimball block, 12 inches south of north corner and 1·1 metres above flagging, being a brass bolt. (See note 5, page 549).

W_3.—Is in *Butler County, Ohio*, on line of the Miami and Erie Canal on lock at *Excello Mills*, on west wall of tumble, north end, on end coping stone, 6 inches from north face and 11 inches from east face, being a square cut. (See note 6, page 549.)

N_3.—Is in *Butler County, Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, 1 mile north of *Trenton*, at bridge over Hill Creek, on east end of pier, in center of nose, 18 inches back from point, being a square cut. (See note 6, page 549.)

V_3.—Is in *Butler County, Ohio*, on line of Cincinnati, Hamilton and Dayton Railroad, 100 metres south of *Le Sourdsville*, on north retaining wall, east end of aqueduct, over canal, opposite north end of railroad bridge over creek, on third stone from end, 16 inches from south face and 8 inches from east face, being highest point in square lettered U. S. C. & G. S.

O_3.—Is in *Butler County, Ohio*, 1 mile south of *Busenbark*, three-fourths mile north of *Overpeck*, on line of the Cincinnati, Hamilton and Dayton Railroad, on arch culvert about 20 metres south of mile post C. 31, on northeast corner of stone, about 6 inches from either face, being a square cut. (See note 6, page 549.)

U_3.—Is in *Butler County, Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, one-fourth mile north of *Rockdale*, on west end of stone culvert covered by roadbed, on coping stone, 8 inches from south face and 6 inches from west face, being a square cut. (See note 6, page 549.)

P_3.—Is in *Butler County, Ohio*, on line of the Cincinnati, Hamilton and Dayton Railroad, 2½ miles north of *Hamilton* depot, on bridge No. 16 over Miami River, on retaining wall at north end of bridge seat, 4 inches from both south and east faces, being a square cut. (See note 6, page 549.)

T_3.—Is in *Butler County, Ohio*, on line of Columbus and Maysville Railroad, one-fourth mile north of *Woodsdale*, on south abutment of bridge over Campbell's Creek, on west end of bridge-seat course, on large stone, 6 inches from both north and west faces, being highest point in circumscribed 1-inch square.

Q_3.—Is in the city of *Hamilton*, *Butler County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, 1 450 metres north of union depot, at three-arched stone bridge over Old River, on east side, north end, on second step below coping of wing wall, 5 inches from both east and south faces, being highest point in circumscribed square.

Hamilton City.—Is in the city of *Hamilton*, *Butler County*, *Ohio*, on foundation of courthouse, northeast corner, in reentrant angle, 15 inches east of east pilaster of basement door and 3 inches north of wall, being north half of west edge of surface inclosed in 2½-inch square lettered "Datum, City elevation 100'."

R_3.—Is in city of *Hamilton*, *Butler County*, *Ohio*, on south side of High street, on courthouse, in east face, at its northeast corner, 1·2 metres south of corner, which is corner stone of building, on first stone south of corner stone, being a brass bolt. (See note 5, page 549.)

S_3.—Is in the city of *Hamilton*, *Butler County*, *Ohio*, in southeast quarter of city, on south face of Cincinnati, Hamilton and Dayton depot, on water table, 33½ inches from southwest corner, and 2 inches above brick paving, being a square cut. (See note 6, page 549.)

Telegraph pole No. 745.—Is on east end of small stone culvert opposite telegraph pole 745, Pennsylvania Railroad, being highest point on square 2¼ inches on a side. It is 2 miles south of *Hamilton*, *Ohio*.

F_4.—Is in *Butler County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, 2¼ miles south of *Hamilton*, on culvert No. 13 (cattle pass), north side, east end, on fifth step below bridge-seat course, 5 inches from both south and east faces, being a square cut. (See note 6, page 549.)

P. R. R. No. 24.—Is on culvert No. 35a, east side, north end, being highest point of a square; 2 miles north of *Flockton*.

P. R. R. No. 23.—Is 1 000 feet west of *Flockton* on culvert No. 34, west abutment, north end, being highest point in square 2½ inches on a side.

G_4.—Is in *Butler County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, 1½ miles north of *Jones*, and 4½ miles south of Hamilton, on viaduct bridge No. 11, north abutment, east end, on second step below bridge-seat course, on southeast corner of stone, 6 inches from either face, being a square cut. (See note 6, page 549.)

P. R. R. No. 21.—Is in culvert No. 32, at *Port Union*, on north abutment, east end, being highest point in square 2½ inches on a side.

P. R. R. No. 20.—Is about 1 mile north of *Crescentville*, on culvert No. 30, north abutment, and east end, being highest point in square 2¼ inches on a side.

H_4.—Is in *Hamilton County*, *Ohio*, 16¾ miles north of Cincinnati and one-fourth mile south of *Crestvue*, on line of Cincinnati, Hamilton and Dayton Railroad, on stone culvert over Carmins Creek, southwest quarter, on end coping stone, 10 inches east of west face and 5 inches north of south face, being a square cut. (See note 6, page 549.)

P. R. R. No. 19.—Is on railroad culvert No. 29, one-half mile south of *Crescentville*, on north abutment, east end, being highest point in square 2½ inches on a side.

P. R. R. No. 17—Is on bridge No. 27 over creek, 2 miles south of *Port Union*, on east end of north abutment, being highest point in square 2½ inches on a side.

I_4.—Is in *Hamilton County*, *Ohio*, 1 mile south of *Glendale*, on the side of the Cincinnati, Hamilton and Dayton Railroad, on culvert No. 9, northwest quarter, on first step below bridge-seat course, 5 inches east of west face and 10 inches north of south face, being a square cut. (See note 6, page 549.)

J_4.—Is in *Springfield Township*, *Hamilton County*, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, 12⅓ miles north of Cincinnati, on bridge No. 8 over Mill Creek, south abutment, east end, on first step below bridge-seat course, 6 inches west of east face, 12 inches south of north face, being a square cut. (See note 6, page 549.)

T_4.—Is in the village of *Lockland*, *Hamilton County*, *Ohio*, on Collectors Lock, 10 feet north of north side of Lock street on east wall of lock on coping stone, 5·6 feet north of south gate, 4 inches east of west face of wall, being a square cut. (See note 6, page 549.)

K_4.—Is in village of *Rensselaer*, *Hamilton County*, *Ohio*, about 1 mile north of *Carthage* on line of Cincinnati, Hamilton and Dayton Railroad at intersection of Hamilton pike and Forest avenue, on north abutment of viaduct, west end, on first step below bridge-seat course, on southwest quarter of stone, 6 inches from face and 8 inches from end of stone, 5·65 metres north of outside rail, being a square cut. (See note 6, page 549.)

L_4.—Is in the village of *Carthage*, *Hamilton County*, *Ohio*, at southeast corner of Jackson and Fourth streets, on the Christian Church building (1879) on west side of church, on water table at base of tower 6 inches north of south angle of tower, and 0·55 metre above ground, being a brass bolt. (See note 5, page 549.)

S_4.—Is in village of *Carthage*, *Hamilton County*, *Ohio*, 10 miles north of Cincinnati on line of Miami and Erie Canal, on south abutment of Fourth street bridge over canal, west end, 6½ feet above towpath and 2½ feet below floor of bridge on second step above retaining wall, on seventh step below coping, 2 inches from end and 6 inches from face of stone, being a square cut. (See note 6, page 549.)

R_4.—Is in the village of *St. Bernard*, *Hamilton County*, *Ohio*, about 8 miles north of Cincinnati, on the line of the Miami and Erie Canal and Baltimore and Ohio Southwestern Railroad, on east face of west abutment of railroad bridge over canal, 1·2 metres above towpath, in eighth course of masonry from top, 1·75 metres north of prominent corner in southwest bridge-seat stone, being horizontal groove in bottom of square cut ⅜ inch deep and 1 inch square, lettered U. S. C. & G. S.

M_4.—Is in the village of *Ivorydale*, a suburb of Cincinnati, *Ohio*, on the line of the Cincinnati, Hamilton and Dayton Railroad, 100 feet south of depot, on bridge No. 4 over Mill Creek, on north abutment, west end of bridge-seat course, 6 inches north of obtuse angle of wing wall, being a square cut. (See note 6, page 549.)

U. S. G. S. No. 498.—Is at *Winston Springs*, *Ohio*, on line of the Cleveland, Cincinnati, Chicago and St. Louis Railroad, on north abutment of bridge over Mill Creek, west end, on coping stone. The original disk had been taken away; the part taken was highest point of ring cut in stone.

Q_4.—Is in the city of *Cincinnati*, *Ohio*, in northern part of city, on line of the Miami and Erie Canal, one-half mile north of Clifton Springs, on Spring Grove tumble of canal, on north wall, second step below bridge seat, 2 metres west of west side of wooden bridge, and 5 inches from face of stone and 6 inches from end of stone, being a square cut. (See note 6, page 549.)

N_4.—Is in the northern part of *Cincinnati*, *Ohio*, on the line of the Baltimore and

Ohio Railroad, on south abutment of bridge No. 3 over Spring Grove avenue, east end, on first course below bridge-seat course, on top of first course of sandstone above limestone, on its northeast corner, 6 inches from either face, being a square cut. (See note 6, page 549.)

O_4.—Is in the city of *Cincinnati, Ohio*, in western part of city, on line of the Baltimore and Ohio Railroad, on viaduct No. 90 over Gist street, north abutment, west end, on second step and second course below bridge-seat course, 5 feet 6 inches below top of rail, 4·9 metres west of rail, 6 inches from face of and 8 inches from end of stone, being a square cut. (See note 6, page 549.)

Cincinnati City.—Is at northeast corner of Richmond and Freeman streets, on extreme southwest corner of water table of building, being marked by a square.

P_4.—Is in city of *Cincinnati, Ohio*, at east end of Richmond street, and east side of Central avenue, 1·25 metres south of prolongation of north curb line of Richmond street, on southwest corner of four-story brick building owned by Mrs. Sarah Neare, on south end of doorstone, 6 inches from either face of corner, being a square cut. (See note 6, page 549.)

T or Cincinnati City No. 1.—*Cincinnati, Ohio.* (See page 565.)

Reference mark to Cincinnati City No. 1,—Is on the new courthouse, 5·37 feet directly above this No. 1, or T. It is a horizontal scratch on a silvered metal plate set flush with the masonry and covered by an iron plate, locked in place.

Y_4.—Is in *Cincinnati, Ohio*, on the northeast corner of Fifth and Main streets, on United States post office building, east side, north end of third window base from southeast corner, 8 inches south from pilaster base supporting columns, 8 inches back (west) from edge of stone, being west of deep area-way approached only through window of building, or by aid of plank, being top of brass bolt leaded vertically and lettered:

U S C
O
& G S

Z_4.—Is in the city of *Cincinnati, Ohio*, on northeast corner of Front and Butler streets, on west end pier of Newport Bridge, at the side of the Louisville and Nashville Railroad bridge, on third course above ground, 10 inches north of south face and 4·4 feet above the pavement, being a brass bolt. (See note 5, page 549.)

Gauge B. M.—Is at north entrance to waterworks building on Front street, 445 metres above Louisville and Nashville bridge, on west side of building, on iron doorsill, southwest end, 5 inches north of south jamb of door and 5 inches back from front edge of sill, being center of cross cut diagonally across corrugations. This bench mark is said by city authorities and United States Gauge Book to be at elevation corresponding to 60·389 on gauge.

U_4.—Is in *Cincinnati, Ohio*, in western part of city, on lower road bridge at Eighth street, over Mill Creek, on east abutment, south side, 21·6 metres east of west end of this abutment and 4·7 metres west of east end, and 0·65 metre below coping, being a brass bolt. (See note 5, page 549.) An arrow cut on vertical face of coping points downward and toward the bench.

A_5.—Is in the village of *Ludlow, Ky.*, opposite Cincinnati, Ohio, on the Southern Railroad bridge, on south pier, under long span (529 feet) being north pier of draw span, on top surface of stone bridge seat of long span, upriver side, under end of ties, 16 inches south of bed plate of truss, 22 inches north of offset in masonry down to bridge seat of draw span, being top surface of a brass bolt flush with top of stone, leaded vertically and lettered U. S. C. & G. S.

V_4.—Is in western part of *Cincinnati*, *Ohio*, on bank of Ohio River, between railroad tracks and Front street, in same vertical plane with west wall of first house (No. 2658) west of Lutheran church "Deutsche Ves. Ev. Prot. Martini Kirche A. D. 1892," on coping of heavy retaining wall, called "Big Four wall," about 160 feet east of west end of wall, being a square cut. (See note 6, page 549.)

U. S. H.—Is in the city of *Cincinnati*, *Ohio*, on west end of Cleveland, Cincinnati, Chicago and St. Louis retaining wall between Front street and railroad tracks, 1·55 metres below top of coping and 6 inches north of south face of wall, being center of indented point surrounded by triangle, lettered

U △ S
H

U. S. G. S.—Is in *Sedamsville*, *Ohio*, at intersection of Delhi avenue and street-car tracks. Chisel mark on cement walk near wall at northeast corner of Hartman's saloon, 8 inches west of corner of water table, and 2 inches out from wall. The chisel mark, which was very slight, was enlarged into a square.

W_4.—Is in the city of *Cincinnati*, *Ohio*, in southwest quarter of city, on Liston avenue, opposite No. 3538, on south side depot of the Cleveland, Cincinnati, Chicago and St. Louis Railroad, on northeast corner of building, north face, on first course of stone below water table, 1·2 metres above the sidewalk and 4 inches west of east corner, being a brass bolt. (See note 5, page 549.)

X_4.—Is at *St. Joseph* station, on Cleveland, Cincinnati, Chicago and St. Louis Railroad, 8·5 miles west of Cincinnati, on the north bank of the Ohio River, 48 feet west of southwest corner of depot and 56·25 feet south of south face of depot, 4·8 feet south of south edge of retaining wall of Cleveland, Cincinnati, Chicago and St. Louis Railroad and 2·7 feet below top of same, on east end of stone box culvert under road crossing culvert lying between Baltimore and Ohio Southwestern and Cleveland, Cincinnati, Chicago and St. Louis tracks and parallel with them, on projecting part of south wall supporting covering stone, being a square cut. (See note 6, page 549.)

Canal stone.—On which No. LXV of transcontinental line of 1879 was supposed to be, was found to be 81 feet west of west side of Baltimore and Ohio depot at *Delhi*, *Ohio*. No mark resembling bench was found, but a portion was spalled off. The elevation of a low point in northwest quarter of cross, showing two sides of an irregular square, was taken. The stone forms a foundation stone of Cleveland, Cincinnati, Chicago and St. Louis station platform and is below plank.

B_5.—Is 2 miles west of *Delhi*, *Hamilton County*, *Ohio*, on coping stone of double-arch culvert, north side, over the buttress between east arch over Muddy Creek and west arch over a railroad track, 85 feet east of west end of coping, 9 inches east of north face, and 2·2 feet above top of rail, being a square cut. (See note 6, page 549.)

C_5.—Is in the village of *Northbend*, *Hamilton County*, *Ohio*, on the line of the Cleveland, Cincinnati, Chicago and St. Louis Railroad, on viaduct bridge opposite Baltimore and Ohio Southwestern depot, on east abutment, west face, 7 metres north of south end, and 1·2 metres above ground, being a brass bolt. (See note 5, page 549.)

D_5.—Is at the Ohio and Indiana State line, on the line of the Baltimore and Ohio Railroad, 2 miles east of *Lawrenceburg*, *Ind.*, on the railroad bridge over the Miami River, east abutment, north side, 5 inches south of north face, and 18 inches east of west end, being a square cut. (See note 6, page 549.)

U.—*Lawrenceburg*, *Ind.* (See page 565.)

E_5.—Is in the city of *Lawrenceburg*, *Dearborn County*, *Ind.*, on west side of Short street, between Baltimore and Ohio Southwestern Railroad and High street, on building of the People's National Bank, north wall, 2¾ feet west of northeast corner and 1·2 metres above ground, in water table, being a brass bolt. (See note 5, page 549.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN CARROLLTON, LA., AND BILOXI, MISS.

No. 1.—*Carrollton*, *La.* (See page 603.)

Old Hampson (Williams).—*Carrollton*, *La.* (See page 603.)

New Hampson (Howell).—*Carrollton*, *La.* (See page 603.)

B. M. 3, (*Ripley*, *1875*).—Is the top of a broken spike driven into the north face of the car house of the New Orleans and Carrollton Railroad. It is 2 feet west of west side of door, on a level with the course of bricks upon which the doorsill rests.

B. M. 4, (*Ripley*, *1875*).—Is the top of a ship spike driven in the north side of the machine shop of the New Orleans and Carrollton Railroad, 0·2 foot from northwest corner. The spike is driven between the bricks, 37 courses from top of window casing.

B. M. 5, (*Burney*, *1875*).—Is a mark

$\overline{\wedge}$
U. S. E.

cut on the west end of iron sill of the north door of the New Orleans and Carrollton Railroad depot.

P. B. M. Carrollton.—The center of small hole in center of copper bolt, leaded horizontally in north face of masonry of northwest corner pillar of old courthouse, at *Carrollton*, *La.* The bolt is in the middle, about 0·03 foot from water table of pillar and about 2·5 feet above the ground. The letters

U S
⊙
P B M

are cut near the bolt.

City B. M. X X Stone.—Top of granite marking stone set in ground, in line of trees, on the west side of Carrollton avenue, about halfway between Third street and Zimple street, *Carrollton*, *La.* The stone is marked thus:

X X M B
JUNE
+
1874.

The mark + denotes the point where the rod was held.

City Stone.—This stone is set at southeast corner of crossing of Washington and Carrollton avenues, near *New Orleans, La.*

Z_1 or P. B. M. 1.—Near *New Orleans, La.* (See page 603.)

Halfway House.—A granite marking stone set in ground on west side of navigable canal (New Basin), near Metairie Ridge bridge, between the Halfway House and the gate to Metairie Cemetery. It is said to be the line stone of the Orleans and Metairie parishes of *New Orleans, La.* The stone is marked on top with a cross.

Height of Metairie Ridge.—Is a granite marking stone set in ground 12 feet southeast from southeast abutment of Lake Bridge, on east side of canal (New Basin). The bridge crosses the canal opposite Toney's House, West End, near *New Orleans, La.* The top of the stone is 8 by 13 inches, and is marked:

BENCHMARK
HEIGHT OF
METAIRIE
RIDGE.

Lake House, West End, La.—This bench mark is the top of a stone set in ground between the Lake House and Toney's House. It is on line with front fence of Toney's House, 160 feet from center of canal and about 30 feet from road crossing the canal on the Lake Bridge, at West End, near *New Orleans, La.*

Y_1 or P. B. M. 2.—*New Orleans, La.* (See page 603.)

X_1 or P. B. M. 3:—*New Orleans, La.* (See page 603.)

W_1 or P. B. M. 4.—*Chef Menteur, La.* (See page 602.)

V_1 or P. B. M. 5.—Near *Rigolets, La.* (See page 602.)

U_1 or P. B. M. 6.—Just east of *East Pearl River in Mississippi.* (See page 602.)

T_1 or P. B. M. 7.—Near *Claiborne, Miss.* (See page 602.)

S_1 or P. B. M. 8.—*Toulme, Miss.* (See page 602.)

R_1 or P. B. M. 9.—Near *Waveland, Miss.* (See page 602.)

Q_1 or P. B. M. 10.—*Bay Saint Louis, Miss.* (See page 602.)

P_1 or P. B. M. 11.—*Bay Saint Louis, Miss.* (See page 602.)

O_1 or P. B. M. 12.—*Hendersons Point, Miss.* (See page. 601.)

N_1 or P. B. M. 13.—*Pass Christian, Miss.* (See page. 601.)

M_1 or P. B. M. 14.—Opposite the *New Orleans 62-mile post.* (See page 601.)

L_1 or P. B. M. 15.—About 639 metres west of *New Orleans 66-mile post.* (See page 601.)

K_1 or P. B. M. 16.—*Mississippi City, Miss.* (See page 601.)

J_1 or P. B. M. 17.—*Beauvoir, Miss.* (See page 601.)

I_1 or P. B. M. 18.—*Biloxi, Miss.* (See page 591.)

H_1 or P. B. M. 19.—*Biloxi Bay.* (See page 592.)

G_1 or P. B. M. 20.—*Biloxi Bay.* (See page 592.)

F_1 or P. B. M. 21.—*Biloxi Bay.* (See page 592.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN MONROE AND SMITHLAND, LA.

P. B. M. 24.—In grass plot south of roundhouse at Vicksburg, Shreveport and Pacific shops, *Monroe, Ouachita Parish, La.* Bench is in southwest corner of plot, 8 metres north of center line of track and 2·4 metres east of east wall of office building. (See note 8, page 550.)

P. B. M. 25.—Is cross cut on northwest corner of iron-roller plate, set on granite cap of concrete pier with sheet-iron casing, at north side of east end of bridge over Ouachita River, at *Monroe*, *Ouachita Parish*, *La.*

P. B. M. 26.—Is an arrow cross (+⟶) cut in granite capstone of concrete pier with sheet-iron casing, at north side of west end of bridge over Ouachita River, at *Monroe*, *La.*

P. B. M. 27.—In northwest corner of courthouse yard at *Monroe*, *La.* Bench is in line of oak trees parallel to courthouse front and midway between two lines of oaks parallel to north wall, 45 metres west and 9 metres north of northwest corner of building. (See note 8, page 550.)

P. B. M. 28.—In northeast corner of yard of T. C. McLain, *West Monroe*, *Ouachita Parish*, *La.*, at southwest corner of Cotton and Natchitoches streets. Bench is 9·2 metres east of center line of McLain's house and 10 metres north of north face of brick chimney at east side of house. (See note 8, page 550.)

P. B. M. 29.—At northwest corner of section house yard at *Chênière* Station, *Ouachita Parish*, *La.* Bench is 17·5 metres south of center line of track and 63·7 metres east of Vicksburg, Shreveport and Pacific pile bridge No. 181. (See note 8, page 550.)

P. B. M. 30.—At northwest corner of yard of C. C. Harris, *Calhoun*, *Ouachita Parish*, *La.* Bench is 18 metres west and 7·5 metres north of northwest corner of Harris's house, and 45 metres south of center of track. (See note 8, page 550.)

P. B. M. 32.—At *Choudrant*, *Lincoln Parish*, *La.*, 1 metre east and 4·4 metres north of southeast corner of Farmers' Union office, and 66 metres north of center line of track. (See note 8, page 550.)

P. B. M. 33.—In courthouse yard, *Ruston*, *Lincoln Parish*, *La.* Bench is 1·5 metres south and 1·5 metres west of southeast corner of brick building used as sheriff's office, at southwest corner of Louisiana and Vienna streets. (See note 8, page 550.)

P. B. M. 34.—Is 50 metres northwest of platform at *Allen Green* Station, *Lincoln Parish*, *La.*, 46 metres north of center line of track, 1 metre east of frame store, and 27 metres northeast of blazed oak. (See note 8, page 550.)

P. B. M. 35.—In northwest corner of yard of Mr. Madden, *Simsboro*, *Lincoln Parish*, *La.* Bench is 1 metre from street line, 1 metre from fence on west side of yard, and 24·5 metres from northwest corner of house. (See note 8, page 550.)

P. B. M. 36.—In southeast corner of section house yard at *Arcadia*, *Bienville Parish*, *La.*, 6·7 metres south and 6·5 metres east of southeast corner of the most easterly of four section houses, 24 metres north of center of track. (See note 8, page 550.)

P. B. M. 37.—In northeast corner of Colbert Hotel yard, *Gibsland* Station, *Bienville Parish*, *La.* Bench is 1·3 metres south and 1·4 metres west of northeast fence corner, and 31·6 metres south of center of track. (See note 8, page 550.)

P. B. M. 38.—In northeast corner of gin yard at *Taylor* Station, *Bienville Parish*, *La.* Bench is 12·5 metres north and 8·3 metres east of northeast corner of gin, and 17·5 metres south of center of track. (See note 8, page 550.)

P. B. M. 39—In southeast corner of yard of P. H. McCary, *Dubberly*, *Webster Parish*, *La.* Bench 1·1 metres north and 1 metre west of fence corner, and 11·8 metres from southeast corner of brick chimney at south side of house. (See note 8, page 550.)

P. B. M. 40.—In northwest corner of Mr. Allison's yard, *Sibley*, *Webster Parish*, *La.*

Bench is 1·1 metres south and 0·8 metre east of fence corner, 28·8 metres south of center line of track, and 15 metres from northwest corner of house. (See note 8, page 550.)

P. B. M. 41.—On east bank of *Bayou Dorcheat*, near Vicksburg, Shreveport and Pacific bridge. Bench is in direct range of second bent of east bridge approach, 22 metres south of center of track, and 20·5 metres east of drawspan of bridge. (See note 8, page 550.)

P. B. M. 42.—In northwest corner of field owned by D. B. Doyle, at *Doyle* Station *Webster Parish, La.* Bench is 45 metres south of Farmers' Alliance Building, 30 metres southeast of southeast corner of Doyle's store, and directly southwest from station platform. (See note 8, page 550.)

P. B. M. 43.—In southwest corner of J. T. Edwards's yard, *Haughton, Bossier Parish, La.* Bench is 11·6 metres south and 10·4 metres west of southwest corner of residence. (See note 8, page 550.)

P. B. M. 44.—In northeast corner of yard of Oliver Williams, *Bodcau, Bossier Parish, La.* Bench is 5·6 metres east and 4·5 metres north of northeast corner of residence and 24·3 metres south of center of track. (See note 8, page 550.)

P. B. M. 45.—Same as △ West Base of Shreveport base line. On east side of Red River, opposite *Shreveport*, about 300 metres from Bossier end of Vicksburg, Shreveport and Pacific bridge over Red River, and 20 metres south of track. Bench is in northwest corner of small field, where road from southeast turns northeast along track.

P. B. M. 46.—In northwest corner of yard of the public building at *Shreveport, La.* Bench is 1·3 metres east and 0·5 metre south of fence corner, and 28 metres north of northwest corner of building. (See note 8, page 550.)

P. B. M. 47.—In southwest portion of field on *Kincaid Place*, left bank of Red River, *Bossier Parish, La.* Bench is 115 metres back of levee on river front, 50 metres east of bank of bayou, and 60 metres northwest from cabin standing east of bayou and back of levee. (See note 8, page 550.)

P. B. M. 48.—At *Lotus Landing*, right bank of Red River, *Caddo Parish, La.* Bench is in northwest corner of yard of Captain Robson's store, 46·5 metres from river, 1·5 metres back of store, and 50 metres south of dwelling house just above the store. (See note 8, page 550.)

P. B. M. 49.—At bend in levee about 430 metres south of gin on *Cash* plantation, right bank of river, *Caddo Parish, La.* Bench is 137 metres from river, 83 metres northwest of bayou, and 3 metres north of thorn tree on outer side of levee. (See note 8, page 550.)

P. B. M. 50.—Near *Caspiana Landing*, right bank of river, *Caddo Parish, La.*, on J. H. Hutchinson's plantation. Bench is 2·5 metres east of gin, 126 metres from river, and 40 metres south of public road. (See note 8, page 550.)

P. B. M. 51.—In southeast corner of Dr. T. Allison's yard, *Campo Bello* plantation, *Caddo Parish, La.*, right bank. Bench is 97 metres from river, 19 metres north and 3·9 metres east of southeast corner of house, and about 300 metres southeast of gin. (See note 8, page 550.)

P. B. M. 52.—On *Bonner's* plantation, *Caddo Parish, La.*, right bank. Bench is 8 metres north and 2 metres east of cabin occupied by S. Smith (colored), 183 metres from river, and 300 metres southwest of a gin standing at first bend of river to the left below Bear Point Landing. (See note 8, page 550.)

P. B. M. 53.—On Stringfellow's plantation, near *Howard* post office, *Red River*

Parish, La., right bank of river. Bench is in southwest corner of yard of cabin occupied by S. Johnson (colored), 23·5 metres south and 6·8 metres west of cabin. Cabin stands 300 metres southwest of plantation house and 200 metres south of gin. It is the first cabin south of post office. (See note 8, page 550.)

P. B. M. 54.—In yard of Thomas Bell, just below mouth of *Loggy Bayou*, on left bank of river. Bench is 10·4 metres north of residence and 45 metres from river bank. (See note 8, page 550.)

P. B. M. 55.—In southwest corner of lot owned by W. P. Scarborough, at *East Point, Red River Parish, La.* Bench is 16·5 metres from river, 3·5 metres south of James Foley's warehouse, and 0·9 metre from front fence of lot. Destroyed in 1892.

P. B. M. 56.—On *Crichton's* plantation, *Red River Parish, La.*, left bank of river. Bench is in southwest corner of yard around two cabins standing where river makes an abrupt turn to the right. Cabins are about 400 metres below Mr. Crichton's residence and 100 metres to left of the public road. (See note 8, page 550.)

P. B. M. 57.—In northwest corner of courthouse yard at *Coushatta, Red River Parish, La.* Bench is 1 metre from north fence line, 1 metre from west fence line, and 33·2 metres from northwest corner of courthouse. (See note 8, page 550.)

P. B. M. 58.—In northwest corner of yard of Methodist church, at *Coushatta, La.* Bench is 0·8 metre from north fence line, 0·9 metre from west fence line, 31 metres from east fence line, and 7·9 metres from northwest corner of church. (See note 8, page 550.)

P. B. M. 59.—On *Upper Brownsville* plantation, *Red River Parish, La.*, in northeast corner of garden back of a negro cabin standing about 600 metres southeast of Lake End Landing and 300 metres from bank. Bench is 10 metres southeast of southeast corner of cabin. (See note 8, page 550.)

P. B. M. 60.—On property of George Johnson (colored), next below *Boyce* plantation, *Natchitoches Parish, La.*, right bank. Property lies just above *Old River* and to left of public road to Campti. Bench is 1·8 metres from north line of residence and on line with front of gallery. (See note 8, page 550.)

P. B. M. 61.—In northwest corner of yard of S. O. Melancon, Le Vassar plantation, *Natchitoches Parish, La.*, at lower end of Cross Point Bend, about 3 kilometres below *Campti, La.* Bench is 8·5 metres northeast of front line of gallery and 6·3 metres northwest of northwest line of house. Destroyed in 1892.

P. B. M. 62.—In small yard adjoining *Willow* post office building, *Natchitoches Parish, La.* Bench is 3·5 metres south of south line of post office and 3 metres west of west line of post office. (See note 8, page 550.)

P. B. M. 63.—In southwest corner of yard of H. P. Gallion, *Natchitoches Parish, La.*, opposite lower end of *Tiger Island*, and on east bank of Fausee River, just above where it branches. Bench is 39 metres west of west line of gallery of residence and 5·5 metres south of south line of residence. (See note 8, page 550.)

P. B. M. 64.—At *St. Maurice, Winn Parish, La.*, in southeast corner of inclosure southeast of E. W. Tedlie's store, 0·8 metre northwest of northwest line of front gallery and 5·2 metres southwest of southwest line of store. (See note 8, page 550.)

P. B. M. 65.—On plantation of C. C. Dunn, *Grant Parish, La.*, near a cabin standing 375 metres above *Dunns Landing*. Bench is 5·1 metres south of south wall of cabin and 8 metres east of east wall. (See note 8, page 550.)

P. B. M. 66.—On plantation of Dr. R. E. Jackson, *Natchitoches Parish, La.*, about 1·5 kilometres below town of *Montgomery* and on right bank. Bench is in northeast corner of Dr. Jackson's yard, 31·6 metres east of east wall of house and 23·3 metres north of north wall. (See note 8, page 550.)

P. B. M. 67.—On J. A. Williams's plantation, at *Buxtons Landing*, *Natchitoches Parish*, *La.* Bench is 60 metres east of east wall of plantation house and 14 metres south of south wall. House stands 80 metres below mouth of Little River. (See note 8, page 550.)

P. B. M. 68.—On right bank, opposite dwelling house on plantation of Isaac McMills and about 6·4 kilometres above town of *Colfax*, *La.* Bench is referenced as follows: No. 1, blazed oak tree southwest of bench, 6 metres distant; No. 2, blazed oak northwest of bench, 11 metres distant; No. 3, △ 248 north of bench, 70 metres distant; △ 248 is on river bank, 260 metres below mouth of small bayou. (See note 8, page 550.)

P. B. M. 69.—In northwest corner of courthouse yard, at southeast corner of Second and Main streets, *Colfax*, *Grant Parish*, *La.* Bench is 8·4 metres north of north wall of courthouse and 16·2 metres west of west wall. (See note 8, page 550.)

P. B. M. 70.—On plantation of Mrs. A. C. Deal, *Grant Parish*, *La.*, about 2 kilometres above *Fairmount* post office and opposite Deloges Rock. Bench is in southeast corner of yard on west side of Mrs. Deal's store, 5 metres south of south wall of store and 9·4 metres west of east wall. (See note 8, page 550.)

P. B. M. 71.—At *Boyce*, *Rapides Parish*, *La.*, next to fence in field belonging to Mr. Boyce and at an angle of lane running back from warehouse along north side of town. Bench is 42 metres west of east wall of J. T. Carnahan's residence and 37·1 metres north of north wall. (See note 8, page 550.)

P. B. M. 72.—On Mr. Marye's plantation, *Rapides Parish*, *La.*, about 5·6 kilometres below *Rapides* post office. Bench is on a small levee 0·7 metre northwest of intersection of levee with division fence between Marye's and Cruikshank's plantations, and 4 metres southeast of angle in levee where it changes its course from southwest to southeast. (See note 8, page 550.)

P. B. M. 73.—In south corner of courthouse yard, corner of Lee and Second streets, *Alexandria*, *La.* Bench is 26·7 metres southwest of southwest wall of courthouse and 21·3 metres southeast of southeast wall. (See note 8, page 550.)

P. B. M. 74.—In east corner of yard of Rapides Parish jail, *Alexandria*, *La.*, on Lee street, between Fifth and Sixth streets. Bench is 3·2 metres southeast of southeast wall of jail and 10 metres northeast of northeast wall. (See note 8, page 550.)

P. B. M. 75.—On plantation of C. O. Harris, *Rapides Parish*, *La.*; right bank about 8 kilometres below *Alexandria*, *La.*, and near a cabin standing 32 metres west of a point on levee which is 22·5 metres below bend in levee opposite and a little above Cannon's wood yard. Bench is 6·3 metres north of north wall of cabin, 17·2 metres east of east wall, and 16 metres back of levee. (See note 8, page 550.)

P. B. M. 76.—Same as △ southwest base of Grand Bend base line, and is on Peart's plantation, *Rapides Parish*, *La.*, on neck of *Grand Bend*. Bench is about midway on neck at side of fence dividing pasture and thicket, on thicket side.

P. B. M. 77.—Near *Jones Quarter Landing*, *Rapides Parish*, *La.* It is about 300 metres below the landing, 10 metres south of parish road, 12 metres from base of State levee, and 81 metres back from bank of Red River. On property of Frank White, 1 metre from division line of Polyte Smith. (See note 8, page 550.)

P. B. M. 78.—About 3·1 kilometres below Poland post office, at *Once More Landing*, *Rapides Parish*, *La.* It is situated in lower rear fence corner of George Wilson's horse lot. (See note 8, page 550.)

P. B. M. 79.—*Egg Bend Landing*, *Avoyelles Parish*, *La.* Top of broken-off wire nail leaded vertically into bottom course of footing of brick chimney at southwest end of dwelling south from Ryland and Didier's store.

P. B. M. 80.—*David Ferry*, *Avoyelles Parish*, *La.* Is horizontal cut in hemispherical head of copper bolt leaded horizontally into seventeenth course of brick above the footing, near the middle of northwest face of chimney at southwest end of house occupied by ——— Laborde. Letters

U S
⊖
B M

are cut into the brick. House is on right bank of Red River, about 400 metres above road to Marksville, La.

P. B. M. 81.—*Normands Landing*, *Avoyelles Parish*, *La.* Is center of horizontal cut in head of copper bolt leaded horizontally into sixteenth course of brick above footing, near middle of south face of chimney at south end of house occupied by R. L. Reynaud, on right bank of Red River. Letters B. ⊖ M. cut in brick.

P. B. M. 82.—*Normands Landing*, *Avoyelles Parish*, *La.* Is center of horizontal cut in head of copper bolt leaded horizontally into twelfth course of brick above footing, near middle of east face of chimney at east side of house occupied by William Vanosdell and owned by R. L. Reynaud. Letters

B M
⊖

cut in brick.

P. B. M. 83.—*Marksville*, *Avoyelles Parish*, *La.* Is horizontal cut in head of copper bolt leaded horizontally into eighteenth course of brick above ground, about the middle of east (Washingtons street) side of parish courthouse. It is between the east door and the window near front side. Marked

U S
⊖
B M

United States signal office is east of courthouse.

P. B. M. 84.—*Mansura*, *Avoyelles Parish*, *La.* Is horizontal cut in head of copper bolt leaded horizontally in northwest pier of gallery of unoccupied store owned by David Siess, on east side of road. Store is about 30 metres south southwest of David Siess's dwelling and about 85 metres southeast of F. Regard's store, marked B. ⊖ M.

P. B. M. 85.—Near southern limits of *Mansura*, *Avoyelles Parish*, *La.* Is horizontal cut in head of copper bolt leaded horizontally into nineteenth course of brick above ground, on south side of chimney at west end of Mme. Victor Claude's dwelling on north side of road leading to Moreauville. Marked

U S
⊖
B M

P. B. M. 86.—*Moreauville, Avoyelles Parish, La.* Is horizontal cut in head of copper bolt leaded horizontally into twenty-second course of brick above ground of chimney on east side of cabin occupied by Edmond Baker (colored) on Dr. Rabelais's plantation. Cabin is about 50 metres south of right bank of Bayou des Glaisés and about 1,000 metres west of where Hamburg road leaves the bank of the bayou. Marked

B M
⊖

P. B. M. 87.—About 445 metres southeast of *Hamburg, Avoyelles Parish, La.* Is center of copper bolt leaded horizontally into twenty-first course of brick above ground, in chimney on west side of cabin occupied by Brazil François on F. M. Pavey's plantation. Cabin is situated about 66 metres from edge of right bank of Bayou des Glaisés. Marked B. ⊗ M.

P. B. M. 88.—About 2·4 kilometres (measured along road) west of *Simmesport, Avoyelles Parish, La.* Is center of cross in head of copper bolt leaded horizontally into thirteenth course of brick above ground of chimney of cabin occupied by W. B. Jones (colored) on H. N. Norwood's plantation. Cabin is on right bank of Bayou des Glaisés and on Atchafalaya road, about 175 metres east of Harland's (also called Hollands') Bayou. Marked B. ⊗ M.

P. B. M. 89.—*Simmesport, Avoyelles Parish, La.* Is in northeast corner of J. E. Trudeaus's front yard and just south of N. Norwood's store.

P. B. M. 90.—On Tom Carruth's plantation, near *Water Valley Landing, Avoyelles Parish, La.* Is 25 metres east of wood line fence, 338 metres west of cabin occupied by William Fields (colored), and 375 metres west of cabin occupied by M. Laborde. Witnessed by three blazed hackberry trees as follows: First, 1 metre diameter, 66° 30′, 8 metres; second, 0·6 metre diameter, 328° 40′, 23 metres; third, 0.6 metre diameter, 271° 25′, 11 metres. All on right bank of Old River and right bank of the Atchafalaya River. (See note 8, page 550.)

P. B. M. 91.—Near *Merrick* post office, *Pointe Coupee Parish, La.* Is at corner of fence around cabin occupied by Sam Morris on D. T. Merrick's plantation, and 285 metres south of levee. (See note 8, page 550.)

P. B. M. 92.—Near *Barbre Landing, Pointe Coupee Parish, La.* Is on S. Barbre's plantation, on west side of hedge on west side of lane dividing S. Barbre's and George Keller's plantations. It is about 125 metres south of levee and 99 metres southeast of cabin occupied by Kate Watson (colored) and 273 metres south of S. Barbre's residence. (See note 8, page 550.)

P. B. M. 93.—About 780 metres (measured along road) southeast of *Barbre Landing, La.* Is top of copper bolt cemented in top of marble post (15 by 15 centimetres) about 13 metres from levee in corner of fence. Marked:

U	S
N ●	O

P. B. M. 94.—About 1,275 metres (measured along road) southeast of *Barbre Landing, La.* Is top of copper bolt cemented in top of marble post (15 by 15 centimetres). Is in front of George Heller's plantation at corner of fence and 13 metres from levee. Marked the same as P. B. M. 93, above.

M. R. C. B. M. $\frac{142}{3}$.—Near *Torras Landing*, *Pointe Coupee Parish*, *La*. Is center of top of limestone post (15 by 15 centimetres) at angle in levee, at end of lane on north side of Joseph Torras's residence and 165 metres south of Catholic church. Marked:

$\boxed{\text{U S}}$

No. XLV.—*Smithland*, *Pointe Coupee Parish*, *La*. (See page 607.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN RAYVILLE AND MONROE, LA.

P. B. M. 16.—In courthouse yard at *Rayville*, *Richland Parish*, *La*. Bench 0·8 metre west of northwest corner of "L" in courthouse front, 0·9 metre north of north wall, and 61 metres south of center of track. (See note 8, page 550.)

P. B. M. 17.—Hole in head of copper bolt leaded in face of "L" of courthouse front, *Rayville*, *La*., 0·09 metre west of north door and 0·4 metre above floor line.

P. B. M. 18.—On east bank of Boeuf River, near *Rayville*, *La*., in a southeasterly direction from Vicksburg, Shreveport and Pacific bridge, 70·6 metres south of center line of track and in direct range of first bent east of bridge approach, 12·5 metres from river bank, and 200 metres northeast of house. (See note 8, page 550.)

P. B. M. 19.—At *Girard*, *Richland Parish*, *La*., east side of yard of Mrs. Brashear, 4 metres east and 4·5 metres south of southeast corner of brick chimney at east end of house and 26 metres south of center line of track. (See note 8, page 550.)

P. B. M. 20.—Hole in head of copper bolt leaded in east face of brick chimney at east end of Mrs. Brashear's house at *Girard*, *Richland Parish*, *La*. Bolt is 0·3 metre from north face of chimney and 1 metre above springing course.

P. B. M. 21.—In southeast corner of garden lying in a northwesterly direction from railway platform at *Crew Lake* station, *Richland Parish*, *La*. Bench is 4·5 metres west of southwest corner of store at Crew Lake, on line of front of store, and 24 metres north of center line of track. (See note 8, page 550.)

P. B. M. 23.—In northeast corner of yard on plantation of F. L. Whitehead, at *Gordon* station, *Ouachita Parish*, *La*. Bench is 14·7 metres north and 9·5 metres east of northeast corner of brick chimney at east end of an L-shaped cabin in same yard as bench. (See note 8, page 550.)

P. B. M. 24.—*Monroe*, *La*. (See page 668.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN DELTA AND RAYVILLE, LA.

No. 215.—*Delta*, *La*. (See page 610.)

P. B. M. 2.—At northeast corner of the most easterly of the Vicksburg, Shreveport and Pacific Railroad section houses at *Mound* station, *Madison Parish*, *La*. Bench is 0·8 metre south and 0·2 metre east of northeast corner of house. (See note 8, page 550.)

P. B. M. 3.—In northeast corner of yard of Mrs. N. Thomas, at *California* station, *Madison Parish*, *La*., about 400 metres south of Vicksburg, Shreveport and Pacific Railroad bridge No. 25. (See note 8, page 550.)

P. B. M. 4.—In southwest corner of yard around cabin and opposite store at *Barnes* station, *Madison Parish*, *La*., 13·4 metres from southwest corner of cabin chimney and 44 metres north of center of railroad siding. (See note 8, page 550.)

P. B. M. 5.—Hole in head of copper bolt leaded horizontally in south wall of courthouse at *Tallulah*, *Madison Parish*, *La.* Bolt is 0·6 metre west of west side of main door and 0·55 metre above floor of gallery.

P. B. M. 6.—Cross cut on west end of iron doorsill at south entrance of *Tallulah* courthouse. It is nearly under P. B. M. 5.

P. B. M. 7.—On east bank of *Lake One*, 57 metres north of east pier of Vicksburg, Shreveport and Pacific Railroad bridge, and in a southwesterly direction from Waddill's sawmill. (See note 8, page 550.)

P. B. M. 8.—At northwest corner of store at *Quebec* station, *Madison Parish*, *La.* Store is 110 metres southwest from west end of railroad siding and 60 metres east of east end of railroad bridge over Bayou Dispute. (See note 8, page 550.)

P. B. M. 9.—On east bank of Tensas River, near *Quebec*, in a southeasterly direction from railroad bridge, and in direct range of second bent of east bridge approach, 8·7 metres south of center line of track. (See note 8, page 550.)

P. B. M. 10.—At *Dallas*, *Madison Parish*, *La.* Bench is 2·35 metres east of brick chimney of first cabin west of Tensas River, on north side of railroad track, and 4·1 metres north of center line of track. (See note 8, page 550.)

P. B. M. 11.—In northwest corner of yard of house occupied by section foreman at *Waverly*, *Madison Parish*, *La.* Bench is 55 metres south of center of railroad track and 20·5 metres north of house, in continuation of west wall. (See note 8, page 550.)

P. B. M. 12.—On west bank of *Bayou Macon*, near Vicksburg, Shreveport and Pacific Railroad bridge. Bench is in direct range of the fourth bent of west bridge approach, 40 metres south of center of track and 10·8 metres northeast of blazed locust. (See note 8, page 550.)

P. B. M. 13.—At *Delhi*, *Richland Parish*, *La.*, in northwest corner of residence lot belonging to W. T. Insley. Bench is 27·3 metres south of center line of track, 20·4 metres east of Catholic church-yard fence, and 1 metre south and 1 metre east of northwest fence corner. (See note 8, page 550.)

P. B. M. 14.—At *Carpenter* station, *Richland Parish*, *La.*, in southeast corner of yard of cabin standing opposite railroad platform. Bench is 15·4 metres north of center of track and 23·8 metres southeast of southeast corner of cabin. (See note 8, page 550.)

P. B. M. 15.—At *Holly Ridge*, *Richland Parish*, *La.*, in yard of residence of W. F. Winstead, 23·4 metres south of front line of gallery, 1·8 metres west of main door to house, and 18·3 metres north of center line of track.

P. B. M. 16.—*Rayville*, *La.* (See page 675.)

P. B. M. 17.—*Rayville*, *La.* (See page 675.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN CONCORDIA AND VIDALIA, LA., AND NATCHEZ, MISS.

T. B. M. 9.—*Concordia*, *La.* No description.

No. LXIII.—*Vidalia*, *La.* (See page 608.)

No. LXII.—*Vidalia*, *La.* (See page 608.)

No. LXI.—*Vidalia*, *La.* (See page 608.)

No. LXIV.—*Vidalia*, *La.* (See page 608.)

M. R. C. Stone $\frac{132}{3}$.—On west side of Trinity street, *Vidalia, La.*, 440 metres back from north line of street, 315° 20', 420 metres from courthouse, and 194° 448 metres from church.

M. R. C. Stone $\frac{132}{4}$.—On east side of Trinity street, *Vidalia, La.*, 1 295 metres from north side of street nearest the river and parallel to it; 136 metres north of north fence around group of cabins on west side of road.

B. M. 1858.—Is cross in brick next to wall under marble sign of clerk's office in *Vidalia, La.*

B. M. Courthouse Pedestal.—Is at northeast corner of courthouse pedestal or water table.

B. M. Polk 1.—Is the top of the letter T in the word "THE" on top of cast-iron covering to water main at the head of Ferry street, *Natchez*, under the hill.

B. M. Polk 2.—Is cross cut on south corner of brick at southwest end of retaining wall, ninth course above ground at corner of wall. Bench is opposite Ray & Grant Building, corner Silver and Fulton streets, *Natchez, Miss.*

B. M. Polk 3.—Erected by Babbitt, June, 1871. Is on west corner of iron door-step of Fulton-street store belonging to Ray & Grant.

B. M. Cor. of State & Broadway sts.—Is top of stone coping, corner of State and Broadway streets.

P. B. M. 1.—Is in the middle park on Natchez Bluffs, about 20 metres from east fence and near a large red oak. Is in line with north side of Berntina alley, which is midway between and parallel to Main and State streets.

B. M. No. 7. (Melvin, 1879).—Is northwest corner of lower step of west entrance to courthouse in *Natchez.*

B. M. (Babbitt, 1874) No. 3.—Is point made with chisel in corrugated iron doorstep in upstream face of brick building in rear of elevator, formerly Ray & Grant's store.

B. M. N (Ewens, 1886).—Is top of spike driven horizontally in mortar course of river face of ice house, downstream corner. Bench is 2½ feet above ground and has "N" cut in brick near bench.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN MONROE AND CONCORDIA, LA.

P. B. M. 27.—*Monroe, La.* (See page 669.)

P. B. M. 28.—*West Monroe, La.* (See page 669.)

P. B. M. 26.—*Monroe, La.* (See page 669.)

P. B. M. 25.—*Monroe, La.* (See page 669.)

P. B. M. 24.—*Monroe, La.* (See page 668.)

B. M. C (Burrows, 1883).—Is on south side of stone cap of south tube in west abutment of railroad bridge at *Monroe, La.* Point not marked.

B. M. D. (Burrows, 1883).—On north (or west?) side of stone cap of north tube of east abutment of railroad bridge at *Monroe, La.* Point not marked.

P. B. M. 9.—At *Logtown, Ouachita Parish, La.* Is in south corner of R. M. Filliol's field, 23 metres from main bank and 70 metres from second bank of river, 16 metres west of west corner of store and 3 metres west of warehouse. (See note 8, page 550.)

P. B. M. 10.—At *Blankston, Caldwell Parish, La.* Is at southwest corner of yard around I. A. Davis's residence, 1 metre from fence and 0·75 metre from post-office building, 38 metres from center of levee, and 75 metres from southwest corner of dwelling. (See note 8, page 550.)

T. B. M. 125.—Is a cross on top of marble stone 0·12 metre square dividing Call's and Faulkner's places. It is 5 metres south of road, 100 metres from left bank of river, and 130 metres southwest from Orange Call's dwelling.

P. B. M. 11.—Is about 1 750 metres below *Riverton* station, *Caldwell Parish, La.* It is 22 metres from center of railroad, 50 metres from Smith Lake, 300 metres from end of trestle approach to drawbridge, and 23 metres from corner of old cabin in field belonging to Widow Ruttland. (See note 8, page 550.)

Gauge B. M. B.—Is a cross cut on top of lower of first two piers from *Riverton* shore. Is on east side of east pier at north end of drawbridge over Ouachita River at Riverton.

Gauge B. M. A.—Is chisel mark cut in upper edge of lowest piece of sheet-iron casing of west pier at north end of drawbridge across Ouachita River at *Riverton*.

P. B. M. 12.—At *Columbia*, *Caldwell Parish, La.* Is in northwest corner of courthouse yard, at the corner of Wall and Main streets. It is 32 metres from northeast corner of "jury room." (See note 8, page 550.)

P. R. P. Gibson.—At *Gibsons Landing*, *Caldwell Parish, La.* Is in northwest corner of J. W. Price's yard, 10 metres north of north wall of house and 5 metres west of west wall. Reference tree is 0·9 metre elm 3 metres east of bench.

P. B. M. 13.—At *Coles Landing*, *Caldwell Parish, La.* It is in southwest corner of field belonging to V. Thompson. Is 16 metres east of Wade Bayou, 20 metres north of east bank of river, and 4 metres east of road. (See note 8, page 550.)

P. B. M. 14.—At *Cottingham Landing*, *Caldwell Parish, La.* It is 300 metres northwest of east bank of river and 22 metres west of road. It is on top of ridge and 8 metres from sloping bank leading into adjacent swamp. (See note 8, page 550.)

B. M. B.—At *Danville*, *Caldwell Parish, La.* Is in northwest corner of horse lot adjoining residence of ——— Banghman, 80 metres west of right bank of river and 85 metres south of right bank of Bayou Dan.

B. M. A.—Is on property of P. H. Carter, between *H. T. Young* and *Sawmill Landings*. Is about 100 metres from bank of river and 2·3 metres inside of field from fence.

P. B. M. 8.—At *Staffords*, *Catahoula Parish, La.* Is top of head of copper bolt leaded in stone 56 by 40 centimetres, with usual pipe on top. Is 70 metres west of west bank of river, 30 metres southwest of southwest corner of Mr. Stafford's house, and opposite mouth of Bœuf River.

P. B. M. 7.—At *Catahoula Shoals*, *Catahoula Parish, La.* Is 12 metres back from west bank of river, in grove of small pines, and 25 metres from southeast corner of old cabin in abandoned field. (See note 8, page 550.)

T. B. M. H.—Is cross cut in top of northeast corner of stone 0·8 by 0·4 by 0·8 metres on west bank of river, 7 metres northeast from corner of fence, in front of *Harrisonburg, La.*

B. M. V.—*Harrisonburg, La.* Is a V mark on first brick above projecting course of brick almost level with surface of ground on east face of northeast corner of clerk's office in courthouse yard.

P. B. M. 6.—*Harrisonburg, Catahoula Parish, La.* Is center of cross cut on head of copper bolt leaded into upper edge of second course of brick, 14 centimetres above stone foundation on west side, and 34 centimetres from southwest corner of Catahoula Parish jail. Is on second brick from corner and letters U. S. cut in brick.

P. B. M. 5.—At *Trinity, Catahoula Parish, La.* Is on property of Guss estate immediately back of kitchen back of house, 0.9 metre from west fence and 10 metres from south fence. (See note 8, page 550.

P. B. M. 4.—At *Jonesville, Catahoula Parish, La.* Is in northeast corner of lot of Dr. Baker, and adjoining his drug store, and 23 metres from corner of streets. (See note 8, page 550.)

P. B. M. 3.—At *Black River* station, *Concordia Parish, La.* Is 35 metres east of left bank of Black River, opposite mouth of Little River, 25 metres from railway track, and 65 metres north from depot platform. (See note 8, page 550.)

P. B. M. 2.—At *Frogmore, Concordia Parish, La.* Is in southwest corner of section house yard of Natchez, Red River and Texas Railway. Is on east bank of Otts Bayou, 10 metres north of track and 11 metres east of trestle over Otts Bayou. (See note 8, page 550.)

T. B. M. 9.—*Concordia, La.* No description.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN RAYVILLE AND CONCORDIA, LA.

P. B. M. 16.—*Rayville, Richland Parish, La.* (See page 675.)

P. B. M. 17.—*Rayville, La.* (See page 675.)

P. B. M. Burke.—At *Burke* Station, 8 kilometres below Rayville, *Richland Parish, La.* Is about 50 metres east of track and about 10 metres north of indistinct road leading back to farmhouse. (See note 8, page 550.)

P. B. M. Archibald.—At *Archibald, Richland Parish, La.* Is in northwest corner of yard of J. J. Archibald, about 8 metres east of center of track and 30 metres south of depot. (See note 8, page 550.)

P. B. M. Mangham.—At *Mangham, Richland Parish, La.* Is in southeast corner of yard of H. H. Nash and 40 metres west from track at a point about 10 metres south of south end of side track. (See note 8, page 550.)

P. B. M. Big Creek.—At *Big Creek, Franklin Parish, La.* Is on property of John Guinn, about 70 metres east of the left bank of Big Creek where New Orleans and Northwestern Railway crosses it and 25 metres south of track. (See note 8, page 550.)

P. B. M. Baskin.—At *Baskin* Station, *Franklin Parish, La.* Is about 25 metres west of track directly opposite the north end of platform and 5 metres north of road. (See note 8, page 550.)

P. B. M. Steele.—At road crossing of New Orleans and Northwestern Railway, at what was formerly known as *Steeles Switch, Franklin Parish, La.* Is about 15 metres east of track and 40 metres south of trestle and at edge of dirt road. (See note 8, page 550.)

P. B. M. Winnsboro.—At *Winnsboro, Franklin Parish, La.* Is in southwest corner of lot owned by Mrs. Adams, directly opposite the depot and about 40 metres west of track. (See note 8, page 550.)

P. B. M. Eden.—At *Eden* Station, *Franklin Parish, La.* Is on property of A. W.

McDuff, about 10 metres east of track, in corner of fence, and about 80 metres north of platform, and about 100 metres east of McDuff residence. (See note 8, page 550.)

P. B. M. Gilbert.—At *Gilbert, Franklin Parish, La.* Is about 40 metres west of track, in the southwest corner of a garden owned by Ephraim Williams, and about 150 metres south of depot. (See note 8, page 550.)

P. B. M. Wisner.—At *Wisner, Franklin Parish, La.* Is about 20 metres east of track, at south end of side track, and 200 metres south of depot. (See note 8, page 550.)

P. B. M. Elam.—At *Elam, Franklin Parish, La.* Is at north edge of Mrs. L. Allen's store and about 30 metres west from track and 2 metres west from pump at northeast corner of store. (See note 8, page 550.)

P. B. M. Peck.—At *Peck* Station, *Catahoula Parish, La.* Is in northeast corner of cotton field belonging to H. & C. Newman, of New Orleans, and about 25 metres west of seed house at station platform. (See note 8, page 550.)

P. B. M. Newman.—On property of H. & C. Newman, 4 kilometres south of *Peck, Catahoula Parish, La.* On north bank of bayou and 10 metres east of south end of trestle over bayou. (See note 8, page 550.)

P. B. M. Chisum.—At *Chisum, Catahoula Parish, La.* It is 2·3 kilometres north of Florence, about 30 metres west of track and at south edge of plantation road on H. & C. Newman's place. (See note 8, page 550.)

P. B. M. Florence.—At *Florence, Sicily Island* post office, *Catahoula Parish, La.* Is about 15 metres west of track, on railroad property, and about 125 metres north of depot. (See note 8, page 550.)

P. B. M. Copeland.—At *Copeland, Catahoula Parish, La.* Is about 35 metres east of track and 35 metres southeast from station platform. (See note 8, page 550.)

P. B. M. Kirk.—At *Kirks Ferry, Catahoula Parish, La.* Is in southeast corner of yard of S. F. Kiper on Tensas River and above mouth of Choctaw Bayou. Is about 10 metres west of main top bank of river and 20 metres southeast of residence. (See note 8, page 550.)

P. B. M. Tensas.—At *Greenville, Catahoula Parish, La.* Is in southwest corner of lot, 80 metres east of track and about 40 metres west of main right bank of river. (See note 8, page 550.)

P. B. M. Lee Bayou.—At *Lee Bayou, Catahoula Parish, La.* Is on bank of Lee Bayou and about 50 metres west of track. (See note 8, page 550.)

P. B. M. Clayton.—At *Clayton, Concordia Parish, La.* Is at corner of fence, about 25 metres northeast of track, 10 metres southeast of left bank of Tensas River, and 25 metres north of depot. (See note 8, page 550.)

P. B. M. Cypress.—At *Cypress City, Catahoula Parish, La.* Is in yard of Henry Ellerbee (colored) and 85 metres west of track. (See note 8, page 550.)

P. B. M. Helena.—At *Helena, Concordia Parish, La.* Is on north side of lane and about 20 metres north of track and on property of Graves & Veaton Company. (See note 8, page 550.)

P. B. M. Concordia.—Is at *Concordia* Station, *Concordia Parish, La.* Is 5 metres south of Natchez, Red River and Texas Railway, 2 metres west from line of east side of depot, and 5 metres west from road crossing track at east end of depot. (See note 8, page 550.)

B. M. 384.—Copper tag above zinc spike reads:

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884
Elev. 88·84

Bench mark is 1·5 metres above ground. Elevation taken on square part of spike.

T. B. M. 9.—*Concordia, La.* No description.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN JONESVILLE AND MOUTH OF BLACK RIVER, LOUISIANA.

P. B. M. 4.—*Jonesville, La.* (See page 679.)

P. B. M. 3.—*Black River, Concordia Parish, La.* (See page 679.)

P. B. M. 5.—*Trinity, La.* (See page 679.)

P. B. M. 5a.—At head of *Jones Bayou, Catahoula Parish, La.* Is on south bank of Jones Bayou and east side of public road on Nicholia place. (See note 8, page 550.)

P. B. M. 6a.—At *McClures Landing, Catahoula Parish, La.* Is 400 metres below McClures Landing, 28 metres west of west bank of river, and 16 metres south of building used as church on McClure place. Is on property of Joe Montgomery in fence corner at head of lane going across neck. (See note 8, page 550.)

P. B. M. 7a.—At *Eva* post office, *Concordia Parish, La.* It is 10 metres west from left bank of Black River, 222 metres north from gin at Calhouns Landing, and 63 metres north of N. Calhoun's residence. (See note 8, page 550.)

P. B. M. 8a.—At *Hardscramble Landing, Concordia Parish, La.* Is 7 metres south of public road, 15 metres south of levee, which is on left bank of Black River on an abandoned place. (See note 8, page 550.)

P. B. M. 9a.—At *Lums, Concordia Parish, La.* Is in fence corner 15 metres southeast of residence occupied by H. L. Pauhl on Lums place and 150 metres north of left bank of Black River. (See note 8, page 550.)

P. B. M. 10a.—At *New Era* post office, *Concordia Parish, La.* Is 23 metres south from left bank of river and 38 metres northeast from residence of Solomon Harris at Emerson Landing. (See note 8, page 550.)

P. B. M. 11a.—At *Acme* post office, *Concordia Parish, La.* Is 30 metres west of Young Pecanty's residence, 22 metres northeast of river and 80 metres below Burleigh Landing. (See note 8, page 550.)

Discharge Jar.—Is on left bank of *Black River*, 375 metres above mouth.

P. B. M. 12a.—*Mouth of Black River, Concordia Parish, La.* Is 30 metres southeast from left bank of Black River, 40 metres northwest from cabin of Henry Delhoste, and 70 metres east of Delhoste Landing on Black River. (See note 8, page 550.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN SHREVEPORT AND JETERS LANDING, LA.

P. B. M. 46.—*Shreveport, La.* (See page 670.)

P. B. M. 1.—At *Albany Point, Caddo Parish, La.* Is in northeast corner of yard, 10·3 metres from northeast corner of house, 16 metres from edge of bluff, and 10 metres northwest of a cedar tree. (See note 8, page 550.)

P. B. M. 2.—At *Henderson Mill, Caddo Parish, La.*, near upper end of Soda Lake. Is on line with north side of deserted house, 10 metres from northwest corner, 28 metres from edge of bluff, 12·4 metres southeast of twin mulberry and hickory trees. Witnessed north and south sides by two buried millstones. (See note 8, page 550.)

P. B. M. 3.—At *Mooringsport, Caddo Parish, La.* Is on north side of C. S. Croom's store, 1·9 metres from northwest corner of gallery, 0·4 metre from edge of gallery, 0·6 metre from northwest corner of wall, and 45 metres from top bank of Ferry Lake. (See note 8, page 550.)

P. B. M. 4.—At *Jeters Landing, Caddo Parish, La.* Is on line of east side of deserted house 0·9 metre from northeast corner, 21·1 metres from edge of bluff, measured on north and south line, and 29 metres from post oak on edge of bluff. (See note 8, page 550.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN MONROE AND PARKEVILLE, LA.

P. B. M. 27.—*Monroe, La.* (See page 669.)

P. B. M. 25.—*Monroe, La.* (See page 669.)

P. B. M. 24.—*Monroe, La.* (See page 668.)

P. R. P. Pargoud.—Is on top of Indian mound, about 100 metres below mouth of *Bayou De Siord, Ouachita Parish, La.* It is about 100 metres east of east bank of Ouachita River and 50 metres south of south bank of Bayou De Siord, and about 200 metres above gin on Pargoud place. (See note 8, page 550.)

P. R. P. Zeph.—Is on the *Bank Smith place, Ouachita Parish, La.* Is in the west edge of the cultivated field, about 50 metres northeast of an abandoned cabin and 60 metres east of east bank of river. Is 250 metres south of wagon road and witnessed by two triangular blazed trees, as follows: 0·8 metre cottonwood, 72° 17′, 45 metres; 0·4 metre redwood, 159° 20′, 12 metres. (See note 8, page 550.)

P. R. P. Rock Row.—At *Rock Row Shoals, Ouachita Parish, La.* Is in west side of yard around residence on Taylor place, 1 metre north of north wall and 12 metres west of west wall of house. Is 30 metres north of left bank of river, and witnessed by two triangular blazed trees, as follows: 0·8 metre chinaberry S. 50° E., 4 metres; 0·3 metre peach N. 10° E., 2·5 metres. (See note 8, page 550.)

P. R. P. Glendora.—Is on the division line between the Hugh Young and *Glendora* places in *Ouachita Parish, La.* It is about 460 metres southeast of the east bank of Ouachita River where the property line strikes same. The bench is midway between two ditches where they unite. (See note 8, page 550.)

T. B. M. 79.—Is boat spike in root of 0·3 metre water oak on west side of road, 7 metres from east bank of river and 60 metres from Hugh Young's yard gate. (At *Glendora, La.*)

P. R. P. Parkeville.—At *Parkeville, Morehouse Parish, La.* It is in northeast corner of yard to house occupied by Bob Tucker (colored) and belonging to James Steele. It is 40 metres back from right bank of Bayou Bartholomew and about 200 metres above its mouth. It is 3 metres east of east end of house and 12 metres north of L to house. Witnessed by two blazed trees as follows: 0·6 metre chinaberry S. 35° W., 6 metres, and 0·5 metre chinaberry N. 80° W., 4 metres. (See note 8, page 550.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN GLENDORA AND FARMERVILLE, LA.

T. B. M. 79.—*Glendora, La.* (See page 682.)

P. R. P. Glendora.—*Glendora, La.* (See page 682.)

P. B. M. Port Union.—Is in south corner of R. C. Webb's yard at *Port Union Landing, La.* Is about 14½ metres south of south corner of dwelling and 60 metres from right bank of river. (See note 8, page 550.)

P. B. M. Hay.—Is in northeast corner of W. T. Hay's yard, 21·4 metres from northeast corner of residence and 30 metres south of public road. (See note 8, page 550.)

P. B. M. White.—Is in north corner of yard of William White, at forks of road coming from Farmerville and going to Ouachita City and Port Union. Is 5 metres south of first road, 25 metres east of second, and 9 metres from north corner of house. (See note 8, page 550.)

P. B. M. Rogers.—Is in southeast corner of yard of Pattison Rogers on "Lower road," *Farmerville* to *Port Union*, and about 7¾ miles from former place. It is 0·6 metre from front fence, 5 metres west of fence dividing yard and horse lot, 3·1 metres southeast of well, and 9½ metres southeast of cabin. (See note 8, page 550.)

P. B. M. Farmerville.—Is in northwest corner of Union Parish courthouse yard at *Farmerville, La.* (See note 8, page 550.)

P. B. M. Scott.—Is on right top bank and 30 metres back of right second bank of Bayou Corney at *Scotts Bluff, Union Parish, La.* Is 19 metres below site of old warehouse and witnessed by three triangular blazed trees, as follows: Bench is on line with and halfway between 0·7-metre black gum north 1·5 metres, and 0·5-metre black gum south 1·5 metres; and 0·5-metre pine northeast 6 metres. (See note 8, page 550.)

P. B. M. Stein.—Is at *Steins Bluff, Union Parish, La.* Is on northeast side and halfway between north and east corners of smallest old store. Old store is about 20 metres west of south end of warehouse. (See note 8, page 550.)

P. B. M. Cox Ferry.—On right top bank of Bayou D'Arbonne, 25 metres east or below ferry road, 12 metres from edge of bank and near a small swale, and witnessed by four triangular blazed trees: 0·60-metre sweet gum, 230°, 2½ metres; 0·50-metre water oak, 190°, 3 metres; 1·40-metres oak, 330°, 8 metres; and 0·5-metre pin oak, 40°, 4 metres. (See note 8, page 550.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN PARKEVILLE, LA., AND LITTLE ROCK, ARK.

P. R. P. Parkeville.—*Parkeville, La.* (See page 682.)

P. R. P. Cashill.—Is on the left bank and 250 metres above the mouth of *Mill Bayou, Union Parish, La.* It is about 20 metres above a marked bend of the top bank of bayou and witnessed by three triangular blazed trees as follows: 0·7-metre sweet gum 154° 20′, 14 metres; 0·4-metre sweet gum 206° 47′, 13 metres; 0·8-metre red oak 342° 05′, 15 metres. (See note 8, page 550.)

P. R. P. Fishtrap.—Is about 500 metres below *Fishtrap Shoals, Union Parish, La.* It is in woods about 80 metres west of west bank of river and witnessed by three triangular blazed trees as follows: 0·5-metre red oak 24° 30′, 7·5 metres; 0·4-metre water oak 228° 44′, 8·5 metres; 0·5-metre water oak 310° 41′, 70 metres. (See note 8, page 550.)

P. R. P. Alabama.—At *Alabama Landing*, *Union Parish*, *La.* It is on south side of road on outside of fence inclosing stock yard, 50 metres from west corner and 80 metres from east corner, and 45 metres southwest of store. Witnessed by three triangular blazed trees as follows: 0·4-metre post oak 78° 11′, 17·3 metres; 0·7-metre gum 197° 43′, 29·3 metres; and 0·4-metre post oak 302° 27′, 16·8 metres. (See note 8, page 550.)

P. R. P. Frank Pierre.—Is on left bank and about 500 metres above mouth of *Frank Pierre Creek*, *Union Parish*, *La.* It is 250 metres west of west bank of river and about 10 metres above mouth of small slough. Witnessed by three triangular blazed trees as follows: 0·6-metre post oak 109° 00′, 10 metres; 0·4-metre pecan 223° 18′, 23 metres, and 0·6-metre post oak 269° 56′, 23 metres. (See note 8, page 550.)

P. R. P. Shiloh.—Is about 200 metres above *Shiloh Shoals*, *Union Parish*, *La.* It is about 90 metres west of west bank of river and 100 metres from camping grounds on the bank of river. Witnessed by three triangular blazed trees as follows: 0·3-metre post oak 59° 29′, 6 metres; 0·9-metre white oak 148° 24′, 12 metres; and 0.4-metre white oak 309° 48′, 15 metres. (See note 8, page 550.)

P. R. P. Lake.—Is about 250 metres below *Lake Landing*, *Union County*, *Ark.*, 16 metres east of east bank of Poole's Bayou, and 80 metres southwest of west bank of river and about 250 metres southeast of boat channel connecting Lake St. Mary and Ouachita River. Witnessed by three triangular blazed trees as follows: 0·6-metre post oak 104° 10′, 15 metres; 0·3-metre post oak 213° 08′, 9·5 metres; and 0·5-metre post oak, 285° 34′, 4 metres. (See note 8, page 550.)

P. R. P. Lapile.—Is about 1·6 kilometres above mouth of *Bayou Lapile*, *Union County*, *Ark.* It is in the woods about 75 metres west of west bank of river and witnessed by three triangular blazed trees as follows: 0·5-metre post oak 203° 23′, 9 metres; 0·3-post oak 247° 15′, 5 metres; 0·7-metre post oak 341° 37′, 7 metres. (See note 8, page 550.)

P. R. P. Belle Point.—Is about 200 metres southwest of *Ouachita Belle Landing*, *Union County*, *Ark.* Is in woods about 175 metres south of road leading back from river. Witnessed by three triangular blazed trees as follows: 0·5-metre sweet gum 71° 47′, 16 metres; 0·2-metre white oak 164° 25′, 5 metres; and 0·4-metre Spanish oak 273° 54′, 4·5 metres. (See note 8, page 550.)

T. B. M. 39.—Is boat spike in root of a white oak, 200 metres southwest from *Belle Point Landing*, and 5 metres from P. R. P. Belle Point.

P. R. P. Eutaw.—Is about 550 metres below *Eutaw Shoals*, *Union County*, *Ark.* It is in the woods about 60 metres west of west bank of river, on bank of small slough, 60 metres south of an old road and witnessed by three triangular blazed trees as follows: 0·5-metre sweet gum 29° 00′; 0·9-metre water oak 182° 40′; and 0·7-metre sweet gum 261° 21′. (See note 8, page 550.)

P. R. P. Jacks Island.—Opposite *Jacks Island*, *Union County*, *Ark.* It is on east side of an old road 100 metres south of river bank and opposite lower end of gravel bar on lower end of Jacks Island. Witnessed by three triangular blazed trees as follows: 0·5-metre gum 181° 00′, 5 metres; 0·6-metre gum 286° 00′, 6 metres; and 0·4-metre red oak 355° 00′, 5 metres. (See note 8, page 550.)

P. R. P. Careyville.—At *Careyville Landing*, *Union County*, *Ark.* It is on side of lane and about 65 metres from the end, 160 metres southeast of river, and 150 metres south of warehouse. (See note 8, page 550.)

P. R. P. Pigeon Hill.—At *Pigeon Hill Landing*, *Union County*, *Ark.* It is on hillside, 15 metres from foot of slope and about 75 metres S. 15° W. from warehouse at landing. Witnessed by three triangular blazed trees, as follows: 0·7-metre pine N. 45° E., 4 metres; 0·4-metre pine S. 30° E., 5 metres, and 0·5-metre pine S. 45° W., 4 metres. (See note 8, page 550.)

P. R. P. Fletcher.—Is about 500 metres below *Fletchers Landing*, *Union County*, *Ark.* It is in edge of woods on east side of field and about 40 metres south of river. Witnessed by three triangular blazed trees, as follows: 0·4-metre water oak, 208° 41′, 14·5 metres; 0·6-metre white oak, 271° 30′, 20·5 metres, and 0·7-metre hickory, 309° 00′, 17·5 metres. (See note 8, page 550.)

P. R. P. Franklin.—Is 250 metres northwest of mouth of *Franklin Bayou*, *Union County*, *Ark.* It is 120 metres southwest of river and 175 metres north of bayou at its nearest point and on first ridge above the bayou. Witnessed by three triangular blazed trees, as follows: 0·5-metre water oak, 14° 45′, 6 metres; 0·7-metre sweet gum, 97° 06′, 12 metres, and 0·7-metre white oak, 258° 03′, 4 metres. (See note 8, page 550.)

P. R. P. Bell Field.—About 5·6 kilometres below *Champagnolle*, *Union County*, *Ark.* Is on south side of Bell's field (uncultivated), about 150 metres from west end and about halfway between road leading to Champagnolle and a neighborhood road, and 470 metres from river bank. (See note 8, page 550.)

P. R. P. Champagnolle.—At *Champagnolle Landing*, *Union County*, *Ark.* It is between forks of small valley entering river immediately below store, about 150 metres back from river bank, and 5 metres from foot of slope. Witnessed by two triangular blazed trees, as follows: 0·5-metre black oak, N. 20° E., 4 metres; 0·5-metre black oak, N. 15° W., 5 metres. (See note 8, page 550.)

P. R. P. El Dorado.—At *El Dorado Landing*, *Union County*, *Ark.* Is in west corner of yard of R. T. Goodwin in prolongation of south wall of dwelling and 7 metres west of west wall. Witnessed by three trees, as follows: 0·3-metre chinaberry, N. 10° E., 3 metres; 0·1-metre cedar, S. 80° E., 8 metres, and 0·2-metre cedar, S. 10° W., 5 metres. (See note 8, page 550.)

P. R. P. Smackover.—Is on right bank of river, 25 metres below mouth of *Smackover Creek* and 20 metres back from edge of bank, and 5 metres from head of slash leading back to swamp. Witnessed by three blazed trees, as follows: 0·6-metre sweet gum, 196°, 6 metres; 0·9-metre sweet gum, 86°, 3 metres, and 0·8-metre sweet gum, 324°, 5 metres. (See note 8, page 550.)

P. R. P. Leppard.—At *Leppards Camp* and 45 metres back from left bank of river. Is on line with upstream side of and 30 metres back from upper back corner of cabin. Witnessed by four blazed trees, as follows: 1·0-metre sweet gum, 160°, 3 metres; 0·6-metre white oak, 258°, 4 metres; 0·8-metre sweet gum, 255°, 14 metres, and 0·4-metre forked holly, 101°, 10 metres. (See note 8, page 550.)

P. R. P. Little Bay.—Is on left top bank of river and left top bank of Little Bay at mouth of *Little Bay*. Is 4 metres back from edge of main bank. There is a second bank about 40 metres wide. Witnessed by four blazed trees, as follows: 0·5-metre black gum, 99°, 3 metres; 0·5-metre sweet gum, 170°, 3½ metres; 0·4-metre holly, 278°, 11 metres, and 1·4-metre black oak, 308°, 17 metres. (See note 8, page 550.)

P. R. P. Beech Hill.—Is at foot of *Beech Hill* about 60 metres northwest of where hills meet the river bank and 100 metres northwest of shanty on top of hill. Witnessed by three blazed trees, as follows: 1·3-metre black gum, north 2½ metres; 0·7-metre beech, west 8 metres; 0·9-metre beech, southwest 13 metres. (See note 8, page 550.)

P. R. P. Walnut Hill.—Is 25 metres from foot of *Walnut Hill*, 25 metres south of right bank of bayou, and 225 metres west of where hills join river bank. Witnessed by three triangular blazed trees, as follows: 1·5-metre tupelo gum, 5 metres; 0·25-metre hackberry, 13 metres, and 0·25-metre elm, 8 metres. (See note 8, page 550.)

T. B. M. 5.—Is in root of 0·15-metre lime tree about 10 metres from right bank of river where Walnut Hills join river bank and 10 metres west of large gum tree.

P. R. P. Frenchport II.—Is about 125 metres back from river bank at *Frenchport* and 100 metres south of old dwelling. Is on top of small knoll and midway between two pine trees having triangular blazes. Pine to west of bench is 0·9 metre diameter and 2 metres distant; pine to east of bench is 0·7 metre diameter and 2 metres distant. (See note 8, page 550.)

P. R. P. Frenchport I.—Is 150 metres back from river bank at *Frenchport*, 1 metre north of north wall of old dwelling, and 25 metres west of west wall, midway between two large triangular blazed gum trees, first north and 1·2 metres diameter, 2 metres distant; second is south and 1 metre diameter. (See note 8, page 550.)

P. B. M. Elliott.—Is at southwest corner of north store building at *Elliott*, *Ark.* Bench is in line with west or front wall of store and 0·3 metre from south wall. (See note 8, page 550.)

Gauge B. M. A (Ewens, 1890).—Is small cross cut in granite sill of east door of George L. Ritchie's store, north side of Main street and about 75 metres east of Cotton Belt Railway track. At *Camden*, *Ark.*

P. B. M. Camden IV.—Is cross cut on stone cap to iron tubular pier under west end of north truss of St. Louis, Arkansas and Texas Railway bridge over Ouachita River near *Camden*, *Ark.* Bench is in line with west edge of rest plate and 344 millimetres north of north edge. Bench is marked

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P. B. M. Camden III. or P. R. P. Camden.—Is a bench mark of St. Louis, Arkansas and Texas Railroad at *Camden*, *Ark.* Is top of small pipe set vertically 266 metres west of bridge and 10 metres west of track and 4 metres from foot of embankment. The small pipe is inside of 0·1-metre pipe which reaches 0·25 metre above smaller pipe.

P. B. M. Camden II.—Is cross cut on south edge of second step from bottom of a flight of 8 stone steps leading to entrance on west side of courthouse at *Camden*, *Ark.* Bench is 0·08 metre from south end of steps and 0·15 metre from west edge.

P. B. M. Camden I.—Is in southwest corner of yard of Shiloh Methodist Church (colored) at *Camden*, *Ark.* Bench mark is 0·5 metre from south fence of yard and 0·7 metre from west fence, 4 metres north from north end of cotton shed of Camden compress and 10 metres east of track to compress. (See note 8, page 550.)

P. B. M. Lester.—Is 200 metres east of *Lester* station and 15 metres south of track.

Stands opposite milepost 452 in edge of clearing along railroad right of way. (See note 8, page 550.)

P. B. M. Chidester.—Is in southwest corner of yard of Dr. Tidwell, 20 metres north of north wall of depot at *Chidester* station and 22 metres east of east wall. Also 1 metre north of south fence of yard, 0·2 metre east of west fence. Witnessed by two triangular blazed trees, as follows: 0·3-metre oak, northwest 6 metres, and 0·2-metre white oak, east 5 metres. (See note 8, page 550.)

P. B. M. Little Missouri.—Is cross cut on top of stone pier at north end (left bank) of Iron Mountain and Southern Railway bridge over the *Little Missouri River*. Bench is midway between rails of track and 0·1 metre from south edge of capstone of pier. On edge of capstone is a V cut with vertex pointing to bench. Bench is marked

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P. B. M. Whelen.—Is is line with north wall of depot at *Whelen*, *Ark.*, and 30 metres east of east wall. Bench is 30 metres south of south wall of store and 1 metre west of west wall. Is 1 metre west of fence around garden inclosure just south of store and 4 metres north of southwest corner of garden. (See note 8, page 550.)

P. B. M. Gurdon II.—Is in northwest corner of small park inclosure immediately west of depot at *Gurdon*. Is 25 metres west of west wall of depot and 3 metres north of north wall. (See note 8, page 550.)

P. B. M. Gurdon I.—Is in line with west wall of depot and 20 metres south of south wall, and immediately in front of Hall hotel, at *Gurdon*, *Ark*. (See note 8, page 550.)

P. B. M. Smithton.—Is at edge of railway right of way and back of milepost 423. Is on right-hand side of track going to *Smithton* and 1·2 kilometres northeast of station. Bench is 0·5 metre from fence along right of way. (See note 8, page 550.)

P. B. M. Curtis.—Is at intersection of line of south wall of depot at *Curtis* with front line of stores standing northwest of depot. Bench is 25 metres west of west wall of depot and 15 metres south of south wall of nearest store to north. (See note 8, page 550.)

P. B. M. Gum Springs.—Is near southwest corner of Iron Mountain and Southern Railway section house at *Gum Springs* station. Bench is in line with west wall of house (main part) and also in line with south wall of L. (See note 8, page 550.)

P. B. M. Arkadelphia II.—Is on pine knoll northwest of Iron Mountain and Southern depot at *Arkadelphia*, *Ark.* Bench is 15 metres northeast of Maddox street and 40 metres from foot of hill, measured along same street. Witnessed by three triangular-blazed trees, as follows: 0·8-metre pine, east 2·2 metres; 0·7-metre pine, southwest 2·1 metres, and 0·7-metre pine, northwest 1·9 metres. (See note 8, page 550.)

P. B. M. Arkadelphia I.—Is cross cut on top of section of iron rail at west corner of small inclosure immediately northeast of Iron Mountain and Southern depot at *Arkaaelphia*, *Ark.* Top of rail projects 0·1 metre above ground and lower end is pierced by two bolts, which are embedded in cement.

Gauge B. M. B (Ewens 189–).—Is nail in running root of large gum about 20 metres back of middle section of gauge and immediately below small ravine running past the section. Root has the letter "B" marked on a small blaze on same root as bench mark and 0·2 metre back of it.

P. B. M. Ouachita River.—Is cross cut on top of pedestal stone at downstream end of pier and right-bank end of Iron Mountain and Southern Railway bridge over Ouachita River near *Arkadelphia*. Bench is 0·04 metre northwest of northwest edge of footplate of truss and 0·12 metre from northeast edge.

P. B. M. Daleville.—Is at north corner of chimney at northwest side of office building of Arkadelphia Lumber Company at *Daleville*, and is cross cut on second footing course (from top) at base of chimney. Building is 50 metres northeast of depot and 0·8 kilometre north of Ouachita River. (See note 8, page 550.)

P. B. M. Donaldson.—Is cross cut on top of section of iron rail near southeast corner of depot at *Donaldson*, *Ark*. Bench is in line with south wall of depot and 2·5 metres from east wall.

P. B. M. Malvern.—Is bottom of square recess cut in north end of stone sill to door at southeast corner of roundhouse at *Malvern*, *Ark*. Roundhouse stands about 200 metres west of Iron Mountain and Southern Railway depot and 100 metres north of Iron Mountain and Southern track, and is the property of Malvern and Hot Springs Railway. Marked

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B M

P. B. M. Traskwood.—Is cross cut on top of section of iron rail at northeast corner of wooded lot in front of G. W. Winter's hotel at *Traskwood*, *Ark*. Bench is about 60 metres south of track and opposite west end of depot.

P. B. M. Saline River.—Is cross cut on top of stone pedestal block at north end of west abutment of Iron Mountain and Southern Railway bridge over *Saline River*. Bench mark is 0·012 metre east of footplate of truss, in prolongation of south edge.

P. B. M. Benton.—Is cross cut on top of section of iron rail at northwest corner of small garden inclosure just east of depot at *Benton*. Bench is 3 metres east of east wall of depot and 3 metres north of north wall.

P. B. M. Alexander.—Is cross cut on top of section of iron rail at southeast corner of small garden inclosure just west of depot at *Alexander*, *Ark*. Bench is 3 metres west of west wall of depot and 2·5 metres south of south wall.

P. B. M. Mabelvale.—Is cross cut on top of iron casting at east side of inclosure around the public well at *Mabelvale*, *Ark*. It is 80 metres east of Iron Mountain and Southern Railway depot and 25 metres south of track. Witnessed by three triangular blazed trees, as follows: 0·3-metre sweet gum, north 2 metres; 0·4-metre black oak, south 2 metres, and 0·6-metre pine, west 8 metres.

P. B. M. Ensign.—Is cross cut on top of iron rail at east fence of yard around section house at *Ensign*, *Ark*. Is 10 metres east of east wall of house and in line with south wall.

No. 1 (or 3).—*Little Rock*, *Ark*. (See page 614.)

O.—*Little Rock*, *Ark*. (See page 614.)

B.—*Little Rock*, *Ark*. (See page 614.)

A.—*Little Rock*, *Ark*. (See page 614.)

B. M. Whittemore.—A bench of local engineers. Is top of water table at southeast corner of Whittemore and Gordon building. It is 10 metres east of No. 1 (or 3), at *Little Rock, Ark.*

B. M. Abert.—A high-water mark of 1866. Is cross cut on northeast corner of Whittemore and Gordon building, at *Little Rock, Ark.*, on east wall and 0·1 metre north of Merrill's gauge. Mark is 1·390 metres above projecting stone at bottom of wall used by Abert as a bench mark (1867).

B. M. Merrill.—Was top of sill to window in east wall of basement of Whittemore and Gordon building, foot of Commerce street, *Little Rock, Ark.* Window was 3 metres from northeast corner of store. The window is now filled in with stonework and the sill taken out. In connecting allowance was made for a 6-inch sill. The point used is not more than 0·1 metre in error.

S. S. Gauge B. M.—Is the highest point of a 2-inch iron rod set solidly in the "Little Rock" about 30 metres east of south end of railroad bridge at *Little Rock.* Rod is 2·5 metres southwest of S. S. incline gauge.

B. M. Statehouse steps.—On northwest corner of lowest step to middle south entrance to statehouse at *Little Rock.*

Gauge B. M. A. (Ewens).—Is horizontal side of a triangle cut on west portion of upstream cylinder of first pier from right bank of Baring Cross Railway bridge. Is about 6 feet below second nut (from top of pier) on side of cylinder.

B. M. 1 (Ewens, 1887).—Is top of third nut (counting down) on west part of upstream cylinder of first pier from right bank of Baring Cross Railway bridge. Is vertically under Gauge B. M. A.

No. 6 (Gauge B. M.).—Is bottom surface of iron cylinder cap of downstream cylinder of third pier from right bank of Baring Cross Railway bridge.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN PARKEVILLE, LA., AND GREENVILLE, MISS.

P. R. P. Parkeville.—*Parkeville, Morehouse Parish, La.* (See page 682.)

P. B. M. Sandidge.—Is on Sandidge place on *Bayou Bartholomew, Morehouse Parish, La.* Bench is about 10 metres north of bank of bayou in the southwest corner of field at end of lane. (See note 8, page 550.)

P. B. M. Myers.—Is on the Widow Myers place on *Bayou Bartholomew, Morehouse Parish, La.* Bench is about 20 metres south of R. J. B. of bayou, in northwest corner of field at end of lane leading to Marble place. (See note 8, page 550.)

P. B. M. Williams.—Is on the *Jones Place*, on *Bayou Bartholomew, Morehouse Parish, La.* Bench is 20 metres north of right bank of bayou, in the southwest corner of yard around cabin (second below residence). (See note 8, page 550.)

P. B. M. Anderson.—Is on the *Jones Place*, on *Bayou Bartholomew, Morehouse Parish, La.* Bench is about 20 metres east of end of lane cutting across neck to the Williams Place and 15 metres south of bank of bayou. (See note 8, page 550.)

P. B. M. Bonner.—Is on the *Bonner Place*, on *Bayou Bartholomew, Morehouse Parish, La.* Bench is in the northwest corner of yard around a cabin on the lower end of the place. The cabin is where the road comes back to the bayou which cuts across the neck that includes what is known as the "Round Turns." (See note 8, page 550.)

P. B. M. Davis 2.—Is on the *Ward Place*, *Bayou Bartholomew*, *Morehouse Parish*, *La.* Bench is in the southwest corner of field adjoining yard to second cabin below the residence.

P. B. M. Ward.—At *Wards Ferry*, *Bayou Bartholomew*, *La.* Bench is 3 metres northeast of bridge across drain on Hope Place and 10 metres north of right bank of bayou. (See note 8, page 550.)

P. B. M. Wells.—Is on the *Wells Place*, *Bayou Bartholomew*, *Morehouse Parish*, *La.* Bench is in the northwest corner of field which is east of the first cabin east of the Wells residence and about 10 metres south of L. T. B. of bayou. (See note 8, page 550.)

P. B. M. Mound.—At *Mound Landing*, *Morehouse Parish*, *La.* Is in northwest corner of yard to cabin of Henry Taylor, about 20 metres south of L. T. B. of bayou and 100 metres below cut ditch. (See note 8, page 550.)

P. B. M. Lindgrove.—At *Lindgrove Landing*, *Bayou Bartholomew*, *Morehouse Parish*, *La.* Bench is in the west corner of field about 50 metres south of abandoned store and 50 metres back from left bank of bayou. (See note 8, page 550.)

P. B. M. Bonita.—At *Bonita*, *Morehouse Parish*, *La.* Bench is in northeast corner of garden belonging to section house of Houston, Central Arkansas and Northern Railway. It is about 16 metres east of track and 45 metres north of section house. (See note 8, page 550.)

P. B. M. Jones.—At *Jones* station, *Morehouse Parish*, *La.* Bench is about 20 metres east of Houston, Central Arkansas and Northern Railway track and 15 metres south of milepost 496, and in corner of field opposite station platform. (See note 8, page 550.)

P. B. M. La.-Ark.—Is about 500 metres south of line between Louisiana and Arkansas and in *Morehouse Parish*, *La.* Bench is in edge of field on south side of road, 15 metres east of track and 80 metres east of left bank of bayou. (See note 8, page 550.)

P. B. M. Wilmot.—At *Wilmot*, *Ashley County*, *Ark.* Is in southeast corner of yard around Hotel Chesmett, about 50 metres northeast of depot and 30 metres west of track. (See note 8, page 550.)

P. B. M. Noble.—Is on James *Noble's place* on *Bayou Bartholomew*, *Ashley County*, *Ark.* Bench is about 40 metres west of Houston, Central Arkansas and Northern Railway track at its nearest point to the bayou. (See note 8, page 550.)

P. B. M. Parkdale.—At *Parkdale*, *Ashley County*, *Ark.* Bench is in northeast corner of section house yard and 6 metres west of Houston, Central Arkansas and Northern Railway track. (See note 8, page 550.)

P. B. M. Sunshine.—Is at *Sunshine*, *Ashley County*, *Ark.* Bench is in north corner of yard to cabin of Ed Honeycutt, about 15 metres east of track and two telegraph poles south of milepost 479. (See note 8, page 550.)

P. B. M. Portland.—At *Portland*, *Ashley County*, *Ark.* Bench is about 20 metres east of track and in southeast corner of section house yard. (See note 8, page 550.)

P. B. M. Kidd.—At *Kidds Spur*, *Ashley County*, *Ark.* Bench is in northwest corner of P. L. McGrudy's yard and about 25 metres east of Houston, Central Arkansas and Northern Railway track. (See note 8, page 550.)

P. B. M. Morrell.—At *Morrell*, *Ashley County*, *Ark.* Bench is in the west corner of yard to section house and about 20 metres northwest of the Houston, Central Arkansas and Northern Railway track. (See note 8, page 550.)

P. B. M. Hudspeth.—At *Hudspeth, Chicot County, Ark.* Bench is in southeast corner of yard to section house and about 15 metres east of Houston, Central Arkansas and Northern Railway track. (See note 8, page 550.)

P. B. M. Dermott.—At *Dermott, Chicot County, Ark.* Bench is in northwest corner of yard to section house and about 15 metres west of Houston, Central Arkansas and Northern Railway track. (See note 8, page 550.)

P. B. M. Baxter.—At *Baxter, Drew County, Ark.* Bench is in east corner of yard of S. A. Duke, about 30 metres southwest of track of Warren branch of St. Louis, Iron Mountain and Southern Railway, and about 50 metres west of west end of bridge across Bayou Bartholomew. (See note 8, page 550.)

G.—*McGehee, Desha County, Ark.* (See page 613.)

P. B. M. McGehee.—*McGehee, Desha County, Ark.* Bench is in west corner of yard of cabin opposite the north end of switch and west of St. Louis, Iron Mountain and Southern Railway track. (See note 8, page 550.)

P. B. M. Trippe.—At *Trippe Junction, Desha County, Ark.* Bench is in south corner of R. D. Crenshaw's yard, north of Warren Branch of the St. Louis, Iron Mountain and Southern Railway track. (See note 8, page 550.)

T. B. M. 117.=Levee B. M. Is iron pipe on west slope of railway dump on west slope of levee and 100 metres from river.

F.—At *Arkansas City, Desha County, Ark.* (See page 612.)

M. R. C. Stone $\frac{6}{3}{}^{3}$. Is top of stone post N. 79° 50′ W., 420 metres from the railway shops below *Arkansas City.* Is 250 metres from edge of woods.

M. R. C. Stone $\frac{6}{2}{}^{3}$. Is stone on inner slope of levee on Clarke Place, opposite *Arkansas City*, 1 600 metres below Shelby's store and 650 metres below junction of levees and 620 metres above another junction.

P. B. M. 84.—*Wilkerson's Landing, Miss.* (See page 696.)

P. B. M. 85.—*Port Anderson, Miss.* (See page 697.)

T. B. M. 121.=Levee Board B. M. Is iron pipe at their station 3710, at angle in levee, 425 metres above second angle below *Port Anderson* residence.

P. B. M. 86.—*Offutts Landing, Miss.* (See page 697.)

P. B. M. Millers Bend.—At *Millers Bend, Washington County, Miss.* Bench was set by Assistant Engineer J. T. Ashler, of the Levee Board, during the winter of 1892–93. Is top of brass bolt in top of stone post between two trees about 20 metres east of angle in levee at Millers Bend.

B. M. O. (1893.)—At *Greenville, Washington County, Miss.* Is in southwest corner of Blanton burial ground, north of Main and east of Locust streets. It is in fence corner and consists of a copper bolt leaded vertically in upper surface of 18 by 18 by 4 inches tile placed about 3 feet below ground. The face of the tile is marked

Mississippi River Commission
U S
B △ M
1893

Tile is surmounted by an iron pipe placed on the tile over the copper bolt.

Greenville, No. 1.—*Greenville, Miss.* (See page 612.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN DELTA, LA., AND GREENVILLE, MISS., VIA GREENWOOD.

No. 215.—*Delta, La.* (See page 610.)

M. R. C. Stone Line $\frac{101}{1}$.—*Kleinston, Miss.* (See page 637.)

P. B. M. 1.—Is cross cut in stone on east side of National cemetery gate, *Vicksburg, Miss.*, placed to hold gate when open.

P. B. M. 2.—Is on east side of public road, about 3 kilometres above *Vicksburg*, by W. H. Hundermark's store, 2·6 metres from northwest corner of yard, 16·4 metres from southwest corner of yard, and 31·92 metres from center of Yazoo and Mississippi Valley Railroad track on approximate perpendicular to same. (See note 8, page 550.)

P. B. M. 3.—Is top of head of large spike driven in north side of brick smokestack of gin on Blakely plantation, about 5 centimetres from ground.

P. B. M. 4.—Is in northwest corner of cabin yard on left bank of *Yazoo River*, about 130 metres southwest of south end of Yazoo and Mississippi Valley Railroad bridge, and 20 metres from top of river bank. (See note 8, page 550.)

P. B. M. 5.—Is cross cut and marked "U. S. B. M." on capstone of south end pier on west side of *Yazoo* and *Mississippi Railroad bridge*.

P. B. M. 6.—Is on left bank of Yazoo River, almost opposite mouth of Steele Bayou, in northeast corner of E. C. Cordwent's yard, *Belle Isle* plantation. (See note 8, page 550.)

P. B. M. 7.—At *Calmar* post office, *Warren County, Miss.* Is in southeast corner of garden attached to and on north side of post office, rented (1892) by J. H. Adler, and belonging to D. M. Legg's store and post office. It is about 1 kilometre southeast of Adams Landing on Yazoo River. (See note 8, page 550.)

P. B. M. 8.—In Yazoo County, Miss., opposite *L'Argent*, 70 metres from left bank of Yazoo River. Is in the west corner of calf lot across the public road from and belonging to cabin on Indian mound, which is opposite the mouth of Big Sunflower River and on Gilruth's plantation. (See note 8, page 550.)

P. B. M. 9.—At *L'Argent, Sharkey County, Miss.* Is in the southeast corner of cotton lot adjoining landing warehouse and about 25 metres from right top bank of Yazoo River. Is about 15 metres southwest of L'Argent store and 50 metres southeast of gin. (See note 8, page 550.)

P. B. M. 10.—At *Satartia, Yazoo County, Miss.* Is in northeast corner of yard of Union Church and Masonic lodge (Satartia Lodge, No. 176) at corner of Plum and Perry streets. (See note 8, page 550.)

P. B. M. 11.—At *Enola, Yazoo County, Miss.* Is in the northeast corner of yard to R. D. Saunder's dwelling, about 8 metres south of J. F. Powell's store and about 30 metres north of R. D. Saunder's store. (See note 8, page 550.)

P. B. M. 12.—At *Yazoo City, Yazoo County, Miss.* Is in north corner of yard to county courthouse. (See note 8, page 550.)

P. B. M. 13.—At *Yazoo City, Yazoo County, Miss.* Is in north corner of yard to city public school building. School is near intersection of Washington and Main streets. (See note 8, page 550.)

P. B. M. 29.—At *Bee Lake, Holmes County, Miss.* Is at north corner of Illinois Central Railway depot. (See note 8, page 550.)

P. B. M. 28.—At *Tchula, Holmes County, Miss.* Is cross cut on top of southeast bolt holding roller to southeast pier of drawbridge over Tchula Lake.

P. B. M. 27.—At *Tchula, Holmes County, Miss.* Is in east corner of yard to Tchula section house belonging to the Illinois Central Railway. (See note 8, page 550.)

P. B. M. 26.—At *Sidon, Leflore County, Miss.* Is in northwest corner of yard to Sidon section house belonging to the Illinois Central Railway. It is about 35 metres south of the depot. (See note 8, page 550.)

P. B. M. 25.—At *Greenwood, Leflore County, Miss.* Is in north corner of yard to Greenwood section house belonging to the Illinois Central Railway. It is about 70 metres east of the depot. (See note 8, page 550.)

P. B. M. 24,—At *Greenwood, Leflore County, Miss.* Is in west corner of yard to Leflore County courthouse at corner of Front and Cotton streets. (See note 8, page 550.)

P. B. M. 23.—At *Fort Loring, Leflore County, Miss.* Is cross cut in stone coping on the north end of the east pier supporting the Georgia Pacific Railway drawbridge over Yazoo River. It is at the northeast corner of the iron rest plate and is marked:

U S
×
P B M

P. B. M. 22.—At *Fort Loring, Leflore County, Miss.* Is in fence corner of fences dividing railway right of way, public road, and small garden, on McLemore & Baird's place. It is about 12 metres south of the Georgia Pacific Railway track and 6 metres west of the right top bank of Yazoo River. (See note 8, page 550.)

P. B. M. 21.—At *Itta Bena, Leflore County, Miss.* Is in southeast corner of yard around Letulah school, and is about 2·5 metres from east fence and 1·5 metres from south fence. (See note 8, page 550.)

P. B. M. 20.—About 750 metres northwest of *Baird, Sunflower County, Miss.* Is about 18 metres east of the south end of the Georgia Pacific Railway approach to bridge over Sunflower River. It is in the northwest corner of yard belonging to house occupied by E. B. and G. B. Wade and owned by J. J. Oliver. (See note 8, page 550.)

P. B. M. 19.—On right bank of *Sunflower River, Sunflower County, Miss.* It is about 14 metres west of north end of Georgia Pacific Railway trestle approach to drawbridge over Sunflower River, and in southeast corner of yard to cabin occupied by Buck Willis on W. A. Pollock's plantation. (See note 8, page 550.)

P. B. M. 18.—About 1 kilometre northwest of *Baird, Sunflower County, Miss.* The point is marked by a cross cut on top of and on west end of south pier of the Georgia Pacific Railway bridge over Sunflower River. It is 0·80 metre from south edge of pier; 0·23 metre south of track on pier; 0·78 metre from west edge of pier; and 0·4 metre west of joint in stone. It is marked

U S
×
B M

P. B. M. 17.—At *Indianola, Sunflower County, Miss.* Is in southwest corner of the grounds around the county courthouse. (See note 8, page 550.)

P. B. M. 16.—At *Heathman*, *Sunflower County*, *Miss.* It is at west end of young *bois d'arc* hedge between board and wire fences in front of yard belonging to residence of J. A. Crawford. It is 2 metres northeast of northeast corner of his store and 5 metres south of the Georgia Pacific Railway track (main line). (See note 8, page 550.)

P. B. M. 15.—At "*The Bogue*," *Washington County*, *Miss.* It is in south corner of yard to cabin occupied by John Bailey (colored) on Bob. Ingram's place. It is about 1 metre from left top bank of Bogue Phalia; about 40 metres northwest of the Georgia Pacific Railway trestle across the Bogue. It is directly opposite the ginhouse on the right bank and about 75 metres southeast of the highway bridge. (See note 8, page 550.)

P. B. M. 14.—At *Stoneville*, *Washington County*, *Miss.* It is in the east corner of orchard belonging to house occupied by A. Jones and belonging to J. C. Greenley. Orchard is between house and grocery store belonging to Yuen Sing & Co. It is 0·7 metre from front fence and 0·4 metre from porch of store. (See note 8, page 550.)

Greenville, No. 1.—*Greenville*, *Miss.* (See page 612.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN FRIARS POINT AND GREENVILLE, MISS.

P. B. M. Friars Point II.—Is center of hole in copper bolt 1 centimetre in diameter, leaded horizontally in a brick in northeast end of southeast wall of brick building belonging to W. H. Dickerson, at *Friars Point*, *Coahoma County*, *Miss.* The building is in block No. 2, of Fullers addition.

P. B. M. 57.—Is top of copper bolt in top of stone on Ledbetter's plantation, 10½ miles below *Friars Point*, *Miss.*, measured along the levee. It is 13 metres east of levee, 610 metres above houses on Ledbetter's plantation, and near three trees (box elder, sycamore, and pecan).

P. B. M. 58.—Is top of copper bolt in top of stone on west slope of levee, about 800 metres above Burkes or *Hughes Landing*, *Coahoma County*, *Miss.* It is 38 metres below bend in levee, and 23 metres above a small honey locust on west slope of levee. Top of bolt is 2 millimetres above top of stone.

P. B. M. 59.—Is top of copper bolt in top of stone in east slope of levee, 3¾ miles below *Hughes Landing*, near Campbell's house, and 3 metres north of a sycamore tree. It is about 80 metres above junction of levees. Top of bolt is 6 millimetres above top of stone.

P. B. M. 60.—Is top of copper bolt in top of stone on east side of levee, 2½ miles above *Sunflower Landing*, *Coahoma County*, *Miss.* It is about 230 metres above deserted cabin on levee, and about 800 metres above △ Richardson.

P. B. M. 61.—Is top of copper bolt in top of stone set on east slope of levee, at *Robinsonville*, *Coahoma County*, *Miss.* Stone is about 90 metres above deserted store on east side of levee, where road from gin crosses levee.

P. B. M. 62.—Is top of copper bolt in top of stone on east slope of levee, near locust trees, about 140 metres above Simpson's store at *Lake Charles Landing*, *Coahoma County*, *Miss.*

P. B. M. 63.—Is top of copper bolt in top of stone on west slope of levee, 1 000 metres above *Australia* post office, *Bolivar County*, *Miss.*

P. B. M. 64.—Is top of copper bolt in top of stone on east slope of levee, 446 metres above △ South Base, at *Carsons*, *Bolivar County*, *Miss.* △ South Base is at turn in levee below the post office.

P. B. M. 65.—Is top of copper bolt in top of stone on east side of levee, near bend of levee, in *Concordia*, *Bolivar County*, *Miss.* The stone is 54 metres below Green's store, 36 metres above Williams's store, and 24 metres from levee.

P. B. M. 66.—Is top of copper bolt in top of stone on east slope of levee, on Stokes's plantation, 7¾ miles below *Concordia*, *Bolivar County*, *Miss.* It is 150 metres below bridge crossing ditches of levee, respectively 91 and 127 metres below houses on east side of levee, 19 metres west of fence, and 6⅔ metres south of elm tree.

P. B. M. 67.—Is top of copper bolt in top of stone on east slope of levee, about 1 mile south of *Terrene*, *Bolivar County*, *Miss.* It is 120 metres north of Ben Williams's house, 106 metres south of Morris Williams's house, and 4·5 metres east of center of levee.

P. B. M. 68.—Is top of copper bolt in top of stone in Colonel Montgomery's front yard, in *Rosedale*, *Bolivar County*, *Miss.* It is 4 metres north of south fence and 1 metre east of west fence.

P. B. M. 69.—Is top of copper bolt in top of stone on east side of levee, one-half mile below Colonel Montgomery's house, at *Rosedale*, *Bolivar County*, *Miss.* It is opposite a sweet gum tree situated on west side of levee at edge of pond, and is 65 metres below fence, above which are two houses.

P. B. M. 70.—Is top of copper bolt in top of stone, at east base of levee, 290 meters below post office at *Riverton*, *Bolivar County*, *Miss.* It is 31 metres below a cottonwood tree on east side of levee, on which tree is T. B. M. 475.

P. B. M. 71.—Is top of copper bolt in top of stone, about three-fourths of a mile below *Beulah*, *Bolivar County*, *Miss.* It is on the land of the Owens heirs, one-quarter of a mile above northwest corner of the Bell plantation, now owned by J. W. Farmer. It is 1 metre southwest of a sycamore tree and 142 metres northeast of a house.

P. B. M. 72.—Is top of copper bolt in top of stone set in ground 1½ metres from cottonwood tree in woods, 42 metres back from Lake Beulah, and 520 metres below *Clark's Landing*, *Bolivar County*, *Miss.*

P. B. M. 73.—Is top of copper bolt in top of stone set in corner of fence in northwest corner of Hughes's plantation 2 miles back from *Prentiss*, *Bolivar County*, *Miss.* It is 72 metres southeast of junction of old and new levees, 65 metres northwest of ginhouse, 27 metres south of southwest corner of dwelling, 12 metres south of west corner of stable.

P. B. M. 74.—Is top of copper bolt in top of stone on east slope of levee, 120 meters below junction of old and new levees, 63 meters west of ginhouse, and 2 miles back of *Prentiss*, *Bolivar County*, *Miss.* It is 80 metres southwest of dwelling, 60 metres southwest of stable, and about 50 metres below P. B. M. 73.

P. B. M. 75.—Is top of copper bolt in top of stone set in east slope of levee, 220 metres south of junction of old and new levees, 2 miles back from *Prentiss*, *Bolivar County*, *Miss.* It is 117 metres southwest of ginhouse, and 100 metres below P. B. M. 74.

P. B. M. 76.—Is top of brass bolt in stone post set in northwest corner of Neblett's plantation, at *Nebletts Landing*, *Bolivar County*, *Miss.* Stone is planted in corner of fence at the turn in levee. It is about 20 metres from levee south and east, and about

25 metres from front of house at said corner of levee. Top of bolt is 2 millimetres above top of stone.

P. B. M. 77.—Is top of brass bolt in top of stone post planted in rear of house owned by D. McGreevy, at *Stormville* (or Storm's), *Bolivar County, Miss.* Stone is 80 metres back of levee and 25 metres back from front of McGreevy's store. It is just inside of fence on south side of road, and about 60 metres north of the post office. Top of bolt is flush with top of stone.

P. B. M. 78.—Is top of brass bolt in stone post set in northwest corner of lot owned by Dr. Richardson, in *Bolivar, Bolivar County, Miss.* It is 15 metres back of levee, and 12 metres north of the northwest corner of Dr. Richardson's house, 6 metres from front of office adjoining the house, 16 metres north of brick cistern in yard, and about 900 metres above Bolivar post office. Top of bolt is 6 millimetres above top of stone.

P. B. M. 79.—Is top of brass bolt in stone post planted on Major Edmonds's plantation at *Buck Ridge, Bolivar County, Miss.* It is about 60 metres back of levee, and about 50 metres northwest of Major Edmonds's house. It is on north side of garden fence near northwest corner of garden. Top of bolt is 5 millimetres above top of stone.

P. B. M. 80.—Is top of brass bolt in stone post set on land of E. F. Miller (lessee), in northwest corner of field at intersection of road leading across the point from Content to Jenkins Landings, with levee road. Stone is about 15 metres back of levee and 18 metres east of Miller's store, at *Content, Bolivar County, Miss.* Top of bolt is 2 millimetres above top of stone.

P. B. M. 81.—Is top of brass bolt in stone post set on grounds of the Jenkins estate, at *Childers*, or *Jenkins Landing*, three-fourths of a mile above Stop Landing, *Bolivar County, Miss.* Stone is 10 metres back from levee, in southwest corner of yard, 25 metres southwest from corner of Jenkins's house, about 27 metres southwest of cistern on south side of house, 50 metres south of cistern on north side of house, and 3 metres south of large gum tree. Top of bolt is 2 millimetres above top of stone.

P. B. M. 82.—Is top of brass bolt in top of stone post set in west corner of W. E. Ringo's yard, at *Mound Place, Bolivar County, Miss.* Stone is about 10 metres back from levee and 75 metres northeast of new store, now building, of W. E. Ringo & Co. Stone is about 27 metres west from corner of house, and about 75 metres southwest of store of Simon & Brown. Top of bolt is 6 millimetres above top of stone.

P. B. M. 83.—Is top of brass bolt in stone post set on O. L. Shelby's plantation, near *Wilkersons Landing, Bolivar County, Miss.* Stone is in southwest corner of yard back of Shelby's house (lately torn down); is 55 metres back of levee, which is here about 200 metres from river bank; it is 40 metres southwest of a red cedar tree, 60 metres southwest of the easterly cistern and 30 metres southwest of the westerly cistern in yard, and about 110 metres west of store at Wilkersons Landing. A blacksmith shop is to be built just west of the site of the old Shelby house. Top of bolt is 3 millimetres above top of stone.

P. B. M. 84.—Is top of brass bolt in stone post set on Lewis Clark's plantation, 1 400 metres below *Wilkersons Landing, Bolivar County, Miss.* Stone is just inside of fence, 15 metres back of levee, 10 metres northwest of house of Daniel Braxton (colored), 20 metres north of woods which extend to Port Anderson, some 3 miles below. Top of bolt is 5 millimetres above top of stone. Reported in 1897 as destroyed.

P. B. M. 85.—Is top of brass bolt in top of stone post set in southeast corner of yard on Thomas S. Kennedy's plantation (John Graves, lessee), at *Port Anderson*, *Bolivar County*, *Miss.* Stone is 25 metres east of a brick cistern at southeast corner of house and 40 metres southeast of a brick cistern at northeast corner of house. It is 55 metres back from levee and about 160 metres above an abrupt turn in levee. Top of bolt is 5 millimetres above top of stone.

P. B. M. 86.—Is top of brass bolt in top of stone post planted on lands of Thomas S. Kennedy (—— Martin, lessee), 300 metres above *Offutts Landing*, *Washington County*, *Miss.* The stone is in southwest corner of field, 1 metre back of old levee, 25 metres north of new levee, which marks the boundary line between Bolivar and Washington counties, and is therefore in Bolivar County, Miss. Top of bolt is 4 millimetres above top of stone.

P. B. M. 87.—Is top of brass bolt set in top of stone planted in corner at intersection of old and new levees, about three-fourths mile back of the river in *Millers Bend*, *Washington County*, *Miss.* Stone is about 1½ miles below Bernard's plantation, is on east side of levee, 15½ metres southwest of oak tree 2 feet in diameter, and 18½ metres northwest of gum tree 2½ feet in diameter, on which is T. B. M. 533. Both of these trees are marked by five notches. Top of bolt is 5 millimetres above top of stone.

P. B. M. 88.—Is top of brass bolt in top of stone post set in southwest corner of field on lands of James Rogers (colored), about 1 mile north of *Argyle*, *Washington County*, *Miss.* Stone is in corner of fence at crossing of new levee and Arkansas City road. The Memphis and Greenville telegraph line here leaves the levee and follows the Arkansas City road. Top of bolt is 3 millimetres above top of stone.

Greenville No. 1.—*Greenville*, *Miss.* (See page 612.)

Greenville North Base △.—Is top of copper bolt in large stone forming north end of the Greenville base line of the Coast and Geodetic Survey. Stone is about 100 metres south of house of M. S. Morgan, and is supposed to be on southern boundary of the city of Greenville and on the northern line of Huntington's plantation. Top of bolt is flush with top of stone.

No. 2.—Near *Greenville*, *Miss.* (See page 612.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN FRIARS POINT AND CLARKSDALE, MISS.

P. B. M. Friars Point II.—*Friars Point*, *Miss.* (See page 694.)

P. B. M. Friars Point III.—Is center of head of iron pipe set vertically in ground at northeast corner of yard of H. H. Gaines. Pipe is 10 metres north of north wall and 1 metre east of east wall of Gaines's house. House is on Chism avenue between Sycamore and Yates streets.

P. B. M. Coahoma.—Is top of pipe set vertically in ground 8 metres south of south wall and in line with east wall of Methodist Church. Church is a large frame house standing almost centrally in a triangle formed by the Yazoo and Mississippi Valley Railroad tracks at *Coahoma*, *Miss.* Bench is 3 metres west of 0·5-metre blazed gum.

P. B. M. Clover Hill.—Is top of pipe set vertically in ground at southwest corner of yard of railway section houses, 15 kilometres north of *Clover Hill* Station on Yazoo and Mississippi Valley main line.

P. B. M. Lyon.—Is top of iron pipe set vertically in ground near northeast corner of Baptist Church at *Lyon, Miss.* Church is a large frame structure about 400 metres south of depot and 200 metres west of track. Pipe is in line with north wall of church and 2 metres east of east wall.

P. B. M. Clarksdale I.—Is top of iron pipe set vertically in ground at west corner of courthouse grounds, *Clarksdale, Miss.* Bench is 18 metres northwest of line of extreme northwest wall and 39 metres southwest of line of southwest wall. Bench is N. 83° W. 41 metres from northwest corner.

P. B. M. Clarksdale II.—Is top of iron pipe set vertically in ground near south corner of main portion of section foreman's house at *Clarksdale, Miss.* Bench is in line with southwest wall of main portion of building and 2 metres from northwest wall of same part of house. House is most northeasterly of three and 400 metres (?) northeast of track.

P. B. M. Clarksdale III.—Is cross cut on stone cap block of northeast pier (*Clarksdale* side) of Yazoo and Mississippi Valley Railway bridge over Sunflower River. Bench is at upstream end of pier, in line with northeast face of pedestal block and 0·1 metre from north corner of pedestal. Bench is marked

U S
+
P B M

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN AUSTIN AND FRIARS POINT, MISS.

P. B. M. Austin I.—*Austin, Miss.* (See page 700.)

P. B. M. Austin II.—*Austin, Miss.* (See page 700.)

P. B. M. Trotters Landing.—Top of copper bolt leaded vertically in top of stone post, 1 metre long and 13 centimetres square, set in ground with top about 5 centimetres above the surface. It is on east side of levee at foot of embankment in J. T. Brame's field, about 6 metres south of where a branch levee runs off toward the east on north side of Mr. Brame's field and about 65 metres north of where main levee enters field. The stone post is marked with the letters U. S. P. B. M. on top.

P. B. M. Glendale.—Top of copper bolt leaded vertically in top of stone post, 1 metre long and 13 centimetres square, set in ground with top about 5 centimetres above surface in northwest corner of T. C. Ferguson's yard at *Glendale, Coahoma County, Miss.* The stone is marked on top with the letters U. S. P. B. M.

P. B. M. Delta.—Top of brass bolt leaded vertically in top of stone post, 1 metre long and 13 centimetres square, set in ground with top about 8 centimetres above surface, inside of field, about 17 metres south of levee and about 625 metres south of where road leading to *Delta, Miss.*, crosses levee. The stone is marked with the letters U. S. P. B. M. on top.

P. B. M. Friars Point I.—Center of hole in outer end of copper bolt, 1 centimetre in diameter, leaded horizontally into brick in southwest wall of jail at *Friars Point, Coahoma County, Miss.* It is 118 centimetres from west corner of building and 135 centimetres above the ground, in second tier of bricks above water table. The brick is marked with the letters P. B. M.

P. B. M. Friars Point II.—*Friars Point, Miss.* (See page 694.)

P. B. M. Helena I.—Center of hole in outer end of copper bolt, 1 centimetre in diameter, leaded horizontally into brick in east end of north wall of brick building on west side of Main street, *Helena, Ark.* The building is the second one south of York street and is owned by Tenney & Cashman.

P. B. M. Helena II.—Center of hole in outer end of copper bolt, 1 centimetre in diameter, leaded horizontally into brick in south wall of brick building in northwest corner of Cherry and Rightor streets, *Helena, Ark.* The building is owned by H. S. & S. H. Horner and is occupied by McKenzie, Horner & Co., dealers in general merchandise. The bench mark is 216 centimetres west of southeast corner of building and 97 centimetres above the sidewalk. The letters P. B. M. are cut in the wall.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN MEMPHIS, TENN., AND AUSTIN, MISS.

P. B. M. Memphis.—*Memphis, Tenn.* (See page 642.)

P. B. M. Horn Lake Creek.—Top of copper bolt leaded vertically into top of stone post 3 feet long and 5 inches square, and set in the ground with its top 4 inches above the surface, 40 metres southwest of ford across *Horn Lake Creek* on Lower Horn Lake road. The following trees are blazed on the side toward the bench mark: A cypress 30 metres northeast, an oak 18 metres north, and an oak 11 metres south of the bench mark. The stone is marked on top:

U S
×
B M

P. B. M. Star Landing.—Top of copper bolt leaded vertically into top of stone post 3 feet long and 5 inches square, set in ground with its top about 4 inches above the surface, in southeast corner of yard in front of James A. Lamb's house at *Star Landing, De Soto County, Miss.*, about 3 metres from south fence, and about 1 metre from east fence. The house is on the north side of the Star Landing and Hernando road, and is 640 metres east of the levee. The stone is marked on top:

U S
×
B M

P. B. M. Commerce.—At *Commerce, Tunica County, Miss.* Top of copper bolt leaded vertically into top of stone post 3 feet long and 5 inches square, set in ground with its top about 4 inches above the surface, in southeast corner of field, at northwest corner of intersection of the "Commerce-Austin" on county road with "Abbey's Lane," in center line of east fence of field, and 12 metres north of south fence. The field belongs to Mr. John R. Bridger. The stone is marked on top:

U S
×
B M

P. B. M. Mhoons Landing.—At the *Mhoons Landing, Tunica County, Miss.* Top of copper bolt leaded vertically into top of stone post 3 feet long and 5 inches square, set in ground with top about 4 inches above the ground, in northwest corner of field, 3 metres from north fence and 0·5 metre from west fence, in front of Allen Brinkley's house, about 400 metres west of road leading to landing, and about 30 metres south of levee. The field belongs to Mhoon and Brinkley. The stone is marked on top:

U S
×
B M

P. B. M. Austin I.—At *Austin*, *Tunica County*, *Miss.* Top of copper bolt in top of stone post 3 feet long and 5 inches square, set in ground with its top about 3 inches above the surface in southeast corner of yard of courthouse, at intersection of Commerce and Coldwater streets, 1 metre from either fence. The stone is marked on top:

U S
×
B M

P. B. M. Austin II.—At *Austin*, *Tunica County*, *Miss.* Top of copper bolt leaded vertically into top of stone post 3 feet long and 5 inches square, set in ground with top about 2 inches above the surface, in the yard of the Methodist Episcopal Church South, on Church street, in line with front side of church, 22 metres west of church, and 1 metre east of west fence. The stone is marked on top:

U S
×
B M

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN CORINTH, MISS., AND DECATUR, ALA.

V.—*Corinth*, *Miss.* (See page 596.)
W.—*Corinth*, *Miss.* (See page 596.)

T. B. M. 1.—Is in *Corinth*, *Miss.*, in the southwestern part of courthouse yard, on curbing of well at its northeast corner; being the highest point in square cut in stone and marked U. S.

P. B. M. 1.—Is in *Burnsville*, *Miss.*, 195 feet south of station, in west wall of brick house belonging to Mr. M. O. Elledge, 105 feet south of its northwest corner, in the fifteenth course of brick from the ground; being center of the punch mark in copper bolt leaded horizontally.

P. B. M. 2.—Is in *Burnsville*, *Miss.*, 138 feet north of center of railroad track, 65 feet east of the east end of depot, in foundation of old turntable, on the east part of wall near center of large coping stone; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 3.—Is 2 250 feet west of depot at *Iuka* and 1 190 feet west of milepost 115, in south end of stone culvert, in top stone, 5¾ inches from the south edge and 37¾ inches from west edge; being top of a copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 41.—Is about a mile west of *Pegram*, *Ala.*, and one-half mile east of milepost 120, on the west abutment of bridge at its northwest corner, on coping stone; being highest point in square cut in stone.

T. B. M. 43.—Is about ¾ of a mile west of *Riverton Junction*, *Ala.*, at bridge over Big Bear River, on east abutment north side; being highest point in square cut in stone.

T. B. M. 45.—Is at *Margerum*, *Ala.*, on footing course of masonry, at the southwest corner of water tank at north edge of track; being the highest point in square.

T. B. M. 47.—Is 1¼ miles east of *Margerum*, *Ala.*, 410 feet west of milepost 125 (from Memphis), on west abutment of railroad bridge over Buzzard Roost Creek, at its southeast corner; being highest point of square cut in stone.

T. B. M. 49.—Is 2¼ miles west of *Cherokee*, 2 190 feet west of milepost 127, on big fill, 10 feet south of center of track, 3 feet below top of tie, on a large embedded rock; being the highest point in a square.

T. B. M. 58.—Is ¾ of a mile west of *Barton* depot, 1 390 feet east of milepost 133, 15 feet south of center of track, on the end of stone culvert; being the highest point in square.

T. B. M. 59.—Is 354 feet west of *Barton* depot, 15 feet north of track center, on an embedded rock; being the highest point in square.

T. B. M. 63.—Is 1½ miles west of *Prides*, *Ala.*, 1 720 feet east of milepost 136, on south end of abutment of bridge over Bear River, on coping 3 feet below top of ties; being highest point of square cut in stone.

T. B. M. 72.—Is at *Prides*, *Ala.*, 2 130 feet toward the river from Prides station, about 450 feet west from L. T. Pride's house, 30 feet east of a large mulberry tree, on east edge of creek bed, on a large ledge of rock washed by its water; being highest point in square marked U. S.

P. B. M. 7.—Is at *Prides*, *Ala.*, 160 feet above mouth of creek that empties just above J. P. Pride's residence, 27 feet back from top edge of high bank on point of bluff, at cluster of bowlders on the north face of a large embedded bowlder, 14 inches above surface of ground; being a copper bolt leaded horizontally. (See note 13a, page 551.)

T. B. M. 73.—Is 20 feet northeast of P. B. M. 7, on a very large bowlder; being highest point of square cut in the rock and lettered T. B. M. by deeply cut letters, at *Prides*, *Ala.*

T. B. M. 68.—Is 2¼ miles east of *Prides* depot, 460 feet east of milepost 140, in big cut, about 25 feet east of the east end of long tangent through Cherokee and Prides, 15 feet south of center of track and 1½ feet above top of tie; being highest point in square cut in ledge.

T. B. M. 71.—Is 4 miles east of *Prides*, *Ala.*, at west end of railroad bridge over Little Bear Creek, on west end of abutment, 460 feet west of milepost 142; being highest point in square cut on stone.

T. B. M. 79.—Is in west edge of *Tuscumbia*, *Ala.*, at east end of railroad bridge over Spring Creek, on the north end of coping stone of abutment, 3 feet below top of ties; being the highest point in square.

T. B. M. 80.—Is in *Tuscumbia*, *Ala.*, on end of a curbstone at the northwest end of the Parshal Hotel; being highest point in square.

P. B. M. 8.—Is in *Tuscumbia*, *Ala.*, in the southwest corner of the county courthouse in water table 6½ inches east of corner; being center punch mark of copper bolt leaded horizontally. (See note 13a, page 551.)

P. B. M. 9.—Is in *Tuscumbia, Ala.*, on the east side of Main street, 16½ feet south from Fifth street, on the stone base of Mr. Wilson's bank building; being a copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 86.—Is opposite *Florence, Ala.*, on east end of south abutment of Memphis and Charleston Railroad bridge over Tennessee River at about the elevation of top of ties; being highest point in square cut in coping.

P. B. M. 10.—Is on south side of the Tennessee River, opposite *Florence, Ala.*, on lower or wagon-way abutment of the Memphis and Charleston Railroad bridge, in east end of bridge-seat stone, 5 inches from its east end and 4½ inches back from its front face; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 87.—Is at *Florence, Ala.*, on the north end of railroad bridge over the Tennessee River, on east end of stone abutment, about the elevation of top of ties; being the highest point in square marked U. S.

Old gauge B. M.—Is at the north end of bridge across the Tennessee River at *Florence, Ala.*, on the second pier north of wagon road, on the west side of bent, on pedestal stone, 7 inches from its west edge and 6 inches from its north edge; being highest point of square in the southwest part of cross marked

U S
+
B M

P. B. M. 11.—Is at *Florence, Ala.*, upon the draw pier of the Memphis and Charleston Railroad bridge across the Tennessee River, 9 feet north of the pivot, 28 inches north of the up-river side of the span when closed and 6 inches outside of the rack; being a copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 12.—Is at *Florence, Ala.*, on the north side of the Tennessee River, the second pier north of the north abutment of Florence bridge, on east pedestal stone, near its northwest corner; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 90.—Is at *Florence, Ala.*, on line of Louisville and Nashville Railroad, on right bank of river, about 300 feet below the northwest corner of lock factory, 16 feet south of track center, and one-half foot above top of ties; being highest point in square cut in ledge of rock.

P. B. M. 13.—Is in *Florence, Ala.*, in the Louisville and Nashville Railroad yards, 374 feet below the northwest corner of lock factory and 203 feet east of a small trestle, 39 feet from top of high river bank 12 feet north of center of south track, and 2 feet above top of ties, in a very large blue limestone; being center of punch mark of copper bolt leaded horizontally and marked U. S. P. B. M.; also an arrow is cut upon the stone pointing to the bolt.

P. B. M. 14.—Is in *East Florence, Ala.*, in old bucket factory now occupied by the Eureka Lumber Company, on the inside face of north wall, in the first pier east of the first arch about 4 feet above the ground, in center stone; being copper bolt leaded horizontally. (See note 13a, page 551.)

T. B. M. 93.—Is 1¼ miles above *East Florence, Ala.*, at foot of hill opposite the end of old railroad, 32 feet east of ravine and 115 feet north of river bank, on ledge of rock in place; being highest point in square.

P. B. M. 15.—Is about 1¼ miles above *East Florence, Ala.*, 215 feet east of ravine, at end of abandoned railroad, about 183 feet above T. B. M. 93, about 650 east from dam on opposite side of river, in vertical ledge of rock; being copper bolt leaded horizontally. (See note 13a, page 551.)

P. B. M. 16.—Is about 2¼ miles above *East Florence, Ala.*, and one-fourth mile below mouth of Four Mile Creek, 28 feet west of the Dunnehue Falling Spring, and about 9 feet in elevation above the path under overhanging rock inside of a wall where there had been a camp; being copper bolt leaded horizontally. (See note 13a, page 551.)

P. B. M. 17.—Is 1¼ miles below *Bainbridge, Ala.*, 1 870 feet below lower end of field, a short distance below the very large rock in river about 20 feet from shore, in a large rectangular bowlder sloping toward the river and forming retaining wall for path, 10 feet toward river from path, about 2 feet from river edge of bowlder and 1 foot from upstream edge; being copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 99.—Is 1 mile below *Bainbridge, Ala.*, about 190 feet below lower end of field, and 50 feet below wire fence running to river and 75 feet from river shore, on a large rock blown down from bluff; being the highest point in square.

P. B. M. 18.—Is at *Bainbridge, Ala.*, 1 160 feet west of the west end of lock 9, Muscle Shoals Canal, 18 feet north of Morrison's Spring, 4 feet west of small blacksmith shop, 37 feet north of center of the present wagon road and 5½ feet above it, under overhanging rock; being a copper bolt leaded horizontally. (See note 13a, page 551.)

T. B. M. 102.—Is at *Lock 9, Muscle Shoals Canal*, on north side and west end; being highest point in square cut in top of masonry.

P. B. M. 19.—Is at *Lock 9, Muscle Shoals Canal*, on the river side of lock, at west heelpost, between the A straps, 7 inches from iron shoe; being copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 103.—Is on south side of *Lock No. 8, Muscle Shoals Canal*, at its foot on south side of masonry; being highest point in square marked

U S
□
T B M

P. B. M. 20.—Is at *Lock No. 8, Muscle Shoals Canal*, on the river side of lock, at the west heelpost, between the A straps, 6 inches from the iron shoe; being copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 104.—Is at *Lock No. 7, Muscle Shoals Canal*, on south side and west end of lock, near the southwest corner of stone forming third step from top; being highest point in square.

P. B. M. 21.—Is on river side of *Lock No. 7, Muscle Shoals Canal*, at west heelpost, between the A straps, about 6 inches from the iron shoe; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 22.—Is on the south end of east abutment of railroad bridge over *Shoal Creek, Muscle Shoals Canal*, 1 445 feet east from foot of lock 7, 1 foot from west edge and 15 inches from south edge of stone; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 105.—Is one-half mile east from *Lock 7, Muscle Shoals Canal*, 150 feet west of section posts 26 and 27, on large rock, about 12 feet south of center of track; being highest point in square cut in stone.

T. B. M. 107.—Is at *Lock No. 6*, *Muscle Shoals Canal*, south side west end, on fourth step below coping; being highest point in square cut on stone.

P. B. M. 23.—Is at *Lock No. 6*, *Muscle Shoals Canal*, on river side, at west heel-post, between the A straps, about 6 inches from iron shoe; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 108.—Is 3 080 feet east of *Lock No. 6*, about 10 feet east from telegraph pole 4, at edge of bank, 10 feet south from center of track on a large rock; being highest point in square.

P. B. M. 24.—On *Muscle Shoals Canal*, at railroad bridge, at *Sixmile Creek*, on west abutment, north side; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 109.—Is about 1¼ miles above *Lock No. 6*, 100 feet east of section posts 22 and 23, 8 feet south of center of track and 2½ feet north of telegraph pole; being highest point in square on embedded rock.

P. B. M. 25.—Is on *Muscle Shoals Canal*, *between Locks 5* and *6*, at railroad bridge over Fourmile Branch, on south end of west abutment, on second step from top, 5 inches south of south edge of coping and 6 inches west of east edge of abutment; being a copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 113.—At *Lock No. 5*, *Muscle Shoals Canal*, on coping at the south side and west end; being highest point in square.

P. B. M. 26.—At *Lock No. 5*, *Muscle Shoals Canal*, on the south wall, on the outer corner of coping at recess of west gate, 10 inches from either face of masonry; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 27.—Is about 800 feet above lock 5, on the west abutment of railroad bridge over *Douglas Branch*, on coping at south end, 8 inches from either face; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 114.—Is on line of *Muscle Shoals Canal*, about 3 200 feet east from *Lock No. 5*, west of section posts 14–15, between telegraph poles 7 and 8, 12 feet south from center of track; being highest point of square on rock.

P. B. M. 28.—Is 260 feet below *Lock No. 4*, *Muscle Shoals Canal*, on north end of east abutment of railroad bridge, in northwest corner of stone, 9 inches from either face; being copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 116.—Is on east end of south wall of *Lock No. 4*, *Muscle Shoals Canal*, near heelpost; being highest point of square cut in coping stone.

P. B. M. 29.—Is at *Lock No. 4*, *Muscle Shoals Canal*, on the south wall and outer corner of coping stone at recess for west gate, 10 inches from either face of masonry; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 30.—Is on *Muscle Shoals Canal*, on the north end of west abutment of bridge across *Blue Water Creek*, on bridge-seat stone, 5½ inches west from edge of abutment and 4½ inches south from cap corner stone; being a copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 118.—Is at *Lock No. 3*, *Muscle Shoals Canal*, on south wall, east end, near the A strap; being highest point in square cut on coping.

P. B. M. 31.—Is at *Lock No. 3*, *Muscle Shoals Canal*, on the south wall, and outer corner of coping at recess for west gate, 10 inches from either face of masonry; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 119.—Is 3 760 feet east of *Lock No. 3*, 18 feet east of telegraph pole 4, west from section posts 7–8, 6 feet south of center of track; being highest point in square cut on stone.

T. B. M. 120.—Is 2 530 feet west of *Lock No. 2*, 110 feet east of telegraph pole 11 (the second pole east of section posts 6–7), 6 feet south of center of track; being highest point in square cut on rock.

T. B. M. 121.—Is at *Lock No. 2*, *Muscle Shoals Canal*, on south wall, south of east gate; being highest point in square cut in coping.

P. B. M. 32.—Is at *Lock No. 2*, *Muscle Shoals Canal*, on the south wall and the outer corner of coping at recess for west gate, 10 inches from either face of masonry; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 33.—Is on *Muscle Shoals Canal*, 1 600 feet east of Lock No. 2, on east abutment of railroad bridge over *Second Creek*, south end, in bridge-seat stone, 6 inches east of west face and 30 inches north of south face of abutment; being a copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 125.—Is at *Lock No. 1*, *Muscle Shoals Canal*, on south side, at the east end of surface wall above the upper gate, just below wing wall; being highest point in square.

P. B. M. 34.—Is at *Lock No. 1*, *Muscle Shoals Canal*, on the south wall, and the outer corner of coping stone at recess for west gate, 10 inches from either face of masonry; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 126.—Is at upper end of *Muscle Shoals Canal*, on the south side, on old dump, between section post 1 and telegraph pole 1, 12 feet south of track center; being highest point of square on rock.

T. B. M. 128.—Is 1⅝ miles above the head of Muscle Shoals Canal and 1½ miles below *Lambs Ferry*, 50 feet from river bank, about 900 feet below upper end of cornfield; being spike in root of an elm tree.

P. B. M. 35.—Is on the north bank of the Tennessee River at *Sycamore Landing*, 78 feet above the dripping spring and 154 feet in direct line from top of bank in road to ferryboat, 25 feet below a pin oak tree, 2½ feet in diameter, in a very prominently exposed ledge 9 inches above ground on shelf of rock. An arrow cut on vertical front face of rock just above points to the bench, which is a copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 36.—Is a short distance above P. B. M. 35, where wagon road comes within 24 feet of face of bluff, 95 feet from top of river bank, 30 feet below prominent point of rock at angle of ledge, 10 feet upstream from large overhanging oak tree growing on top of ledge. An arrow is cut into face of rock pointing toward the bench, which is a copper bolt leaded horizontally. (See note 13a, page 551.)

P. B. M. 37.—Is 1 mile below *Lock B*, *Elk River Canal*, 25 feet from shore line and 26 feet east of fence meeting bluff in face of rock bluff; being a copper bolt leaded horizontally. (See note 13a, page 551.)

P. B. M. 38.—Is about ¾ of a mile below *Lock B*, *Elk River Canal*, in face of rock bluff above root of uprooted linn tree that leans against bluff, 65 feet above path, 16 inches above ground; being copper bolt leaded horizontally. (See note 13a, page 551.)

T. B. M. 140.—Is at *Lock B*, *Elk River Canal*, on the north side, east gate, between A straps; being highest point in square cut in coping.

P. B. M. 39.—Is at *Lock B*, *Elk River Canal*, on the south wall and outer corner of coping at recess for lower gate, 8 inches from either face of masonry; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 40.—Is at *Lock A*, *Elk River Canal*, on the south wall and outer corner of coping at recess for lower gate, 10 inches from either face of masonry; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 141.—Is at *Lock A*, *Elk River Canal*, on the south wall, east end, and about 10 inches from north edge of masonry; being highest point in square cut in coping.

P. B. M. 41.—Is on south shore of *Elk River Canal*, 690 feet east of *Lock A*, 38 feet south from shore of canal, in exposed ledge of rock 2½ feet above ground and 1 foot from edge of ledge; being top of a copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 42.—Is at the head of *Elk River Canal*, 1 690 feet above *Lock A*, on east wall of wasteweir, 6 inches from south edge of stone, and 7 inches east of timbering; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 142.—Is 1 440 feet above *Lock A*, *Elk River Canal*, on top of dam or canal wall; being highest point of square cut on big rock.

P. B. M. 43.—Is on the gauge pier of canal wall or dam opposite *Miltons Bluff* and 1·2 miles above lock A, on south side, 2½ feet above top of wall of dam in top of large center stone; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 143.—Is on the south shore of canal at *Miltons Bluff*, 5 feet from water, and a short distance east of old derrick, on a large flat rock; being highest point in square.

T. B. M. 146.—Is 1¼ miles above *Miltons Bluff*, in strip of brush between two small cornfields, about 200 feet south of river bank, on a large oak tree; being highest point in square.

P. B. M. 44.—Is midway between Miltons Bluff and Browns Ferry, ½ mile below *Robinsons Landing*, 590 feet below end of Robinson's field, in woods on top of bank by side of path, 9 feet from two blazed elms, on a stone monument marked U. S., set in summer of 1892 in connection with survey made to examine the South Channel; being top of copper bolt leaded vertically and set at center of cross on stone.

P. B. M. 45.—Is 700 feet below *Browns Ferry*, 180 feet below where the road turns away from the river, on north edge of wagon road on top of river bank, on a stone post standing 4 inches above the ground and marked U. S., set in connection with survey of 1892; being a copper bolt leaded vertically into stone at center of cross.

P. B. M. 46.—Is 530 feet below *Browns Ferry* where the road turns away from the river, 18 feet north of center of wagon road on top of river bank, on a stone post marked U. S., standing 3 inches above the ground, and set in 1892; being top of spike leaded vertically.

P. B. M. 47.—Is 440 feet below *Findleys Landing* in face of large rock just above path, and 20 inches above surface of ground, being a copper bolt leaded horizontally. (See note 13a, page 551.)

T. B. M. 176.—Is in *Decatur*, *Ala.*, one-half mile below the Memphis and Charleston Railroad bridge, on "Slick Rock," 3 feet south of river shore and 0·8 foot above water at medium stage, being highest point in square cut on rock.

P. B. M. 48.—Is in *Decatur, Ala.*, one-half mile below Memphis and Charleston Railroad bridge, on "Slick Rock," but a few feet from T. B. M. 176, in recess in second shelf below top of rock, 3½ feet above ordinary stage of water, being a copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 49.—Is in *Decatur, Ala.*, 740 feet below the Memphis and Charleston Railroad bridge, on first point of prominent rocks below bridge, 18 feet below a leaning elm tree 1 foot in diameter, 6 feet above medium stage of water, on vertical face of rock, nine-tenths of a foot above ground and 7½ inches west of drill mark of blast, being a copper bolt leaded horizontally. (See note 13a, page 551.)

P. B. M. 50.—Is in *Decatur, Ala.*, on the south abutment of Memphis and Charleston bridge, on the downriver end of the abutment, 6 inches south of river face of stone, in the ninth course of masonry from top and 3½ feet above ground, being a copper bolt leaded horizontally. (See note 13a, page 551.)

Old B. M. U. X S.—Is in *Decatur, Ala.*, on the west end of the south abutment of Memphis and Charleston bridge, on bridge-seat stone, 1 foot from its west edge, marked "U. X S.," the part taken being the rounded point in the top of the X.

P. B. M. 51.—Is in *Decatur, Ala.*, on the draw pier of the Memphis and Charleston Railroad bridge across the Tennessee River, on downstream side of draw, inside of rack, being top of copper bolt leaded vertically. (See note 13a, page 551.)

Old railroad B. M.—Is on pier of fixed span just north of draw on top surface of coping, downriver side, and corner toward *Decatur*.

P. B. M. 52.—Is opposite *Decatur, Ala.*, in second pier from the north end of bridge, on the upriver end of pier, being top of copper bolt leaded vertically. (See note 13a, page 551.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN RIVERTON JUNCTION, ALA., AND PITTSBURG LANDING, TENN.

P. B. M. 4.—Is in the western extremity of *Riverton, Ala.*, about one-half mile below the depot, 27 feet from river bank and 1⅓ feet east of farm fence running to the river, a stone post 4 feet long standing 6 inches above top of ground, being a copper bolt leaded vertically. (See note 13a, page 551.)

Lift Lock Center Line Stone 3.—Is three-fourths of a mile above *Riverton, Ala.*, on section No. 11, of Colbert Shoals Canal, above the lift lock, a stone for marking the center line of canal, being the southeast corner of stone.

P. B. M. 5.—Is three-fourths of a mile above *Riverton, Ala.*, 1 200 feet south of lift lock, Colbert Shoals Canal, in cultivated field on conspicuous Indian mound, being highest point of limestone post set in ground (=old gauge bench mark).

P. B. M. 6.—Is one-half mile above *Lift Lock, Colbert Shoals Canal*, in limestone post marking the south corner of United States building reservation, opposite station 33 of canal, 10 feet north of highway and 13 feet south of road fence, being a copper bolt leaded vertically into the northeast corner of post.

P. B. M. 53.—Is 2 miles below *Riverton, Ala.*, one-third mile below Big Bear River, directly back from Eastport Landing, in creek bed at foot of bluff, 130 feet up the creek from fence. A white-oak tree, on east side of creek, 11 inches in diameter, is blazed facing the bench. On east side of creek bed, 2·9 feet back from top edge of long, unbroken step of rock of 9 inches rise and extending clear across creek, in broken angle formed by next step, which is worn through in middle where water runs over it, 5½ inches north of this second step and 7½ inches west of other part of same step, being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 54.—Is 2¾ miles below *Big Bear River*, *Alabama*, on property of Mr. Joe Payne, a short distance below Paynes Landing, in woods on slope, at foot of bluff, about 40 feet to the east of a beech tree standing on top of bluff and 60 feet to the north of a hickory tree, in first ledge of rock below Paynes Landing, 14 inches above ground, being center of punch mark in a copper bolt leaded horizontally. (See note 13a, page 551.)

P. B. M. 55.—Is a quarter of a mile above *Indian Creek* on land of R. W. Busbee, at foot of bluff, 50 feet from fence, 20 feet back from black walnut tree 15 inches in diameter, and 20 feet from hickory tree deeply blazed toward the bench. On rounding ledge east of creek, 2½ feet above ground, just below and 5 inches from first vertical shelf, being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 56.—Is at *Buggs Landing*, *Tishomingo County*, *Miss.*, 0·4 mile from the river on the left or north bank of Whetstone Creek, 78 feet above where the road crosses it, in front (vertical) face of the slate-like rock where it has split off and fallen into creek, 2 feet above the east part of this vertical face and 1 foot above ground, being a copper bolt leaded horizontally.

P. B. M. 57.—Is at foot of bluff ½ mile below *Buggs Landing*, *Miss.*, on land of Mr. Sam Buggs, about 245 feet below ravine running into bluff, in small grotto at mouth of small cave, 15 feet above a beech tree 16 inches in diameter, 32 feet above fence and 60 feet below a small spring, being top of copper bolt leaded vertically into ledge of rock. (See note 13a, page 551.)

P. B. M. 58.—Is one-half mile above *Yellow Creek*, *Tenn.*, on the Widow Johnson's estate at second "rock waterfall" above the creek, on the second shelf from the bottom, which shelf is 2 feet wide and extends entirely across the creek 8 feet below the center of waterway, directly below a 6-inch white ash tree, blazed toward bench that elbows out from rocks, about 25 feet above an elm blazed facing the bench, being a copper bolt leaded vertically. Messrs C. C. Johnson and J. B. Bullard saw the bench set. (See note 13a, page 551.)

P. B. M. 59.—Is about 1½ miles below *Yellow Creek*, on the Winn estate, in the large ledge directly over the center of the inlet of the famous Winn spring, 2 feet above the water surface, being the top of a copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 60.—Is on the road up the bluff from Boyds, Edwards, and Duncans landings, at intersection of Pickwick road and Rocky Branch, near *Boyds Landing*, *Tenn.*, at foot of bluff, just opposite where road crosses creek, and on west side of road at the lower part where shale rock shows as bed of creek, on shelf of shale rock about 2 feet above ground, opposite and 39 feet from red oak tree blazed in the form of an ellipse, facing the bench, being a copper bolt leaded vertically. (See note 13a, page 551.)

Old P. B. M. 1.—Is three-fourths of a mile above *Hamburg Landing*, *Tenn.*, on the very large bowlder of concrete rock at the base of bank, 10 feet outside of line of trees and brush, two trees standing near by are blazed, being top of iron bolt leaded vertically in rock standing 1½ inches above surface of rock.

Old P. B. M. 2.—Is at *Pittsburg Landing* in wall of national cemetery, in that portion parallel to the river, about 500 feet above the northeast corner of wall in center of coping stone, being a three-quarter-inch iron bolt leaded vertically and standing an inch above surface of stone.

P. B. M. 61.—Is at *Pittsburg Landing*, *Tenn.*, in coping stone of wall of national cemetery, about 325 feet above its northeast corner and about 2 feet beyond angle in wall, being copper bolt leaded vertically. (See note 13a, page 551.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN BIRMINGHAM, ALA., AND MERIDIAN, MISS., AND BETWEEN YORK AND DEMOPOLIS, ALA.

P. B. M. 1.—Is in *Birmingham*, *Ala.*, in the southeast corner of west wing of courthouse, 10 inches from east corner, second course above base stone, being center of center punch mark in copper bolt leaded horizontally. (See note 13a, page 551.)

T. B. M. 1.—Is in *Birmingham*, *Ala.*, at the Third-avenue entrance to courthouse, west side on base stone of fence behind stone post; being highest point in square.

P. B. M. 2.—Is in *Birmingham*, *Ala.*, on the northeast corner of First avenue and Nineteenth street, about 72 feet north of First avenue, on base stone under sixth pillar of L. Sak's store, on south end of stone; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 3.—Is in *Birmingham*, *Ala.*, in north side of west entrance to custom-house, on third step from top, between pillar of arch and pilaster; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 2.—Is in *Birmingham*, *Ala.*, on north side of the dummy car track, about 3 600 feet below the post office or custom-house, on Eleventh street in front of store, 10 feet west from end of curbing at waterway; being square cut on curbing.

T. B. M. 3.—Is in *Elyton*, *Ala.*, 325 feet east of section house 160. on stone culvert on the northeast corner, 18 inches from edge of timber; being highest point in square.

T. B. M. 7.—Is 1½ miles west of *West End*, *Ala.*, on line of the Alabama Great Southern, 328 feet east of road crossing, in center of south end of the southeast abutment of top stone; being highest point in square.

P. B. M. 4.—Is on line of the Alabama Great Southern, 1½ miles above *Powderly*, *Ala.*, 470 feet below center of road crossing, 29 feet south of center of track, in very large bowlder forming the north bank of ditch; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 8.—Is at *Powderly*, *Ala.*, 100 feet below crossing of Alabama Great Southern and dummy line, 50 feet south from center of track on upper part of large ridge of rock; being highest point in square.

T. B. M. 9.—Is 66 feet below milepost 146 from Meridian and 13 feet north of center of track; being highest point in square cut on bowlder.

T. B. M. 10.—Is 1½ miles east of *Hillman*, *Ala.*, station, 100 feet below bridge 84, and 26 feet north of track, on stone ledge; being highest point in square.

T. B. M. 11.—Is 250 feet above *Hillman*, *Ala.*, switch, at the north side of bridge No. 85, on very large rock in bed of Downeys Creek; being highest point in square cut on rock.

T. B. M. 13.—Is about halfway between mail crane at *Turpin*, *Ala.*, post office and crossing of road to mines, on northeast abutment of viaduct on second step from top and 5 inches from first step; being highest point in square.

T. B. M. 14.—Is in *Bessemer, Ala.*, 1 300 feet east of brickyard and 39 feet north from center of track, in front of and 14 feet from 12-inch sweet gum tree, on center of rock in place dipping north; being highest point in square.

T. B. M. 15.—Is in *Bessemer, Ala.*, 300 feet above the crossing of the Alabama Great Southern and Louisville and Nashville tracks, on southeast corner of stone culvert; being highest point in square.

P. B. M. 5.—Is in *Bessemer, Ala.*, on the southeast corner of Nineteenth street and Fourth avenue, at the main (corner) entrance of brick building with stone trimmings occupied by the Bessemer Loan and Improvement Company, in east end of top stone; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 18.—Is in *Jonesboro, Ala.*, at the north side of the track in base stone of the southeast corner of water tank; being highest point in square.

T. B. M. 24.—Is three-fourths of a mile below *McCalla, Ala.*, about 1 700 feet below bridge No. 87, on southeast corner stone of open culvert; being highest point in square.

T. B. M. 27.—Is one-fourth mile above *Baylor, Ala.*, and 490 feet north of milepost 131 from Meridian, on the northwest corner of culvert, on third step from bottom; being highest point in square cut on stone.

P. B. M. 6.—Is at *Kimbrell, Ala.*, 57 feet west from center of track, at a point 550 feet above the upper fence at crossing, on a very large ridge of limestone rock, 50 feet above pyramidal point at lower end of rock and 8½ feet from cedar tree 4 inches in diameter; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 32.—Is about 1¼ miles south of *Tannehill, Ala.*, and one-half mile above *Standiford*, 656 feet south of milepost 127 from Meridian, at southeast corner of bridge No. 94; being highest point in square cut in stone.

T. B. M. 39.—Is three-fourths of a mile below *Woodstock, Ala.*, and 334 feet south of milepost 122 from Meridian, on southwest corner of culvert, 2 feet from end of stone; being highest point in square.

T. B. M. 42.—Is about three-fourths of a mile below *Bibbville, Ala.*, on south side of track, opposite milepost 120 from Meridian; being highest point in square cut in stone.

P. B. M. 7.—Is about one-half mile above *Vance, Ala.*, 1 312 feet south of milepost 118 from Meridian, 328 feet south of old ginhouse, on north end of culvert marked 1888, upper side, on first step below coping; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 47.—Is three-fourths mile below *Vance, Ala.*, about 2 950 feet below milepost 117 from Meridian, on northwest corner of small culvert, on second step from top; being highest point in square.

P. B. M. 8.—Is about 795 feet below *Coaling* station, on south end of culvert, under the Alabama Great Southern track, on west side, third step from top, on corner of stone 11 inches north of south end and 11 inches from east face; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 60.—Is 50 feet above the lower end of rock cut below *Johnson, Ala.*, on shelf of rock on south side of track, and of same elevation as top of rail, 20 feet below old fence on opposite side of track; an arrow is cut below, pointing up to the bench; being highest point in square.

P. B. M. 9.—Is 1 640 feet above *Cottondale* station, on north end of large stone culvert, on west end of coping stone, 2 feet east of the west edge and 6 inches from north face; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 69.—Is 2 miles below *Cottondale, Ala.*, 740 feet below milepost 102 from Meridian, on the west side of track and southwest corner of small stone culvert; being the highest point in square cut in stone.

T. B. M. 70.—Is 2⅝ miles below *Cottondale, Ala.*, 1 280 feet above milepost 101 from Meridian, on the northwest corner of small open culvert; being highest point in square.

T. B. M. 75.—Is 1⅝ miles above *Tuscaloosa* depot and one-fourth mile above milepost 98 from Meridian, on south end of large stone culvert, on east end of coping stone; being highest point in square.

P. B. M. 11.—Is in *Tuscaloosa, Ala.*, on the southwest corner of Market and Cotton streets, on the city hall, on stone base under window sill, 19·7 feet south of the main entrance; being top of copper bolt leaded vertically. (See note 13a, page 551.)

Old B. M. 3.—Is at Lock No. 1, on the land corner stone nearest head of steps leading down to lock walls, on the surface at southeast quarter of cross.

P. B. M. 12.—Is in *Tuscaloosa, Ala.*, at Lock No. 1, Warrior River Canal, on south wall of lock, east end, 9 inches from edge of wall, just above recess for gate; being top of copper bolt leaded vertically. (See note 13a, page 551.)

Old B. M. 4.—Is at Lock No. 1, on face angle of coping at the southeast quoin of Lock 1; being small circle cut inside of square.

Old B. M. 5.—Is on south pier of *Tuscaloosa* county bridge, on projection of foundation course; being top of iron bolt leaded vertically.

P. B. M. 13.—Is about 980 feet below pier of the new Mobile and Ohio bridge at the west side of the inclined gauge, under the forty-third foot mark, on stone monument set in ground; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 10.—Is in *Tuscaloosa, Ala.*, 1 145 metres below the Alabama Great Southern depot, on north end of stone culvert, on second step below coping, 6 inches from first step and 8 inches from face of second step; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 78.—Is five-eighths mile below depot at *Tuscaloosa, Ala.*, 460 feet below milepost 96 from Meridian, on east end of brick culvert; being highest point in square cut on brick.

T. B. M. 80.—Is 2½ miles below *Tuscaloosa, Ala.*, 740 feet below road crossing, and 295 feet above milepost 94 from Meridian, on west end of stone culvert and south end of coping; being highest point in square.

T. B. M. 88.—Is at *Englewood, Ala.*, 180 feet above lower end of switch, on cement top of east end of iron culvert pipe; being highest point in square.

T. B. M. 94.—Is in *Hull, Ala.*, 100 feet south of station, on west end of culvert, on top of first brick north of center joint over iron pipe; being highest point in square.

P. B. M. 14.—Is in *Hull, Ala.*, 63 feet above the north end of station and 10 feet east of center of track, on brick culvert, 1 foot from north face and 6 inches from end; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 100.—Is in *Moundville, Ala.*, 164 feet below depot, on foundation stone of water tank, on the northwest corner of the west one of the two north pillars; being highest point of square cut on stone.

P. B. M. 15.—Is in *Moundville, Ala.*, about 170 feet south of depot, in foundation stone of water tank, in the northwest corner of the southwest pedestal of center quadrilateral; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 16.—Is at *Powers, Ala.*, 656 feet above station, on east end of large stone culvert, on first step below coping, north side; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 17.—Is in *Akron, Ala.*, on west side of track, opposite the north end of depot, on brick culvert, on top of first brick south of center joint and 1 foot back from west end; being highest point in square.

P. B. M. 18.—Is at the *Warrior River, Ala.*, on Alabama Great Southern Railroad, on south end of pier at the east end of drawspan, on the southwest corner of coping, 10 inches from west face and 8 inches from south face of coping; being top of copper bolt leaded vertically. (See note 13a, page 551).

T. B. M. 122.—Is one-third mile west of west end of trestle at *Warrior River, Ala.*, on foundation stone of water tank, south side, on the northeast pedestal of the quadrilateral; being highest point of square cut on stone.

T. B. M. 123.—Is about 2⅛ miles above *Eutaw, Ala.*, and 490 feet above milepost 64 from Meridian, on top of south end of brick culvert; being highest point in square.

T. B. M. 124.—Is 1¾ miles above *Eutaw, Ala.*, 3 150 feet above milepost 63 from Meridian, just above deep cut on south end of brick culvert; being highest point in square cut on brick.

P. B. M. 19.—Is in *Eutaw, Ala.*, 460 feet below the north side of depot, on coping of brick culvert, north side, 4 feet above the south end, about 7 inches back from face; being top of bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 20.—Is in *Eutaw, Ala.*, on Greensborough street, in the northwest corner of Palmer, Banks & Co.'s store, in base stone under window sill, just off from sidewalk; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 132.—Is 2¼ miles above *Hairston, Ala.*, 1 875 feet below milepost 58 from Meridian, 572 feet above whistle post, on the southwest quarter of stone culvert, on fourth step from bottom; being highest point in square cut on stone.

T. B. M. 138.—Is 1¼ miles below *Hairston, Ala.*, 515 feet above milepost 54 from Meridian, on the northwest quarter of stone culvert, on fourth step from bottom; being highest point in square cut on stone.

T. B. M. 139.—Is 1¼ miles above *Boligee, Ala.*, 3 215 feet below milepost 54 from Meridian, on east end of stone culvert, north side, on second step below coping; being highest point in square cut on stone.

P. B. M. 21.—Is on same culvert as T. B. M. 139, 1¼ miles above *Boligee, Ala.*, 3 345 feet above section foreman's house, on east end of stone culvert, south side, on second step from top, 10 inches from outer edge and 8 inches from face of stone; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 150.—Is 1⅜ miles below *Miller, Ala.*, 1½ miles above Epes, 960 feet above upper end of trestle east of Tombigbee River, at a point of curve of first curve in track above trestle, on top of railroad iron set as a post to mark point of curve; being on surface at southwest quarter of cross cut on iron.

P. B. M. 22.—Is on the east side of Tombigbee River, opposite *Epes, Ala.*, in the east face of east pier of the Alabama Great Southern Railroad bridge, in the eleventh brick of tie course from south end of pier, and in the fifty-eighth course of brick below the first projecting course at top; being copper bolt leaded horizontally. (See note 13a, page 551.)

P. B. M. 23.—Is at *Epes, Ala.*, in south end of pier at east end of drawspan, in coping stone, 7 inches from south end and 28 inches from east face; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 152.—Is in *Epes, Ala.*, 40 feet west of depot, on north end of brick culvert, in the middle of the sixth brick from the west face; being highest point in square cut on brick.

T. B. M. 153.—Is about 1 mile west of *Epes, Ala.*, 530 feet below road crossing, at lower end of cut on south end of the tile culvert; being highest point in square cut on the pipe.

T. B. M. 156.—Is about one-half mile east of *Parker, Ala.*, 850 feet below milepost 42 from Meridian, at the upper end of long cut and tangent, at point of curve on south side of track, on surface in the northeast quarter of cross, on top of iron tangent post.

T. B. M. 157.—Is at *Parker, Ala.*, 570 feet south of the north switch stand, on southeast quarter of stone culvert; being highest point in square cut in stone.

T. B. M. 160.—Is 3¼ miles above *Livingston, Ala.*, 1 150 feet above milepost 39 from Meridian, on the southeast corner of brick culvert; being highest point of square.

T. B. M. 162.—Is about 1⅝ miles above *Livingston, Ala.*, 1 740 feet below milepost 38, on west end of brick culvert, on center of first brick north of center joint; being highest point in square cut on brick.

P. B. M. 24.—Is in *Livingston, Ala.*, in the public square on corner of Washington and Market streets, in northeast corner of building for office of the probate judge, on east face 9 inches from corner and in the seventeenth course of brick above the projection at the ground; being copper bolt leaded horizontally.

P. B. M. 25.—Is three-fourths of a mile below *Livingston, Ala.*, on south pier of bridge over the Sucarnochee Creek, on west end of pier on the southeast corner of capstone, 5 inches from north face and 5 inches from the west end; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 172.—Is 3 miles above *York, Ala.*, and 490 feet below milepost 30 from Meridian and section post 43–44, at north end of curve, on tangent post consisting of a piece of railroad iron 5 feet long set 3 feet in ground; being point in the northwest quarter of cross.

T. B. M. 175.—Is 1⅜ miles above *York, Ala.*, 615 feet below milepost 28 from Meridian, on the west end of brick culvert, on the sixth brick from the south end; being highest point of square cut in brick.

P. B. M. 26.—Is in *York, Ala.*, 490 feet below depot and directly below intersection of Alabama Great Southern and Southern Railroad crossing, on east end of stone culvert, south side, on first step below coping, 5 inches from east end and 3½ inches from north face; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 179.—Is 1⅝ miles below *York, Ala.*, 820 feet above milepost 25 from Meridian, at south end of long tangent beginning at water tank one-half mile below York, at south side of track, on iron tangent post, on point in southeast quarter of cross.

T. B. M. 182.—Is 3¾ miles below *York* station, 230 feet north of milepost 23 from

Meridian, on the west end of brick and double tile culvert, on the center brick between the two tiles; being highest point of square cut in brick.

P. B. M. 27.—Is in *Cuba, Ala.*, about 400 feet below depot on the rear property line stone of the Alabama Great Southern Railroad Company, 100 feet north of track, in front of Holiness Church and opposite the jug factory, being top of copper bolt leaded vertically in center of stone. (See note 13a, page 551.)

T. B. M. 188.—Is 1⅝ miles below *Cuba, Ala.*, 975 feet below milepost 19 from Meridian, at west end of cut around sharp curve, on north end of brick and tile culvert; being highest point in square cut in cement over the centre of tile.

P. B. M. 28.—Is in *Toomsuba, Miss.*, 120 feet above the east end of depot, in the fourth brick from the west side of brick culvert running under siding on the north side of track; being top of copper bolt leaded vertically. (See note 13a, page 551.)

T. B. M. 207.—Is 1 335 feet below milepost 7 from Meridian, 400 feet above *Russell, Miss.*, on the northeast corner of brick culvert under track; being highest point of square cut in cement.

T. B. M. 217.—Is in *Meridian, Miss.*, at the southeast corner of Fifth street and Twentieth avenue, about 120 feet east of south entrance, on opposite side of street, on curb 26 feet east of east point of curve; being highest point in square.

C.—*Meridian, Lauderdale County, Miss.* (See page 594.)

P. B. M. 29.—Is in *Meridian, Miss.*, at the south entrance to the post office building on the west end of doorsill stone, 4 inches from west jamb and 3 inches from south face of stone; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 1.—Is in *Coatopa, Ala.*, in the southeast corner of Parker's store, in the sixteenth course of brick from ground and sixth from south corner; being copper bolt leaded horizontally.

P. B. M. 2.—Is in *McDowell, Ala.*, on pedestal stone of water tank foundation, on the northeast corner of northeast stone of north quadrilateral, 8 inches from east face and 6 inches from north face of stone; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 3.—Is three-fourths mile east of *McDowell, Ala.*, on south end of west pier of bridge over the Tombigbee River, in coping 8 inches from east face; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 4.—Is three-fourths mile east of *McDowell, Ala.*, on north end of east pier of bridge over Tombigbee River, in coping stone; being top of copper bolt leaded vertically. (See note 13a, page 551.)

Old B. M.—Is in *Demopolis, Ala.*, on Washington street, opposite the fire department station, at the front entrance to Demopolis Inn, on east end of iron doorsill (this was formerly the Royal Hotel), on raised letters cast on sill, "Progress Manf'g. Co., Meridian, Miss.;" the point taken is the center of the arc C.

P. B. M. 5.—Is in *Demopolis, Ala.*, on the southeast corner of Walnut and Capitol streets, on the northwest corner of the Mayer Block, on north end of base stone under north window, 6½ inches above sidewalk and 6½ inches south of buttress; being top of copper bolt leaded vertically. (See note 13a, page 551.)

P. B. M. 6.—Is in *Demopolis, Ala.*, on the northeast corner of Washington and Strawberry streets, on the southeast corner of Cheshire Webb Building, on east end of base stone under window east of east entrance, 6 inches above sidewalk; being top of copper bolt leaded vertically. (See note 13a, page 551.)

DESCRIPTIONS OF PERMANENT BENCH MARKS FROM COLUMBUS, KY., TO MEMPHIS, TENN.

P. B. M. 7.—Middle of small hole in copper bolt set in south side of brick building, halfway between the most eastern windows of main building in first course of bricks below window sills. The building is situated on Front street, at *Columbus*, *Ky.*, fronting on river, and belongs to the Bank of Kentucky; it is called the "Mansion House." Marked

U S
⊙ February 3, 1877.
B M

P. B. M. 8.—Center of small hole in top of copper bolt in stone post which is set in southeast corner of Baptist Church yard, in *Columbus*, *Ky.*, 1·5 metres from each fence. The stone is marked by the letters U. S. It is 496 metres from P. B. M. 7.

P. B. M. 9.—Small hole in copper bolt set in east face of corner stone on northeast corner of same Baptist Church in *Columbus*, *Ky.* Church corner of Roane street and fourth street from river.

P. B. M. 10.—Is top of copper bolt in top of stone post in ground set on "Chalk Bluffs," about 3 miles below *Columbus*, *Ky.* It is 35 metres north of old shed, 5 metres north of a cherry tree. It is between road and river, 150 metres back from river and 20 metres from road. At this point on the road a lane leads south between fields.

P. B. M. 11.—Is top of copper bolt in stone post in woods 200 metres back from river, 160 metres southeast of corner of cornfield, three-fourths mile above *Worshams Landing*, *Ky.*, and 7 miles below Columbus.

P. B. M. 12.—Is top of copper bolt in stone post in woods 30 metres above edge of heavy timber, 1¾ miles below *Worshams Landing*, *Ky.*

P. B. M. 13.—Is top of copper bolt in stone post in northwest corner of P. J. Frenz's front yard, ½ metre from west fence. Bench is 2¾ miles above *Hickman*, *Ky.*, and 400 metres below mouth of Little Obion River.

P. B. M. 14.—Is top of copper bolt in stone post in northwest corner of Episcopal Church yard, *Hickman*, *Ky.*, 1 metre from each fence.

P. B. M. 15.—Is center of square cut on top of southeast corner of stone window sill in southwest corner of Millet's block, corner of Union and Clinton streets, *Hickman*, *Ky.* Vertical face of sill is marked U. S. B. M.

P. B. M. 16.—Is top of copper bolt in stone post in northwest corner of Golder's front yard, 4¼ miles below *Hickman*, *Ky.*

P. B. M. 17.—Is top of copper bolt in stone post in woods 9½ miles below *Hickman*, *Ky.* It is 80 metres from east bank of No. 8 chute and 20 metres from Cane Creek, on land of Henry Bochares.

P. B. M. 18.—Is top of copper bolt in stone post 62 metres from river, about 1 mile below foot of No. 8 chute, 72 metres southwest of dwelling house on land of Richard Finch. Approximately 13 miles below *Hickman*, *Ky.*

P. B. M. 19.—Is top of copper bolt in stone post 60 metres from river, 340 metres above Lester's house, 17 miles below *Hickman*, *Ky.*, 1 metre north of fence, and 1½ metres from sycamore tree. This bench is 2 miles above Kentucky and Tennessee State line.

P. B. M. 20.—Is top of copper bolt in stone post 1 830 metres below *Kentucky and Tennessee State line*, 80 metres above △ Kentuck and on line between △ Kentuck and △ Lester, and 100 metres from river.

P. B. M. 21.—Is top of copper bolt in stone post in woods 58 metres from river and 38 metres from road and 5½ miles below *Lesters Landing*, *Tenn.*

P. B. M. 22.—Is top of copper bolt in stone post in southwest corner of Amberg's front yard in northern end of *Tiptonville*, *Tenn.*

P. B. M. 23.—Is top of copper bolt in stone post in north side of Nicholas Brady's yard, 1 metre from fence, *Tiptonville*, *Tenn.* (Brady's house is brick.)

P. B. M. 24.—Is top of copper bolt in stone post in woods 4 miles below *Tiptonville*, *Tenn.* It is 500 metres back from river at △ Riley, which stands on river bank. Bench is 20 metres north of public road.

P. B. M. 25.—Is top of copper bolt in stone post in woods on land of Robert Watson, now occupied by J. B. George. It is 6¾ miles below *Tiptonville*, *Tenn.*, and 1·6 miles above Basses Landing. It is 150 metres west of house and 6 metres west of road.

P. B. M. 26.—Is top of copper bolt in stone post in woods on land of G. W. Curtis, 892 metres below *Reelfoot* or Donnahauers *Landing*, *Tenn.* It is 80 metres from river and 100 metres north of Curtis's house.

P. B. M. 27.—Is top of copper bolt in stone post in woods at *Motts Landing*, *Tenn.*, on land of Terrell Fields, 4 miles above Booths Point, Tenn., 140 metres back from river and 29 metres from an old shed. It is N. 37° E. 89 metres from Fields's house, now occupied by John Hazaleno.

P. B. M. 28.—Is top of iron bolt in stone post in woods S. 60° E. 480 metres from *Booths Point Landing*, *Tenn.* It is 55 metres east of fence and 4 metres from hickory tree.

P. B. M. 29.—Is top of copper bolt in stone post in corner of woods, 2 metres west of fence, 28 metres south of large cottonwood tree, 20 metres southeast of sycamore tree, and 16 metres east of box-elder tree, 226 metres from river, on land of W. M. Pate, and 4½ miles below *Booths Point*, *Tenn.*

P. B. M. 30.—Is top of copper bolt in stone post in woods 200 metres from river and 97 metres east of northeast corner of cornfield, 1 metre southeast of cottonwood tree, 8¾ miles below *Booths Point*, *Tenn.*, on land of Joseph Mitchell.

P. B. M. 31.—Is top of copper bolt in stone post 1 metre west of small sycamore tree, 18 metres east of public road, —— miles below *Booths Point*, *Tenn.*, 43 metres east of old chute, 93 metres west of fence on land of W. S. Henley.

P. B. M. 32.—Is top of copper bolt in stone post which marks △ Obion, 1½ miles above *Hales Point*, *Tenn.*, 1 140 metres above mouth of Obion River, 10 metres west of public road. A high observing station is built over the point.

P. B. M. 33.—Is top of copper bolt in stone post in woods on land of ——— Thompson, esq., about 1¼ miles below *Hales Point*, *Tenn.* It is 75 metres east of house now occupied by Daniel Cauglan, 60 metres south of road, 1 metre east of large elm tree about three-fourths mile from river. It is 472 metres above bend in road between Hales Point and Ripley.

P. B. M. 34.—Is top of copper bolt in stone post in woods 65 metres east of river bank at "Wardloss Packet," 6 miles below *Hales Point*, *Tenn.*, 3 metres south of elm tree near canebrake on land of Merriweather heirs.

P. B. M. 35.—Is top of copper bolt in stone post in woods 2 metres east of large cottonwood tree, 47 metres from river, 110 metres northeast of junction of Mississippi and Forked Deer rivers, 40 metres north of Forked Deer River, about one-half mile above head of *Forked Deer Island* (*No. 26*).

P. B. M. 36.—Is top of copper bolt in stone post in woods on east side of chute of Island 26, 90 metres from chute, 4 miles above *Ashport*, *Tenn.*

P. B. M. 37.—Is stone in ground in woods 85 metres back from river, 200 metres above *Ashport*, *Tenn.*, 1 metre north of sycamore tree on land of J. S. Kelly.

P. B. M. 38.—Is top of copper bolt in stone post in ground in woods 90 metres from river, 1 metre east of large red oak, 4½ miles below *Ashport*, *Tenn.*

P. B. M. 39.—Is top of copper bolt in stone post back of cotton field, 1 metre west of sycamore tree, 24 metres west of fence, 329 metres back from △ Plum Point on river, 1 mile below *Plum Point*, *Tenn.*, on land of E. B. Friend.

P. B. M. 40.—Is top of copper bolt in stone post in woods 45 metres back from river and 2½ miles below *Plum Point*, *Tenn.*, 1 metre east of sycamore tree and 1 metre west of box-elder tree.

P. B. M. 41.—Is top of copper bolt in stone post at base of bluffs above *Fort Pillow Landing*, *Tenn.*, at mouth of Cold Creek. It is 30 metres from river and 80 metres below Horace Dike's house.

P. B. M. 42.—Is top of copper bolt in stone post in woods on land of A. Lea & Co., about three-fourths mile west of post office at *Fulton*, *Tenn.*, 125 metres back from river, and about 140 metres east of a graveyard in the woods. It is 12 metres east of fence and 300 metres west of Dr. Allen's house.

P. B. M. 43.—Is top of copper bolt in stone post in woods 50 metres from river and about 20 metres from base of bluffs. It is 2 metres from an elm tree, and 1 648 metres below the flouring mill at *Fulton*, *Tenn.*

P. B. M. 44.—Is top of copper bolt in stone post in woods 110 metres back from river and 588 metres above the mouth of *South Hatchee River*, *Tenn.*

P. B. M. 45.—Is top of copper bolt in stone post on Hatchee Island, 2 miles above *Randolph*, *Tenn.*, on land of Lena Alston, 40 metres northwest of house, 45 metres west of Hatchee Island Chute.

P. B. M. 46.—Is top of copper bolt in stone post on high knoll in west end of *Randolph*, *Tenn.*, between Memphis road and river, 44 metres from Mrs. Deakin's house, 32 metres south of stable. A △ stands between this bench and the river.

P. B. M. 47.—Is top of corner bolt in stone post in woods 21 metres north of Randolph and Memphis road, at point where road crosses an old fortification line, 2 metres from a large cottonwood tree. It is 1 200 metres below *Randolph* post office, measured along Memphis road.

P. B. M. 48.—Is top of copper bolt in stone post on east bank of levee, about 700 metres below *Richardsons Landing*, *Tenn.*, 85 metres back from river, 80 metres south of △ Richardsons, 6 miles below Randolph, Tenn.

P. B. M. 49.—Is top of copper bolt in stone post in woods on land of ——— Etherly, 4 miles below *Richardsons Landing*, *Tenn.*, 150 metres from bank of chute of Island No. 35, 150 metres south of southeast corner of field.

P. B. M. 50.—Is top of copper bolt in stone post back of *Paynes Landing*, *Tenn.* It is 242 metres east of △ Wallace and 257 metres from river, 17 metres north of end of lane, 2 metres west of fence, and 12 miles below *Randolph*, *Tenn.*

P. B. M. 51.—Is top of copper bolt in stone post 160 metres from the river, 140 metres south by southeast of a house and 1 metre from small sycamore tree on land of L. Ziegler. It is 750 metres below upper end of "old" river at Centennial Cut-off, Tipton County, Tenn., 4 miles above *Thomas Landing*, *Tenn.*

P. B. M. 52.—Is top of copper bolt in stone post on land of J. R. Walt, 160 metres from river, 480 metres above *Thomas Landing*, *Tenn.* It is 1 metre west of box elder tree, 1½ metres east of mulberry tree.

P. B. M. 53.—Is top of copper bolt in stone post in canebrake 102 metres from river (old bed), and about 2 miles below Centennial Cut-off, 52 metres south of road leading east from river, 1¼ miles below mouth of Batemans Bayou, Tenn., 1¾ miles above *Brinkleys Landing*, *Tenn.*, on land of John Turner's heirs.

P. B. M. 54.—Is top of copper bolt in stone post in woods on land of ——— Duncan, about 130 metres from chute of *Island No. 40*. It is 2 732 metres below head of chute, 95 metres east of road.

P. B. M. 55.—Is top of copper bolt in stone post in edge of woods east of field, 130 metres east of river, about one-fourth mile below foot of *Island No. 40*, and northeast of cabin, which is 14 metres from river.

P. B. M. 56.—Is top of copper bolt in stone post in woods on land of ——— Claybrook and Williams. It is 10 metres east of slough, 40 metres west of Memphis road, 446 metres south of Costin's house, and 267 metres south of a cabin in field. By the public road this bench is just 6 miles above the new custom-house at *Memphis*, *Tenn.*

P. B. M. Memphis.—*Memphis*, *Tenn.* (See page 642.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN CAIRO, ILL., AND COLUMBUS, KY.

P. B. M. 1.—*Cairo*, *Ill.* (See page 599.)

P. B. M. 2.—*Cairo*, *Ill.* (See page 599.)

P. B. M. 3.—*Cairo*, *Ill.* (See page 598.)

P. B. M. 4.—Is center of upper surface of copper bolt set in stone post 1·08 metres long, upper surface of stone 0·05 metre above surface of ground. From P. B. M. 4 to whitewood (?) tree, 1·3 metres diameter, distance 10·5 metres, azimuth 150°; sycamore tree 0·8 metre diameter, distance 14 metres,a zimuth 225°; poplar tree, 1·3 metres diameter, distance 22 metres, azimuth 352°; hard-wood tree, 0·8 metre diameter, distance 15 metres, azimuth 79°. All the above trees marked with a large blaze.

P. B. M. 5.—Is top of copper bolt set in top of stone post 1·08 metres long, set in ground with upper surface of stone 0·09 metre above surface of ground. From P. B. M. 5 to poplar tree, 1·8 metres diameter, distance 8·3 metres, azimuth 110°; hard-wood tree, 0·4 metre diameter, distance 11.2 metres, azimuth 190°; poplar tree, 1·3 metres diameter, distance 19 metres, azimuth 320°. All of the above trees marked with a large blaze.

P. B. M. 6.—Is top of copper bolt set in stone post 0·96 metre long, set in northeast corner of cleared field belonging to Joseph Dupoiste, at *Fort Jefferson*, *Ky.* Top of post is 0·10 metre below surface of ground. The stone is marked with the letters U. S.

P. B. M. 7.—*Columbus*, *Ky.* (See page 715.)

P. B. M. 8.—*Columbus*, *Ky.* (See page 715.)

P. B. M. 9.—*Columbus*, *Ky.* (See page 715.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN GRAFTON AND CAIRO, ILL.

P. B. M. 1.—Is copper bolt in top of stone in ground in woods on Calhoun Point, at mouth of Illinois River, near *Grafton, Ill.* It is 60 metres from edge of woods on Illinois River and 150 metres from edge of woods on Mississippi River.

P. B. M. 2.—Is top of copper bolt in top of stone in ground in woods at mouth of Illinois River on left bank, 157 metres back from river, 4 metres east of fence, 15 metres south of road, 2 100 metres above Catholic church in *Grafton, Ill.*, and within triangle formed by three pecan trees.

P. B. M. 3.—Is copper bolt in top surface of doorstep of Catholic church, *Grafton, Ill.* It is 22 centimetres from front of step and 13 centimetres from north jamb.

P. B. M. 4.—Is copper bolt in east end of door step of eastern door in Allen's brick building, adjoining Grafton Flouring Mills, *Grafton, Ill.* It is 104 millimetres from front surface of step.

P. B. M. 5.—Is a copper bolt leaded in the natural rock on side of bluff above high-water mark. It is 450 metres below flour mill at *Jersey Landing, Ill.*, and about 4 miles below Grafton, Ill. The letters U. S. P. B. M. are cut in the rock near the copper bolt.

P. B. M. 6.—Is copper bolt leaded vertically in the natural flat rock; top of rock flush with surface of ground. It is 5 600 metres below flour mill at *Jersey Landing, Ill.* It lies near high-water mark and about 9 metres west of the mouth of small ravine which comes out of valley facing Eagles Nest.

P. B. M. 7.—Is copper bolt in natural rock on hillside, in woods 19 metres above high-water mark and 3 150 metres below mouth of *Piasa Creek.* The letters U. S. P. B. M. are cut near bolt.

P. B. M. 8.—Is copper bolt leaded vertically in east end of water table on the south side of the Alton waterworks building, in sixth window from corner, *Alton, Ill.* The letters U. S. cut near the bolt.

P. B. M. 9.—Is copper bolt leaded vertically in south end of doorstep, in north-west corner of German Catholic Church in *Alton, Ill.*

P. B. M. 10.—Is top of copper bolt in stone post in ground in woods on land of ——— Gringering, about 300 metres east of his house and 5 miles below *Alton, Ill.* It is about 500 metres from river bank.

P. B. M. 11.—Is top of copper bolt in stone in ground in woods 450 metres back from triangulation station Gillen, 2 metres north of honey locust tree, about 10 metres north of road, and about 11 miles below *Alton, Ill.* There is a road leading back from river past this bench mark.

P. B. M. 12.—Is top of copper bolt in stone in ground in corner of grove 20 metres west of Columbia road, 12·8 miles above steel railroad bridge at *St. Louis, Mo.* It is on land of ——— Chambers, about opposite lower end of Wilsons Island No. 5.

P. B. M. 13.—Is top of copper bolt in top of stone in ground in small grove on east side of Baden and St. Louis street-car track, 6·4 miles above the railroad bridge at *St. Louis, Mo.* It is 110 metres south of northern terminus of Baden street-car track and 37 metres east of same.

P. B. M. 14.—Is small hole in center of copper bolt leaded horizontally in third course of stones on north side of western engine room of St. Louis waterworks, *St. Louis, Mo.* It is 147 centimetres west of west coping to main entrance to building. The letters U. S. P. B. M. are cut near the bolt.

P. B. M. 15.—Is small hole in copper bolt leaded horizontally in the west pier of arch No. 4, on east side of pier of St. Louis steel bridge, at *St. Louis, Mo.* It is 6·14 metres south of north end of pier and 14 centimetres above top course of granite. The letters U. S. are cut in the granite below the bench mark.

P. B. M. 16.—Is top of copper bolt leaded vertically in east end of doorstep of second door from northeast corner of brick saloon adjoining St. Louis Park, at junction of Jefferson avenue and Carondelet road, *St. Louis, Mo.* Bench mark is 29·5 centimetres from front face and 10 centimetres west of buttress adjoining doorstep.

P. B. M. 17.—Is top of copper bolt leaded vertically in north end of north doorstep of E. Mueller's store, north of northeast corner of Main and Franklin streets, *Carondelet, Mo.*

P. B. M. 18.—Is center of copper bolt leaded horizontally in water table in northeast corner of guardhouse at *Jefferson Barracks, Mo.*

P. B. M. 19.—Is center of copper bolt leaded horizontally in east face of stone in fourth course from top in east end of culvert at *Cliff Cave, Mo.*, on Iron Mountain Railroad.

P. B. M. 20.—Is top of copper bolt leaded vertically in upper surface of third stone from top in southwest retaining wall of arched culvert over *White House Creek*, on Iron Mountain Railroad.

P. B. M. 21.—Is top of copper bolt leaded vertically in top stone directly over keystone of arch on north side of arched culvert, 650 metres below *Jefferson* station, *Mo.*, on Iron Mountain Railroad. The letters U. S. P. B. M. are cut near the bolt.

P. B. M. 22.—Is top of copper bolt leaded vertically in southern abutment to southern approach to railroad bridge on Iron Mountain Railroad at *Kimmswick, Mo.*

P. B. M. 23.—Is center of copper bolt leaded horizontally in east face of stone in northeast corner of southern pier of railroad bridge, 400 metres below station house at *Sulphur Springs, Mo.*

P. B. M. 24.—Is center of copper bolt leaded horizontally in natural rock in overhanging bluff 1 000 metres below station house at *Illinois* station, *Mo.* This is the first bluff that is seen from water's edge, standing opposite point where Iron Mountain Railroad leaves Mississippi River.

P. B. M. 25.—Is top of copper bolt leaded vertically in Cornice Rock, about 2 metres from river edge of rock and about 160 metres south of foot of Cornice Island, and 1 000 metres south of mouth of *Platin Rock Creek, Jefferson County, Mo.*

P. B. M. 26.—Is top of copper bolt leaded vertically in top of Robbers Rock, on north side, and 1 736 metres above *Rush Tower, Mo.* Robbers Rock is large sandstone on beach and is plainly visible for three-fourths of a mile up or down the river.

P. B. M. 27.—Is center of copper bolt leaded horizontally in limestone wall (natural rock) at *Rush Tower, Mo.*, and 11 metres from post office building.

P. B. M. 28.—Is top of copper bolt leaded vertically in large limestone bowlder on beach, 1 000 metres above *Brickey's Mill, Cliff* post office, *Ste. Genevieve County, Mo.* This beach is a little lower than extreme high-water mark.

P. B. M. 29.—Is center of copper bolt leaded horizontally in limestone wall (natural rock) at end of bluff, about 4 metres north of a red oak tree, about 30 metres north of

—— Maple's farmhouse, and 3 miles below *Cliff* post office, *Ste. Genevieve County, Mo.* This bench mark is about 1 foot above surface of ground at base of bluff, and is about 8 metres above high-water mark.

P. B. M. 30.—Is center of copper bolt leaded horizontally in natural rock 1 580 metres above *White Sand Depot Landing, Ste. Genevieve County, Mo.* It is about 250 metres north of southern end of bluff. The letters U. S. P. B. M. are cut near the bolt.

P. B. M. 31.—Is center of copper bolt leaded horizontally in natural rock wall 14 metres north of a spring at *Limestone Point, Ste. Genevieve County, Mo.*, and is about 2½ miles above Ste. Genevieve, Mo. The letters U. S. P. B. M. are cut around the bolt.

P. B. M. 32.—Is top of copper bolt leaded vertically in west end of doorstep on south side of Rozier's warehouse, southwest corner Main and Washington streets, *Ste. Genevieve, Mo.*

P. B. M. 33.—Is center of copper bolt leaded horizontally in south side at south-east corner of public school building in *Ste. Genevieve, Mo.*, 4 inches from corner in fifth course of stones below the bricks. The letters U. S. P. B. M. are cut near the bolt.

P. B. M. 34.—Is center of copper bolt leaded horizontally in east face of large corner stone of engine house of Quarrytown Grindstone Works, at *Quarrytown, Mo.*, 3 miles below Ste. Genevieve, Mo. The letters U. S. P. B. M. are cut near the bolt.

P. B. M. 35.—Is center of copper bolt leaded horizontally in west end of water table in southwest corner of storehouse belonging to E. S. Lanbaugh, on northeast corner of Second and Walnut streets, *Ste. Mary's, Mo.* The bolt is countersunk about 5 millimetres in the stone. The letters U. S. P. B. M. are cut near the bolt.

P. B. M. 36.—Is center of copper bolt leaded horizontally in southwest corner of Martin Roundstone's ice house, on east side of Walnut street, *Ste. Marys, Mo.* The letters U. S. P. B. M. are cut near the bolt. The bolt is in fifth course of stone from bottom.

P. B. M. 37.—Is top of copper bolt leaded vertically in stone post set in ground in woods about 4 miles below *Ste. Marys, Ste. Genevieve County, Mo.* It is 990 metres back from river and 24 metres west of lane running south from river road. Lane turns off from river road in vicinity of John Lawrence's house. This bench mark is S. 40° W. from farm house, 7 metres N. 75° W. from ash tree, and 4½ metres N. 52° E. from box elder tree.

P. B. M. 38.—Is horizontal copper bolt in water table of drug store, northeast corner of Schuchert's Block, *Chester, Ill.*

P. B. M. 39.—Is horizontal copper bolt in front face of Cole Brothers' stone elevator, 1·32 metres east of southwest corner and the same distance above the ground, 1 240 metres below *Chester, Ill.*

P. B. M. 40.—Is top of copper bolt in stone monument set in southeast corner of woods 576 metres back from a long lane just west of large wheat field from turn of road, 40 metres north of farmhouse of Marcus Peto. It is 2 metres south of elm tree 4 feet in diameter, 12 metres west from hackberry tree 18 inches in diameter, and 200 metres northwest of house not occupied.

P. B. M. 41.—Is top of copper bolt in stone in ground 50 metres south of end of lane, 1 metre from fence, 1 420 metres back from river at *Bois Brule* post office, *Perry County, Mo.*

P. B. M. 42.—Is center of copper bolt set horizontally in vertical face of natural rock at upper extremity of bluff 643 metres below *Grand Eddy* post office, *Perry County, Mo.* It is about 3½ metres below upper end of United States water gauge and 14 metres below extreme upper point of bluff rocks. The letters U. S. P. B. M. are cut in the rock near the bolt.

P. B. M. 43.—Is center of copper bolt leaded horizontally in a large rock in the woods about 4 miles below *Grand Eddy*, *Perry County*, *Mo.* It is 740 metres below a house, 175 metres back from the river, and 30 metres back from edge of timber, and at the upper end of a stretch of prairie land which extends down to 76 landing.

P. B. M. 44.—Is top of copper bolt leaded vertically in a large bowlder, 10 feet by 10 feet by 6 feet, 6 metres from edge of bank, 17 metres above second gate above farm-houses of Napoleon Gill, 100 metres above barn on Cape Cinque Hommes, Perry County, Mo., and 3¾ miles above *Wittenberg*, *Mo.*

P. B. M. 45.—Is center of copper bolt leaded horizontally in stone foundation wall of Wittenberg Flouring Mill, at *Wittenberg*, *Mo.*, on side facing the river between the ground-floor door and down-river corner of mill.

P. B. M. 46.—Is center of copper bolt leaded horizontally in east face of rock, 2 metres east of road, 400 metres below *Wittenberg*, *Mo.* It is situated between the houses of Denny and Tucker, 23 metres from the former and 31 metres above the latter's house. It is 11 metres below Denny's shop and 29 metres above Tucker's barn.

P. B. M. 47.—Is top of copper bolt leaded vertically in the point of rocks 95 metres below "Tower Rock," Perry County, Mo., and opposite the upper end of *Grand Tower*, *Ill.* It is 15 metres east of an iron bolt leaded vertically in the rock and marked U. S. 53. The letters U. S. P. B. M. are cut near the copper bolt.

P. B. M. 48.—Is center of copper bolt leaded horizontally in face of rock at *Birmingham Point*, *Perry County*, *Mo.* It is 813 metres above the mouth of Apple Creek, and 28⅝ metres above a scrubby, gnarled sycamore tree growing in the rocks. The rocks here are conglomerate in horizontal strata, and from the river present the appearance of a stairway. The letters U. S. P. B. M. are cut near the bolt in the rock. It is about 30 metres above a living spring, which comes out of the gravel just below the strata of rock.

P. B. M. 49.—Is top of copper bolt leaded vertically in the bluff rock 3 655 metres below mouth of *Apple Creek*, *Cape Girardeau County*, *Mo.* In front of this bench mark are three very large rocks standing out from the bluff and partly detached therefrom.

P. B. M. 50.—Is center of copper bolt leaded horizontally in natural rock in river bluff 712 metres below rock called "The *Devil's Tea Table*," in *Cape Girardeau County*, *Mo.*

P. B. M. 51.—Is center of copper bolt leaded in the steeply inclined face of the last reliable ledge of rocks of the chain extending south from *Moccasin Springs*, *Mo.*, and at the point where the bluffs begin to recede from the river 2 500 metres above Bainbridge Creek. The letters U. S. are cut in the rock.

P. B. M. 52.—Is a horizontal copper bolt set in vertical face of ledge of rocks 35 centimetres thick. The bolt is 1·2 metres above the ground, is 775 metres below Henry Shineman's house and 565 metres above the foot of the bluffs. These bluffs are 4 miles above north end of *Cape Rock*, *Cape Girardeau County*, *Mo.*, ¾ mile from river, and on land of Elisha Sheppard's heirs.

P. B. M. 53.—Is center of horizontal copper bolt, set in vertical face of ledge, just below a ravine at the lower end of *Cape Rock*. Its elevation is about high water.

P. B. M. 54.—Is a horizontal copper bolt in the outer vertical face of stone step, which extends under buttress at the northeast corner, second entrance from the north, to Marble City Hotel, on Water street, *Cape Girardeau, Mo.*

P. B. M. 55.—Is horizontal copper bolt in vertical face of good homogeneous hard rock, just below and near the southeast corner of St. Vincent's College, about 45 metres west of river, in south part of *Cape Girardeau, Mo.*

P. B. M. 56.—Is horizontal brass key, in vertical face of solid rock of fairly hard homogeneous sandstone, or granite, very white when cut. Ledge forms bank of river, and is at lower end of *Cape Girardeau*, in front of St. Vincent's College. It is about 35 metres east of railroad track.

P. B. M. 57.—Is center of horizontal copper bolt, set in smooth vertical face, in ledge of blue or gray limestone, at its upper or western extremity, on the land of the Taylor estate. It is 0·8 metre above the ground, 1 metre below top of vertical part, and 10 metres below where the ledge disappears under the ground. It is S. 70° E., 75 metres from mouth of Le Croix Creek, and 1 574 metres above lower U. S. water-gauge at *Gray's Point, Mo.*, being just in view of the lower part of Cape Girardeau, Mo. The letters U. S. P. B. M. are cut in the face of the rock.

P. B. M. 58.—Is center mark on horizontal copper bolt leaded in the vertical face, looking toward the river, of the center one of three large rocks, the lowest and largest of which forms the bank of the river, and is known as "Counterfeit Rock," or "Standing Rock of the Grand Chain." It is 10 metres from the top of the river bank, 80 metres above the line between Matthew Roe and H. S. Wray, 600 metres above Wrays Landing, on the land of said Matthew Roe, situated about 3 miles above *Commerce, Mo.* It is about 0·8 metre above the ground. The letters U. S. P. B. M. are cut in the rock.

P. B. M. 59.—Is the center of a horizontal copper bolt leaded in the steeply inclined face, looking toward the river, of a large silicious rock mostly covered with earth, being one of a group of many in a ravine 1 190 metres above U. S. P. B. M. 60, in *Commerce.* It is 0·6 metre above the ground, and about 60 metres back from the river, the ground rising in this distance 15 metres. It is in a shallow, rocky ravine, at upper side of the first strip of cultivated land, near the river, south of the bluffs, on land of Mrs. C. Halfner. The letters U. S. P. B. M. are cut in the rock.

P. B. M. 60.—Is point in center of horizontal copper bolt leaded in vertical face of ledge, looking toward the river 0·55 metre above the ground and 3·37 metres above the high water of 1858. The top surface of this rock or ledge, which extends across the street, forms the road bed. It is just in front of a point about 30 metres above Wm. Anderson's large brick house, on elevated site, at the north or upper end of *Commerce, Mo.* There are a large number of large pieces of rock lying on the bank here that have from time to time rolled down from the same general ledge, but the one selected is so large and extends back in the bank so far that it is reliable.

P. B. M. 61.—Is center of horizontal copper bolt set in front or east face of foundation of Wm. Anderson's large brick dwelling house, at the upper end of *Commerce, Mo.* It is 2 metres north of center of front entrance and 36 centimetres above the ground.

P. B. M. 62.—Is mark in center of horizontal copper bolt set in the vertical face of the northwest abutment of stone culvert under road over Muddy Creek, 1 metre above the ground, 75 metres from the top of the river bank and 1 960 metres above Santa Fé Store, which latter is opposite *Commerce, Mo.*, in the State of Illinois. This foundation or masonry rests on the natural rock. The letters U. S. P. B. M. are cut in the rock near the bolt.

P. B. M. 63.—Is 185 metres right up the same creek (Muddy Creek) in the left-hand ravine going up from the culvert in which is U. S. P. B. M. 62. It is center of copper bolt set in vertical face of a very large rock on part of the ledge just on the right of the creek going up, 1·5 metres above the ground, 1·5 metres below the top of the rock, and 2 metres from the projecting end.

P. B. M. 64.—Is top of copper bolt in top of stone in ground 1 260 metres back from river, 1 metre north of fence on north side of road leading east from *Goose Island* post office, or Athertons Landing, about 19 miles above Cairo, Ill.

P. B. M. 65.—Is top of copper bolt in top of stone in ground in woods about 1 500 metres back from river, and 8½ miles above *Cairo* post office, *Alexander County, Ill.* It is 26 metres from graded road (otherwise known as levee), and 93 metres from a school-house for negroes, and 2¼ miles below Spies's mills.

P. B. M. 66.—Is top of copper bolt in stone post in open woods. It is 61 metres east of a point on the Illinois Central Railroad, which point on the railroad is 391 metres north of the 3-mile post from *Cairo, Ill.*

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN KEOKUK, IOWA, AND GRAFTON, ILL.

P. B. M. 1.—Is top of copper bolt leaded vertically into coping of shore side of lower lock of Des Moines Rapids Canal, *Keokuk, Iowa.* Bench is in recess between stone steps and stone pier of lower hydraulic tower, on south side of pier.

P. B. M. 2.—Is copper bolt leaded horizontally in south face of Iowa shore pier of railroad bridge, *Keokuk, Iowa*, 8 inches above bench of pier, in the tenth stone from west end.

P. B. M. 3.—Is copper bolt leaded horizontally in southwest corner of 3-story stone building, owned by Mr. Patterson, facing on Water street, second door from corner of Johnson street, *Keokuk, Iowa*, 8 inches above west doorsill, on inner side of outer wall, 50 feet from corner of Water and Johnson streets.

P. B. M. 4.—Is small conical hole in rock at intersection of cross cut in upper surface of top stone of buttress of *Des Moines River bridge.*

P. B. M. 5.—Is copper bolt leaded horizontally into north wall of brick building, 1½ feet from northeast corner and 3 feet from ground. Building is in upper end of *Alexandria, Mo.*, facing river and 60 feet from bank. The north wall faces slough emptying into river and 50 metres from it. Building owned by Charles Bocker; post office located in building.

P. B. M. 6.—Is copper bolt leaded horizontally in upper corner of stone masonry on front side of northeast corner of Baptist Church at *Gregorys Landing, Mo.* Church is 150 metres north from junction of railroad and wagon road.

P. B. M. 7.—Is copper bolt leaded vertically in marking stone set at root of oak tree, 24 metres west of railroad. Stone is 1·7 metres west of tree in northeast corner of field, 10 metres south of small ravine, 650 metres below bridge No. 14. Tree is 12 inches in diameter.

P. B. M. 8.—Is copper bolt leaded horizontally in north wall of Down's Hotel, *Canton, Mo.* Bolt is in fifth stone from ground, fourth stone from corner of wall made by office-door entrance and in second stone from first window west of office entrance. Hotel is on southwest corner of Lewis and Fifth streets.

P. B. M. 9.—Is copper bolt leaded horizontally in east side of back foundation of German Methodist Episcopal Church, corner of Sixth and Washington streets, *Canton, Mo.* Bolt is in third stone from ground and in second from north corner and directly under window facing east.

P. B. M. 10.—Is copper bolt leaded vertically in top surface of southeast corner of south abutment of railroad bridge No. 35, over Wyaconda Creek. Bolt is 2 feet from south face, 4 feet from east face of abutment, and about 1 mile above *La Grange, Mo.*

P. B. M. 11.—Is copper bolt leaded horizontally in northeast corner stone of Queensberry & Schneider's tobacco works, situated on southwest corner of Washington street and St. L., K. & N. W. R. R., at *La Grange, Mo.* Bolt is in east face, 15 inches from corner of stone and 2 feet from ground.

P. B. M. 12.—Is center of copper bolt leaded horizontally in third course of masonry from bottom and ninth from top of west abutment of Quincy Railroad bridge, *West Quincy, Mo.* Bolt is in north face, 2 inches from east corner.

P. B. M. 13.—Is copper bolt leaded vertically in top surface of top stone of northeast corner of north pier forming south face of north abutment of covered railroad bridge over the *Fabius River.* Bolt is near the center of stone 5 feet below and 8 feet east of rail.

P. B. M. 14.—Is top of copper bolt leaded vertically in top surface of stone, forming west end of north pier to railroad bridge over *North River.* Bolt is 8 inches from north edge of stone, 2 feet from west edge, and 14 inches from base of strut.

P. B. M. 15.—Is copper bolt leaded vertically in stone post set in northeast corner of cultivated field, 5 metres from wagon road, 15 metres west of railroad, 20 metres from north one of two elm trees standing alone in wagon road, fence forming line between woods and cultivated ground, 466 metres north of *Hilton* station.

P. B. M. 16.—Is copper bolt leaded horizontally in face of natural rock at east entrance of tunnel at Missouri end of railroad bridge at *Hannibal, Mo.* Bolt is in rock facing east and on south side of tunnel, 7 feet south of entrance and about 4 feet above road level.

P. B. M. 17.—Is copper bolt leaded vertically in top surface of east stone of north abutment of small railroad bridge 1 mile below *Hannibal, Mo.*, and 50 metres northeast of house of Mr. Johnson.

P. B. M. 18.—Is copper bolt leaded vertically in top of top course of masonry at river side of north end of principal abutment of railroad bridge across Lick Creek, 800 metres below depot at *Saverton, Mo.*

P. B. M. 19.—Is marking stone planted in corner of yard of Catharine Hayes, 6 miles south of Saverton, 1½ miles above *Ashburn.* Stone is 8 metres southwest of southwest corner of house and 25 metres from river bank, a little below dam at Gilberts Island.

P. B. M. 20.—Is copper bolt set vertically in top of marking stone set on line of rail fence 8 metres east of large maple tree on east bank of small creek bed, 3 metres north of bridge over creek. Stone is 7 metres south of wagon road, 17 metres west of railroad, 23 metres south of south corner of house of Mr. Warner, and one-fourth mile north of *Ashburn, Mo.*

P. B. M. 21.—Is marking stone planted in east edge of cultivated field about 77 metres from south bank of *Salt River*, at place where St. L., K. & N. W. R. R. crosses the river. Stone is set about 15 metres to the west of track, nearly opposite the south end of the trestle on south end of bridge.

P. B. M. 22.—Is copper bolt leaded vertically in marking stone in southwest fence corner of fence running east and west and one south. South fence stops at corner and begins again 10 metres farther east, on east and west fence. Stone is 20 metres west of railroad and 50 metres above mouth of *Salt River*.

P. B. M. 23.—Is copper bolt leaded horizontally in first layer of stone below brick in northeast face of brick saloon on the northwest corner of Water and Main streets, *Louisiana, Mo.* Bolt is in second stone north of door in same wall of building.

P. B. M. 24.—Is copper bolt set vertically in top surface of top stone forming the northeast corner of the west abutment of railroad bridge over Mississippi River at *Louisiana, Mo.* Top of bolt is even with the surface of the stone.

P. B. M. 25.—Is center of hole in copper bolt in side of natural rock 7 metres south of railroad, 9 metres north of oak tree 14 inches in diameter, on bank above, 500 metres below railroad bridge across gully, and 6 000 metres below railroad bridge across Mississippi River at *Louisiana, Mo.* Five notches cut in tree.

P. B. M. 26.—Is copper bolt leaded vertically in top of marking stone set at intersection of two fences on south side of lane and west of railroad. Lane is 5 metres wide. The north fence stops before it reaches as far east as the south fence. A small creek is 3 metres north of the north fence. A row of apple trees is just inside the north fence. Stone is 5½ metres west of railroad and 15 metres west of river; about 60 metres east of old log house of Peter Yaeger, and about 3 miles above *Clarksville, Mo.*

P. B. M. 27.—Is center of horizontal copper bolt leaded in the natural rock in side of small bluff bank 3½ metres east of railroad track, below wagon road, 12 metres from river bank, 440 metres above vinegar works at *Clarksville, Mo.*, and 120 metres below mouth of Calumet Creek. It is between railroad and house of Philip Bedair.

P. B. M. 28.—Is copper bolt leaded horizontally in the southeast corner stone of Carroll House, *Clarksville, Mo.* Stone is at the head of stairs leading to basement. Bolt is set in south face of stone about 10 inches above the sidewalk.

P. B. M. 29.—Is top of copper bolt leaded vertically in top surface of marking stone set in the ground 5 metres east of the Sny Levee, opposite *Clarksville, Mo.*, about 50 metres east of ferry landing in Calhoun County, Ill. Stone is 220 metres along the levee below where levee crosses chute.

P. B. M. 30.—Is copper bolt leaded vertically in top surface of marking stone set in the ground on east side of Sny Levee at intersection of plantation road, on south of road, which crosses levee and continues to the river. Levee is 50 metres east of river. A large elm stump 6 feet in diameter and 10 feet tall stands in the road 20 metres west of levee. Stone is opposite Island No. 463, about one-third its length above the lower end, and about 3½ miles below P. B. M. 29, opposite *Clarksville.*

P. B. M. 31.—Is copper bolt leaded vertically in top of marking stone set on east side of levee at its base, 4 metres east of the middle of levee, in fence corner inclosing field with woods on north side and levee on west side. It is about 100 metres east of river and 175 metres northwest of house occupied by Mr. Gain and owned by Messrs. Rock and Baker.

P. B. M. 32.—Is conical hole in top surface of rock projecting from side of wagon road, about halfway up steep hill on north bank of small stream, 10 metres north of middle of stone culvert. Rock is at root of two poplar trees growing about 1 foot apart. Bench is at intersection of cross, 6 inches from west edge and 10 inches from south edge of rock, and about 50 metres east of east shore of *Hamburg Bay*.

P. B. M. 33.—Is top of copper bolt leaded vertically in top surface of natural rock projecting from east side of wagon road about 240 metres south of house of Mr. Blacksmith, and about 4 miles north of *Hamburg*, *Ill.* The bolt is 18 inches from corner, and 10 inches from the two sides of the stone, only one corner of which projects.

P. B. M. 34.—Is copper bolt leaded horizontally in the north face of natural rock forming south side of the first creek south of *Hamburg*, *Calhoun County*, *Ill.* Bench is about 120 metres east on road from where the road makes a sharp bend from south to east. There are a mill and two houses at the turn of the road. Bench is about 5 metres north of fence around orchard. Bolt is about 1 foot below the top surface of rock, and about 4½ feet above creek bottom, which is of stone. Rock is in layers, the bolt being in top layer.

P. B. M. 35.—Is point 1½ inches from south corner and one-half inch from east side of shore line triangulation stone set by Assistant Engineer John Eisenmann. Stone is 38 metres east of river bank, about 250 metres below Island No. 482, and 3½ metres northwest of large elm tree marked with two triangles opposite midway between two houses on *Westport Island*.

P. B. M. 36.—Is top of copper bolt leaded in the top of marking stone set about 8 metres from the river bank, on the Illinois shore, a short distance south of a point opposite the head of Islands Nos. 487, 486, and 485, and about 1 190 metres above warehouses at *Reds Landing*, *Calhoun County*, *Ill.* It is one-half metre south of lower fence of two on land of Ira Lawson, about opposite the head of the aforesaid islands, and about 50 metres north of the boundary line between the land of the above-named Ira Lawson and the land of John M. Lewis.

P. B. M. 37.—Is cross about in the middle of triangulation stone set by Assistant Engineer John Eisenmann at the root of a large poplar tree about 10 metres from small house and 5 metres from fence surrounding house. The house is opposite the foot of *Sterling Island*.

P. B. M. 38.—Is top of marking stone set by Assistant Engineer John Eisenmann 1½ metres west of foot of sycamore tree blazed and marked with a triangle. Stone is 50 metres east of river bank and 27 metres east of road running to Hogville. It is about 800 metres south from Church's Landing, and about 400 metres north from warehouses at *Hogville Landing*, *Calhoun County*, *Ill.*

P. B. M. 39.—Is top of copper bolt leaded vertically in top of marking-stone set in the ground one-half metre inside the fence on the west side of the field of J. H. Eildemann, about 100 metres north from upper landing warehouse at *Turners Landing*, *Calhoun County*, *Ill.*

P. B. M. 40.—Is top of triangulation shore line marking stone set by Assistant Engineer John Eisenmann about 90 metres back from Illinois bank of Mississippi River, about 600 metres south of foot of island No. 197, and about 2 900 metres south from the lower *Turners Landing* warehouse.

P. B. M. 41.—Is center of copper bolt leaded horizontally in solid sand rock above and back of the road, 74 metres east and below top of a hill at point of bluff at *West Point, Calhoun County, Ill.*, facing the north. It is about 1 metre above level of road, and is about 150 metres around the point from the warehouse at West Point.

P. B. M. 42.—Is center of copper bolt leaded horizontally in the north face of large bowlder, embedded partly in the ground about 40 metres around east from northwest corner of the bluff rocks below *Hastings Landing, Calhoun County, Ill.*, about 225 metres below warehouse on the land of E. B. Brown. It is third large bowlder at foot of hill on the north side of corner west from the top of bank of small branch that empties into the river below the warehouse, and is about 8 metres east from fence that leads about southwest from the east side of warehouse at landing.

P. B. M. 43.—Is center of copper bolt leaded horizontally in the west face of bluff rock about 2½ metres underneath where the upper surface of rocks commence to be exposed at the foot of the hill, about 20 metres around north on west side of hill from southwest projecting corner of the bluffs on the north side of the valley, second one north of *Martins Landing, Calhoun County, Ill.*, and first one south of valley where John Zarley lives.

P. B. M. 44.—Is center of horizontal copper bolt set in solid bluff rock facing northwest about 900 metres south of Martins Landing, and about 1 300 metres north of *Millers Landing, Calhoun County, Ill.* It is about 500 metres below a dwelling house. The bolt is in the upper stratum of exposed rock.

P. B. M. 45.—Is center of horizontal copper bolt leaded in solid bluff rock at *Thomas Landing, Calhoun County, Ill.* The bolt is between the east end of the coke furnace and the river, and about 40 metres above the trestlework of the coal mine.

P. B. M. 46.—Is center of copper bolt leaded horizontally in the west end of solid rock at the southern edge of cultivated field, 20 metres from water's edge at high water, 335 metres west of Frank Herchmeyer's dwelling house, and 1 mile below *Dixons Landing, Calhoun County, Ill.*

P. B. M. 47.—Is center of copper bolt leaded horizontally in solid bluff rock about 12 metres above water's edge, at high water, 350 metres north of *Point Landing*, 25 metres north of small stone ice house belonging to Joseph Navar, about 5 metres below top of bluff rock, and about 250 metres northeast of Joseph Navar's dwelling house, in *Calhoun County, Ill.*

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN KEOKUK, IOWA, AND FULTON, ILL.

P. B. M. 1.—Is top of copper bolt leaded vertically in coping of west wall of sluiceway at south end of middle canal lock, 2 miles above *Keokuk, Iowa.*

P. B. M. 2.—Is top of brass bolt leaded vertically in top of coping of west wall near southwest tower of guard lock at *Nashville, Iowa.* Marked U. S. P. B. M.

P. B. M. 3.—Is at *Montrose, Iowa.* It is center of hole in copper bolt leaded horizontally in upper foundation stone of brick store building on south corner of Main and Cedar streets. It is on the east side, 3 feet from north corner. Marked U. S. P. B. M.

P. B. M. 4.—Is top of copper bolt leaded vertically in top of west end of south abutment of Chicago, Burlington and Quincy Railroad bridge over Painter Creek, 1 mile south of *Viele* station, *Iowa.* Marked U. S. P. B. M.

P. B. M. 5.—Is top of copper bolt leaded vertically in northeast cornerstone of middle pier of Chicago, Burlington and Quincy Railroad bridge over Little Devils Creek, one-half mile south of *Viele* station, *Iowa*. Marked U. S. P. B. M.

P. B. M. 6.—Is top of copper bolt leaded vertically in top of stone abutment of Chicago, Burlington and Quincy Railroad bridge over Devils Creek, one-half mile north of *Viele* station, *Iowa*. Marked U. S. P. B. M.

P. B. M. 7.—Is at *Fort Madison*, *Iowa*. It is top of copper bolt leaded vertically in water table of the Central Hotel on Front street, near the depot. It is near the center of the building on the south side. Marked U. S. P. B. M.

P. B. M. 8.—Is at *Fort Madison*, *Iowa*. It is center of hole in copper bolt set horizontally in middle of west side of brick chimney of wooden-ware factory on northeast corner of Front and Broadway streets. Bolt is 3 feet above base of chimney. Building owned by W. H. Cretzinger. Marked U. S. P. B. M.

P. B. M. 9.—Is on brick house of James Gibbs. 4 miles above *Fort Madison*, *Iowa*. It is center of hole in copper bolt leaded horizontally in top foundation stone on south side, 3 feet from southeast corner. House stands about 150 metres west of Chicago, Burlington and Quincy Railroad track. Marked U. S. P. B. M.

P. B. M. 10.—Is on east abutment of Chicago, Burlington and Quincy Railroad bridge over Skunk River, 9 miles north of *Fort Madison*, *Iowa*. It is top of copper bolt leaded vertically in north end of abutment. Marked U. S. P. B. M.

P. B. M. 11.—Is on stone building known as Patterson's grocery, 3½ miles south of *Burlington*, *Iowa*, on south side of Chicago, Burlington and Quincy Railroad. It is center of hole in copper bolt set horizontally on north side, near northeast corner, 2½ feet from the ground. Marked U. S. P. B. M.

P. B. M. 12.—Is 2¼ miles south of west end of Burlington Railroad bridge, in natural rock, on line of Chicago, Burlington and Quincy Railroad. It is 700 metres south of trestle near sawmill, south of *Burlington*, *Iowa*, is 4 metres from center of track and one-half metre above track. It is center of hole in copper bolt leaded horizontally in base of limestone bluff near end of cut. Marked U. S. P. B. M.

P. B. M. 13.—Is on north end of west abutment of the Chicago, Burlington and Quincy Railroad bridge over Mississippi River at *Burlington*, *Iowa*. It is top of copper bolt leaded vertically in abutment. Marked U. S. P. B. M.

P. B. M. 14.—Is on north end of east abutment of same bridge. It is top of copper bolt leaded vertically in abutment. Marked U. S. P. B. M. Mackenzie B. M. 49 is on the same abutment, and is 6 millimetres above P. B. M. 14.

P. B. M. 15.—Is on east abutment of Chicago, Burlington and Quincy Railroad bridge over Prairie Slough, about 2 miles above the east end of bridge across the Mississippi River at *Burlington*. It is top of copper bolt leaded vertically in north end of abutment. Marked U. S. P. B. M.

P. B. M. 16.—Is on north end of west abutment of trestle No. 59, about 4½ miles north of the east end of *Burlington* bridge on the line of the Chicago, Burlington and Quincy Railroad. It is top of copper bolt leaded vertically in abutment. Marked U. S. P. B. M.

P. B. M. 17.—Is on Robert Moir's brick store building at *Oquawka*, *Ill.* It is center of hole in copper bolt leaded horizontally in stone pillar at southwest corner, about 2 feet above the water table. The building stands on the northwest corner of Schuyler and Second streets, and is also used for the Journal office. Marked U. S. P. B. M. Mackenzie B. M. 48 is on step of same building.

P. B. M. 18.—Is on brick building on southeast corner of Third and Schuyler streets, at *Oquawka, Ill.* It is center of hole in copper bolt set horizontally on west side of northwest corner, 2½ feet above the ground. Marked U. S. P. B. M.

P. B. M. 19.—Is on brick building on the northwest corner of Main and Second streets, *Keithsburg, Ill.* It is top of copper bolt leaded vertically in stone step on the south side of the building, and marked U. S. P. B. M. The building is owned by Mr. Parsons and used for a furniture store.

P. B. M. 20.—Is on step of Mr. Rife's brick dwelling on the northwest corner of Main and Fifth streets, *Keithsburg, Ill.* It is top of copper bolt leaded vertically in the southwest corner of upper stone step on south side of house, and is not marked.

P. B. M. 21.—Is on foundation of water tank 2 miles east of *New Boston, Ill.*, on line of Chicago, Burlington and Quincy Railroad. It is center of hole in copper bolt set horizontally on west side of tank, under a strut, below top of foundation. It is 150 metres east of covered railroad bridge over Edwards River. Marked U. S. P. B. M.

P. B. M. 22.—Is on foundation of Keokuk Northern Line Packet Company's warehouse at *New Boston, Ill.* It is center of hole in copper bolt set horizontally in north wall near the northeast corner in top of stone foundation, 0·7 metre from ground Marked U. S. P. B. M.

P. B. M. 23.—Is on Union Hotel, *New Boston, Ill.* It is center of hole in copper bolt set horizontally in north wall, 0·4 metre from the northeast corner and 1·1 metres from ground. Marked U. S. P. B. M.

P. B. M. 24.—Is on top of southeast corner of stone foundation of tall chimney of old sawmill at *Port Louisa, Iowa.* Mill now torn down. This is the same bench mark as Mackenzie B. M. 45.

P. B. M. 25.—Is top of stone set in ground 22 metres south of gate leading to Esquire Walton's house, 7½ miles south of *Muscatine, Iowa.* Stone is at height of high water of 1851, is 8 metres north of wagon road, and 15 metres from edge of river bank. A block is set over the stone, three marking-stakes set 3 feet off, and three small black locust trees blazed near by. Stone is said to have been set by Major Allen several years ago. Top of stone is about 1 foot below the surface of the ground.

P. B. M. 26.—Is on brick foundation of Mr. E. Beatty's dwelling on right bank of river, about 7 miles below *Muscatine, Iowa.* It is center of hole in copper bolt set horizontally in east side of northeast corner of foundation. Marked U. S. P. B. M.

P. B. M. 27.—Is on brick chimney of Hershey's lower sawmill, *Muscatine, Iowa.* It is center of hole in copper bolt set horizontally on the middle of the east face of chimney, about 3 feet above ground. Marked U. S. P. B. M.

P. B. M. 28.—Is on waterworks chimney at *Muscatine, Iowa.* It is center of hole in copper bolt set horizontally in north face of chimney, about 1·1 metres from the ground. Marked U. S. P. B. M.

P. B. M. 29.—Is on north abutment of wagon bridge, 50 metres north of station at *Muscatine, Iowa.* It is top of copper bolt set vertically in northeast corner of abutment. Marked U. S. P. B. M.

P. B. M. 30.—Is on abutment of Chicago, Rock Island and Pacific Railroad bridge, 3 miles north of *Muscatine, Iowa.* It is top of copper bolt set vertically in top of stone coping of south end of west abutment. Marked U. S. P. B. M.

P. B. M. 31.—Is on abutment of Chicago, Rock Island and Pacific Railroad bridge over Sweetland Creek, about 5 miles north of *Muscatine, Iowa*. It is top of copper bolt leaded vertically in west end of north abutment. Marked U. S. P. B. M.

P. B. M. 32.—Is in natural rock on line of Chicago, Rock Island and Pacific Railroad about 6 miles above *Muscatine, Iowa*. It is center of hole in copper bolt set horizontally in face of rock, where it has been blasted off for railroad bed. It is 4 feet above the track, 20 feet north of center of track, and 740 metres west of bridge 77. Marked U. S. P. B. M.

P. B. M. 33.—Is on foundation of pottery owned by John Feasted, at *Fairport, Iowa*. It is center of hole in copper bolt set horizontally in west side, near southwest corner of stone foundation. This pottery is about 350 metres above railroad station and near the river bank. Marked U. S. P. B. M.

P. B. M. 34.—Is on middle pier of bridge over Pine Creek, about 2 miles north of *Montpelier, Iowa*, on the line of the Chicago, Rock Island and Pacific Railroad. It is top of brass bolt leaded vertically in north end of pier. Bridge is No. 60. Marked U. S. P. B. M.

P. B. M. 35.—Is on south pier of Chicago, Rock Island and Pacific Railroad bridge No. 52, 1 kilometre south of *Montpelier, Iowa*. It is top of brass bolt set vertically in west end of pier. Marked U. S. P. B. M.

P. B. M. 35*a*.—Is on west abutment of Chicago, Rock Island and Pacific Railroad bridge No. 45, about one-half mile east of the depot at *Montpelier, Iowa*. It is top of brass bolt leaded vertically in south end of abutment. Marked U. S. P. B. M.

P. B. M. 36.—Is on William Karge's brick store and post office building at *Buffalo, Iowa*. It is center of hole in brass bolt leaded horizontally in the east side, near southeast corner, 3 feet above the foundation. The building is on the northwest corner of Hecker and Second streets. It is unmarked.

P. B. M. 37.—Is on foundation of brick house of Eliza M. Dodge, one-half mile east of *Buffalo, Iowa*. It is center of hole in brass bolt set horizontally in upper foundation stone on west side, near southwest corner, about 1 metre from ground. House stands about 100 metres north of line of Chicago, Rock Island and Pacific Railroad. It is marked U. S. P. B. M.

P. B. M. 38.—Is on foundation of vinegar works at lower end of *West Davenport, Iowa*, near the river bank. It is center of brass bolt set horizontally in west side, near the southwest corner, about 0·4 metre from ground. Marked U. S. P. B. M.

P. B. M. 39.—Is on north abutment of Rock Island and *Davenport* Railroad bridge over the main channel of the Mississippi River. It is top of copper bolt leaded vertically in coping of east or upper side of abutment, on a plane with the sidewalk. It is 4·1 metres from river face of abutment and 0·1 metre inside of railing. Marked U. S. P. B. M.

P. B. M. 40.—Is on base of stone tower of United States arsenal stone building, A, 1865, at lower end of *Arsenal Island*. It is center of hole in copper bolt leaded horizontally in east side of northeast corner, about 4 feet from the ground. Marked U. S. P. B. M.

P. B. M. 41.—Is on foundation of the Atlantic Brewery, near Chicago, Rock Island and Pacific Railroad depot at *Rock Island, Ill*. It is center of hole in copper bolt set horizontally in upper foundation stone on the north side at the northeast corner. Marked U. S. P. B. M.

P. B. M. 42.—Is on south abutment of wagon bridge crossing from *Moline, Ill.*, to head of Rock Island. It is top of copper bolt set vertically on east end of abutment. Marked U. S. P. B. M.

P. B. M. 43.—Is on brick basement of H. Smith's dwelling house at *Watertown, Ill.* It is center of hole in copper bolt leaded horizontally in the west side near the northwest corner. The house stands 50 metres southeast of the Chicago, Milwaukee and St. Paul Railroad depot. It is marked U. S. P. B. M.

P. B. M. 44.—Is on brick schoolhouse at *Hampton, Ill.* It is center of hole in copper bolt set horizontally 0·5 metre from ground on east side near southeast corner of large new public-school building. It is marked U. S. P. B. M.

P. B. M. 45.—Is on stone foundation of Baker & Hayward's brick store building on levee at *Hampton, Ill.* It is center of hole in copper bolt leaded horizontally in north side of northwest corner of building, and is at the high-water mark of 1880. Marked U. S. P. B. M.

P. B. M. 46.—Is on stone foundation of H. M. Gilchrist's brick store building at *Rapids City, Ill.* It is center of hole in copper bolt leaded horizontally in west side of northwest corner, 4 feet above ground. The building is on the river bank. Marked U. S. P. B. M.

P. B. M. 47.—Is on abutment of bridge of Chicago, Milwaukee and St. Paul Railroad over Barbers Creek, three-fourths mile south of *Port Byron, Ill.* It is top of copper bolt leaded vertically in west end of north abutment. Marked U. S. P. B. M.

P. B. M. 48.—Is on foundation of Mr. N. Dorrance's brick store building at *Port Byron, Ill.* It is center of hole in copper bolt leaded horizontally in west side of southwest corner of stone foundation, and marked U. S. P. B. M. The building stands between Main street and the railroad track and about 75 feet from the river bank.

P. B. M. 49.—Is on iron doorstep of new brick store building of A. H. Wandt at *Port Byron, Ill.* It is top of north bolthead of front row of bolts on south doorstep on east side of building on east side of Main street. Bolthead marked with a cross cut through its center by a cold chisel. Marked U. S. P. B. M. on bricks below.

P. B. M. 50.—Is on stone warehouse of Northern Line Packet Company, at *Cordova, Ill.* It is center of hole in copper bolt set horizontally in south side, near southwest corner, and marked U. S. P. B. M. The warehouse stands at water's edge, and the bench is 2 metres below high-water mark. Mackenzie B. M. 39 is on same building.

P. B. M. 51.—Is on stone foundation of William G. Marshall's brick elevator, near Chicago, Milwaukee and St. Paul Railroad depot at *Cordova, Ill.* It is center of hole in copper bolt set horizontally in north face, near northwest corner, in third corner stone from top of foundation. Marked U. S. P. B. M.

P. B. M. 52.—Is on foundation of brick store building of Harper & Son at *Albany, Ill.* It is center of hole in copper bolt set horizontally in west side at southwest corner of building and marked U. S. P. B. M. The building is some 90 metres from river and fronts on the main business street of the town. It is almost directly back of their old brick storehouse, now caving into the river, on which is Mackenzie B. M. 37.

P. B. M. 53.—Is on base of a large shoulder of natural rock projecting from the bluff 1¼ miles north of *Albany, Ill.* It is center of hole in copper bolt leaded horizontally into the base of cliff 1 foot above ground and about 3·5 metres above a wagon road, and marked U. S. P. B. M. It is 15 metres east of wagon road and 90 metres east of Chicago, Milwaukee and St. Paul Railroad.

P. B. M. 54.—Is on abutment of Chicago, Milwaukee and St. Paul Railroad bridge, 2½ miles north of *Albany, Ill.* It is top of copper bolt set vertically in west side of south abutment. Marked U. S. P. B. M.

P. B. M. 55.—Is on south abutment of bridge over Cat Tail Creek of Chicago, Milwaukee and St. Paul Railroad. It is top of copper bolt set vertically in top of east end of abutment. This bridge is just south of the line of the Chicago, Burlington and Quincy Railroad and about 2 miles south of *Fulton, Ill.*

P. B. M. 56.—Is on east end of north abutment of Chicago, Milwaukee and St. Paul Railroad bridge over Cat Tail Creek, 2 miles south of *Fulton, Ill.*, and about 200 metres south of Chicago, Burlington and Quincy Railroad crossing. It is top of copper bolt set vertically in top of abutment.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN FULTON AND CHICAGO, ILL.

[All permanent bench marks on this line are lettered U. S. P. B. M. For descriptions of permanent bench marks 53, 54, 55, and 56, see above.]

P. B. M. 57.—Is at *Fulton, Whitesides County, Ill.*, on the northeast corner of Cherry and Bench streets. It is center mark of copper bolt leaded horizontally in south face of stone foundation wall to the Northern Illinois College, 3½ feet above the ground, and 14 inches from the southwest corner of foundation.

P. B. M. 58.—Is in *Whitesides County, Ill.*, on the southeast abutment of the railroad bridge north of *Fulton Junction*, 970 metres north from crossing of Chicago, Milwaukee and St. Paul and the Chicago and Northwestern railroads; being the top of a copper bolt leaded vertically in the bridge-seat stone.

B. M. 35.—Of Captain Mackenzie, at *Fulton*, on water table, southeast corner of engine room of elevator, under planking.

P. B. M. 59.—Three miles north of *Fulton Junction*, in *Whitesides County, Ill.*, in west end of north abutment of railroad bridge; being the top of copper bolt leaded vertically in second course of stone from top.

P. B. M. 60.—At *Thomson, Carroll County, Ill.*, west end of Christian church, 250 metres east of Chicago, Milwaukee and St. Paul Railroad; being the center mark of copper bolt leaded horizontally in the foundation wall.

P. B. M. 61.—One mile south of *Savanna, Carroll County, Ill.*, in middle pier and directly under railroad bridge No. E 392, being top of copper bolt leaded vertically.

P. B. M. 62.—At *Savanna, Carroll County, Ill.*, on doorsill of engine room of the Chicago, Milwaukee and St. Paul Railroad Company's elevator on the bank of the river; being top of copper bolt leaded vertically in the south end of the south door, east side. Captain Mackenzie's B. M. 34 is on the same sill, marked +.

P. B. M. 63.—At *Savanna, Carroll County, Ill.*, on northwest corner of Main and Jefferson streets, in facing stone, south face, southeast corner of brick building owned by W. B. Laws; being the center of copper bolt leaded horizontally.

P. B. M. 64.—At *Savanna, Carroll County, Ill.*, 2½ miles east of the Junction House, and 50 metres south of the main line of the Chicago, Milwaukee and St. Paul Railroad, in the top of west end of north abutment of wagon bridge over Plum River; being the top of copper bolt leaded vertically.

P. B. M. 65.—Is 300 meters north of "1-mile post," west of *Hickory Grove* station, Chicago, Milwaukee and St. Paul Railroad, *Carroll County, Ill.*, in east side of stone foundation wall of barn owned by J. Fish; being the center mark of copper bolt leaded horizontally, 5 feet south of door and 3 feet above ground.

P. B. M. 66.—At *Mount Carroll, Carroll County, Ill.*, about 100 metres south of depot and 40 metres east of Chicago, Milwaukee and St. Paul Railroad, in barn building attached to elevator; being the center mark of copper bolt leaded horizontally in the west end of south face of stone foundation, 3 feet above the ground.

P. B. M. 67.—About 4 miles west of *Lanark, Carroll County, Ill.*, north end of east abutment of railroad bridge No. 454 (Chicago, Milwaukee and St. Paul Railroad), over Carroll Creek; being the top of copper bolt leaded vertically in the second course of stone from the top. In the stone are cut the letters U. S. P. B. M., and the date, May 25, 1883.

P. B. M. 68.—At *Lanark, Carroll County, Ill.*, 25 feet from the southwest corner of Carroll and Main streets on the upper doorstep of brick building occupied by a bank and owned by Walff Brothers; being the top of copper bolt leaded vertically in upper doorstep on Carroll street and 1½ feet above ground.

P. B. M. 69.—Is 2¼ miles east of *Lanark, Carroll County, Ill.*, on the line of the Chicago, Milwaukee and St. Paul Railroad, in coping of north end of east abutment of railroad bridge over Carroll Creek; being the top of a copper bolt leaded vertically.

P. B. M. 70.—Is 3½ miles east of *Lanark Junction, Carroll County, Ill.*, on the line of the Chicago, Milwaukee and St. Paul Railroad, 140 meters south of the track in barn building owned by Mr. M. Crabtree; being the center mark of copper bolt leaded horizontally in the east end of the north face of stone foundation wall, 2 feet above the ground.

P. B. M. 71.—At *Foreston Junction, Ogle County, Ill.*, where the Chicago, Milwaukee and St. Paul Railroad passes under the Illlnois Central, in the lower step of west wing of south abutment of the stone archway in the fourth course of stone from the bottom; being the top of a copper bolt leaded vertically.

P. B. M. 72.—At *Adeline* station, Chicago, Milwaukee and St. Paul Railroad, *Ogle County, Ill.*, in elevator building of the aforesaid railroad company; being the center mark of copper bolt leaded horizontally in the east face of stone foundation wall at the southeast corner, about 4 feet above the ground.

P. B. M. 73.—At *Leaf River, Ogle County, Ill.*, 70 metres east of the depot and just opposite the water tank in elevator building owned by D. Sprecker; being the center mark of copper bolt leaded horizontally in the east end of south face of the stone foundation wall, about 4 feet above the ground.

P. B. M. 74.—At *Byron, Ogle County, Ill.*, 560 metres south of the Chicago, Milwaukee and St. Paul Railroad track measured on Walnut street, in brick and stone building fronting on said street, and occupied by hardware and dry-goods stores, and the Commercial Hotel, owned by J. F. Spalding; being center mark in copper bolt leaded horizontally in north wall of northeast corner, 11 inches from corner and 4 feet above ground.

P. B. M. 75.—Is 1¼ miles east of *Byron, Ogle County, Ill.*, on the line of the Chicago, Milwaukee and St. Paul Railroad track, in west abutment of railroad bridge over Rock River; being the top of copper bolt leaded vertically in stone coping, south side.

P. B. M. 76.—At *Stillman Valley*, *Ogle County*, *Ill.*, 50 metres east of the depot and 20 metres south of the main track of the Chicago, Milwaukee and St. Paul Railroad Company, in the west front of foundation wall of the elevator building owned by J. D. & J. J. White; being the center mark of copper bolt leaded horizontally 11 inches from the northwest corner.

P. B. M. 77.—Is 2 600 metres west of *Davis Junction*, *Ogle County*, *Ill.*, in north end of west abutment of small bridge of the Chicago, Milwaukee and St. Paul Railrod; being the top of a copper bolt leaded vertically in the coping stone.

P. B. M. 78.—At *Monroe*, *Ogle County*, *Ill.*, 24 metres west of depot of the Chicago, Milwaukee and St. Paul Railroad, in east face of stone foundation wall of elevator building owned by D. A. Cipperly; being the center mark of copper bolt leaded horizontally 1½ feet north of southeast corner and 3½ feet above the ground.

P. B. M. 79.—At *Fielding*, *Dekalb County*, *Ill.*, 10 metres north of main track of the Chicago, Milwaukee and St. Paul Railroad, in south face of stone foundation wall of elevator; being center mark of copper bolt leaded horizontally 25 feet west of the southeast corner and 2½ feet above the ground.

P. B. M. 80.—At *Kirkland*, *Dekalb County*, *Ill.*, 175 metres south of railroad track, on street running to depot from the south, in brick building owned by Dean & Rowen, to be used when completed for a bank; being the center of a copper bolt leaded horizontally 6 inches from the northwest corner on the west face of stone foundation 5 feet above the ground.

P. B. M. 81.—At *Kingston*, *Dekalb County*, *Ill.*, one-half mile east of the depot and 10 metres north of the main track, in a brick store building in Chapman's addition belonging to Mr. Julius Chapman; being center mark in copper bolt leaded horizontally in the water table on west face, northwest corner.

P. B. M. 82.—At *Genoa*, *Dekalb County*, *Ill.*, 100 metres south of main track of the Chicago, Milwaukee and St. Paul Railroad, at the corner of Main and Emmet streets, in brick store building owned by Alexander Crawford; being the top of a copper bolt leaded vertically in the south end of stone doorsill on the east side.

P. B. M. 83.—At *Hampshire*, *Kane County*, *Ill.*, on State street, in brick building owned by Phillip Shultz and used for post office and drug store, in the stone water table in the west face of the southwest corner; being the center mark of copper bolt leaded horizontally.

P. B. M. 84.—At *Pingree Grove*, *Kane County*, *Ill.*, about 100 metres northeast of depot, in foundation of store building owned by J. B. Schedden, in north face 5 feet from the northwest corner, 1 foot above the ground; being the center mark of a copper bolt leaded horizontally.

P. B. M. 85.—Is three-fourths of a mile west of *Dumser* station, *Kane County*, *Ill.*, on the line of the Chicago, Milwaukee and St. Paul Railroad, in railroad culvert No. 19, 20 metres north of railroad track; being the top of a copper bolt leaded vertically in coping stone in east end of north abutment.

P. B. M. 86.—At *West Elgin*, *Kane County*, *Ill.*, corner of State street and Highland avenue, in water table of the large brick building known as the Waverly House, on north face, 6 inches from the northeast corner and 4 feet above the ground; being center mark of a horizontal bolt.

P. B. M. 87.—At *West Elgin*, *Kane County*, *Ill.*, on the southwest corner of River street and the Chicago, Milwaukee and St. Paul Railroad track, on the north face of brick and stone business building owned by Robert Beckwith; being the top of copper bolt leaded vertically in east end of stone doorstep.

B. M. Newcomb.—At *East Elgin, Ill.*, on Center street, between Du Page and Chicago streets, being cross (×) cut in west face of brick foundation wall of building owned by the Elgin Scientific Association.

P. B. M. 88.—Is 1⅛ miles south of *Elgin, Kane County, Ill.*, in west end of south abutment of the Chicago, Milwaukee and St. Paul Railroad bridge over Fox River; being the top of a copper bolt leaded vertically in the coping stone.

P. B. M. 89.—At *Bartlett, Cook County, Ill.*, 150 metres northwest of depot and 100 metres north of railroad track of the Chicago, Milwaukee and St. Paul Railroad, in the stone foundation of the Congregational Church; being the center mark of copper bolt leaded horizontally on the east face of the southeast corner.

P. B. M. 90.—At *Roselle, Dupage County, Ill.*, on the southeast corner of Chicago street and road crossing it, in the north face of foundation wall of brick business building owned by Mathew Secker, standing about 80 metres north of railroad track; being the center of copper bolt leaded horizontally, 3 feet from the northeast corner and 2 feet above the ground.

P. B. M. 91.—At *Itasca, Dupage County, Ill.*, 80 metres north of track of the Chicago, Milwaukee and St. Paul Railroad, and in a northeasterly direction from the depot, in the foundation wall of frame store building (east face) owned by Dr. Elijah Smith; being the center of copper bolt leaded horizontally, 2 feet from the southeast corner.

P. B. M. 92.—At *Bensenville, Dupage County, Ill.*, 40 metres north of depot, in south side of frame store building, owned by C. A. Franz; being the center of copper bolt leaded horizontally in the stone foundation, 1 foot west of the southeast corner and 2 feet above ground.

P. B. M. 93.—At *Mannheim, Cook County, Ill.*, 250 metres northwest of the depot of the Chicago, Milwaukee and St. Paul Railroad, in the south side of the base of the brick chimney at Mr. C. H. Bossenberg's creamery; being the center mark of copper bolt leaded horizontally in the middle of the chimney and 3 feet above the ground.

P. B. M. 94.—At *Cragin, Cook County, Ill.*, on the northeast corner of Grand and Armitage avenues, about 150 metres north of the line of the Chicago, Milwaukee and St. Paul Railroad, in the east face of foundation wall of Jennings's brick saloon building; being the center mark of copper bolt leaded horizontally, 10 inches from the southeast corner and 4 feet above the ground.

P. B. M. 95.—At *Chicago, Ill.*, on the southeast corner of Dixon street and Bloomingdale road, about 20 metres southwest of crossing of the Chicago, Milwaukee and St. Paul, and Chicago and Northwestern railroads, in the west face of brick building known as L. Epps & Co.'s malt house, 6 inches from the northwest corner and 2½ feet above the ground; being the center of a copper bolt leaded horizontally.

P. B. M 96.—At *Chicago, Ill.*, on the south side of Chicago avenue at Nos. 242 and 244, near Clark street, in police station brick building, in the north face, 1 foot west of the northeast corner and 3½ feet above the ground; being the center mark of a copper bolt leaded horizontally.

P. B. M. 97.—At *Chicago, Ill.*, on the northeast corner of Chicago avenue and Pine street, in the east face of the southeast buttress of stone engine house of the Chicago waterworks, in the stone water table, 18 inches north of the southeast corner and 3 feet above the ground.

P. B. M. 98.—At *Chicago, Ill.*, on the northwest corner of Chicago avenue and Pine street, in middle of the south wall of water tower, in the east end of the south doorsill, 3 feet above the ground; being the top of a copper bolt leaded vertically.

P. B. M. 99.—At *Chicago, Ill.*, in Illinois Central Railroad stone freight depot, situated on Goodrich street docks on the west side of Slip A, opposite the Central Elevator, in east face of foundation wall, 1 foot south of the northeast corner and 2½ feet above the ground; being the center mark of a copper bolt leaded horizontally.

P. B. M. 100.—*In Lake Michigan*, on the crib of the Chicago waterworks, on the top of the iron cylinder of shaft of the 5-foot tunnel, nearly of same elevation as the zero of the gauge, on the east side of the top of the shaft; being a cross (×) cut with cold chisel, not lettered.

DESCRIPTIONS OF CHICAGO CITY BENCH MARKS.

B. M. I.—Is top of east end of stone step of private entrance to No. 161 North avenue, on the northwest corner of Halsted street and North avenue.

B. M. II.—Is stone step west corner of brick house No. 153 Division street, being the third lot west of Grace street.

B. M. III.—Water table of roundhouse, northeast corner of Halsted street and West Chicago avenue, established before "the fire."

B. M. IV.—Extreme corner of stone sidewalk at the northeast corner of Wesson street and East Chicago avenue.

B. M. VI.—East end of coping of iron fence of police station on the south side of Chicago avenue near Clark street.

B. M. VII.—On corner of stone water table, northwest corner of tower of St. James Church, at southeast corner of Cass and Huron streets.

B. M. VIII.—Corner of stone water table, southeast corner of Chicago waterworks (machine shop), east of Pine street, on Chicago avenue.

B. M. IX.—North corner of iron frame of manhole to Chicago avenue shaft at waterworks into 7-foot tunnel, said to have been disturbed by grading sidewalk.

B. M. XIII.—Upper surface of lower horizontal bar (compression member) between the southerly pillars of light-house on the north side of the mouth of Chicago River.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ST. PAUL, MINN., AND SAVANNA, ILL.

T. B. M. 1.—Is in *St. Paul, Minn.*, on the southeast corner of Washington and Eagle streets, on curbing, directly over the center of inlet grating; being the highest part of square cut in the granite.

P. B. M. 65.—Is in *St. Paul*, on the southeast corner of Washington and Eagle streets, 9·2 feet from the south side of Washington, 1·0 foot above the old city storehouse, which stands on the east side of Eagle, in center of a regulation tile 18 inches square and 4 inches thick, set 2⅔ feet below the surface of ground; being the top of a ⅜-inch copper bolt leaded vertically.

P. B. M. 66.—Is top of cap over iron pipe 4 inches in diameter and 4 feet long, set directly over and concentric with P. B. M. 65, and standing 16 inches above ground.

P. B. M. 67.—Is in *St. Paul*, on the left bank of the Mississippi River, on the shore pier of Wabasha Street Bridge, on the northwest corner of the upper pier, 6 inches from bridge seat stone; being the top of copper bolt leaded vertically, marked

U S
⊙
P B M

P. B. M. 68.—Is in *St. Paul*, on the left bank of the Mississippi River, on lower wing wall of Kansas City and St. Paul Railway Bridge, 4·76 feet above the lower end of bridge seat course and 2·75 feet back from its front edge; being top of copper bolt leaded vertically, marked

U S
⊙
P B M

Old U. S. B. M. A.—Is in *St. Paul*, on the left bank of the Mississippi River, on the lower bench of retaining wall of embankment of the Chicago, St. Paul and Kansas City Railway Bridge; being the highest point of ring cut in top of stone marked ⊙.

P. B. M. 70.—Is in *St. Paul*, about 100 feet west of Jackson street, on the north side of railroad tracks opposite the Diamond Joe Freight Depot, at the east end of retaining wall and 4 inches back of its face; being the top of copper bolt leaded in regulation tile.

P. B. M. 71.—Is top of cap over iron pipe set over P. B. M. 70, about 14 inches above ground.

P. B. M. 72.—Is on the *St. Paul* city courthouse, Fifth and Wabasha streets, on the west end of doorsill of the south entrance to basement, 6 inches from either wall; being the top of a copper bolt leaded vertically, marked

U S
P B M

Old U. S. B. M. 2½.—Of survey of 1889, is in *St. Paul*, on north abutment, east side, lowest step of wing wall of Chicago, St. Paul and Kansas City Bridge, about 2 inches from its face; also, about 2 inches from the second step, said to have been marked by a scratch "†"; now being highest point in square cut in stone.

P. B. M. 73.—Is in the east end of *St. Paul*, on the southeast side of the wall, which is on the southeast side of Schmidt & Constanz's brewery, about 120 feet north from railroad tracks and 30 feet from the sand-rock bluff; being a copper bolt in tile set 3 feet below ground.

P. B. M. 74.—Is top of cap on iron pipe set over P. B. M. 73, standing about 12 inches above ground.

P. B. M. 75.—Is 1 174 feet below the depot at *Daytons Bluff, Minn.*, 1 890 feet below the water tank and 1½ feet west of the west fence of the Chicago, Milwaukee and St. Paul Railway, at the south end of gate, at runway leading to the railroad embankment; being top of copper bolt in tile.

P. B. M. 76.—Is top of cap on iron pipe set over P. B. M. 75, standing about a foot above the surface.

T. B. M. 8.—Is about 720 feet below *Highwood, Minn.*, station, midway between tracks, on a stone monument 7 inches square; being the highest point in small square cut on top surface.

T. B. M. 9.—Is about 3 010 feet below *Highwood* station, between the Chicago, Burlington and Northern and the Chicago, Milwaukee and St. Paul tracks, on the east end of stone culvert under the Chicago, Milwaukee and St. Paul track, on coping stone; being the highest point in square.

T. B. M. 10.—Is about 1½ miles below *Highwood* station, opposite the foot of Pig Eye Lake, several hundred feet below railroad cut, at the west foot of embankment, by P. B. M. 77, on a very large, conspicuous granite bowlder; being the highest point in square.

P. B. M. 77.—Is about 1½ miles below *Highwood*, opposite the foot of Pig Eye Lake, at the west fence of the Chicago, Milwaukee and St. Paul right of way on its east side, about 60 feet below the large granite bowlder carrying T. B. M. 10; being a copper bolt in tile.

P. B. M. 78.—Is top of cap on iron pipe set over P. B. M. 77, standing 14 inches above ground.

T. B. M. 11.—Is about 1 350 feet above the depot at *Red Rock, Minn.*, 140 feet south of a large bowlder lying at the west foot of bank overgrown with vines, 9 feet east of the west right-of-way fence, 35 feet northeast from an oak tree 1 foot in diameter, blazed; being highest point in square cut on embedded bowlder.

T. B. M. 12.—Is in *Newport, Minn.*, on the southeast corner of lot belonging to and at the residence of Mr. H. A. Jones, depot agent of the Chicago, Milwaukee and St. Paul Railway, on the top of heavy iron rod driven into the ground marking his corner, on the northeast edge of rod.

P. B. M. 79.—Is in *Newport, Minn.*, on the northeast corner of lot belonging to and at the residence of Mr. H. A. Jones, depot agent of the Chicago, Milwaukee and St. Paul Railway, set exactly on the corner as per original gas pipe, removed; being copper bolt in tile.

P. B. M. 80.—Is top of cap on iron pipe set over P. B. M. 79, standing about 4 inches above surface of ground.

Old U. S. B. M. 12.—Also called Old P. B. M. 3, is at *Newport Landing*, 80 feet above the upper warehouse, in top of ledge two-thirds of the way up the river bank; being the top of a large ringbolt, with ring.

P. B. M. 81.—Is at *St. Paul Park*, at the southwest corner of Broadway and Third street, on the Syndicate Block, on the east end of doorstep; being the top of a copper bolt leaded vertically, marked

U S
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P B M

T. B. M. 14.—Is on the street between *St. Paul Park and Pullman*, named Tenth avenue, at its south line and 15 feet west of the right of way of the Chicago, Burlington and Northern Railway; being top of iron gas pipe.

P. B. M. 83.—Is between *St. Paul Park and Pullman*, on the north side of Tenth avenue and 1½ feet east of the west right-of-way limit of the Chicago, Burlington and Northern Railway; being top of copper bolt in tile.

P. B. M. 84.—Is top of cap on iron pipe set over P. B. M. 83, standing 1 foot above ground.

T. B. M. 17.—Is 1⅞ miles below *Pullman* station 1 870 feet south of Tibbits Crossing in the upper part of a long rock cut, on the west side of the Chicago, Burlington and Northern track, about 2 feet above the ties, on a very hard and prominent point of ledge; being the highest point in square, marked U. S. B. M.

P. B. M. 85.—Is opposite the head of *Nininger Slough*, 1½ feet north of the south line of the Chicago, Burlington and Northern right-of-way fence, about 30 feet from a blazed oak tree standing in field, facing the P. B. M., and being top of copper bolt in tile.

P. B. M. 86.—Is top of cap on iron pipe set over P. B. M. 85, standing 14 inches above ground.

T. B. M. 22.—Is behind *Island 18*, 1 140 metres above the upper culvert at foot of Nininger Slough, several feet north of the Chicago, Burlington and Northern track, 9 feet below a small wooden box culvert under track; being the highest point in square cut on an embedded sandstone.

P. B. M. 87.—Is directly opposite the foot of *Nininger Slough*, on the west end of culvert under the Chicago, Milwaukee and St. Paul track, on the coping stone, 5·7 feet south of the center of culvert; being the top of copper bolt leaded vertically, marked

U S
P B M

Old U. S. B. M. 23.—Also called Old P. B. M. 4, is about 700 feet below the mouth of *Nininger Slough*, between railroad tracks, at the Franklin Coulee Culvert, on the upper end of coping stone; being the highest point in square.

T. B. M. 23.—Is on left bank, about 1½ miles above *Hastings, Minn.*, at prominent point of bluff, 1 103 metres above the crossing of Chicago, Burlington and Northern and the Stillwater branch of the Chicago, Milwaukee and St. Paul, midway between tracks; being the highest point in square cut on a large sandrock, marked U. S. B. M. The same letters, but very large, are cut in the face of the sand bluff just back.

P. B. M. 88.—Is opposite *Hastings*, on the line of the Chicago, Burlington and Northern Railway, 108½ feet eastward from center of track and 169½ feet south from its crossing with the Stillwater branch of the Chicago, Milwaukee and St. Paul, just west of wire fence and north of the gate through it, leading to the house of Thomas McDermott; being top of copper bolt in tile.

P. B. M. 89.—Is top of cap on iron pipe set over P. B. M. 88, standing 1 foot above ground.

P. B. M. 96.—Is opposite *Hastings*, on the line of the Chicago, Milwaukee and St. Paul, 935 feet up the track from the draw pier of the Hastings Bridge, at bridge No. 270, over slough, on the east end of north abutment, at the south part of curve of coping stone; being the highest point in square marked U. S.

P. B. M. 97.—Is at *Hastings, Minn.*, on the draw pier of the Chicago, Milwaukee and St. Paul Railway bridge, on the upstream side, top of masonry, 6 inches south of the gangway leading from draw pier to the upper breakwater crib.

T. B. M. 26.—Is 723 metres above the upper end of the Chicago, Burlington and Northern trestle at *Point Douglas*, on the east side of track, at the base of the rock cut, about 80 feet above the center of E. H. Whittaker's house, 178 feet above the upper end of the railroad bridge, which is midway between the houses of G. H. Campbell and E. H. Whittaker; being a square cut on ledge directly under P. B. M. 90.

P. B. M. 90.—Is 723 metres above the upper end of the Chicago, Burlington and Northern trestle at *Point Douglas*, on the east side of track, in face of rock cut, 80 feet above the center of E. H. Whittaker's house, 178 feet above the upper end of railroad bridge, which is halfway between the houses of G. H. Campbell and E. H. Whittaker, being center of copper bolt leaded horizontally, marked

U S
⊙
P B M

and directly over T. B. M. 26.

T. B. M. 27.—Is at *Prescott, Wis.*, on the west pier of the Chicago, Burlington and Northern bridge over the St. Croix River, on the south side of track, on top stone; being highest point in square marked U. S.

P. B. M. 91.—Is at *Prescott, Wis.*, on the east pier of the Chicago, Burlington and Northern bridge over the St. Croix River, on the north end of bridge seat; being a copper bolt leaded vertically, marked the same as P. B. M. 90.

T. B. M. 28.—Is at *Prescott, Wis.*, at the east end of the Chicago, Burlington and Northern bridge over the St. Croix River, on the north side of track, 2½ feet from rail, on retaining wall 1 foot east of its west end; being highest point in square.

T. B. M. 30.—Is about 1¾ miles below the bridge across the St. Croix River at *Prescott*, about 15 feet eastward from center of track at foot of bank, about 133 metres below the Chicago, Burlington and Northern bridge over Pine Coulee, and about 65 feet below milepost 24, just below P. B. M. 92; being the highest point in square cut on bowlder.

P. B. M. 92.—Is about 1¾ miles below the bridge across the St. Croix River at *Prescott*, 125 metres below the Chicago, Burlington and Northern bridge across Pine Coulee, 38 feet below milepost 24, and 5 feet west of the east wire fence of the right of way; being the top of copper bolt in tile.

P. B. M. 93.—Is top of cap on iron pipe set over P. B. M. 92, standing 1 foot above surface.

P. B. M. 94.—Is about 3¾ miles below *Prescott, Wis.*, 43 feet south of the center of the Chicago, Burlington and Northern bridge No. 562, 46 feet east of the center of track, and 53 feet westward from a blazed oak tree on the slope of bluff; being top of copper bolt in tile.

P. B. M. 95.—Is top of cap on iron pipe set over P. B. M. 94, standing 1 foot above ground.

T. B. M. 35.—Is opposite *Smiths Bar*, behind and one-third of its length above the lower end of small lake, 1 540 feet below milepost 28, 1 078 feet below bridge 554, 15 feet below a small wooden box culvert, and 20 feet eastward from center of track; being the highest point in square cut on a limestone rock, marked U. S.

P. B. M. 98.—Is at *Smiths Landing*, about 10 feet above the lower end of bridge 552 and 105 feet eastward from center of track, 20 feet south from center of creek bed, and 154 feet from the southeast corner of Smith's house, now occupied by George Gunter, under plum tree; being top of copper bolt in tile.

P. B. M. 99.—Is top of cap on iron pipe set over P. B. M. 98, standing 1 foot above ground.

T. B. M. 37.—Is at *Smiths Landing*, opposite the extreme lower end of bridge 552, Chicago, Burlington and Northern, at the east foot of embankment, by a blazed post, on a round embedded bowlder; being the highest point in square cut in stone.

T. B. M. 38.—Is 1 000 metres below *Smiths Landing*, 124 metres above milepost 30 from St. Paul, 45 feet above bridge 549, 37 feet from center of track on bank of river, on a large blue sandstone; being the highest point in square.

T. B. M. 39.—Is 490 metres below *Morgans Coulee*, 124·6 metres below milepost 31, on the east side of railroad, on an embedded rock in the slope of a cut; being the highest point in square.

T. B. M. 40.—Is 93 metres below Chicago, Burlington and Northern bridge 544, on the north side of track at foot of bluff, 8 feet from center of track, opposite a blazed tree, on a rock; being the highest point in square.

T. B. M. 47.—Is three-fourths of a mile above *Diamond Bluff*, *Wis.*, on land of Ed. Colter, 213 metres south from center of bridge over Wind or Spring Creek, about at the elevation of extreme high water, at foot of bank, about 25 metres southward from the end of small road bridge over run, and about 40 metres from river, at a medium stage of water, on a large embedded granite bowlder; being the highest point in square, marked: U. S.

P. B. M. 100.—Is three-fourths of a mile above *Diamond Bluff*, on land of Ed. Colter, 7 metres northward from T. B. M. 47, on point of bank, about 600 feet below Wind or Spring Creek, 62 feet southward from center of the small road bridge and 21 feet nearer the river, 22½ feet northwest from a 4-inch oak tree blazed; being copper bolt in tile.

P. B. M. 101.—Is top of cap on iron pipe set over P. B. M. 100, 1 foot above ground.

T. B. M. 45.—Is in *Diamond Bluff*, 70 metres below the Chicago, Burlington and Northern station and 19 metres northward from center of track, 3 feet south of wire fence, on a large bowlder; being the highest point in square.

P. B. M. 102.—Is in *Diamond Bluff*, 70 metres east of the Chicago, Burlington and Northern station, 14 metres southward from main track and 2 metres north of the wire fence; being top of bolt in tile.

P. B. M. 103.—Is top of cap on iron pipe set over P. B. M. 102, standing 1 foot above ground.

T. B. M. 46.—Is three-fourths of a mile below *Diamond Bluff*, 37 feet south from center of track, 94 metres below the east end of bridge 536 over Dry Run, on the large bowlder in borrow pit; being the highest point in square, marked

U S
□
T B M

P. B. M. 104.—Is three-fourths of a mile below *Diamond Bluff*, *Wis.*, 29 metres south of center of track and 90 metres below the east end of bridge 536 over Dry Run, 2 metres northward from blazed post in wire fence, at foot of bank in borrow pit, copper bolt in tile.

P. B. M. 105.—Is top of cap on iron pipe set over P. B. M. 104, standing about 14 inches above ground.

T. B. M. 48.—Is about 2¼ miles below *Diamond Bluff*, 700 feet above Neros Crossing, 400 feet above Gardner Skidmore's house, 12 feet north from center of Chicago, Burlington and Northern track, on the slanting face of ledge of rock; being the highest point in square, marked: U □ S.

T. B. M. 50.—Is at *Trenton*, *Wis.*, on top of bluff, about 100 feet back from edge of descent and 45 feet east of old storehouse, in an oak tree 10 inches in diameter; being a 6-inch wire spike in west root of tree.

T. B. M. 51.—Is at *Trenton Landing*, about 70 feet south of road, 65 feet back from line of willows, on top of bank, on the south root of a large elm tree 30 inches in diameter, blazed, marked U; being top of a 6-inch wire spike.

P. B. M. 106.—Is at *Trenton Landing*, *Wis.*, about 30 feet below T. B. M. 51, 3½ feet toward the river from a blazed tree; being a copper bolt in tile.

P. B. M. 107.—Is top of cap on iron pipe set over P. B. M. 106, standing about 14 inches above ground.

T. B. M. 52.—Is on the left bank of chute opposite the head of *Island 24* 300 metres below the north end of pile dike, 6 feet back from top of bank, in the center between three cottonwood trees blazed, and 7 feet from all, on a 14-inch new cottonwood stump; being top of 6-inch wire spike.

T. B. M. 53.—Is on the extreme upper end of Island 24, 2 miles above *Pucketville*, about 75 feet eastward from the river bank, on a 4-foot elm stump; being a 6-inch wire spike.

P. B. M. 108.—Is about 55 feet southward from T. B. M. 53, 2 miles above *Pucketville*, at the center of the head of Island 24, on the highest ground, about 125 feet from the river and 100 feet from the chute; 2 maple trees near by are blazed facing the P. B. M.; being top of copper bolt in tile.

P. B. M. 109.—Is top of cap on iron pipe set over P. B. M. 108, standing 1 foot above ground.

P. B. M. 110.—Is on Island 24, opposite Red Wing, in *Pucketville*, 200 feet below the ferry landing, in the front part of Mr. Truttman's yard, 12 feet back from the front angle of retaining wall, 10½ feet northwest from the large cottonwood tree carrying T. B. M. 56, 3·7 feet eastward from a 12-inch maple, 21 feet from the southwest corner of Mr. Truttman's house; being top of copper bolt in tile.

P. B. M. 111.—Is top of cap on iron pipe set over P. B. M. 110, standing 1 foot above ground.

P. B. M. 112.—Is in *Red Wing*, *Minn.*, on the southwest corner of Plum and Levee streets, in the northeast corner of the La Grange mill, in the east face of the foundation wall, 2·3 feet south from the north face and 2·1 feet above the sidewalk; being the center mark in copper bolt leaded horizontally, marked

U S
P B M

P. B. M. 113.—Is at *Red Wing*, about 1 300 feet below the Chicago, Milwaukee and

St. Paul depot, at the base and upper end of Barn Bluff, on the lower abutment, river side of small railroad bridge, on the first step below the top, 6 inches from the first step; being top of copper bolt leaded vertically, and marked

U S
⊙
P B M

T. B. M. 57.—Is three-fourths of a mile below the small railroad bridge at the upper end of Barn Bluff, at the foot of Barn Bluff, about 45 feet east from the northeast corner of the Pioneer Lime Works, on the top stone of wall retaining the wagon road; being the highest point in square, marked U □ S.

T. B. M. 58.—Is 1¾ miles below *Red Wing*, between the two road crossings, about 328 feet above the slaughterhouse, 6½ feet northward from center of track, opposite a crossing signal board, 810 feet above P. B. M. 215; being the highest point in a square, on an embedded rock.

P. B. M. 114.—Is nearly 2 miles below *Red Wing*, at a wagon-road crossing, 5 feet below its east fence and 20 feet northward from center of track, one-fourth of a mile above the slaughterhouse; being copper bolt in tile.

P. B. M. 115.—Is top of cap on iron pipe set over P. B. M. 114, standing a foot above ground.

T. B. M. 59.—Is on the right bank about 2⅜ miles below *Red Wing*, opposite the head of Island 26, in front of the Minnesota Reform School building, on a large triangular sandstone, about 10 feet southwest of a blazed elm tree and 20 feet from shore, at a medium stage, marked U □ S.

T. B. M. 60.—Is on the right bank, about 3 miles below *Red Wing*, *Minn.*, 492 feet below the foot of Island 26, 39 feet from low-water shore at foot of bluffs, 2 feet above a very large and conspicuous white rock, on a large embedded bowlder; being the highest point in square, marked

U S
□

T. B. M. 61.—Is about 3⅜ miles below *Red Wing* and ⅝ mile above the head of Island 28, just above a little tow-head and 180 feet above a large lone elm tree near shore at a medium low stage, on a very large piece of rock; being highest point in square, marked U □ S.

P. B. M. 116.—Is 1¾ miles above *Wacouta* and 1 722 feet above the head of South Channel, at the east foot of the round point of bluff on the lower side of creek, above fishermen's shanties above old B. M. 32, 15 feet west from a 6-inch blazed ash, marked U S, 31 feet north from another blazed ash, and 20 feet east from a blazed oak tree; being a copper bolt in tile.

P. B. M. 117.—Is top of cap on iron pipe set over P. B. M. 116, standing a foot above surface of ground.

P. B. M. 118.—Is at *Wacouta*, below Ida Creek, at the point of steep sand bluff, close to the south side of wire fence, 17½ feet above the large elm in which is located T. B. M. 62; being copper bolt in tile.

P. B. M. 119.—Is top of cap on iron pipe set over P. B. M. 118, standing about 1 foot above the surface of the ground.

P. B. M. 120.—Is on Lake Pepin, about 3¾ miles above *Lake Side*, on the wide, flat, wooded sand point, on the first point below the United States light, about in center of the point east and west, 230 feet from the end of the point at a medium low stage, 262 feet west, 10 degrees north from the east shore and 193 feet southeast from the northwest shore line; being copper bolt in tile; trees blazed.

P. B. M. 121.—Is top of cap on iron pipe set over P. B. M. 120, standing about 1 foot above ground.

T. B. M. 66.—Is on the right bank of Lake Pepin, about 3 280 feet below the wide, flat, wooded sand point, which is about 3¾ miles above *Lake Side*, 295 feet below the exceedingly large rock, under a 6-inch ash tree blazed, on an embedded bowlder about the middle of the beach; being highest point in square, marked U □ S.

T. B. M. 67.—Is on the right bank of Lake Pepin, about 2¾ miles above *Lake Side* and 1½ miles below the wide, flat, sand point at the south end of a long stretch of straight shore, 25 feet below two exceedingly large rocks in the middle of the way, 20 feet from a linn tree blazed, on an embedded bowlder; being the highest point in square, marked U □ S.

T. B. M. 69.—Is on right bank of Lake Pepin, 1½ miles above Lake Side, 3 600 feet above *Point no Point*, in the middle of the way, 28 feet from foot of bluff and 49 feet east from a blazed elm (top of tree broken off) on the east end of an embedded bowlder; being the highest point in square, marked U □ S.

T. B. M. 70.—Is on *Point no Point*, Lake Pepin; being the last point in view from Lake Side looking up the lake, 60 feet below a very large round prominent bowlder standing out in lake, 28 feet from foot of bluff, near the shore in the way, easily seen, on a large flat rock well embedded, with its upper face inclining about 25 degrees with the northeast horizon; being a square, marked U □ S.

P. B. M. 122.—Is on Lake Pepin, at *Lake Side*, at the Lake Side Hotel, 50 feet southward from the driven well on the point, 7 feet east of path leading to well, 13 feet eastward from the oak tree bearing T. B. M. 72; being copper bolt in tile about 3 feet underground.

P. B. M. 123.—Is top of cap on iron pipe set over P. B. M. 122, standing about 1 foot above ground.

T. B. M. 76.—Is on Lake Pepin, at *Florence*, at the southeast corner of A. M. C. Johnson's dooryard, at the northwest corner of intersecting roads, about 197 feet back from river bank, on base stone of iron fence, 2·1 feet north from the corner; being the highest point in square, marked U □ S.

P. B. M. 124.—Is on Lake Pepin, in *Florence*, on the northwest corner of the same streets as T. B. M. 76, 134 feet north from the corner, which is the southeast corner of Mr. A. M. C. Johnson's yard, on the west side of wagon road, 6 inches back of the face line produced, of iron fence; being a copper bolt in tile about 3 feet below surface.

P. B. M. 125.—Is top of cap on iron pipe set over P. B. M. 124, standing about a foot above ground.

T. B. M. 77.—Is on Lake Pepin, 3 363 feet below *Florence*, on the beach, 60 feet from foot of high bank, on a large, prominent, black granite bowlder, easy to find; being the highest point in square, marked U. S.

P. B. M. 126.—Is on Lake Pepin, in the village of *Central Point*, on the east boundary line of Front street, 66 feet from the fence on the west side of Front street, 152 feet northward from the northwest corner of Main and Front streets, 92 feet from the southeast corner of the sawmill office, 240 feet southeast from the property corner of George H. Grannis and F. A. Coon, and 95 feet from the southwest corner of sawmill; being copper bolt in tile.

P. B. M. 127.—Is top of cap on iron pipe set over P. B. M. 126, standing about 8 inches above the surface of ground.

P. B. M. 128.—Is on Lake Pepin, in *Lake City*, on the west side of Front street, between Lyon avenue and Center street, on T. W. Palmer's shoe store, in the north end of the window seat, being top of a copper bolt leaded vertically, marked

U S
⊙
P B M

P. B. M. 129.—Is on Lake Pepin, in *Lake City*, on the southeast corner of Front and Center streets, on the Merchants' Bank building, in east end of stone doorstep, being a copper bolt leaded vertically, and marked the same as P. B. M. 128.

Old U. S. B. M.—Is in *Lake City*, on the Diamond Joe Elevator, 10·5 feet west of the southeast corner, on the foundation stone, at the west end of stone pier, in the southeast quarter of old cross.

P. B. M. 130.—Is on Lake Pepin, 2 miles below *Lake City*, ½ mile above the first high bluff, 105 feet below bridge 156, on the Chicago, Milwaukee and St. Paul right of way, at the east fence, 115 feet from the top of the lake bank, at the upper end of cut; being a copper bolt in tile.

P. B. M. 131.—Is top of cap on iron pipe set over P. B. M. 130, standing about a foot above ground.

T. B. M. 84.—Is 3 miles below Center street of *Lake City*, on Lake Pepin, 9 feet toward the bluff from the center of the Chicago, Milwaukee and St. Paul Railway, 3 000 feet below bridge 154, opposite a blazed telegraph pole, on an embedded rock in the side of bank, projecting 1 foot above the surface; being highest point in square.

T. B. M. 86.—Is on Lake Pepin, at *Keplers Coulee*, 1½ miles above *Kings Coulee* station, at the upper side of the point of land north of the railroad, covered with very large rocks, at the upper end of a very large bowlder supporting the railroad embankment, 15 feet from center of track and 25 feet from lake; being the highest point in square, marked

U S
□
T B M

P. B. M. 132.—Is on Lake Pepin, at *Keplers Coulee*, 1½ miles above *Kings Coulee* station, on the north sloping face of the exceedingly large bowlder on which T. B. M. 86 is cut; being the top of a copper bolt leaded vertically, and marked the same as P. B. M. 128.

T. B. M. 87.—Is on Lake Pepin, at *Kings Coulee*, on the Chicago, Milwaukee and St. Paul Railway bridge No. 146, on the north end of the west abutment, on the front edge of the second top stone from north end; being the highest point in square, marked: U S.

P. B. M. 133.—Is on Lake Pepin, 150 feet below the section house, 49 feet south from center of track, 82 feet below the center of bridge 146, on the right of way at south fence, 7 feet east of the east gatepost of gate across road leading through to Smith's land; being a copper bolt in tile.

P. B. M. 134.—Is top of cap on iron pipe set over P. B. M. 133, standing a foot above ground.

T. B. M. 88.—Is on Lake Pepin, at *Dutchmans Coulee*, 1 mile below Kings Coulee station, 853 feet below bridge 142, at the upper end of a small cut, 15 feet toward lake from center of track, on a large, round, embedded bowlder supporting the embankment; being the highest point in square, marked U □ S.

T. B. M. 89.—Is on Lake Pepin, 1⅝ miles below *Kings Coulee*, 275 feet above bridge 140, on the lake side of track, at the lower end of cut, 200 feet above Copelands Coulee bridge, just above Theodore Halm's house, on an embedded bowlder; being the highest point in square, marked U □ S.

T. B. M. 90.—Is on Lake Pepin, 1½ miles above *Reeds Landing*, at Eli Roscoes Coulee, on the south side of track, on the base stone of the east retaining wall in bed of creek; being the highest point in square, marked U □ S.

P. B. M. 135.—Is on Lake Pepin, 1½ miles above *Reeds Landing*, at Eli Roscoes Coulee, in the point of hill between the wagon road and railroad opposite John Sandburn's house, 31 feet south from center of track, 16 feet east from the east bank of creek where T. B. M. 90 is located, and 20 feet north from the north side of road bridge; being a copper bolt in tile, 3 feet under ground.

P. B. M. 136.—Is top of cap on iron pipe set over P. B. M. 135, standing 1 foot above ground.

T. B. M. 91.—Is at the foot of Lake Pepin, three-fourths mile below *Roscoes Coulee*, on prominent point of south shore, at the north side of the north railroad ditch, 9 feet from center of track, on large embedded rock, 810 feet above bridge 134; being the highest point in square, marked U □ S.

P. B. M. 137.—Is at *Reeds Landing*, 246 feet below Knapp, Stout & Co.'s warehouse, on the south side of Water street, in the north door of S. Trautmann's store, in the south end of the stone doorstep; being a copper bolt leaded vertically, marked the same as P. B. M. 128.

T. B. M. 93.—Is at *Reeds Landing*, 3 170 feet below the Chicago, Milwaukee and St. Paul depot, 45 feet below the intersection of the said railroad with the tangent produced of the Chicago, Milwaukee and St. Paul pontoon bridge over the Mississippi River, 10 feet northward from center of track, on an embedded rock; being the highest point in square.

Old U. S. B. M. A.—Is at *Reeds Landing*, just above the pontoon bridge across the Mississippi, at the northwest corner of Arthur Dunn's residence, which is on the south side of street, facing the river; being the bottom of the corner strip.

P. B. M. 138.—Is at *Reeds Landing*, 58 feet east from the intersection of the south fence of Water street with the tangent produced of the pontoon bridge, in the northeast corner of Arthur Dunn's lot, 8 feet south from the front fence and 1·6 feet west of the east fence; being copper bolt in tile, 3 feet under ground.

P. B. M. 139.—Is top of cap on iron pipe set over P. B. M. 138.

P. B. M. 140.—Is in *Wabasha, Minn.*, on the northwest corner of Pembroke and Main streets, on The People's Bank, near the north post of door of corner entrance, directly under the brick line on the south side of the south window, in water table; being a copper bolt leaded vertically, marked the same as P. B. M. 128.

Old U. S. B. M. 62¼.—Is in *Wabasha*, at the elevator, between tracks on the north face of retaining wall and 3 feet above the corner of the wall, on the west side of runway under track to elevator, on the front part of top surface of lower corner of stone, marked B M.

Old U. S. B. M. E.—Is in *Wabasha*, on the old Commercial Hotel, on the southeast corner of Main and Bailey streets, on the north front of the hotel, on the upstream end of stone doorsill between two doors, 3½ inches out from the brick wall.

P. B. M. 141.—Is in the lower part of *Wabasha*, in Campbell's Addition, in the northwest corner of Mrs. E. J. Dugan's lot, just above T. B. M. 96, 1·2 feet from the west fence and 1·6 feet south from the street fence; being a copper bolt in tile, 3 feet under ground.

P. B. M. 142.—Is top of cap on iron pipe set over P. B. M. 141.

P. B. M. 143.—Is on *Teepeeota Point*, in the northeast corner of David Pugh's yard, 1½ feet from the east fence and 22 feet south from corner of fence, 102 feet from the northeast corner of the house and 89 feet from river; being a copper bolt in tile.

P. B. M. 144.—Is top of cap on iron pipe set over P. B. M. 143.

P. B. M. 145.—Is on the right bank, 1¼ miles above *Alma*, at the lower line of dike closing chute behind Island 36, about 20 feet east of T. B. M. 102 and 60 feet back from river bank, midway between elm tree and elm stub, both blazed toward the P. B. M.; being top of copper bolt leaded in tile and set 3 feet below surface of ground.

P. B. M. 146.—Is top of cap on iron pipe set over P. B. M. 145.

T. B. M. 104.—Is in the upper end of *Alma*, 30 feet toward river from center of track of the Chicago, Burlington and Northern Railway, on foundation of water tank on the northeast corner of the northwest pier, opposite Aultman Taylor's machine warehouse; being the highest point in square, marked U □ S.

P. B. M. 147.—Is in the upper end of *Alma, Wis.*, on the foundation of the Chicago, Burlington and Northern water tank, at the same tank as T. B. M. 104, in the south part of the southeast stone base; being top of copper bolt leaded vertically, marked the same as P. B. M. 128.

Old U. S. B. M. 1.—Is at *Alma, Wis.*, on the river front of John Harry's brick store, near the downstream end of stone window base; being highest point in circle cut in stone, ⊙.

Old U. S. B. M. 3.—Is at *Alma, Wis.*, on the west side of the main street, in the front of Mr. Fritsche's brick store, on the downstream window sill; being a circle cut in stone, ⊙.

P. B. M. 148.—Is at *Alma, Wis.*, on the east side of the main street, in water table of Commercial Hotel, at the south side of entrance, 6 inches below the iron column; being top of copper bolt leaded vertically, marked the same as P. B. M. 128.

Old U. S. B. M. 4.—Is in the lower end of *Alma*, opposite the sawmill and lumber office, 60 feet above small road bridge on the east side of street, at the entrance to F. Lane's residence; being the highest point in square.

T. B. M. 105.—Is three-fourths of a mile below *Alma* sawmill, 49 feet below milepost 81, 35 feet below C. Moser's red barn, in a large embedded rock forming the north bank of north railroad ditch; being the highest point in square, marked U □ S.

P. B. M. 149.—Is three-fourths of a mile below *Alma* sawmill, at the east fence on the right of way of the Chicago, Burlington and Northern Railway, by milepost 81, in front of C. Moser's house, 16 feet below gate for farm crossing; being copper bolt leaded in tile, 3 feet below surface of ground, same place as T. B. M. 105.

P. B. M. 150.—Is top of cap on iron pipe set over P. B. M. 149, about a foot above ground.

T. B. M. 107.—Is 2 miles below *Alma* sawmill, in the highway, about 8 feet west of the east road fence and 60 feet above the small white house at the east roadside, 13 feet northwest of the northwest corner of Anton Loetsche's yard; being the highest point in square, on embedded rock, marked U □ S.

P. B. M. 151.—Is about 2¾ miles below *Alma* sawmill, 984 feet below bridge 445, and 787 feet below milepost 83, at the west fence on the right of way of the Chicago, Burlington and Northern Railway, directly opposite the large barn with stone foundation and basement owned by Mr. Bartsch, and midway between two prominent points of bluff. It is 3 300 feet below T. B. M. 108 and 45 feet from center of track; being a copper bolt in tile, 3 feet under ground.

P. B. M. 152.—In top of cap on iron pipe set over P. B. M. 151.

P. B. M. 153.—Is 2 493 feet below the depot at *Cochrane*, at the mouth of Rose Valley, at road crossing, on the right of way of the Chicago, Burlington and Northern track, in corner of fence on the east side of track below the road; being a copper bolt in tile 3 feet below the surface of ground.

P. B. M. 154.—Is top of cap on iron pipe set over P. B. M. 153.

T. B. M. 117.—Is 5¼ miles above the limekiln at the upper end of *Fountain City, Wis.*, at the northeast corner of August Bensel's wagon house, on base stone; being highest point in square.

P. B. M. 155.—Is 3¾ miles above the limekiln at the upper end of *Fountain City*, at the farm residence of Peter Suter, 28 feet above the center of the railroad viaduct No. 439 over the wagon road, and 25 feet southwest from the center of the Chicago, Burlington and Northern track; being top of copper bolt in tile 3 feet below surface of ground.

P. B. M. 156.—Is top of cap on iron pipe set over P. B. M. 155.

T. B. M. 121.—Is about 1¼ miles above the limekiln at the upper end of *Fountain City*, on the east side of highway, 200 feet below railroad bridge No. 437 over Maumandee Creek, in front of the southwest corner of Martin Ludwig's yard, on the opposite side of the road, and 79 feet from P. B. M. 157; being the highest point in square, on embedded stone, marked U □ S.

P. B. M. 157.—Is on the opposite side of the road and 79 feet from T. B. M. 121, about 1¼ miles above the limekiln at the upper end of *Fountain City*, 331 feet below the south end of the Chicago, Burlington and Northern bridge No. 437, over Maumandee Creek, on the right of way of the Chicago, Burlington and Northern Railway, at the east fence; being top of copper bolt leaded in tile and set 3 feet below surface of ground.

P. B. M. 158.—Is top of cap on iron pipe set over P. B. M. 157.

T. B. M. 122.—Is in the upper end of *Fountain City*, just east of the limekiln, on the upper side of bridge No. 433, in the east end of cap directly over pile; being the south one of two spikes, with a square around it.

Old U. S. B. M. 1 H. W. G.—Is at *Fountain City, Wis.*, 30 feet below bridge 428 of the Chicago, Burlington and Northern Railway, 50 feet east from center of track, on the south side of Eagle street, which leads to the steamboat landing, at the southwest corner of Bohrie's warehouse, on foundation stone, marked B. M.; being the highest point of square within the circle cut in stone.

Old U. S. B. M. A.—Is in *Fountain City, Wis.*, on the northwest corner of Main and Eagle streets, at the southeast corner of Sherer's Hotel, on the water table; being the highest point of triangle inside of circle, marked B. M.

P. B. M. 159.—Is in *Fountain City, Wis.*, east of Eagle street, on the south side of Main street, on Charles Niemann's saloon, on the upper end of window sill; being the top of copper bolt leaded vertically, and marked

U S
⊙
P B M

T. B. M. 123.—Is 1¾ miles below Eagle street, *Fountain City*, 52 feet above milepost 98 and 10 feet northeast from center of track, on a ledge of rock at about the same elevation as the track; being highest point in square, marked U □ S.

P. B. M. 160.—Is 1¾ miles below Eagle street, *Fountain City*, 2 362 feet below the Chicago, Burlington and Northern bridge No. 221 and 31 feet northeast from milepost 98, below large curve in railroad line, on the right of way, 1 foot from wire fence; being copper bolt leaded in tile, 3 feet below the ground.

P. B. M. 161.—Is top of cap on iron pipe set over P. B. M. 160, about 1 foot above ground.

T. B. M. 124.—Is at mouth of slough opposite *Island 65*, 1 453 feet below milepost 99 and 840 feet below bridge 418, at the upper end of cut below Jack Cook's house, on the bluff side of track; being the highest point in square on rock, marked U □ S.

T. B. M. 125.—Is at the head of *Island 69*, 16 feet above the overhead cable track running from the quarry to the river, on the bluff side of the Chicago, Burlington and Northern track, on large rock in side of bank; being the highest point in square, marked U □ S.

P. B. M. 162.—Is at the head of *Island 69*, 524 feet below T. B. M. 125, on the Chicago, Burlington and Northern right of way, at the east fence, about 150 feet above viaduct over road running to the low-water landing; being copper bolt in tile, about 3 feet underground.

P. B. M. 163.—Is top of cap on iron pipe set over P. B. M. 162.

T. B. M. 126.—Is behind *Island 69*, 12 feet northeast from the Chicago, Burlington and Northern track, 715 feet below milepost 101 and 1 148 feet above bridge 415, on embedded rock; being the highest point in square, marked U □ S.

T. B. M. 127.—Is opposite *Winona, Minn.*, on the east side of the Chicago, Burlington and Northern Railway, 3 280 feet above its crossing with the Chicago and Northwestern Railway, 1 640 feet above bridge 413, over slough, behind and 49 feet from milepost 102 in cut, on large rock in foot of bank, marked U □ S; being the highest point in square.

P. B. M. 164.—Is on the left bank of the river, opposite *Winona*, on the right of way of the Chicago and Northwestern Railway, at the east fence, 279 feet north from the north end of bridge over the Mississippi; being a copper bolt in tile, 3 feet under ground.

P. B. M. 165.—Is top of cap on iron pipe set over P. B. M. 164.

Old U. S. B. M. XVII.—Is at *Winona*, on the left bank of the river, in the abutment of the Chicago and Northwestern Railway bridge, at the upper side of the downstream bedplate of the northeast post, on line with the five rivets; being the highest point in square.

P. B. M. 166.—Is at *Winona*, on the north end of the Chicago and Northwestern Railway bridge, on the west end of first pier south of abutment, 4 feet from the north face and 2 feet from end of pier; being top of copper bolt leaded vertically, and marked

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P B M

P. B. M. 167.—Is in *Winona*, on the north wing wall, land abutment of the Chicago and Northwestern Railway bridge, on the seventh stone step from the top, 5 inches back from its north face and 7 inches from the west face of the sixth step; being top of coppper bolt leaded vertically, marked

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P B M

New gauge at *Winona*.—On the Chicago and Northwestern Railway bridge, on the pier at the south end of drawbridge, at the lower part of its river face, dressed in the masonry to feet and tenths.

Old U. S. B. M. b.—Is in *Winona*, on the down-river side of the Winona waterworks engine house, on the river end of the stone doorsill of door toward river; being the highest point in circle.

Winona City B. M.—Is in *Winona*, *Minn.*, at the entrance to the waterworks standpipe, on the west end of bottom step; being marked by a light cross.

Old U. S. B. M.—Is in *Winona*, on the east face of water tower, on the bottom surface of a deep notch cut in base stone about 2 feet above ground; being the highest point in square, on river side of old line.

P. B. M. 168.—Is in *Winona*, *Minn.*, in the courthouse, on the north front of the west window sill, about 1 foot above ground; being top of copper bolt leaded vertically, marked

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P B M

Old U. S. B. M. B—Of gauge record, is in *Winona*, on the southwest corner of East Front and Franklin streets, opposite L. C. Porter's mill, at the front door of brick office on the downstream end of step; being the highest point in square.

Old U. S. B. M. on Liberty and Second streets.—Is in *Winona*, on the southwest corner of East Second and Liberty streets, on the upstream end of the west window sill, 19·7 feet west from the east corner of building; being the high point in rear part of square.

Old U. S. B. M. on Keys's barn.—In lower *Winona*, 492 feet above the Winona and Southwestern and Chicago, Burlington and Northern Railway bridge across the Mississippi, on the north side of approach, just in the rear of Mr. Keys's house, on brick barn, on the upstream end of the stone window sill of window facing river; being the high point in rear part of old square.

P. B. M. 169.—Is in lower *Winona*, on the Winona and Southwestern and Chicago, Burlington and Northern Railway bridge, on the upstream end of the first pier from the abutment, on the southwest corner of coping stone; being top of copper bolt leaded vertically, marked

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P B M

P. B. M. 170.—Is at *Minneopa*, below Winona, on the southwest side of the Chicago, Milwaukee and St. Paul track, 82 feet below the lower end of bridge over Pine Creek, which is the first creek below Winona, in E. A. Goodfellow's front yard, about 45 feet below T. B. M. 129, 1½ feet southwest from front fence; being a copper bolt in tile 3 feet underground.

P. B. M. 171.—Is top of cap on iron pipe set over P. B. M. 170.

T. B. M. 130.—Is 2·6 miles below the Winona and Southwestern Railway bridge across the Mississippi at lower *Winona*, 3 182 feet above Homer and 1 804 feet below milepost 117 of the Chicago, Milwaukee and St. Paul track, 10 feet northeast from the center, at the mouth of a wooden box drain, on a large rock; being the highest point in the square marked U □ S.

T. B. M. 131.—Is 2 920 feet below station *Homer*, and 1 686 feet below bridge 42, 10 feet southwest from center of track, 367 feet below P. B. M. 172 and 173, on rock; being the highest point in a square, marked U □ S.

P. B. M. 172.—Is 2 552 feet below station *Homer*, on the bluff side of the Chicago, Milwaukee and St. Paul track, 1 foot east from the fence, in front of Mr. William Besner's brick house, on the hill, opposite a lone hickory tree standing on the bluff side of the wagon road; being a copper bolt in tile 3 feet below surface of ground.

P. B. M. 173.—Is top of cap on iron pipe set over P. B. M. 172.

T. B. M. 132.—Is opposite the foot of *Island 75*, on the line of Chicago, Milwaukee and St. Paul track, 2 371 feet above milepost 120, 15 feet north from the center of track on embedded rock, marked U □ S; being the highest point in square.

T. B. M. 133.—Is opposite the closing dike of *Island 76*, 594 feet below bridge 36, on the line of the Chicago, Milwaukee and St. Paul track, 15 feet north from center, on an embedded rock, marked U □ S; being the highest point in square.

P. B. M. 174.—Is 2¾ miles below *Homer*, opposite the end of closing dike behind Island 76, 656 feet below bridge 36, on the Chicago, Milwaukee and St. Paul right of way, at the bluff side fence, and 984 feet below milepost 120; being a copper bolt in tile 3 feet under ground, 75 feet more or less below T. B. M. 133, and about 15 feet above grade of track.

P. B. M. 175.—Is top of cap on iron pipe set over P. B. M. 174.

T. B. M. 135.—Is opposite the foot of Island 77, 4 593 feet above *Lamoille*, 1 952 feet below center of bridge 32 of the Chicago, Milwaukee and St. Paul track, and 1 666 feet above milepost 122 from St. Paul, at the upper end of cut, 8 feet northeast from center of track, on an embedded bowlder, marked U □ S; being the highest point in square.

P. B. M. 176.—Is at *Lamoille, Minn.*, 154 feet above the Chicago, Milwaukee and

St. Paul depot, at foot of bluff, 50 feet southwest from center of track, 35 feet above the upper end of bridge, and 69 feet below the frame house; being top of a copper bolt in tile.

P. B. M. 177.—Is top of cap on iron pipe set over P. B. M. 176.

T. B. M. 142.—Is about 1 mile above *Richmond*, at E. Leach's crossing, just above the upper roadside fence, 15 feet east of center of track, on an embedded bowlder; being the highest point in square, marked U □ S.

P. B. M. 178.—Is in *Richmond*, *Minn.*, 1 900 feet below bridge 16 and 615 feet above the upper end of siding, 101 feet above the upper end of Jacob Danenhower's house, 105 feet below the lower end of barn, 47 feet west of center of the Chicago, Milwaukee and St. Paul track; being top of copper bolt in tile set 3 feet below surface of ground.

P. B. M. 179.—Is top of cap on iron pipe set over P. B. M. 178.

T. B. M. 144.—Is in front of Queens Bluff in *Richmond*, 639 feet above milepost 127, about the center of siding, 12 feet east of track center, on the ledge of rock in small cut, being highest point in square, marked U □ S.

T. B. M. 146.—Is 2¼ miles above *Dakota*, just above Island 90, 656 feet above Henry Winter's house, on the line of the Chicago, Milwaukee and St. Paul Railway, 12 feet west of center of track; being the highest point in square, marked U □ S.

P. B. M. 180.—Is about 1½ miles below *Richmond*, 787 feet below the line of dike above the head of Island 90, and 285 feet above the house of Henry Winters, directly opposite the farm crossing, 39 feet from center of track toward the river, also 39 feet back from top of river bank; being copper bolt in tile, 3 feet underground.

P. B. M. 181.—Is top of cap on iron pipe set over P. B. M. 180.

P. B. M. 182.—Is at *Dakota*, *Minn.*, 656 feet above the Chicago, Milwaukee and St. Paul Depot, and 430 feet below milepost 131, on the west side of wagon road, 262 feet west from center of track on line with the stone fence in front of Amos Shay's residence, and 13 feet above its upper end, also 69 feet from a lone blazed cottonwood tree standing on the east side of wagon road, engraved

U S
P B M

being copper bolt in tile, 3 feet underground.

P. B. M. 183.—Is top of cap on iron pipe set over P. B. M. 182.

Old U. S. B. M. 131.—Is in *Dakota*, *Minn.*, 269 feet below the Chicago, Milwaukee and St. Paul Depot, 9½ feet west from center of track, on the water-tank foundation, at the lower side, front pier, on the southeast corner of base stone; being the highest point in circle ⊙.

Old U. S. B. M. 130½.—Also called Old P. B. M. 18, is in the upper end of *Dresbach*, on the east end of stone culvert, under high fill, 200 feet from the river, on the southeast corner of coping stone; being the highest point in circle cut on the sandstone.

P. B. M. 184.—Is in *Dresbach*, *Minn.*, on the northwest corner of Second and G streets, on the front of R. Remp's brick store, on the south end of the stone doorstep; being the top of copper bolt leaded vertically, marked

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P B M

T. B. M. 151.—Is about 3 609 feet below *Dresbach*, and 2 792 feet below milepost 133, on line of Chicago, Milwaukee and St. Paul Railway track, 12 feet east from center, on an embedded bowlder; being highest point in square, marked U □ S.

P. B. M. 185.—Is about 3 609 feet below *Dresbach*, on opposite side of track from T. B. M. 151, 425 feet below Henry Becker's house, and 280 feet above his limekiln, 62·7 feet below the head block at upper end of siding, at west fence, and 48·7 feet west from center of track; being copper bolt in tile, 3 feet underground.

P. B. M. 186.—Is top of cap on iron pipe set over P. B. M. 185.

T. B. M. 153.—Is at the mouth of *Dresbach* Slough, 1 079 feet above milepost 135, on the bank of the Chicago, Milwaukee and St. Paul Railway track, 12 feet west from center, on a rock marked U □ S; being the highest point in square.

T. B. M. 154.—Is 1¾ miles above *River Junction*, on the line of the Chicago, Milwaukee and St. Paul Railway track, about 100 feet above Ferndale Cottage, and 65 feet below the very large and conspicuous bowlder on the west side of west ditch, 196 feet above milepost 136, on an embedded bowlder, marked U □ S; being the highest point in square.

P. B. M. 187.—Is above *La Crescent, Minn.*, about 1 320 feet above the depot at River Junction, and 915 feet above the head block at the lower end of siding, 400 feet below J. A. Selzer's stone house, and 95 feet above Mr. Edwards's house, on the bluff side of the Chicago, Milwaukee and St. Paul Railway track, 66 feet from center, and 48 feet from side track; being copper bolt in tile, 3 feet underground.

P. B. M. 188.—Is top of cap on iron pipe set over P. B. M. 187.

T. B. M. 155.—Is above *La Crescent*, and 590 feet above River Junction depot, 50 feet west from the center of the Chicago, Milwaukee and St. Paul Railway track, on a land monument, which is a square stone set in the ground, and standing 2 feet above surface, marked on top with a diagonal line and a figure 3; being the highest point in the upper part of the figure 3.

Old U. S. B. M. 139.—Also called old P. B. M. 19, is on the right bank, on the west pier of the Chicago, Milwaukee and St. Paul Railway bridge, across the Mississippi above *La Crosse, Wis.*, on the upstream point or nose of capstone; being the highest point in small square in the south part of old circle.

P. B. M. 189.—Is on the west pier of the Chicago, Milwaukee and St. Paul Railway bridge above *La Crosse*, on the same pier as old B. M. 139, lower side of track, on the downstream end of capstone; being a copper bolt leaded vertically, marked

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P B M

P. B. M. 190.—Is on the east pier of the Chicago, Milwaukee and St. Paul Railway bridge, over the east channel of the Mississippi River above *La Crosse*, on the downstream side directly south from center of shoe, 9 inches from face of stone; being top of copper bolt leaded vertically, marked the same as P. B. M. 189.

T. B. M. 157.—Is in *North La Crosse*, in the west pier of drawbridge, over Black River No. 0, in the north end of pier; being highest point in square cut on coping stone.

P. B. M. 191.—Is in *North La Crosse*, on the Chicago, Milwaukee and St. Paul Railway bridge No. 0, over Black River, in the south side of the east pier, 15 inches from the southwest corner; being top of a copper bolt leaded vertically, marked the same as P. B. M. 189.

T. B. M. 158.—Is in *North La Crosse*, near the entrance to the Chicago, Milwaukee and St. Paul roundhouse, in the water-tank foundation stone, the northwest pier, on beveled edge of the top stone in broken square, marked U □ S.

La Crosse City B. M.—Is on the west side of Front street between Main and Pearl streets, on the southeast corner of old building joined to the south side of stone building, on the top surface of water table, 0·7 foot above the lower corner; being the highest point in square. The building is occupied by "S. Becker, commission and produce."

P. B. M. 192.—Is in *La Crosse, Wis.*, on the United States post office building, on the northeast corner of Fourth and State streets, at the south side of the south one of three doors fronting on Fourth street; being the door next to the tower, a copper bolt leaded vertically in the doorstep, marked the same as P. B. M. 189.

T. B. M. 160.—Is in *La Crosse*, on the west side of the Chicago, Burlington and Northern depot, on the Second street side, at the south side of second door above the south end of main building; being the highest point in square, marked U □ S.

La Crosse City B. M.—At east end of bridge, is in *La Crosse* just north of the land pier to wagon bridge across the Mississippi, on the southwest corner of the small brick building, 1 foot above the south corner and 0·8 foot above the ground; being the bottom of a notch cut in the brick.

P. B. M. 193.—Is in *La Crosse* in the west face of the land pier to the highway bridge across the Mississippi, 5 feet from its north end and 3·5 feet above ground; being the center of a copper bolt leaded horizontally, marked

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P B M

T. B. M. 161.—Is in *La Crosse*, one-half mile below the highway bridge across the Mississippi, on the southeast corner of First and Market streets, on the brick building of the La Crosse Soap Company, on the First street front, on the south end of a stone doorstep; being highest point in square, marked U □ S.

T. B. M. 162.—Is in the south end of *La Crosse*, on John Gund's stone brewery, 60 feet south from center of track, 8·4 feet west from the east corner, on the sloping water table; being highest point in square, marked U □ S.

P. B. M. 194.—Is on the line of the Chicago, Burlington and Northern Railway, 2 miles below the brewery at south end of *La Crosse*, on the right of way at the west wire fence, opposite South Junction depot, and 33 feet south of the same; being copper bolt in tile, 3 feet underground.

P. B. M. 195.—Is top of cap on iron pipe set over P. B. M. 194.

P. B. M. 196.—Is 3¾ miles above *Stoddard, Wis.*, on the line of the Chicago, Burlington and Northern Railway, 870 feet above milepost 140, about one-half mile below Jack Branak's house and saloon, and one-fifth mile above Carl Bay's house, 21 feet below the gate to farm crossing, on right of way, 2 feet from the east fence; being copper bolt in tile, 3 feet underground.

P. B. M. 197.—Is top of cap on iron pipe set over P. B. M. 196.

T. B. M. 170.—Is 2¼ miles above *Stoddard, Wis.*, 2 526 feet below milepost 141, 15 feet east of center of track, about half way through large cut on embedded bowlder; being the highest point in square, marked U □ S.

T. B. M. 172.—Is about 3 281 feet above *Stoddard*, near the upper end of the first tangent above the depot, 853 feet below milepost 143, and 328 feet below the farm crossing, 25 feet east from center of the Chicago, Burlington and Northern track, on embedded bowlder; being the highest point in square, marked U □ S.

P. B. M. 198.—Is in *Stoddard, Wis.*, on foundation to water tank, on the northeast corner of the northeast pier; being top of copper bolt leaded vertically, and marked

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P B M

P. B. M. 199.—Is at *Warners Landing*, 280½ feet up the track from O. Warner's house, 60 feet above bridge 342, and 29·2 feet east of the center of the track, on the Chicago, Burlington and Northern Railway right of way, at the east fence; being copper bolt in tile, 3 feet underground.

P. B. M. 200.—Is top of cap on iron pipe set over P. B. M. 199.

T. B. M. 175.—Is at *Britts Landing*, 75 feet above milepost 147, on the east side of track, on a rock; being the highest point in square, marked U □ S.

P. B. M. 201.—Is 1⅝ miles above *Genoa*, 351 feet below bridge 333, and 1 837 feet above milepost 148, on the right of way of the Chicago, Burlington and Northern Railway, at the east fence, between road and highway, in front of Frank Riley's property; being copper bolt in tile, 3 feet underground.

P. B. M. 202.—Is top of cap on iron pipe set over P. B. M. 201.

T. B. M. 177.—Is 1½ miles above *Genoa* depot, on line of the Chicago, Burlington and Northern Railway, 2 516 feet below milepost 148, and 656 feet above P. B. M. 201 and 202, 12 feet east of center of track on a large rock; being highest point in square, marked U □ S.

T. B. M. 178.—Is one-half of a mile above *Genoa, Wis.*, 2 326 feet below milepost 149, in front of the large stone house of John Franzini, on rough bowlder on the east side of the highway which runs along east of railroad; being the highest point in square, marked U □ S.

P. B. M. 203.—Is in *Genoa, Wis.*, on the west side of the main street, in front of Albert Zabolio's store, on the stone doorstep of the upstream door, near the southeast corner step; being the top of copper bolt leaded vertically, marked

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P B M

Old U. S. B. M. i.—Also called old P. B. M. 21, is in *Genoa, Wis.*, on the last stone building in the town going south, on the side of the building facing the river, second floor, on the upstream corner of the stone doorsill; being the highest point in square.

T. B. M. 180.—Is 1 mile below *Genoa*, 187 feet below bridge 327, and 174 feet above milepost 151, 19 feet east of center of track; being a large spike in an oak stump.

P. B. M. 204.—Is 2¾ miles below *Genoa* and 23 feet below T. B. M. 182, 147 feet above bridge No. 322, and 93·5 feet below John T. Elger's house, on the right of way of the Chicago, Burlington and Northern Railway, 34·5 feet east from center of track, being copper bolt in tile, buried 3 feet underground.

P. B. M. 205.—Is top of cap on iron pipe set over P. B. M. 204.

T. B. M. 186.—Is at *Tippets Landing*, *Wisconsin*, 1 640 feet below Mr. Tippet's house, and 1 128 feet below the warehouse on the river bank, 12 feet west of the center of the Chicago, Burlington and Northern Railway, on an embedded rock; being the highest point in square, marked U □ S.

P. B. M. 206.—Is at *Tippets Landing*, about 150 feet below T. B. M. 186, and 1 296 feet below the old warehouse, on the east side of the Chicago, Burlington and Northern Railway, 33½ feet from the center. It is also 1 mile above Victory, in the bed of the old wagon road under the bluff used before the railroad was built; being top of copper bolt leaded in tile, set 3 feet underground.

P. B. M. 207.—Is top of cap on iron pipe set over P. B. M. 206.

P. B. M. 208.—Is in *Victory*, *Wis.*, on the southeast corner of block 17 and at the northeast corner of Terhune and Rice streets, on the south abutment, west side of wagon bridge, on the corner top stone, 3 inches from end of wall; being top of copper bolt leaded vertically, marked the same as P. B. M. 203.

T. B. M. 188.—Is 1 mile below *Victory* Depot, on line of the Chicago, Burlington and Northern Railway, 2 100 feet above milepost 158 and 197 feet above bridge No. 309, 30 feet east of center of track, on an embedded bowlder, marked U □ S; being the highest point in square.

P. B. M. 209.—Is 2½ miles above *De Soto*, 164 feet east from bridge No. 307, over Battle Creek and 36 feet east of wagon road, at the north side of north wire fence of lane leading from Richard Valliant's house; being copper bolt in tile buried about 3 feet underground.

P. B. M. 210.—Is top of cap on iron pipe set over P. B. M. 209.

T. B. M. 192.—Is about a mile above *De Soto*, *Wis.*, 1 138 feet above milepost 160, in cut 12 feet east from the center of the Chicago, Burlington and Northern Railway, on an embedded bowlder; being the highest point in square, marked U □ S.

T. B. M. 193.—Is in the upper end of *De Soto*, at the warehouse formerly owned by C. Lytel & Co., now owned by the De Soto Lumber Company, on the south end of the south top stone of pier supporting runway over the Chicago, Burlington and Northern Railway track, 7·2 feet east from the center of track; being highest point in square marked U □ S.

P. B. M. 211.—Is in the upper end of *De Soto*, on the north side of the Diamond Joe Warehouse, 9 inches from the west side and 5·3 feet above the ground; being the center mark in copper bolt leaded horizontally, marked

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P B M

P. B. M. 212.—Is in *De Soto*, in the foundation of water tank of the Chicago, Burlington and Northern Railway, in top stone of the south one of the two west piers; being top of copper bolt leaded vertically, marked the same as P. B. M. 211.

T. B. M. 195.—Is 1¾ miles below *De Soto*, 860 feet below bridge No. 298 and 360 feet below milepost 163, 15 feet west of center of track; being highest point in square on rock, marked U □ S.

P. B. M. 213.—Is 1¾ miles below *De Soto* and 394 feet below milepost 163, at the upper end of the stretch where the Winneshiek Slough comes back to the railroad, on the right of way of the Chicago, Burlington and Northern Railway, at the west fence, 26 feet from center of track at lower end of the rock cut and 32 feet below T. B. M. 195; being copper bolt in tile set about 3 feet below surface of ground.

P. B. M. 214.—Is top of cap on iron pipe set over P. B. M. 213.

T. B. M. 196.—Is about 2 miles below *De Soto*, 1 315 feet above milepost 164, 361 feet above bridge No. 294, and 90 feet above an exceedingly large rock at the east railroad fence, in a small cut at the foot of the east slope, 12 feet from the center of the Chicago, Burlington and Northern Railway, on an embedded bowlder; being the highest point in square, marked U □ S.

T. B. M. 197.—Is 1½ miles above *Rush Creek*, 2 699 feet below milepost 164 and 60 metres above the small waterway under bridge No. 291, directly under a very prominent point of bluff on the east side of the Chicago, Burlington and Northern Railway, 20 feet from the center, on a large flat rock, embedded and inclining toward the south; being the highest point in square, marked U □ S.

T. B. M. 198.—Is about 2½ miles above *Ferryville* depot of the Chicago, Burlington and Northern Railway, in *Wisconsin*, and 88 metres below milepost 166, also 377 feet below the south end of long trestle over Rush Creek, on the east side of the Chicago, Burlington and Northern Railway, at the right-of-way fence, 17 feet from center of track, on a large rock embedded; being the highest point in square, marked U □ S.

P. B. M. 215.—Is about 2½ miles above *Ferryville* depot, *Wis.*, 18 feet below T. B. M. 198, 394 feet below the lower end of long trestle over Rush Creek, and 94 metres below milepost 166, opposite a blazed elm standing on the east side of wagon road; also 328 feet below a blazed elm between railroad and wagon road near south end of trestle; being a copper bolt in tile about 3 feet underground.

P. B. M. 216.—Is top of cap on iron pipe set over P. B. M. 215.

T. B. M. 200.—Is 4 593 feet above *Ferryville*, on line of the Chicago, Burlington and Northern Railway, near the upper end of the first cut above Ferryville, 1 256 feet above milepost 168 and 213 feet above bridge No. 282, 10 feet east of center of track, on a large, flat rock embedded; being the highest point in square, marked U □ S.

P. B. M. 217.—Is in *Ferryville*, *Wis.*, 164 feet above the Chicago, Burlington and Northern depot and 29½ feet east of center of track, 39 feet from the southeast corner of J. S. Oleson's house and store, all at the upper side of road crossing; being a copper bolt in tile set 3 feet underground.

P. B. M. 218.—Is top of cap on iron pipe set over P. B. M. 217.

T. B. M. 202.—Is 1½ miles below *Ferryville*, at the lower end of a light cut, 256 feet below milepost 170, 12 feet west of the Chicago, Burlington and Northern track, on a hard gray sandstone, embedded and marked U □ S; being the highest point in square.

T. B. M. 204.—Is 4 miles below *Ferryville*, *Wis.*, at the place where the Winneshiek Slough comes into railroad, 1 247 feet below milepost 172, on the north side of bridge No. 273, east of track, at corner of fence, on an embedded bowlder, marked U □ S; being the highest point in square.

P. B. M. 219.—Is 4 miles below *Ferryville*, *Wis.*, at the place where the Winneshiek Slough comes into railroad, opposite the south end of bridge No. 273, 46 feet east from the center of the track, 15 feet west from wagon road, and 15 feet south from center of bridge or "cattle pass," in the corner of fence; being a copper bolt in tile 3 feet underground.

P. B. M. 220.—Is top of cap on iron pipe set over P. B. M. 219.

P. B. M. 221.—Is about 1¼ miles above *Lynxville, Wis.*, at Coopers Coulee, 731 feet above bridge 269 and 56 feet above milepost 175, 35 feet west of center of the Chicago, Burlington and Northern Railway track, outside of right of way, about 1½ feet from fence and 25 feet east from a forked oak tree; being a copper bolt in tile set about 3 feet underground.

P. B. M. 222.—Is top of cap on iron pipe set over P. B. M. 221.

T. B. M. 206.—Is about 10 feet down the track from P. B. M. 222, 1¼ miles above *Lynxville*, at the upper side of Coopers Coulee, 722 feet above bridge No. 269 and 46 feet above milepost 175, 12 feet west of center of the Chicago, Burlington and Northern Railway track, on embedded rock, marked U □ S; being highest point in square.

T. B. M. 207.—Is in the north end of *Lynxville*, at the Chicago, Burlington and Northern depot, on foundation stone of water tank, on the south one of the two west piers; being top of copper bolt leaded vertically, marked

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P B M

Old U. S. B. M.—Is on Bright's warehouse, in *Lynxville, Wis.*, on the northeast corner of warehouse, 984 feet below the Chicago, Burlington and Northern Railway depot, on top of foundation; being the highest point in circle, marked B ⊙ M.

P. B. M. 223.—Is in *Lynxville, Wis.*, on the north side of the principal street running back from the river, on the south front of Mr. King's brick store, in the east end of the doorsill; being top of copper bolt leaded vertically, and marked the same as P. B. M. 207.

T. B. M. 209.—Is about three-fourths of a mile below *Lynxville*, 623 feet below bridge No. 266, in the middle of light cut, 66 feet below milepost 177, on the west side of the Chicago, Burlington and Northern Railway track, 12 feet from center, on large embedded bowlder, marked U □ S; being the highest point in square.

T. B. M. 211.—Is at *Viola*, about 3¼ miles below Lynxville, 1 345 feet below bridge 261, near the upper end of the first cut, 525 feet below Mr. Caya's house, just above a large cubical rock lying at water's edge, and 12 feet east from center of track of the Chicago, Burlington and Northern Railway, on a rock marked U □ S; being highest point in square.

P. B. M. 224.—Is at *Viola*, about 3⅛ miles below Lynxville, 909 feet below bridge No. 261, being 43·6 feet above T. B. M. 211, in the southwest corner of Mr. Caya's dooryard, 95 feet from the southwest corner of his red frame house, 50 feet southeast from track, and 1 foot north from line of fence; being a copper bolt in tile set 3 feet under ground.

P. B. M. 225.—Is at *Viola;* being top of cap on iron pipe set over P. B. M. 224.

T. B. M. 212.—Is one-half mile below *Viola*, 702 feet above milepost 180, 9·3 feet east of the center of the Chicago, Burlington and Northern Railway track, on natural ledge of rock, marked U □ S; being the highest point in square.

T. B. M. 213.—Is 1½ miles below *Viola*, about in center of the first cut below bridge No. 260, 639 feet distant, and 1 529 feet above milepost 181, 3 feet above grade on natural ledge of rock, marked U □ S on face; being the highest point in square.

T. B. M. 215.—Is about 1 mile above *Charme, Wis.*, on the line of the Chicago, Burlington and Northern Railway, at the lower end of wooded point of land at shore, and 689 feet below the large flat piece of ledge standing on edge between railroad and river, 16 feet high; it is also 55 metres below bridge No. 256, and 1 959 feet above milepost 183, 30 feet from center of track, on an embedded bowlder, marked U □ S; being the highest point in square.

P. B. M. 226.—Is about 1 mile above *Charme, Wis.*, on the line of the Chicago, Burlington and Northern Railway, at the lower end of wooded strip at shore, 689 feet below the large flat piece of ledge standing on edge between railroad and river, 16 feet high. It is also 1 959 feet above milepost 183, and 180 feet below bridge No. 256, at the east railroad fence, directly behind T. B. M. 215; being a copper bolt in tile set 3 feet below the surface of ground.

P. B. M. 227.—Is top of cap on iron pipe set over P. B. M. 226.

P. B. M. 228.—Is 984 feet below *Charme* station, one-half mile above Mr. Valley's house, and 656 feet above the lower end of siding behind the center of Island 164, 10 feet east of the center of track and 4 feet above grade, in face of natural ledge of rock, marked

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being center of copper bolt leaded horizontally.

T. B. M. 216.—Is 984 feet below *Charme* depot and one-half mile above Mr. Valley's house, about 10 feet east of center of track and 15 or 20 feet below P. B. M. 228, on natural ledge of rock, marked U □ S; being highest point in square.

T. B. M. 218.—Is 1½ miles below *Charme*, 518 feet below milepost 185, and 492 feet above bridge No. 246, at the north edge of farm crossing, on an embedded bowlder, 25 feet east of the center of the Chicago, Burlington and Northern Railway; being the highest point in square, marked U □ S.

P. B. M. 229.—Is 3 miles below *Charme*, on G. L. Miller's place, now occupied by M. Sage, 257 feet below section post 30–29, 72 feet above bridge No. 243, 127 feet from the southwest corner of the house, and 95 feet from the northeast corner of barn, on the Chicago, Burlington and Northwestern Railway right of way, 18 inches east of the west fence; being copper bolt in tile 3 feet below surface of ground.

P. B. M. 230.—Is top of cap on iron pipe set over P. B. M. 229.

P. B. M. 231.—Is in *Prairie du Chien, Wis.*, in the northeastern part of the town, on the west end of St. Gabriel's Catholic Church, 19 inches from the north side, and 4 feet above ground; being a horizontal copper bolt leaded in the masonry, marked

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T. B. M. 225.—Is in the northeastern part of *Prairie du Chien*, on the east side of the street, and about 75 feet south of St. Gabriel's Catholic Church, at the street entrance to Father Kramer's residence, on the southeast corner of the large stone step, marked U □ S; being the highest point in square.

T. B. M. 226.—Is in *Prairie du Chien*, on the east end of the Chicago, Milwaukee and St. Paul Railway bridge across the Mississippi River, on the south end of cap over the piles at end; being top of drift bolt over pile, marked with a square □.

P. B. M. 232.—Is in *Prairie du Chien*, 2 100 feet below the east end of the Chicago, Milwaukee and St. Paul Railway bridge across the Mississippi River at the river front of the Dousman House, on the upper end of the stone window sill of the first window below the upper entrance; being the top of a copper bolt leaded vertically, and marked

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Old U. S. B. M. a.—Is in *Prairie du Chien*, on the Dousman House, on the downstream end of the downstream doorsill; being the highest point in circle cut in stone.

T. B. M. 227.—Is in *North McGregor, Iowa*, 131 feet below the depot, 8 feet east from the southeast corner of the small wagon road and footbridge, and 6 feet below the floor on the river end of south abutment; being the highest point in square, marked U □ S.

P. B. M. 233.—Is in *North McGregor*, on the north side of North street, in O. A. Bratsberg's brick store, in the water table 1 foot east from the entrance, marked the same as P. B. M. 232; being top of copper bolt leaded vertically.

T. B. M. 228.—Is in *South McGregor, Iowa*, at the northwest corner of Main street and the railroad, at the sidewalk entrance to Gregor McGregor's residence, on the river end of bottom step, on a level with the sidewalk, marked U □ S; being the highest point in square.

P. B. M. 234.—Is in *South McGregor, Iowa*, on the north side of Main street, just above the Masonic block, in brick building occupied by the Elbling Cigar Manufactory, in stone doorsill 2 feet from the southwest corner of building, and 4·5 inches back from the front line; being top of copper bolt leaded vertically, and marked the same as P. B. M. 232.

P. B. M. 235.—Is in *South McGregor, Iowa*, southwest from the little park in center of the town, in the west end of the brick building owned by Mrs. J. Reynolds, and now occupied by the Huntington Grain Firm, 23 inches south from the northwest corner and 4 feet and 10 inches above the ground; being center mark of copper bolt leaded horizontally, and marked the same as P. B. M. 232.

T. B. M. 230.—Is about 1¾ miles below *South McGregor* and 55 metres above milepost 66, on the bluff side of the Chicago, Milwaukee and St. Paul Railway, 15 feet from the center, on a large prominent bowlder, marked U □ S; being the highest point in square.

P. B. M. 236.—Is about 1¾ miles below *South McGregor*, 275 feet above milepost 66, directly opposite Picture Rock, on the right of way of the Chicago, Milwaukee and St. Paul Railway, 35 feet east of the center of track; being copper bolt in tile 3 feet underground.

P. B. M. 237.—Is top of cap on iron pipe set over P. B. M. 236, on opposite side of track, and 59 feet above T. B. M. 230.

T. B. M. 231.—Is about one-half mile below the mouth of Wisconsin River, on the south abutment of bridge K 382, on the river end of the second course of stone from the top, 1 foot from the northeast corner of stone, marked U □ S; being the highest point in square.

P. B. M. 238.—Is about 3¼ miles below *South McGregor*, ½ mile below the mouth of Wisconsin River, and 1 968 feet below milepost 67 of the Chicago, Milwaukee and St. Paul Railway, 45 feet west from the center of track, directly opposite the lower end of bridge K 382, in which T. B. M. 231 is located, in the steeply inclined face of hard ledge of rock, marked the same as P. B. M. 232, and is the center of a copper bolt leaded horizontally.

T. B. M. 232.—Is at the head of *Island 176*, 482 feet above milepost 68 (from La Crosse), on the south abutment of bridge 378 K, of the Chicago, Milwaukee and St. Paul Railway, at its east end, on the third course of stone from top, about 3 feet west from the east end of stone and 3 inches back from the north face, marked U □ S; being the highest point in square.

P. B. M. 239.—Is behind islands 176 and 178, on the line of the Chicago, Milwaukee and St. Paul Railway, 1 214 feet below the lower switch block of station *Sny McGill*, and 50 feet below milepost 70 from La Crosse, just east of the west right-of-way fence, 30 feet from center of track; being copper bolt in tile set 3 feet below surface of ground.

P. B. M. 240.—Is top of cap on iron pipe set over P. B. M. 239.

Old U. S. B. M. b.—Is in the upper end of *Clayton, Iowa*, on the large stone mill at the west side of the Chicago, Milwaukee and St. Paul Railway track, on the river front of the building, at the lower window and lower end of window sill; being the top of a ringbolt, 1 inch above surface.

Old U. S. B. M. also called Old P. B. M. 27.—Is at depot in *Clayton*, *Iowa*, at the Chicago, Milwaukee and St. Paul Railway depot, on the top stone of foundation pier, at the northeast corner of platform, behind center of circle ⊙.

P. B. M. 241.—Is in *Clayton*, *Iowa*, on the south side of Main street, about 656 feet back from river bank, on the southwest corner of Main and Douglas streets, on the brick building occupied by Frank Lier & Co., on east end of doorstep, marked the same as P. B. M. 232, and is top of a copper bolt leaded vertically.

T. B. M. 239.—Is about 1 mile below *Clayton*, 866 feet below milepost 74, 230 feet above wooden sand hopper, on the most northerly one of two large bowlders, 19 feet west of center of track; being the highest point in square cut on top face, 1 foot from edge, marked U □ S.

P. B. M. 242.—Is opposite the lower part of Island 182, nearly 3 miles below *Clayton*, and 141 feet below milepost 76, on the line of the Chicago, Milwaukee and St. Paul Railway, 45 feet above the highest point of heavy rock-cut waste, about in the center of long side-hill rock cut, at prominent point of bluff in the steeply inclined face of rock, 4½ feet above grade, marked the same as P. B. M. 232, and is center mark in copper bolt leaded horizontally.

T. B. M. 241.—Is in the same ledge as P. B. M. 242, about 4 feet farther down the river, and only about 2 feet above grade of track, marked U □ S on face of ledge; being the highest point in square.

P. B. M. 243.—Is ¼ of a mile below *Eckard Siding*, where the Chicago, Milwaukee and St. Paul Railway comes to the bluff, 215 feet above milepost 78–83, opposite the upper end of curve, 96½ feet west from center of track, 4½ feet from corner of fence, and between this fence and the highway which runs parallel with the railroad. It is also 82 feet above a cluster of butternut trees; being a copper bolt in tile set 3 feet below the surface of ground.

P. B. M. 244.—Is top of cap on iron pipe set over P. B. M. 243.

T. B. M. 245.—Is opposite the head of McMillan Island, on the line of the Chicago, Milwaukee and St. Paul Railway, about 1 mile below *Eckard* station, 1 722 feet above milepost 79 from La Crosse, and 722 feet above the first road crossing below Eckard, 27 feet west from center of track, on an embedded rock, marked U □ S; being the highest point in square.

P. B. M. 245.—Is about 2⅓ miles above *Guttenberg*, on the line of the Chicago, Milwaukee and St. Paul Railway, midway between bridges Nos. 284 and 286, and 2 001 feet below milepost 80, at light cut, 28·5 feet east of the center of track and 2 feet west from right-of-way fence, 30 feet west of blazed 14-inch hickory tree; being a copper bolt in tile set 3 feet underground.

P. B. M. 246.—Is top of cap on iron pipe set over P. B. M. 245.

P. B. M. 247.—Is in *Guttenberg*, on the northeast corner of Herder and First streets, on the front of Joseph Huene's general store, in doorstep, 5·8 feet from the southwest corner of the building, 4½ inches from the angle of casing, and 3½ inches back from the face of stone; being top of copper bolt leaded vertically, and marked

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P. B. M. 248.—Is in *Guttenberg*, *Iowa*, on the west side of Front street, 72·7 feet above the northwest corner of Front and Goethe streets, in the Clayton County Bank building, 8½ feet upstream from the south side of entrance way and 3·7 feet above the bottom step, marked the same as P. B. M. 247; being the center mark in copper bolt leaded horizontally.

T. B. M. 250.—Is in *Guttenberg*, *Iowa*, on the Chicago, Milwaukee and St. Paul Railway, 2 254 feet below the depot, on the upper abutment of bridge No. 274, on the river side of track, on the fourth course of stone from top, marked U □ S; being the highest point in square.

T. B. M. 252.—Is about 2¼ miles below the depot at *Guttenberg*, on the line of the Chicago, Milwaukee and St. Paul Railway, 213 feet above bridge No. 258, at the lower end of cut, 17 feet east of center of track, on an embedded bowlder, marked U □ S; being the highest point in square.

P. B. M. 249.—Is about 2¼ miles below *Guttenberg*, about 63 feet below T. B. M. 252 on the opposite side of track, 1½ feet east of the west right-of-way fence and 18 feet from the center. It is ½ mile below where the track comes to the bluff, 150 feet above bridge No. 258, at the place where wagon road turns up into coulee and 24½ feet east of center of road; being a copper bolt in tile set 3 feet below surface.

P. B. M. 250.—Is top of cap on iron pipe set over P. B. M. 249.

T. B. M. 253.—Is about 3 miles below *Guttenberg* and 3¼ miles above the point of bluff at railroad on the north side of Turkey River, on bridge No. 236, north abutment, east end, 1 foot west from end of abutment and 6 inches north of its south face, marked U □ S; being the highest point in square.

T. B. M. 254.—Is 1¾ miles above the point of bluff at Chicago, Milwaukee and St. Paul Railway, on the north side of Turkey River, 331 feet below milepost 87 (from La Crosse), 12 feet west of center of track, on ledge of rock, marked U □ S; being the highest point in square.

T. B. M. 256.—Is 1 575 feet above the Chicago, Milwaukee and St. Paul Railway bridge No. 212, over Turkey River, and 738 feet above the switch at *Turkey River Junction*, 8 feet west from center of track, about 2 feet above grade of track, on natural ledge of rock, marked U □ S on its face; being the highest point in square.

P. B. M. 251.—Is on the line of Chicago, Milwaukee and St. Paul Railway, 1 552 feet above bridge No. 212, over Turkey River, 118 feet above the cattle guard, and 249 feet below sign "Turkey River Junction, stop," 13 feet west of center of track and 23 feet below T. B. M. 256, and about 2 feet above grade of ties, in ledge of rock, marked the same as P. B. M. 247 on its face; being the center mark in copper bolt leaded horizontally.

T. B. M. 257.—Is on the line of the Chicago, Milwaukee and St. Paul Railway, at Turkey River, on the upper stone pier of the bridge No. 212, on the west side of the track, 9 feet from the west end of the pier and 7 inches back from its north face; being the highest point in square, marked U □ S.

P. B. M. 252.—Is at *Turkey River Junction*, *Iowa*, 1 148 feet above the depot, at the upper end of the Chicago, Milwaukee and St. Paul Railway bridge No. 212, over Turkey River, on the west end of the pier, carrying also T. B. M. 257, 14 inches east from extreme point of rounding capstone, marked the same as P. B. M. 247 and is top of a copper bolt leaded vertically.

T. B. M. 258.—Is on the line of the Chicago, Milwaukee and St. Paul Railway, 1 689 feet below the depot at *Turkey River Junction*, 1 660 feet above milepost 90, and 50 feet above the very large and prominent bowlder on the west side of the track, also 328 feet above the farmhouse at point of woods on river side of track, 15 feet west of center, on a ledge of rock, marked U □ S; being the highest point in square.

P. B. M. 253.—Is on the line of Chicago, Milwaukee and St. Paul Railway track, 2⅝ miles above *Buena Vista*, *Iowa*, 53 feet below the center of bridge 204 K, on right of way of the Chicago, Milwaukee and St. Paul Railway, at fence on the bluff side, 36 feet from center of track; being a copper bolt in tile set 3 feet below surface of ground.

P. B. M. 254.—Is top of cap on iron pipe set over P. B. M. 253, standing about a foot above ground.

T. B. M. 262.—Is opposite the foot of Island 196, 1 mile above *Buena Vista* and 2 986 feet above milepost 93, and 15 feet toward the bluff from the center of the Chicago, Milwaukee and St. Paul Railway track, on the upper one of three large, prominent pieces of rock lying but a few feet from each other, marked U □ S; being the highest point in square.

T. B. M. 264.—Is in *Buena Vista*, *Iowa*, 82 feet above the depot and 35 feet above the road crossing, on the bluff side of the track, 9 feet from the center, about 2½ feet above grade, on a hard ledge of rock, marked U □ S; being the highest point in square.

P. B. M. 255.—Is in *Buena Vista*, at the southeast corner of R. & E. Meuth's general store, 6 inches from the south face and 4.3 feet above ground, in wall marked the same as P. B. M. 247 and is the center mark in copper bolt leaded horizontally.

T. B. M. 265.—Is three-quarters of a mile below *Buena Vista*, *Iowa*, 1 840 feet below milepost 94–67, and 590 feet below bridge No. 194, on the bluff side of track, 15 feet from center, on an embedded bowlder, marked U □ S; being the highest point in square.

T. B. M. 267.—Is 2 miles below *Buena Vista*, 1 575 feet below section post 11–12, 1 411 feet below bridge 188 K, and 775 feet above Dry Hollow bridge (186 K), on the line of the Chicago, Milwaukee and St. Paul Railway, 10 feet south from center, on the ledge of rock, marked U □ S; being the highest point in square.

P. B. M. 256.—Is 1½ miles above *Waupeton*, *Iowa*, 1 739 feet above milepost 96–65, 122 feet above bridge 186 K, over Dry Hollow, on the bluff side of track, 16·5 feet from center, just outside of the right-of-way fence; being a copper bolt in tile set 3 feet underground.

P. B. M. 257—Is top of cap on iron pipe set over P. B. M. 256.

T. B. M. 269—Is 1¼ miles above *Waupeton*, 593 feet below milepost 96–65, 377 feet above bridge 180 K, and just below a prominent ledge of white rock on the bluff side of track, 10 feet from center; also 146 metres below bridge No. 182, 2 feet above grade of track, on ledge of rock marked U □ S; being the highest point in square.

T. B. M. 270—Is 1 171 feet above the depot at *Waupeton*, 420 feet below milepost 97–64, 262 feet above bridge No. 174, on bluff side of track, 10 feet from center, on the natural ledge of rock, about level with the grade, marked U □ S on its face; being the highest point in square.

P. B. M. 258—Is 853 feet below *Waupeton*, 612 feet below bridge No. 172, on the north face of bluff, at the point where it begins to curve to the south, 36 feet south from the center of the Chicago, Milwaukee and St. Paul Railway track and 2 feet south from the south right-of-way fence; being a copper bolt in tile set 3 feet underground.

P. B. M. 259—Is top of cap on iron pipe set over P. B. M. 258.

T. B. M. 273—2⅛ miles below *Waupeton* and 1¼ miles below Cameron, Iowa, on the line of the Chicago, Milwaukee and St. Paul Railway, 2 053 feet above milepost 100–61, 100 feet, more or less, below the very large and conspicuous piece of ledge covered with vines lying on the bluff side of right of way, on a bowlder marked U □ S; being the highest point in square.

P. B. M. 260—Is at *Finley Landing*, on the line of the Chicago, Milwaukee and St. Paul Railway, 649 feet below milepost 101–60 and 180 feet above bridge No. 162 on the right of way, 2 feet from the south fence and 38 feet from center of track; being a copper bolt in tile set 3 feet underground.

P. B. M. 261—Is top of cap on iron pipe set over P. B. M. 260.

P. B. M. 262—Is in front of *Island 207*, 919 feet above milepost 102–59, and 79 feet above section post 10–11, on the west abutment of bridge No. 156, at its north end, on the fourth stone step from top, and 3 inches from the end face of the third step, 9 inches back from the east face; being top of copper bolt leaded vertically and marked the same as P. B. M. 247.

T. B. M. 277—Is at *Frenchtown Landing*, one-fourth mile above milepost 104–57, 115 feet below bridge No. 148, and 25 feet above the end of platform at entrance to picnic grounds, 20 feet south from center of track, on a flat rock, embedded, marked U □ S; being the highest point in square.

P. B. M. 263—Is at *Frenchtown Landing*, 35 feet above T. B. M. 277, 1 335 feet above milepost 104–57, 80 feet below bridge No. 148, and 60 feet above platform on side of railroad and at the entrance to picnic grounds, on the east side of coulee, 38 feet south from center of track, on the right of way, 1½ feet from the south limit, under the extreme northwest point of table-land forming the picnic ground; being a copper bolt in tile set 3 feet underground.

P. B. M. 264—Is top of cap on iron pipe set over P. B. M. 263.

Old P. B. M. No. 30—Is at *Specht Ferry, Iowa*, on the upper stone doorstep to Specht's stone house, downstream end, front edge, marked ⊙; being the highest point in the upper portion of circle.

Old U. S. B. M. a—Is at *Specht Ferry, Iowa*, at the northeast corner of Specht's house, on the water table, but a few inches above the corner, marked B ⊙ M; being the highest point on front segment.

P. B. M. 265—Is at *Specht Ferry, Iowa*, 354 feet below center of the Chicago, Milwaukee and St. Paul Railway depot, 164 feet below bridge No. 140, 174 feet below the lower side of stone milk house, 1 foot above fence forming the west side of the railroad cattle pen, on the bluff side of track, 37·4 feet from center; being copper bolt in tile set about 3 feet underground.

P. B. M. 266.—Is top of cap on iron pipe set over P. B. M. 265.

T. B. M. 279.—Is one-third mile below the Chicago, Milwaukee and St. Paul Railway depot at *Specht Ferry*, one-half mile above milepost 106-55, and 82 feet below a large bare ledge of rock inclining at an angle of about 45 degrees with the horizon, on bluff side of track, 10 feet from the center, on the natural ledge of rock, marked U □ S; being the highest point in square.

T. B. M. 280.—Is 1½ miles below *Specht Ferry, Iowa*, at Parsons Bar, in cove or borrow pit at the lower end, and base of heavy sidehill cut, about 300 feet, more or less, above bridge No. 134, where the railroad leaves the river bank and enters woods, on natural ledge of hard rock, about 50 feet from track center, marked U □ S; being the highest point in the square.

P. B. M. 267.—Is 1½ miles below *Specht Ferry*, at Parsons Bar, on the extreme point of bluff, between rock quarry where T. B. M. 280 is located and railroad bridge No. 134, 25·5 feet south from center of track; being a copper bolt in tile set 3 feet under ground.

P. B. M. 268.—Is top of cap on iron pipe set over P. B. M. 267.

P. B. M. 269.—Is 2¼ miles above the *Little Maquoketa River*, on the line of the Chicago, Milwaukee and St. Paul Railway and 3⅛ miles below Specht Ferry, 912 feet below milepost 108-53, and opposite the lower end of bridge No. 128, over Leisures Creek, 49 feet east from center of track, on the right of way in the corner of fence formed by main fence and wing fence to bridge No. 128, in slope of bluff; being a copper bolt in tile set about 3 feet underground.

P. B. M. 270.—Is top of cap on iron pipe set over P. B. M. 269.

T. B. M. 283.—Is 1½ miles above the *Little Maquoketa River* bridge, on the line of the Chicago, Milwaukee and St. Paul Railway, two-thirds of a mile above *Zollicoffer Lake* and 1 076 feet above milepost 109-52, 12 feet west of track, on a large flat rock inside of bank, inclining perhaps 30 degrees to the horizon, marked U □ S; being the highest point in square.

P. B. M. 271.—Is on the right of way of the Chicago, Milwaukee and St. Paul Railway track, 531 feet below the south end of bridge 124 K, over the Little Maquoketa River, very closely on line produced of the east side of said bridge, 6¾ miles above Dubuque, and three-fourths of a mile above *Edmore* siding, on the west side of track, 2 feet from the fence, opposite the center of curve in railroad line; being copper bolt in tile set about 3 feet below surface of ground.

P. B. M. 272.—Is top of cap on iron pipe set over P. B. M. 271.

T. B. M. 287.—Is 2·3 miles above *Eagle Point*, 1 569 feet below milepost 112–49, 1 161 feet above bridge 120 K, 377 feet below bridge 122 K, and 836 feet below the small railroad platform in front of Mr. Cushing's house, 6 feet west from the center of track, on the upper end of capstone of small stone culvert, marked U □ S; being the highest point in square.

P. B. M. 273.—Is 58 feet south of the small stone culvert on which T. B. M. 287 is located, 2·3 miles above *Eagle Point*, 436 feet below bridge 122 K, and 896 feet below the railroad platform in front of Mr. James Cushing's house, 23·3 feet east from the center of track, on right of way; being copper bolt in tile set 3 feet below the surface of ground.

P. B. M. 274.—Is top of cap on iron pipe set over P. B. M. 273.

T. B. M. 289.—Is about 1¼ miles above *Eagle Point*, one-fourth mile below milepost 113–48, midway between two small wooden box culverts, 20 feet west of center of track, on natural ledge, marked U □ S; being highest point in square.

Old U. S. B. M. 23.—Is at *Eagle Point*, above Dubuque, at the prominent point of river bank covered with large rock, above the ferry landing, on the southwest portion of the very large triangular-shaped rock lying at the water's edge; being the highest point in the bottom part of the letter "B" cut on the rock.

T. B. M. 291.—Is in *Eagle Point*, Dubuque, on the Dubuque Woodenware Company's drying house, east of the railroad tracks, on top of the stone foundation, 10 feet from the west side, on the lower side of building, marked U □ S; being the highest point in square.

T. B. M. 275.—Is in *Eagle Point*, Dubuque, in the main building of the Dubuque Woodenware Company, on the river bank, in the foundation on the south side, 1·8 feet from the west corner and 2·1 feet above the ground; being the center mark in copper bolt leaded horizontally, marked

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P. B. M. 276.—Is at *Eagle Point*, one-fifth mile below the Dubuque Woodenware Company's works, on the line of the Chicago, Milwaukee and St. Paul Railway, 2 181 feet above milepost 115–46, 394 feet above bridge No. 114, and 267 feet below bridge No. 114½, over sewer, on the upper end of mound built up from earth excavation from the opposite side of the track, 1½ feet west from the east fence and 13·6 feet from center of track; being a copper bolt in tile set 3 feet below surface of ground.

P. B. M. 277.—Is top of cap on iron pipe set over P. B. M. 276.

T. B. M. 293.—Is the upper part of *Dubuque*, on the line of the Chicago, Milwaukee and St. Paul Railway, at the northwest corner of their freight-car repair shop, on the southwest corner of the foundation stone, marked U □ S; being the highest point in square.

T. B. M. 294.—Is in *Dubuque*, about one-half mile below the Chicago, Milwaukee and St. Paul Railway shops, at the southeast corner of the Iowa Coffin Company's warehouse, on top of the foundation stone; being the highest point in square.

P. B. M. 278.—Is on the same building as T. B. M. 294, at the northwest corner of Fifteenth and Pine streets, *Dubuque*, *Iowa*, on the south side of the Iowa Coffin Company's warehouse, on the west end of the first doorstep from Pine street; being top of a copper bolt leaded vertically and marked the same as P. B. M. 275.

T. B. M. 295.—Is in *Dubuque, Iowa*, on southwest corner of Elm and Ninth streets, on the end of the curb abutting against the northeast corner of the Chicago, St. Paul and Kansas City freight house, marked U □ S; being the highest point in square.

P. B. M. 279.—Is in *Dubuque, Iowa*, at the northeast corner of the United States post office building, 10 inches south of the north corner and 3 feet above the stone paving; being the center mark of a copper bolt leaded horizontally and marked the same as P. B. M. 275.

City B. M.—On the Julien House, in *Dubuque, Iowa*, on the north side of Second street, at the east door of the older part of the Julien House, on the east end of doorstep, which is about 32 feet west of Iowa street; being the highest point in square.

City B. M.—On Jess's store, in *Dubuque*, on the southwest corner of First and Main streets, near the southeast corner of Jess's store, on the north end of doorstep; being the highest point in square.

T. B. M. 296.—Is in *Dubuque, Iowa*, on the north side of Fourth street, opposite the Chicago, Milwaukee and St. Paul Railway depot, on the Page House, 26½ inches east of the southeast corner of the building, on water table 6 inches in front of the west window, marked U □ S; being the highest point in the square.

P. B. M. 280.—Is in *Dubuque, Iowa*, on the west end and first pier of the Illinois Central Railway bridge across the Mississippi River, at the upper end of pier, near its west edge, and about in the center of the bridge-seat stone; being top of copper bolt leaded vertically and marked the same as P. B. M. 275.

Old U. S. B. M. a.—Is in *East Dubuque, Ill.*, on the west abutment of the Jack Knife Draw of the Illinois Central Railway over the Chicago, Burlington and Northern Railway on its south end, on the southeast corner of top stone, marked B ⊙ M; being the highest point of square within the old circle.

Old U. S. B. M. b.—Is in *East Dubuque*, east of the Chicago, Burlington and Northern Railway track, under the end of the Dubuque highway bridge across the Mississippi, on the upstream foundation stone supporting the triangular truss of said highway bridge, on the upstream corner of stone, marked B ⊙ M; being the highest point of square within the old circle.

T. B. M. 297.—Is in *Dubuque, Iowa*, on the Illinois Central depot, at its north end, about in the center of the east side of the tower, in water table; being the highest point in square.

Old U. S. B. M. a.—Is in *Dubuque, Iowa*, at the river front below the harbor, on the Diamond Joe store, on the upstream end of the upstream stone doorsill, marked □; being the highest point of circle in square.

Old U. S. B. M. b.—Is in *Dubuque*, on the river front below the harbor, on the southeast corner of Houser & Linnehan's boat store, 1½ feet above the corner, on the water table, in the center of buttress, marked ⊙; being the highest point of circle in circle.

P. B. M. 281.—Is in the southern extremity of *Dubuque*, at the bluff, one-eighth mile below the sawmill, directly opposite the end of runway to mill, 305 feet above the head block of the sawmill siding, 26 feet west from center of siding, in a recess in the face of rock bluff, being the center mark in a copper bolt leaded horizontally, and marked the same as P. B. M. 275.

T. B. M. 299.—Is about 1 mile below *Dubuque*, at point of bluff on the lower side of the ravine through which the Illinois Central Railway passes from the river, 623 feet below the bridge on the Chicago, Milwaukee and St. Paul Railway track, 164 feet above the house owned by R. Smith and 98 feet west of the center of the Chicago, Milwaukee and St. Paul Railway track, on top of a large, flat rock, marked U □ S; being the highest point in square.

P. B. M. 282.—Is about 1 mile below *Dubuque*, at point of bluff on the south side of Rugdale Hollow, through which the Illinois Central Railway passes from the river, about 36 feet from T. B. M. 299, 623 feet from the Chicago, Milwaukee and St. Paul Railway Bridge, 180 feet above a house owned by R. Smith, 131 feet west from center of track, 43 feet northwest from a blazed elm on the upper side of a large flat rock; being a copper bolt in tile set about 3 feet underground.

P. B. M. 283.—Is top of cap on iron pipe set over P. B. M. 282.

T. B. M. 301.—Is about 3¼ miles below Dubuque, 660 feet below milepost 121–40, 370 feet above the upper head block of siding at *Cattes* and 295 feet below Creston Crossing, on the lower side of coulee, 25 feet west from center of track, on natural ledge of rock, marked U □ S; being the highest point in square.

P. B. M. 284.—Is on the upper side of coulee, where T. B. M. 301 is located, 344 feet below milepost 121–40, and 669 feet above the upper head block of switch to *Cattes Siding*, 43 feet from center of track on the bluff side in fence corner by gate, being a copper bolt in tile set 3 feet underground.

P. B. M. 285.—Is top of cap on iron pipe set over P. B. M. 284.

T. B. M. 302.—Is opposite the foot of Island 228, 72 feet above the lower head block of switch at *Cattes Siding*, 15 feet west from center of side track, in natural ledge of rock, marked U □ S; being the highest point in square.

T. B. M. 303.—Is about 1⅓ miles above the head of Ninemile Island, on the line of the Chicago, Milwaukee and St. Paul Railway, directly opposite milepost 122–39, on bluff side, 9 feet from center, on natural ledge of rock, marked U □ S; being the highest point in square, about 1 mile below *Cattes Siding*.

T. B. M. 304.—Is about 5 miles below Dubuque and a half mile above the head of Ninemile Island, near *Cattes Siding*, on the south abutment of bridge No. 86, river end, on the second course of stone below the bridge seat, on its northeast corner, marked U □ S; being the highest point in square.

Old U. S. B. M. 24.—Is about 5 miles below Dubuque and a half mile above Ninemile Island, near *Cattes Siding*, on the south abutment of bridge No. 86, where T. B. M. 304 is located, on the river end of abutment, lowest course of stone, on the northeast corner of step, now marked □; being the highest point in square.

P. B. M. 286.—Is 6 miles below Dubuque, on the line of the Chicago, Milwaukee and St. Paul Railway, at the *Shawondassee Club Grounds* station, 76 feet below the south end of the platform and 86 feet above the boundary fence between Paul Eiffer's and Frank Noel's lands, on the west side of track, 47·1 feet from the center; being a copper bolt in tile set about 3 feet underground.

P. B. M. 287.—Is top of cap on iron pipe set over P. B. M. 286.

T. B. M. 307.—Is behind Ninemile Island, about one-half mile below *Massey* station, on the Chicago, Milwaukee and St. Paul Railway, 1 970 feet below milepost 124–37, 449 feet above bridge 80 K and 170 feet below bridge 82 K, about 30 feet west of the center of track, in the base of a black-oak tree; being top of large spike.

T. B. M. 308.—Is about 1⅜ miles below *Massey* station, Chicago, Milwaukee and St. Paul Railway, on the south abutment of bridge 78 K, west end, on the second course of stone from top, on its southwest corner, marked U □ S; being the highest point in square.

P. B. M. 288.—Is opposite the foot of *Ninemile Island*, at the wood yard, 20 feet below the road leading from wood yard across the Chicago, Milwaukee and St. Paul Railway track up the bluff, 36 feet east from center of track and 2 feet west of the east right of way fence; being a copper bolt in tile set 3 feet underground.

P. B. M. 289.—Is top of cap on iron pipe set over P. B. M. 288.

T. B. M. 311.—Is 1 mile below P. B. M. 288 and 289, on the south abutment of bridge No. 76, west end, on the second course of stone from top, marked U □ S; being highest point in square.

T. B. M. 312.—Is opposite the head of Island 235, 1 270 feet above milepost 128–33, 410 feet below bridge 72 K, at *Snyder's* wood yard, 12 feet west of center of track, on the lower end of a very large inclined rock at a rocky point, marked U □ S; being the highest point in square.

P. B. M. 290.—Is 285 feet above T. B. M. 312, about 3 miles above *Gordons Ferry*, 125 feet below center of bridge 72 K, opposite the head of Island 235, 43 feet west of the center of the Chicago, Milwaukee and St. Paul Railway track, on the right of way, at the railroad fence;. being copper bolt in tile set 3 feet underground.

P. B. M. 291.—Is top of cap on iron pipe set over P. B. M. 290.

T. B. M. 314.—Is about 1 mile above *Gordons Ferry*, *Iowa*, on the line of the Chicago, Milwaukee and St. Paul Railway, 52 feet below sign "Gordon's Ferry, One Mile," on the south abutment, river end of bridge 68 K, just above ruins of the large stone house, on the fourth course of stone from top, on the center of the north end of the inner stone, marked U □ S; being the highest point in square.

P. B. M. 292.—Is about 1 mile above *Gordons Ferry*, 345 feet above Tete du Mort Creek, 215 feet below bridge No. 68, on which T. B. M. 314 is located, and 75 feet below the old stone building, 27 feet west from center of the Chicago, Milwaukee and St. Paul Railway track; being a copper bolt in tile set 3 feet underground.

P. B. M. 293.—Is top of cap on iron pipe set over P. B. M. 292.

T. B. M. 315.—Is about one-half mile above *Gordons Ferry*, 572 metres below bridge No. 66, and 1 213 feet above the water tank, midway between two projecting points of bluff 12 feet west from center of track, and 1½ feet above grade on natural ledge of rock, marked U □ S; being the highest point in square.

P. B. M. 294.—Is at *Gordons Ferry*, 250 feet below bridge No. 64, 215 feet below depot, 125 feet above the lower head block of siding, 45 feet below the lower side of stock yard, and 34 feet from center of main track on bluff side; being a copper bolt in tile set 3 feet underground.

P. B. M. 295.—Is top of cap on iron pipe set over P. B. M. 294.

T. B. M. 318.—Is 1¼ miles below *Gordons Ferry*, *Iowa*, on the line of the Chicago, Milwaukee and St. Paul Railway, 396 feet below milepost 132–29, and 18 feet west from center of track, ½ foot above surface of ground, on a flat rock, marked U □ S; being the highest point in square.

P. B. M. 296.—Is 1½ miles below *Gordons Ferry*, about ⅓ mile below milepost 132–29, on a low ridge at the upper side of coulee, 49 feet west from the center of the Chicago, Milwaukee and St. Paul Railway track, on the right of way, at the west fence; being a copper bolt in tile set 3 feet underground.

P. B. M. 297.—Is top of cap on iron pipe set over P. B. M. 296.

T. B. M. 321.—Is at the point of bluff at the head of Bellevue Slough, at the lower end of cut, in front of house owned by A. M. Brown, and 15 feet below the path running to this house, 125 feet above bridge No. 56, at the upper side of cattle guard, 12 feet west of the center of the track, on natural ledge of rock, marked U □ S; being the highest point in square. It is above *Smiths* station.

P. B. M. 298.—Is on the opposite side of the track from T. B. M. 321, at the head of Bellevue Slough, ¾ of a mile above *Smiths* station, 110 feet above bridge No. 56, 55 feet below the lower line of A. M. Brown's house, 12 feet below the cattle guard, on the river side of track, 16 feet from center, on small bench of ground between cattle guard and gate leading down to river; being a copper bolt in tile.

P. B. M. 299.—Is top of cap on iron pipe set over P. B. M. 298.

T. B. M. 323.—Is behind Bellevue Slough, 1¼ miles below *Smiths* station, on the Chicago, Milwaukee and St. Paul Railway, 148 feet below a stone culvert about in center of short, heavy fill, at the lower end of the long curve, 60 feet east from center of track, several feet outside of the right of way. It is also 1 902 feet above bridge No. 50, on a 10-inch oak tree; being a spike in its root.

P. B. M. 300.—Is behind Bellevue Slough, 262 feet from low-water edge, 1¼ miles below *Smiths*, and 3 miles above North Bellevue, 1 900 feet above bridge 50 K, and 150 feet below the stone culvert on the right of way at the east fence, but a few feet below T. B. M. 323; being a copper bolt in tile set 3 feet underground.

P. B. M. 301.—Is top of cap on iron pipe set over P. B. M. 300.

P. B. M. 302.—Is 1 mile above *North Bellevue*, on the line of the Chicago, Milwaukee and St. Paul Railway, and 1 279 feet below milepost 138–23, in the north abutment, east end of bridge 48 K, on the third course of stone from top, marked

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being the center of copper bolt leaded vertically.

P. B. M. 303.—Is 1 mile above *North Bellevue*, 40 feet back from high-water line on river bank and 45 feet north of bank of creek which is crossed by Chicago, Milwaukee, and St. Paul Railway bridge 48 K, where P. B. M. 302 is located, about 984 feet from said railroad, and about 410 feet below large stone arch culvert under wagon road, and 36 feet south from another wagon road winding around the south point of bluff; being a copper bolt in tile set 3 feet underground.

P. B. M. 304.—Is top of cap on iron pipe set over P. B. M. 303.

P. B. M. 305.—Is in the upper part of *Bellevue*, on the west line of Front street, in the northeast corner of lot owned by Mrs. Booth, 2 feet south from the north side of lot and south side of a street; being a copper bolt in tile set 3 feet underground.

P. B. M. 306.—Is top of cap on iron pipe set over P. B. M. 305.

P. B. M. 307.—Is in *Bellevue*, on the southeast corner of Court and Second streets, on the front of the stone store owned by John Baumann, on the lower end of water table, 2½ feet above the south corner; being top of copper bolt leaded vertically, and marked

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Old U. S. B. M.—Is in *Bellevue*, at river shore, on Killburn & Co.'s warehouse, on projecting stone at the east end of the south wall, just below the iron bolt plate; being highest point in circle cut in stone.

T. B. M. 326.—Is in the south end of *Bellevue*, on the line of the Chicago, Milwaukee and St. Paul Railway, on bridge 44 K, over Mill Creek, between the flour mill and sawmill, on the north pier at its east end, marked U □ S; being the highest point in square.

P. B. M. 308.—Is in the lower end of *Bellevue*, *Iowa*, on the river bank, in first building above the sawmill, a two-story stone store, owned by M. G. Heiler, at its west front, second door from north end, marked U ⊙ S; being top of a copper bolt leaded vertically.

P. B. M. 309.—Is 2 miles below *Bellevue*, 558 feet above the center of the Chicago, Milwaukee and St. Paul Railway Bridge 42 K, over Duck Creek, 148 feet above milepost 142–19, at upper side of highway crossing, at the south side of fence running to cattle guard, and 20 feet east from center of track; being a copper bolt in tile set 3 feet underground.

P. B. M. 310.—Is top of cap on iron pipe set over P. B. M. 309.

T. B. M. 329.—Is one-fourth mile below bridge 42 K, about 2½ miles below *Bellevue*, one-third mile below milepost 142–19, on line of the Chicago, Milwaukee and St. Paul Railway, and 279 feet above sluiceway under track, 12 feet west from center of track, on the west side of ditch on natural outcropping of ledge of rock, marked U □ S; being the highest point in square.

T. B. M. 331.—Is 3½ miles below *Bellevue*, on the line of the Chicago, Milwaukee and St. Paul Railway track, 250 feet above C. A. Harrington's house, on the southwest corner of the stone culvert, 3 feet above the south side and 3 inches back from the west end, marked U □ S; being the highest point in square.

P. B. M. 311.—Is 3½ miles below *Bellevue*, on the line of the Chicago, Milwaukee and St. Paul Railway, 705 feet below the stone culvert on which T. B. M. 331 is located, 177 feet below the lower side of C. A. Harrington's stone barn, 40 feet above the wooden drain under the track, at the lower end of small cut, 33 feet east from center of track, and 1½ feet west from the east right of way fence; being a copper bolt in tile set about 3 feet underground.

P. B. M. 312.—Is top of cap on iron pipe set over P. B. M. 311.

P. B. M. 313.—Is at the third tree from the river of the same row of trees where T. B. M. 333 is located, about 5½ miles below *Bellevue*, on the south side of slough at the foot of Island 250, 88 feet from the northwest corner of Mr. Golden's log house; being top of copper bolt in tile set about 3 feet underground.

P. B. M. 314.—Is top of cap on iron pipe-set over P. B. M. 313.

P. B. M. 315.—Is opposite Island 253, one-third mile below the log house at *Golden's* wood yard, 56 feet back from top of bank, and 2 feet below the fence on the lower side of clearing and upper side of woods, which runs at about right angles to the river bank, 8 feet above a 10-inch ash tree, blazed, facing the bench; being a copper bolt in tile set 3 feet underground.

P. B. M. 316.—Is top of cap on iron pipe set over P. B. M. 315.

P. B. M. 317.—Is at *Harris Landing*, *Ill.*, on land owned by Jackson Harris, on the east side of highway on top of the sand bluff, 184 feet above the house now occupied by L. T. Green, in the northwest corner of small field above the dooryard, very close to roadside fence; being top of copper bolt in tile set 3 feet underground.

P. B. M. 318.—Is top of cap on iron pipe set over P. B. M. 317.

P. B. M. 319.—Is at *Harris Landing*, *Ill.*, on Jackson Harris's farm, now occupied by L. T. Green, 207 feet below his house, in the roadside, very close to the east fence, 3 feet below the fence at south side of dooryard, at the north end of the lilac hedge; being copper bolt in tile set about 3 feet underground.

P. B. M. 320.—Is top of cap on iron pipe set over P. B. M. 319.

P. B. M. 321.—Is about 1½ miles below *Harris Landing* and 1½ miles above Island 256, back from the top of sand bluff, under the east fence of highway, 31 feet southeast from cattle pen, under wagon road leading from pasture through cattle chute to river, northeast from two large honey locust trees standing in said chute at top of bluff; being copper bolt in tile set 3 feet below surface.

P. B. M. 322.—Is top of cap on iron pipe set over P. B. M. 321.

P. B. M. 323.—Is opposite the foot of *Island 256*, about 574 feet back from high-water line, over beyond top of same bluff, on land of Mrs. McCabe, widow; about one-half mile south of Benjamin Hatfield's house, and 62 metres south of west of a 3-foot oak tree, standing in field, at point of brush and head of small valley running east, by the wire fence on the south side of field; being a copper bolt in tile set about 3 feet under surface of ground.

P. B. M. 324.—Is top of cap on iron pipe set over P. B. M. 323.

P. B. M. 325.—Is at the foot of point of sand bluff on the south side of and 951 feet from left bank of Apple River, three-quarters of a mile above *Arnold Landing*, at the corner of cultivated land, just above high-water level, on Mr. Eddy's land, about 60 feet south of an oak tree; being a copper bolt in tile set 3 feet underground.

P. B. M. 326.—Is top of cap on iron pipe set over P. B. M. 325.

P. B. M. 327.—Is at *Arnold Landing*, *Ill.*, on Mr. Eddy's large brick house, at the southeast corner of main part, on the south face of the top foundation stone, 3 inches from the east end and 2 inches from top of stone; being the center mark in a copper bolt leaded horizontally and marked

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P. B. M. 328.—Is one-half mile below *Arnold Landing*, 98 feet above T. B. M. 345, 148 feet below lower end of long cut and 1 mile above Marcus Station, on the line of the Chicago, Burlington and Northern Railway, 45 feet south from center of track, on the north side of the south right of way fence; being copper bolt in tile set 3 feet underground.

P. B. M. 329.—Is top of cap on iron pipe set over P. B. M. 328.

P. B. M. 330.—Is one-fifth mile below the depot at *Marcus*, 200 feet above the head block at the lower end of the northeast siding, 18 feet above the head block of the southwest siding, 35 feet southwest from center of track on the southwest side, and close to wire fence, on the highest ridge of ground, 27 feet north of blazed white-oak tree; being a copper bolt in tile set 3 feet underground.

P. B. M. 331.—Is top of cap on iron pipe set over P. B. M. 330.

P. B. M. 332.—About 2½ miles above *Savanna* and 1¾ miles below Marcus, on the line of the Chicago, Burlington and Northern Railway, opposite the upper end of bridge No. 40, on river side of track, 48 feet from center, in the angle formed by the right of way fence and the wing fence to said bridge; being a copper bolt in tile set 3 feet below the ground.

P. B. M. 333.—Is top of cap on iron pipe set over P. B. M. 332, about 1 foot above the ground.

P. B. M. 334.—Is 1½ miles above *Savanna, Ill.*, 443 metres below the center of bridge No. 35, about 90 feet below small white house 318 feet above milepost 284–147, and 150 feet below the point of tangent at lower end of long curve, opposite the north end of prominent portion of bare rock bluff, on the east side of the right of way, 3 feet west of high board fence; being a copper bolt in tile set 3 feet below the surface of ground.

P. B. M. 335.—Is top of cap on iron pipe set over P. B. M. 334, standing about 1 foot above ground.

P. M. M. 62.—*Savanna. Ill.* (See page 733.)

Old U. S. B. M. 18.—Is ring bolt in *Savanna, Ill.*, on the south side of the Chicago, Milwaukee and St. Paul Railway elevator, about 12 feet from the west corner and 1½ feet above the ground; being top of ring bolt leaded horizontally.

P. B. M. 63.—*Savanna, Ill.* (See page 733.)

P. B. M. 336.—Is in *Savanna, Ill.*, on the southeast corner of Main and Murray streets, on the Radke House, owned by A. McRadke, at the first doorstep from the north end of the building, on its north end; being top of copper bolt leaded vertically and marked

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P. B. M. 337.—Is in *Savanna, Ill.*, about 65 feet below T. B. M. 354, on the line of the Chicago, Burlington and Northern Railway to Fulton, 600 feet below the crossing with the Chicago, Milwaukee and St. Paul Railway to Sabula, on land of A. Hershey, 12 feet back from top of bank of slough and 15 feet below Jones & Jordan's boathouse; being a copper bolt in tile set 3 feet underground.

P. B. M. 338.—Is top of cap on iron pipe set over P. B. M. 337, standing about a foot above the surface of the ground.

P. B. M. 64.—*Savanna, Ill.* (See page 733.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ST. PAUL AND AITKIN, MINN.

P. B. M. 65.—*St. Paul, Minn.* (See page 737.)

T. B. M. 1.—*St. Paul, Minn.* (See page 737.)

P. B. M. 67.—*St. Paut, Minn.* (See page 738.)

P. B. M. 68.—*St. Paul, Minn.* (See page 738.)

P. B. M. 70.—*St. Paul, Minn.* (See page 738.)

Old U. S. B. M. A.—*St. Paul, Minn.* (See page 738.)

T. B. M. 23.—Is in *St. Paul, Minn.*, being a square, □, cut in top stone on north end of east abutment of Chicago, Milwaukee and St. Paul Railway bridge over Pleasant avenue, a quarter of a mile east of Ridgewood station; square is about 4 inches from northwest corner of stone.

T. B. M. 22.—Is in *St. Paul, Minn.*, on north end of east abutment of Chicago, Milwaukee and St. Paul Railway bridge over Victoria street, 50 metres east of Ridgewood station, on Chicago, Milwaukee and St. Paul Railway Short Line, between St. Paul and Minneapolis; being the highest point in square cut in top of stone, 8 inches from the northwest corner of stone, marked U □ S.

P. B. M. Macalester.—Is a tile and pipe on south side of the Chicago, Milwaukee and St. Paul Railway Short Line, between St. Paul and Minneapolis, 250 metres east of Snelling avenue, 16 rail lengths east of center of Macalester Station, 11 metres south of center of south track, 3½ metres east of 10-inch cottonwood. (See note 14, page 551.)

T. B. M. 18.—Is in *St. Paul, Minn.*, on west abutment of Chicago, Milwaukee and St. Paul Railway bridge over Prior avenue, about 30 metres east of center of Marian Park station, about 10 inches from the south and east edges of stone at southeast corner of south end of abutment, marked U □ S.

T. B. M. 16.—Is on the Pelham street bridge over the Chicago, Milwaukee and St. Paul Railway tracks, about 70 metres east of Desnoyer Park station in west end of *St. Paul, Minn.*; being a square cut on the southwest corner of stone pedestal under west column on north side of tracks, marked U □ S.

T. B. M. 13.—Is a square cut in northeast corner of top of large square granite stone on north side of entrance to State University grounds in southeast *Minneapolis, Minn.*, at northwest corner of University avenue and Fifteenth avenue SE.

P. B. M. University Campus.—Is a copper bolt in center of stone post in Minnesota State University campus in southeast *Minneapolis*, on north side of Pleasant street, 1 metre north of granitoid walk, 34 metres west of intersection of Pleasant street and street running along in front of University buildings, 15 metres south of Mechanic Arts building; stone post is about 6 inches above ground.

P. B. M. Pillsbury Hall.—A horizontal line in center of bronze plate set into wall of tower on north side of the south entrance to Pillsbury Hall at Minnesota State University in southeast *Minneapolis, Minn.*; it is 18 inches above ground and 2 metres from junction of tower and wall of main building on north side of tower. Bronze plate marked with the letters U. S. C. and G. S.

T. B. M. 12.—A square cut on top of stone cover of catch basin at southwest corner of University avenue and Tenth avenue, southeast *Minneapolis, Minn.*, 3 inches back of curb line on west side of University avenue, marked U □ S.

P. B. M. $\frac{286}{2}$.—A tile and pipe in southeast *Minneapolis, Minn.*, on left bank of Mississippi River, about 150 metres below end of Great Northern Railway bridge over the Mississippi River below St. Anthony Falls, one-half metre west of west right of way fence of Great Northern Railway, and 5 metres north of corner of fence. (See note 14, page 551.)

P. B. M. Great Northern.—A square cut in top of west end of south abutment of bridge on University avenue over Great Northern Railway tracks on Second avenue, northeast *Minneapolis*, *Minn.*, in center of abutment, 6 inches from west end; marked

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P B M

P. B. M. Brewery.—A square cut in the north end of lowest step of main entrance to the office of the Minneapolis Brewing Company, on the east side of Marshall street, between Twelfth and Thirteenth avenues, northeast *Minneapolis*, *Minn.;* step is 1 inch above sidewalk, marked the same as P. B. M. Great Northern.

T. B. M. 11.—A square cut on top of north end of east abutment of Northern Pacific Railway bridge over the Mississippi River at end of Seventeenth avenue, northeast *Minneapolis*, *Minn.;* square is 8 inches from north edge and 5 inches from west edge of top stone of abutment, 2·3 metres above bridge seat.

P. B. M. Gluck.—A copper bolt leaded vertically into top of water table at southeast corner of main building of Gluck's brewery, on west side of Marshall street, between Twentieth and Twenty-first avenues, northeast *Minneapolis*, *Minn.*, 17 metres from iron gate on Marshall street; bolt is 4·3 feet above ground, marked

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P B M

P. B. M. $\frac{266}{2}$.—A tile and pipe on left bank of Mississippi River one-fourth metre north of a fence on north line of Twenty-seventh avenue, northeast *Minneapolis*, *Minn.*, 5 metres east of fence corner and 72 metres west of west line of Marshall street. (See note 14, page 551.)

T. B. M. 3.—A square cut in southwest corner of stone doorstep at main entrance to Louis Opshal's hotel and saloon, on northeast corner of Marshall street and Forty-second avenue, northeast *Minneapolis*, *Minn.*, property of Minneapolis Brewing Company. Marked U □ S.

P. B. M. $\frac{267}{2}$.—A tile and pipe about three-fourths of a mile above upper limits of *Minneapolis*, *Minn.*, and one-fourth of a mile above center line of section 27, on left bank of Mississippi River, at junction of fences, one-half metre west of fence on west side of wagon road and one-half metre south of fence running west from road, about 75 metres back from river bank, 500 metres above angle in road, 200 metres below another angle in road. (See note 14, page 551.)

P. B. M. $\frac{268}{2}$.—A tile and pipe about 3¼ miles above the city limits of Minnepolis, Minn., about one-half mile above *Fridley* post office, 100 metres back from left bank of river, on property of McMullen, one-half mile above Rice Creek, one-half metre south of an east and west fence along south side of cultivated strip and at corner of timber. Blazed trees: 10-inch oak, 349°—2·6 metres; 6-inch oak, 267°—4·6 metres. (See note 14, page 551.)

T. B. M. 27.—On brick schoolhouse on public road between Minneapolis and Anoka, Minn., on left bank of Mississippi River, 4½ miles above Fridley mill and 6½ miles below *Anoka;* being a square cut on north end of lower step at front entrance to schoolhouse near △ Dunn.

P. B. M. △ Dunn.—A tile pipe on property of John Dunn, SW. ¼ SE. ¼ sec. 26, T. 31, R. 24, 250 metres west of river road on left bank of river, about 9 miles above upper limits of Minnapolis, Minn. Station in timber opposite first angle in road, 120 metres above Dunn's (brick) schoolhouse. Blazed trees: 12-inch oak, 298°—7·4 metres; 10-inch oak, 353°—3·4 metres; 12-inch oak, 67°—3·8 metres; 8-inch oak, 143°—3·4 metres. (See note 14, page 551.)

T. B. M. 29.—On Northern Pacific Railway bridge over Coon Creek, about 5 miles below *Anoka, Minn.;* being a square cut in granite stone on top of west end of north abutment of bridge.

P. B. M. $\frac{269}{2}$.—A tile and pipe on left bank of river, about 200 metres above *Dunn Island*, three-fourths of a mile above mouth of Coon Creek, at the edge of timber, 100 metres back from river bank, on slope near the foot of bench, 40 metres north of east and west wagon road, on property of John Dunn. Blazed trees: 20-inch oak, 79°—4·2 metres; 15-inch oak, 152°—7·0 metres; 15-inch oak, 199°—7·9 metres. (See note 14, page 551.)

P. B. M. △ Powell.—A tile and pipe on south side of river road about 3½ miles below *Anoka, Minn.*, on left bank of river, on section line between secs. 16 and 21, T. 31N, R. 24W, on line between property of George Smith and Lewis Greenwald, 2 metres north of south road fence, directly south of residence of S. J. Powell, one-half mile below district school No. 2. Blazed trees: 10-inch scrub oak, 101°—12·5 metres; 24-inch scrub oak, 352° 25′—12·3 metres. (See note 14, page 551.)

P. B. M. $\frac{270}{2}$.—A tile and pipe on top of left bank of river about 2¾ miles below wagon bridge over Mississippi River at *Anoka, Minn.*, 1 metre south of east and west fence on section line between secs. 17 and 20, T. 31 N., R. 24 W., about 150 metres west of section corner $\frac{17}{20}\frac{16}{21}$ on property of Charles L. Gibbs. Blazed tree: 8-inch oak, 301°—3·5 metres. (See note 14, page 551.)

P. B. M. Anoka.—On wagon bridge over Mississippi River at *Anoka, Minn.*, being the top of a copper bolt leaded vertically into the top of upper end of first pier from left-bank end of bridge, or pier between abutment and draw pier, 2 feet from extreme upper point of pier, marked

U S
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P. B. M. $\frac{271}{2}$.—A tile and pipe in *Anoka, Minn.*, on left bank of river, 600 metres above wagon bridge over Mississippi River, in Rice street, one-fourth of a metre north of fence on south line of street, and about 75 metres east of where Rice street ends on river bank. Blazed 10-inch oak, 270°—42 metres. (See note 14, page 551.)

P. B. M. $\frac{272}{2}$.—A tile and pipe 3 miles above *Anoka, Minn.*, on public road 800 metres back from left bank of river, opposite foot of Clouquet Island, in corner of fence, 1 metre west of fence on west side of road, on property of A. J. Smith, and 14 metres south of a point opposite south end of Smith's house. Blazed 18-inch elm, 312°—6·8 metres. (See note 14, page 551.)

P. B. M. $\frac{273}{2}$.—A tile and pipe on right of way of the Great Northern Railway, about one-half mile below *Itasca* station, about 500 metres below schoolhouse, 200 metres above foot of Goodwins Island, 150 metres above lower end of railway curve, 75 metres above a milepost marked S. 107—St. P. 33, one-half metre south of north right of way fence. (See note 14, page 551.)

P. B. M. $\frac{274}{2}$.—A tile and pipe, 3 miles below *Elk River*, *Minn.*, 500 metres below lower end of Island No. 200, about 300 metres back from left bank of river, at edge of timber and cultivation, 1 metre toward river from wire fence on property of A. L. Stimson, sec. 14, T. 32 N., R. 26 W., about 215 metres below Stimson's house. Blazed trees: 10-inch oak, 323°—9 metres; 4-inch oak, 61°—8·6 metres; 4-inch oak, 109°—6 metres. (See note 14, page 551.)

P. B. M. $\frac{275}{2}$.—A tile and pipe on left bank of river, 150 metres below ferry landing at lower end of town of *Elk River*, *Minn.*, one-half metre toward river from west right of way fence of Great Northern and Northern Pacific railways, one-half metre west from junction of fences and nearly in line with center of north and south street. (See note 14, page 551.)

P. B. M. Elk River.—A square cut on top of iron cap on top of downstream cylinder of middle pier of wagon bridge over *Elk River*, just above milldam, 1 foot from downstream edge of cylinder. Marked U ⊡ S.

P. B. M. $\frac{276}{2}$.—A tile and pipe opposite *Otsego*, *Minn.*, in north and south public road, one-half metre west of wire fence along east line of road, about 150 metres back from left bank of river, 57 metres north of bend in road to ferry. Blazed trees: 5-inch oak, 85°—16·2 metres; 15-inch oak, 27° 50′—27·2 metres; 5-inch oak, 1°—15·4 metres. (See note 14, page 551.)

P. B. M. $\frac{277}{2}$.—A tile and pipe on left bank of river, 6 miles below *Monticello*, *Minn.*, 100 metres above head of Demicks Island, 75 metres from river bank, 1 metre east of wire fence along an old wagon road running nearly north. Blazed trees: 18-inch oak, 62°—10·2 metres; 18-inch oak, 269°—2 metres. (See note 14, page 551.)

P. B. M. $\frac{278}{2}$.—A tile and pipe in public road, about 3 miles below *Monticello*, *Minn.*, about 300 metres east of J. C. Johnson's house, 100 metres west of junction of fences, in sec. 32, T. 33 N., R. 27 W., about 600 metres back from left bank of river, one-half metre south of fence on north line of road.

P. B. M. ◬ East Base (Monticello Base Line).—A tile and pipe in east and west public road on north side of river, about 1 mile below a point opposite lower limits of *Monticello*, *Minn.*, 1 metre south of fence on north line of road. Adjoining property belongs to Mr. McAllester. (See note 14, page 551.)

P. B. M. ◬ West Base (Monticello Base Line).—A tile and pipe in east and west public road on north side of river, opposite lower end of *Monticello*, *Minn.*, about 200 metres below turn in the road at river bank, 1 metre south of fence on north side of road. Adjoining property belongs to Mr. Taft. (See note 14, page 551.)

P. B. M. $\frac{279}{2}$.—A tile and pipe in east and west public road, opposite upper end of picnic grounds at lower end of *Monticello*, *Minn.*, one-half metre north of fence on south side of road, about 100 metres west of W. M. Taft's house, about 100 metres back from left bank of river, and 25 metres west of angle in fence. (See note 14, page 551.)

T. B. M. 70.—On wagon bridge over Mississippi River at *Monticello*, *Minn.*; being a square cut on top of stone cap of downstream cylinder of shore pier on left bank, marked U □ S.

P. B. M. $\frac{280}{2}$.—A tile and pipe, about 2 miles above *Monticello*, *Minn.*, one-half mile below lower end of Lanes Island (also known as Thompsons Island), about 300 metres back from left bank of river, one-half metre west of north and south fence, about 80 metres upstream from large square two-story house, in line with center of north and south road and 39 metres south from junction of fences at road. Road makes nearly a right angle at this point. (See note 14, page 551.)

P. B. M. $\frac{281}{2}$.—A tile and pipe, 5 miles above *Monticello, Minn.*, about 400 metres above head of Island No. 163, about 600 metres back from left bank of river, in corner of fence on west side of north and south wagon road, on property of Henry Castle, 300 metres back from edge of timber.

P. B. M. $\frac{282}{2}$.—A tile and pipe on public road, 300 metres back from left bank of river at foot of *Bear Island* (No. 161), one-half metre north of fence on south side of road through John Dyson's land, and 70 metres downstream from his house.

P. B. M. $\frac{283}{1}$.—A tile and pipe in public road, about 1½ miles back from left bank of river, about 2½ miles above *Bear Island*, 42 metres down river from junction of roads, 33 metres down river from angle in fence, one-half metre north of wire fence, and about 250 metres down river from J. P. Anderson's house.

P. B. M. $\frac{284}{1}$.—A tile and pipe in public road, about three-fourths of a mile back from left bank of river, 3 miles below *Clearwater, Minn.*, on south side of road, 1 metre west of fence corner on north and south section line between property of Barney Powers and property of B. H. Lee, about 200 metres below house. (See note 14, page 551.)

P. B. M. $\frac{285}{2}$.—A tile and pipe opposite *Clearwater, Minn.*, about 200 metres back from left bank of river, 200 metres above wagon road to ferry, on property of W. J. Kirk, 1½ metres west of fence running in northerly direction, and 32 metres south of fence corner. Blazed trees: 18-inch oak, 224°—7 metres; 15-inch oak, 249°—7·7 metres. (See note 14, page 551.)

P. B. M. $\frac{286}{2}$.—A tile and pipe 3 miles above *Clearwater, Minn.*, about 200 metres back from left bank of river at head of Island No. 151, on high ridge in jack oaks, about 100 metres upstream from edge of timber and cultivated field, 16 metres downstream from east and west wire fence, and on south side of a very large ravine. Blazed trees: 4-inch oak, 19°—4·6 metres; 12-inch oak, 78°—12.9 metres; 15-inch oak, 319° 40′—20·1 metres. (See note 14, page 551.)

P. M. M. $\frac{287}{1}$.—A tile and pipe on public road nearly due east of *St. Augusta* Church spire, one-half metre east of junction of fences on south side of road adjoining property of Mrs. Carrie Bowen, and about 150 metres north of her house. (See note 14, page 551.)

P. B. M. $\frac{288}{2}$.—A tile and pipe 200 metres back from left bank of river at head of Island No. 139, about 2½ miles below Normal School building in *St. Cloud, Minn.*, on property of S. A. Gray, at corner of cultivated field and timber, on high ground, one-half metre south of east and west fence, and 27¼ metres east of junction of fences. Blazed trees: 7-inch oak, 86°—8·6 metres; 9-inch oak, 146°—9·2 metres; 9-inch oak, 249°—6·5 metres. (See note 14, page 551.)

P. B. M. $\frac{289}{2}$.—A tile and pipe in *East St. Cloud, Minn.*, about 500 metres below upper wagon bridge, between Fourth and Fifth streets, on property of Mr. Wilson, 5 metres back from top of left bank of river, 15 metres south of a ravine, in scrub-oak timber. Blazed trees: 18-inch oak, 94°—3·2 metres; 24-inch oak, 242°—13·6 metres; 4-inch oak, 333°—3·8 metres. (See note 14, page 551.)

P. B. M. St. Cloud.—On great Northern Railway bridge over Mississippi River, at

St. Cloud, Minn.; being a copper bolt leaded vertically into top of lower end of abutment at left-shore end of bridge, 27 inches back from face of abutment and 24 inches from lower corner of abutment, and about 26 inches below top of rail.

T. B. M. 110.—The highest point on granite bowlder, on top of left bank of Mississippi River, near *St. Cloud, Minn.*, about 40 metres above a point opposite the mouth of the Sauk River, 2 inches north of hole in bowlder where copper bolt was leaded by United States Engineers from the St. Paul office. The copper bolt has been dug out, but T. B. M. 110 is practically at the same elevation.

P. B. M. $\frac{290}{2}$.—A tile and pipe 1 mile above *Sauk Rapids, Minn.*, 100 metres below foot of Clarks Island, directly opposite small towhead in northwest corner of small cultivated field, at junction of fences, 15 metres back from left bank of river, and about 100 metres above a signboard on railroad which reads "Sauk Rapids One Mile." Blazed 5-inch oak, 160°—11 metres. (See note 14, page 551.)

T. B. M. 112.—On Northern Pacific Railway, 350 metres above milepost 77, and about 200 metres below △ *Sauk Rapids;* being the highest point on the bell of large cast-iron drainpipe directly over mark cut thus ∧; it is on the east end of the upper one of two drainpipes of opening under railroad.

P. B. M. $\frac{291}{2}$.—A tile and pipe about 4 miles above the town of *Sauk Rapids*, 150 metres back from left bank of river at foot of Wautab Rapids, in corner of fence on west side of public road, on property of J. K. Miller. East and west fence is Miller's south line, and is center line through sections 3 and 4. Blazed trees: 10-inch oak, 335°—9·1 metres; 9-inch oak, 21°—4·9 metres; 9-inch oak, 71°—1·5 metres. (See note 14, page 551.)

P. B. M. $\frac{292}{2}$.—A tile and pipe on public road, about 600 metres below large granite knob (known as *Little Rock*), on which is △ Wautab, about 600 metres back from left bank of river, on high ground back of cultivated field, 125 metres south of junction of fences, and one-half metre west of fence on west side of road. Blazed trees: 6-inch oak, 278°—4·5 metres; 6-inch oak, 308°—4 metres. (See note 14, page 551.)

P. B. M. $\frac{293}{2}$.—A tile and pipe 10 metres back from left bank of river, about one-half mile above Brockaway Schoolhouse No. 7, 4 miles below *Rice, Minn.*, on property of J. H. Anderson, and about 350 metres above his house, in open grassy spot, 73 metres below an east and west fence which runs to water's edge. Blazed trees: 15-inch oak, 197°—9 metres; 20-inch oak, 287½°—13·5 metres; 18-inch oak, 26°—4·9 metres. (See note 14, page 551.)

P. B. M. △ Back Base (Rice Base Line).—A tile and pipe in open prairie 300 feet west of Northern Pacific Railway, 2 miles south of *Rices* station, about 10 metres south of section line. (See note 14, page 551.)

P. B. M. △ River Base (Rice Base Line).—A tile and pipe on left bank of river, in public road, about 2 miles below *Rice, Minn.*, about one-half mile above ferry, and 8 metres below section line. (See note 14, page 551.)

P. B. M. $\frac{294}{2}$.—A tile and pipe in public road, 1½ miles below *Rice, Minn.*, on high terrace about 200 metres back from left bank of river, 18 metres below junction of fences, one-half metre toward river from fence on north side of road adjoining property of Minneapolis Loan and Trust Company, 190 metres downstream from where road makes an angle and runs north to Rice. Log house stands near angle in road. (See note 14, page 551.)

P. B. M. $\frac{285}{2}$.—A tile and pipe in public road, about 600 metres above Russels Ferry, which is due west of *Rice, Minn.*, 400 metres back from left bank of river, one-half metre east of fence on west side of road, 100 metres above house of George P. McGee, who owns the property on east side of road; property on west side of road belongs to Robert Russel. (See note 14, page 551.)

P. B. M. $\frac{286}{2}$.—A tile and pipe 50 metres back from left bank of river, opposite head of Islands Nos. 88 and 89, about 1¼ miles above mouth of Platte River, on property of J. H. Higgins and 230 metres downstream from his house, one-half metre south of east and west fence at edge of timber and cultivated field. Blazed trees: 18-inch oak, 60°—10·6 metres; 18-inch oak, 102°—6·4 metres; 15-inch oak, 263°—5·6 metres. (See note 14, page 551.)

P. B. M. $\frac{287}{2}$.—A tile and pipe 300 metres back from left bank of river, opposite *North Prairie, Minn.*, on top of high ridge in oak timber, 16 metres south of public road which runs from Royalton to North Prairie Ferry, about 100 metres back from corner of fence. Blazed trees: 15-inch oak stub, 129°—9·3 metres; 15-inch oak stub, 228°—13·4 metres. (See note 14, page 551.)

P. B. M. $\frac{288}{2}$.—A tile and pipe opposite head of Island No. 77, about 1½ miles above wagon bridge over Mississippi River, known as the *Royalton* bridge, on top of high terrace, about 400 metres back from left bank of river, on property of Peter McDougall and about 275 metres above his house, one-half metre west of a wire fence at edge of timber and cultivated field. Blazed tree: 20-inch oak, 79° 25′—21·7 metres.

P. B. M. $\frac{289}{2}$.—A tile and pipe 11 metres back from left bank of river, 4½ miles above *Royalton* bridge, 450 metres below Cashs Island, 250 metres below Island No. 73, opposite lower end of cultivated field, about 20 metres below a bunch of white birch which stands at water's edge (only birch in this vicinity), in timber. Blazed trees: 18-inch oak, 20°—24·9 metres; 8-inch oak, 83°—9·3 metres; 12-inch oak, 274°—6·3 metres. (See note 14, page 551.)

P. B. M. $\frac{290}{2}$.—A tile and pipe on left bank of river, 4 miles below *Little Falls, Minn.*, at head of Island No. 64, on property of George Kruger, and 30 metres below his house, 30 metres toward river from public road. Blazed trees: 18-inch oak, 76°—9 metres; 15-inch oak, 130°—9 metres. (See note 14, page 551.)

P. B. M. $\frac{291}{2}$.—A tile and pipe 400 metres back from left bank of river, at head of Island No. 59, about three-fourths of a mile below *Little Falls, Minn.*, on property of P. W. Hayes and on his south line, at junction of fences, about 200 metres west of public road, in pasture. Blazed trees: 18-inch oak, 266°—18·4 metres; 10-inch oak, 294°—15·4 metres; 12-inch oak, 125°—23·8 metres. (See note 14, page 551.)

T. B. M. 152.—In *Little Falls, Minn.*, on Hotel Buckman, at southeast corner of First street and First avenue, south, being a square cut in top of lower step at First street entrance to hotel, 6 inches above sidewalk and 34 inches south of northwest corner of hotel, marked U □ S.

P. B. M. $\frac{292}{2}$.—A tile and pipe 5 metres back from top of left bank of river, about 1 mile above railroad bridge over Mississippi River at *Little Falls, Minn.*, in open place in timber opposite entrance to fair grounds, 200 metres below foot of large island; a wagon road is cut down to river in front of bench mark. Blazed trees: 5-inch oak, 89°—7·9 metres; 8-inch oak, 248°—21·6 metres; 8-inch oak, 294°—22·5 metres. (See note 14, page 551.)

P. B. M. $\frac{303}{2}$.—A tile and pipe in public road at *Belle Prairie* church, 4½ miles above Little Falls, Minn., 300 metres back from left bank of river, three-fourths of a metre west of fence on east side of road, 17 metres north of junction of fences, and 44 metres north from line of north wall of Belle Prairie Church. Blazed tree: 18-inch oak, 259°—1·9 metres. (See note 14, page 551.)

P. B. M. $\frac{304}{2}$.—A tile and pipe in public road 3 miles above *Belle Prairie* Church, about 500 metres back from left bank of river, opposite foot of Island No. 45, one-half metre east of fence on west side of road, 2 metres south of fence corner, 15 metres south of Leon Bellefenil's house. Blazed tree: 20-inch oak, 306°—24 metres. (See note 14, page 551.)

P. B. M. $\frac{305}{2}$.—A tile and pipe 300 metres back from left bank of river, 4½ miles below ferry at *Fort Ripley*, *Minn.*, one-half mile below foot of Island No. 38, opposite point where timber commences along river, on property of D. Brauchaud and about 600 metres below his house, one-half metre east of north and south fence, 8 metres south of junction of fences, 100 metres above upper one of two lone pine trees which stand in cultivated field. Blazed tree: 10-inch oak, 304°—4·4 metres. (See note 14, page 551.)

P. B. M. $\frac{306}{2}$.—A tile and pipe in north and south wagon road 500 metres back from left bank of river, 1¼ miles below *Fort Ripley* ferry, opposite foot of Island No. 24, 500 metres below J. F. Kimball's house; adjoining property belongs to W. A. Clark, three-fourths of a metre from fence on west side of road, 125 metres south of junction of fences. Blazed tree: 7-inch oak, 229°—3 metres. (See note 14, page 551.)

P. B. M. $\frac{307}{2}$.—A tile and pipe on right of way of Northern Pacific Railway, about 1 mile above *Fort Ripley* station, about 150 metres above railroad bridge over Nocosippi River, one-half metre west of fence on east side of track, 8 metres south of line of south wall of house on opposite side of track. Blazed tree: 8-inch oak, 281°—5·2 metres. Southeast corner of house, 74° 26′—54·2 metres. (See note 14, page 551.)

P. B. M. $\frac{308}{2}$.—A tile and pipe 3 miles above *Old Fort Ripley*, one-half metre east of an old fence on top of left bank of river, opposite a lone 30-inch elm snag which stands on top of right bank, 200 metres above a large bunch of small pines standing near river, directly back of an 18-inch Norway pine which stands on slope of river bank and is the only one in the vicinity. Blazed trees: 18-inch Norway pine, 110°—6·2 metres; 10-inch jack pine, 38°—7·5 metres. (See note 14, page 551.)

P. B. M. $\frac{309}{2}$.—A tile and pipe 300 metres back from left bank of river, about 200 metres above Island No. 22, on property of George Smith and 170 metres downstream from his house, in pasture, one-half metre west of north and south fence, 50 metres north of fence corner. Blazed tree: Lone 8-inch oak, 214°—11·6 metres. (See note 14, page 551.)

P. B. M. $\frac{310}{2}$.—A tile and pipe on left bank of river near *Old Crow Wing Ferry*, about opposite upper mouth of Crow Wing River, on property of Charles Bailey, 15 metres north from corner of timber, 75 metres back from crest of high ridge. Mr. Bailey's house stands south 20° east (magnetic bearing) about 250 metres. Blazed trees: 10-inch oak, 182°—13·1 metres; 8-inch oak, 342°—6·3 metres. (See note 14, page 551.)

P. B. M. $\frac{311}{2}$.—A tile and pipe 3 miles above *Old Crow Wing Ferry*, on top of high ridge, 20 metres back from water's edge on left bank of river, 500 metres below a cultivated field on right bank, low ground along river on both sides of bench mark; an

18-inch Norway pine stands on slope of bank 5 metres downstream and a dead snag stands 30 metres upstream on slope of bank. Blazed trees: 15-inch white pine, 6°—6 metres; 18-inch Norway pine, 124°—11·2 metres. (See note 14, page 551.)

P. B. M. $\frac{312}{2}$.—A tile and pipe on left bank of river 3½ miles below railroad bridge at *Brainerd, Minn.*, 100 metres below mouth of Buffalo Creek, 50 metres above head of island, on top of ridge, 30 metres back from water's edge, about 50 metres above a mound. Blazed trees: 8-inch jack pine, 291°—4·8 metres; 10-inch jack pine, 344°—3·9 metres; 8-inch jack pine, 85°—5·9 metres. (See note 14, page 551.)

T. B. M. 195.—The highest point, on large granite bowlder, about 2 metres east of Northern Pacific Railway track, 2¾ miles below *Brainerd, Minn.*, one-fourth mile above milepost 3, and just below road crossing.

T. B. M. 196.—On Northern Pacific Railway right of way, 1½ miles below *Brainerd, Minn.*, one-half mile below milepost 1, being a square cut on highest point of large granite bowlder 5 metres east of track, 6 inches north of hole in top of bowlder, at south end of railroad cut.

P. B. M. $\frac{313}{2}$.—A tile and pipe in *Brainerd, Minn.*, on top of high bank, about 600 metres below lower wagon bridge over Mississippi River, 300 metres back from left bank of river, at corner of fence near southwest corner of Third and Quince streets, 5 metres north of south line of Quince street, 40 metres north of George Sargent's house and 1 metre northwest of northeast corner of his lot. (See note 14, page 551.)

P. B. M. "Sanitarium."—In *Brainerd, Minn.*, in southeast corner of Sanitarium (Northern Pacific Railway Hospital) grounds, on right bank of river, at west end of Northern Pacific Railway Bridge over Mississippi River, 2 metres from east fence and 5 metres from south fence around Sanitarium grounds; established under the direction of United States Engineer office at St. Paul, Minn. It is the head of a copper bolt in stone 16 inches square and 6 inches thick, sunk 4 feet in ground and surmounted by an iron pipe 4 inches in diameter and 4 feet long, with cast-iron cap at surface of ground marked with letters U S E B M.

P. B. M. △ South Base (Brainerd Base Line).—A tile and pipe on south side of jack-pine grove, 20 metres from edge of high ground, and on prolongation of north and south street (Mill street) leading south from sawmill in northeast *Brainerd*. Supposed to be in alley of a newly surveyed addition, about 20 feet east of line of ditch running south across meadow lands. Blazed trees: 8-inch jack pine, 188°—11·2 metres; 6-inch jack pine, 261°—15·1 metres. (See note 14, page 551.)

P. B. M. △ North Base (Brainerd Base Line).—A tile and pipe in center of Mill street in northeast *Brainerd*, about 150 metres from left bank of river, 11 metres nearly south of switch block on Brainerd and Northern Minnesota Railway, 40 metres northeast of road crossing, and opposite east and west roadway through Brainerd Lumber Company's lumber yard.

P. B. M. $\frac{314}{2}$.—A tile and pipe in northeast *Brainerd, Minn.*, 25 metres back from left bank of river, in front of X I W sawmill, 25 metres toward river from railroad track and about 250 metres below end of railroad bridge. Blazed tree: Norway pine, 166° 15′—20·5 metres; △ North Base, 17°33′—163·8 metres. (See note 14, page 551.)

P. B. M. $\frac{315}{2}$.—A tile and pipe on left bank of river 3 miles above sawmill in northeast *Brainerd, Minn.*, on ridge about 44 feet above water surface one-half mile above point where river narrows up, 200 metres above a high wooded point (150 feet high), directly back of low point of land, 100 metres above a bay on right bank, and 75 metres back from water's edge. Blazed trees: Jack pine, 181°—12·7 metres; jack pine, 317°—5·4 metres; jack pine, 23°—10·6 metres. (See note 14, page 551.)

P. B. M. $\frac{317}{2}$.—A tile and pipe about 600 metres above the mouth of *Rabbit River*, on left bank about 65 metres back from top of bank, surrounded by three large white pines, about 100 metres above Island No. 4 and about 40 metres upstream from highest point of ridge. Blazed trees: 36-inch white pine, 240°—10·3 metres; 24-inch white pine, 331°—2·9 metres; 36-inch white pine, 49°—13·5 metres. (See note 14, page 551.)

P. B. M. $\frac{318}{2}$.—A tile and pipe 3½ miles above the mouth of *Rabbit River*, on top of high ridge, 100 metres back from water's edge on left bank of river, 75 metres above point where ridge leaves the river, one-half mile below Half Moon Marsh, in Sec. 1, T. 47 N., R. 30 W. of fourth principal meridian, near a Norway pine on top of ridge. Blazed trees: Norway pine, 91°—16·3 metres; 20-inch white pine, 186°—37 metres.

P. B. M. $\frac{319}{2}$.—A tile and pipe 30 metres back from left bank of river, 500 metres above Dr. Camp's house (*Old Indian Mission*), in timber, 75 metres below mouth of slough on right bank. Blazed trees: 15-inch basswood, 257°—1·5 metres; 12-inch ash, 348°—5·5 metres; 18-inch ash, 75°—8·6 metres. (See note 14, page 551.)

P. B. M. $\frac{320}{2}$.—A tile and pipe on left bank of river 1½ miles below mouth of *Pine River*, 1 mile above Foster's house, on north slope of ridge, 5 metres back from bank of river, 25 metres upstream from highest point of ridge, in section 17, about one-fourth mile north of south line. Blazed trees: 6-inch Norway pine, 185°—9·6 metres; 10-inch white pine, 268°—9·6 metres; 6-inch Norway pine, 237°—3·2 metres. (See note 14, page 551.)

P. B. M. $\frac{321}{2}$.—A tile and pipe on left bank of river, 2½ miles above mouth of Pine River, 1 mile below *Island Lake*, 35 metres back from top of bank, 75 metres below high ridge, 2 metres west of wagon road, in section 15. Blazed trees: 8-inch ash, 195°—15·3 metres; 24-inch oak, 236°—34·2 metres; 24-inch oak, 336°—15 metres. (See note 14, page 551.)

P. B. M. $\frac{322}{2}$.—A tile and pipe 54 metres back from left bank of river, about three-fourths of a mile below *Towhead Rapids*, in section 24, about one-fourth of a mile west of township line, on first bench back from river, opposite a point where high sand bank strikes river, near two 24-inch white pines standing northeast. Blazed trees: 24-inch white pine, 302°—6·3 metres; 18-inch white pine, 59°—15·7 metres; 12-inch white pine, 148°—15·2 metres. (See note 14, page 551.)

P. B. M. $\frac{323}{2}$.—A tile and pipe on left bank of river about 25 metres above head of *Island No. 1*, 5 metres back from top of high bank, 15 metres from water's edge, 15 metres downstream from small ravine. Blazed trees: 15-inch white pine, 62° 20′—21 metres; 6-inch white pine, 179°—10·6 metres. See note 14, page 551.)

P. B. M. $\frac{324}{2}$.—A tile and pipe on left bank of river, 1½ miles above *Dean Brook*, on top of high bank 8 metres back from top, at east edge of cultivated field, 200 metres below house on right bank, in section 2. Blazed trees: 7-inch jack pine, 278°—9 metres; 10-inch jack pine, 217°—1·6 metres. (See note 14, page 551.)

P. B. M. $\frac{325}{2}$.—A tile and pipe on left bank of river, 250 metres above mouth of *Hay Creek*, on high ground 75 metres back from river, on property of John Doteler, near fence which is the line between John Doteler and Frank Doteler; 339° 7′—65·1 metres to northwest corner of Frank Doteler's house. (See note 14, page 551.)

P. B. M. $\frac{326}{2}$.—A tile and pipe about 600 metres above mouth of *Cedar Brook*, in cultivated field, just inside of fence on south side of public road, 35 metres below junction of fences, 50 metres back from left bank of river, on property of D. McGillis estate, 100 metres above house and on same side of road. (See note 14, page 551.)

P. B. M. $\frac{327}{2}$.—A tile and pipe 3 miles below *Aitkin*, *Minn.*, on property of Conrad Schwab and about 50 metres southeast of his house, 75 metres back from left bank of river, 3 metres east of small ditch, 3 metres west of fence, in section 15. Blazed trees: 36-inch basswood, 39°—23·1 metres; 8-inch basswood, 105°—3·5 metres; 15-inch ash, 173°—5·3 metres. (See note 14, page 551.)

P. B. M. Courthouse.—In *Aitkin*, *Minn.*, being a horizontal furrow in copper bolt leaded into second course of brick above foundation at southwest corner of L on south side of Aitkin County courthouse, 8 inches east of corner and 4 feet above ground. Courthouse built in 1888. Marked U ⊖ S P B M.

P. B. M. $\frac{328}{2}$.—A tile and pipe in *Aitkin*, *Minn.*, in cultivated field, one-half metre west of fence on west side of street leading to wagon bridge over Mississippi River, 11 metres south of fence corner on property of Hodgeden and McDonald, and about 75 metres back from left bank of river. (See note 14, page 551.)

P. B. M. △ Lower Base (Aitkin Base Line.)—A tile and pipe, about 20 metres back from left bank of river, and about 1 500 metres above wagon bridge over Mississippi River at *Aitkin*, *Minn.*, at extreme lower end of point of timber, on line with east and west road, 650 metres west of angle in road at township line, one-fourth of a mile south of section line between sections 13 and 24. (See note 14, page 551.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN DULUTH AND ST. PAUL, MINN.

B. M. 1 of U. S. Engineers.—At *Duluth*, is the upper surface of the water table of Miller's Block, at the east corner of Lake avenue and Superior street, Duluth, Minn. It is 12 feet and 1 inch south of the corner of building, and on the Lake avenue side. Established in 1873.

B. M. 19 of U. S. Engineers.—At *Duluth*, is top of tack in square of black paint on top surface of cap, at north end of Graves Slip, in Duluth, Minn. Is about 2 feet from a snubbing post and 234 feet north of the first angle in the wharf. Was established in 1887.

B. M. 23 of U. S. Engineers.—At *Duluth*, is marked by square of black paint, 2 inches in diameter, and is top surface of granite pedestal supporting an iron post of the Sixth avenue viaduct, over the railroad tracks at Duluth, Minn. It is at the eastern end of the southern bent of posts, and is near the north line of Railroad street.

B. M. Iron Bay Iron Works.—Is cross cut in office doorstep of Iron Bay Iron Works building, at *West Duluth*, *Minn.* It is 6 inches from north jamb and 2 inches from front of step.

P. B. M. 1.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 522 feet northward from the West End depot, and 44 feet eastward from the St. Paul and Duluth Railway track. It is 59 feet southward from Railroad bridge No. 48, and about 5 miles south of the *Duluth* Union depot.

P. B. M. 1A.—Is top of iron cap on top of pipe over P. B. M. 1, described above.

P. B. M. 2.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 43 feet eastward of the St. Paul and Duluth Railway track, and 66 feet west of the public road leading from Duluth to Fond du Lac, and 1 476 feet northward from the depot at *Smithville, St. Louis County, Minn.* It is 156 feet northeastward from the railroad section house. There is an iron post projecting 6 inches above ground, 148 feet southward from the bench mark, and on which are letters St. P. & D. R. R. This post is said to be the northeast corner of SE. ¼, of NE. ¼ of sec. 27, T. 49, R. 15.

P. B. M. 2A.—Is top of iron cap on top of pipe over P. B. M. 2, described above.

P. B. M. 3.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 52 feet north of the St. Paul and Duluth Railway track, 6 562 feet west of the St. Paul and Duluth Railway depot at *Short Line Park, St. Louis County, Minn.* It is at the east end of high embankment on the St. Paul and Duluth Railway, and is in southwest corner of a field.

P. B. M. 3A.—Is top of iron cap on top of pipe over P. B. M. 3, described above.

P. B. M. 4.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 49 feet south of the St. Paul and Duluth Railway track, and 6 890 feet east of the depot at *Thomson, Carlton County, Minn.* It is 298 feet west of a cattle guard, and 2·5 feet north of the right of way south fence.

P. B. M. 4A.—Is top of iron cap on top of pipe over P. B. M. 4, described above.

P. B. M. 5.—Is cross cut on top of window sill of the Carlton County courthouse at *Carlton, Minn.* It is in the first window north of the tower and on the western side of the building. The bench mark is marked thus: U S + B M.

P. B. M. 6.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 1 foot southward from the southern fence of the Superior and St. Paul Military road and on land of Michael O'Donnell, in Carlton County, Minn. It is 371 feet eastward from the northwest corner of sec. 1, T. 47, R. 17, and is 190 feet northward from O'Donnell's house, and is about 6 miles southward from the town of *Carlton.*

P. B. M. 6A.—Is top of iron cap on top of pipe over P. B. M. 6, described above.

P. B. M. 7.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is about 100 feet northward from the Military road and 500 feet westward from the bridge over Blackhoof River, and 8·5 miles eastward from *Barnum,* in *Carlton County, Minn.* There are two Norway pine trees blazed, respectively, 79 feet northward and 62 feet northeastward from the bench mark.

P. B. M. 7A.—Is top of iron cap on top of pipe over P. B. M. 7, described above.

P. B. M. 8.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 59 feet northwestward from the Military road and 193 feet northward from the junction of the Military road with public road leading to Barnum. The bench mark is 3·9 miles east of *Barnum,* in *Carlton County, Minn.*

P. B. M. 8A.—Is top of iron cap on top of pipe over P. B. M. 8, described above.

P. B. M. 9.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is in the southeast corner of sec. 36, and is 17 feet northward from the township corner marking Ts. 46 and 47, Rs. 18 and 19, and being the northwest corner of T. 46, R. 18, in Carlton County, Minn. The township corner is marked by an iron bolt driven about 3 feet in the ground and is in the public road. The bench mark is about 1 mile east of *Barnum* depot.

P. B. M. 9A.—Is top of iron cap on top of pipe over P. B. M. 9, described above.

P. B. M. 10.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 20 feet 8 inches from the southeast corner of L. L. Sargeant's dwelling house, in *Moose Lake*, *Carlton County*, *Minn*. It is 145 feet eastward from the St. Paul and Duluth Railroad track, and 282 feet eastward from the railway depot, and 525 feet eastward from a warehouse under which is the northwest corner of sec. 21, T. 46, R. 19.

P. B. M. 10A.—Is top of iron cap on top of pipe over P. B. M. 10, described above.

P. B. M. 11.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 321 feet southward from the south side of the railway depot at *Sturgeon Lake*, *Pine County*, *Minn.*, and 34 feet east of the St. Paul and Duluth Railway track. It is 209 feet southwestward from Cunningham's barn, on a steep hillside which slopes southeastward to the bed of a former lake.

P. B. M. 11A.—Is top of iron cap on top of pipe over P. B. M. 11, described above.

P. B. M. 12.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is on land of H. S. Akin, in *Willow River* village, *Pine County*, *Minn*. It is 3·3 feet west of the southwest corner of sec. 2, T. 44, R. 20; is 23 feet from each of two white pine witness trees to the section corner above named, and is 108 feet northeastward from Akin's house.

P. B. M. 12A.—Is top of iron cap on top of pipe over P. B. M. 12, described above.

P. B. M. 13.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe, on land of Hugh Conway, at *Kettle River* station, *Pine County*, *Minn*. It is 262 feet west of a point on the St. Paul and Duluth Railway track, which is 390 feet south of the railway depot. It is 32 feet west of a fence and 147 feet westward from the northwest corner of a schoolhouse.

P. B. M. 13A.—Is top of iron cap on top of pipe over P. B. M. 13, described above.

P. B. M. 14.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 45 feet east of the St. Paul and Duluth Railway track and 1 060 feet south of the railway section house at *Miller* station, *Pine County*, *Minn*. It is 60 feet southeastward from the east end of a wooden culvert under the railway track.

P. B. M. 14A.—Is top of iron cap on top of pipe over P. B. M. 14, described above.

P. B. M. 15.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 121 feet west of the St. Paul and Duluth Railway track and 150 feet northwestward from the northwest corner of the railway depot at *Sandstone Junction*, *Pine County*, *Minn*.

P. B. M. 15 A.—Is top of iron cap on top of pipe over P. B. M. 15, described above.

P. B. M. 16.—Is a cross cut on top the granite bridge seat of the northeast corner of the trussed span of the St. Paul and Duluth Railway over Grindstone River at *Hinckley*, *Pine County*, *Minn*. It is 6 inches from the south face and 6 inches from the east face of the stone and 10 inches from the southeast corner of the bed plate under the inclined end post of the bridge. It is marked thus: U S + B M.

P. B. M. 17.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is in the northeast angle formed by the crossing of the St. Paul and Duluth and the Eastern Minnesota railways at *Hinckley*, *Pine County*, *Minn*. It is 123 feet northeastward from the center of the crossing, 48 feet northwestward from center of the Eastern Minnesota Railway, and 65 feet eastward from the center of the St. Paul and Duluth Railway.

P. B. M. 17 A.—Is top of iron cap on top of pipe over P. B. M. 17, described above.

P. B. M. 18.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 46 feet east of the St. Paul and Duluth Railway track, 4·5 feet west of right-of-way fence and 2 600 feet south of the railway depot at *Mission Creek, Pine County, Minn.* There is an excavation in the railroad track at this point about 3 feet deep.

P. B. M. 18 A.—Is top of iron cap on top of pipe over P. B. M. 18, described above.

P. B. M. 19.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 71 feet westward from the north head block of the railway siding at *Browns Hill, Pine County, Minn.*

P. B. M. 19 A.—Is top of iron cap on top of pipe over P. B. M. 19, described above.

P. B. M. 20.—Is cross cut in top of east end of wall supporting the track stringers at the north end of the trussed span of the St. Paul and Duluth Railway over Snake River at *Pine City, Pine County, Minn.* It is 21 inches east of the east track stringer and 26 inches west of the west side of the inclined end post at the northeast corner of the span. It is marked thus: U S + B M.

P. B. M. 21.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is in the south side of Robinson Park at *Pine City, Pine County, Minn.;* is 4 feet north of the park fence, 59 feet west of the southeast corner of the park, 141 feet east of the southwest corner of the park, and 151 feet west of the St. Paul and Duluth Railway track.

P. B. M. 21 A.—Is top of iron cap on top of pipe over P. B. M. 21, described above.

P. B. M. 22.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. Is on land of E. Edgerton, at *Brock Creek* station, *Pine County, Minn.* It is 54 feet east of the St. Paul and Duluth Railway track, 53 feet southeastward from the southeast corner of railway bridge No. 18, and 243 feet southward from the railway depot. The bench mark stands near the edge of a small bluff, and is 265 feet westward from Edgerton's dwelling house.

P. B. M. 22 A.—Is top of iron cap on top of pipe over P. B. M. 22, described above.

P. B. M. 23.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is in the Presbyterian churchyard at *Rush City, Chisago County, Minn.:* is 4 feet north of north wall of church and 65 feet from the northwest corner of the churchyard.

P. B. M. 23 A.—Is top of iron cap on top of pipe over P. B. M. 23, described above.

P. B. M. 24.—Is a cross cut in top of stone foundation of St. Paul and Duluth Railway, north of water tank at *Rush City, Chisago County, Minn.* It is on the northeast corner of the north pier of the third bent of framework from the east side of the track, and is about 4 inches from the corner of the stone. Is marked thus: U S + B M.

P. B. M. 25.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe at *Harris* village, *Chisago County, Minn.* Is on the north end of a small knoll, 53 feet east of the St. Paul and Duluth Railway track and 55 feet west of the east fence of the public road; 849 feet southward from the railway depot and 206 feet eastward from S. J. Stark's dwelling house.

P. B. M. 25 A.—Is top of iron cap on top of pipe over P. B. M. 25, described above.

P. B. M. 26.—Is a cross cut on top of stone foundation of the St. Paul and Duluth

Railway water tank at *North Branch*, *Chisago County*, *Minn.* It is on the northwest corner of the second pier from north end of second bent of framework from the railway track, and is marked thus: U S + B M.

P. B. M. 27.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. It is 45 feet east of the St. Paul and Duluth Railway track and 711 feet south of the south line of Third street of *North Branch* village, *Chisago County*, *Minn.*, and is about 3 feet from the right of way fence.

P. B. M. 27 A.—Is top of iron cap on top of pipe over P. B. M. 27, described above.

P. B. M. 28.—Is top of copper bolt in vitrified clay slab in ground, and surmounted by iron pipe. Is on land of J. B. Dyarman, in *Stacy* village, *Chisago County*, *Minn.* It is 179 feet west of the St. Paul and Duluth Railway track, 164 feet northwestward from the railway depot, and 13 feet north of the north side of Dyarman's dwelling house.

P. B. M. 28 A.—Is top of iron cap on top of pipe over P. B. M. 28, described above.

P. B. M. 29.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe. It is on R. M. Fullerton's land in *Wyoming* village, *Chisago County*, *Minn.* It is 70 feet east of the southeast corner of section 18, township 33 north, range 21 west, 139 feet east of the St. Paul and Duluth Railway track, 2 feet north of the north line of Fourth street, and 1 100 feet north of the Wyoming Railway depot.

P. B. M. 29 A.—Is top of iron cap on top of pipe over P. B. M. 29, described above.

P. B. M. 30.—Is a cross cut in top of foundation stone of St. Paul and Duluth Railway water tank at *Forest Lake* village, *Washington County*, *Minn.* It is on the north pier of the second bent of framework from the railway track, and is marked thus: U S + B M.

P. B. M. 31.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe on the railroad reservation at *Forest Lake*, *Washington County*, *Minn.* It is 366 feet northwestward from a point on the St. Paul and Duluth Railway track which is on a line with the north side of the railway depot, and is 225 feet westward from the track, measured at right angles thereto.

P. B. M. 31 A.—Is top of iron cap on top of pipe over P. B. M. 31, described above.

P. B. M. 32.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe. It is in the northeast corner of lot 1, block 31, of *Forest Lake* village, *Washington County*, *Minn.* Is 102·5 feet west of the St. Paul and Duluth Railway track and about 545 feet southwestward from the railway depot.

P. B. M. 32 A.—Is top of iron cap on top of pipe over P. B. M. 32, described above.

P. B. M. 33.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe, on Mrs. Frances Kitchliis's land, in *Centerville*, *Washington County*, *Minn.* It is 121 feet east of the St. Paul and Duluth Railway track, 7 feet north of an oak tree, 25 feet southward from the northwest corner of Mrs. Kitchliis's lot, and 187 feet northward from her store and dwelling house.

P. B. M. 33 A.—Is top of iron cap on top of pipe over P. B. M. 33, described above.

P. B. M. 34.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe. It is 3 feet west of fence, 75 feet east of the St. Paul and Duluth Railway track, 410 feet northward from the *Bald Eagle Junction* depot, *Ramsey County*, *Minn.*, and 449 feet northward from the crossing of the St. Paul and Duluth and the Minneapolis, Sault Ste. Marie and Atlantic railways.

P. B. M. 34 A.—Is top of iron cap on top of pipe over P. B. M. 34, described above.

P. B. M. 35.—Is a cross cut on top of the southeast corner of the foundation stone at the south end of the east bent under the north water tank of the St. Paul and Duluth Railway at *White Bear, Ramsey County, Minn.* It is 42 feet from the southwest corner of the pump house and 160 feet from the north end of the White Bear depot, and is marked thus U S + B M.

P. B. M. 36.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe. It is on lot 12, block 53, in *White Bear* village, *Ramsey County, Minn.* Is 37 feet east of the west line of Railroad avenue and 8 feet south of the south wall of the White Bear Hotel.

P. B. M. 36 A.—Is top of iron cap on top of pipe over P. B. M. 36, described above.

P. B. M. 37.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe. It is in the east side of Railroad Park, *White Bear, Ramsey County, Minn.* Is 121 feet south of the south line of Fourth street, 207 feet from the northeast corner of the railway depot, and 85 feet from the northwest corner of a brick building now occupied by the Union Meat Market.

P. B. M. 37 A.—Is top of iron cap on top of pipe over P. B. M. 37, described above.

P. B. M. 38.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe. Is 1·2 miles south of *White Bear* depot, *Ramsey County, Minn.* Is 2 feet west of right of way fence, 46 feet east of the east track of the St. Paul and Duluth Railway, 302 feet northward from the head block of the Minneapolis Branch of the St. Paul and Duluth Railway, and 315 feet northward from the switchman's house.

P. B. M. 38 A.—Is top of iron cap on top of pipe over P. B. M. 38, described above.

T. B. M. 185.—Is a cross cut on top of the foundation stone of the first bent east of the St. Paul and Duluth Railway tracks at the second highway over bridge south of *White Bear, Ramsey County, Minn.* It is 13 feet 3 inches north of the south end of the mudsill foundation, and the bridge is 1·5 miles north of the Gladstone depot.

P. B. M. 39.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe. It is in the northwest angle formed by the crossing of the St. Paul and Duluth and the Wisconsin Central railways. Is 71 feet from the railroad (western) crossing, 33 feet west of the west track of the St. Paul and Duluth Railway, 153 feet westward from the southwest corner of the Buford plow factory, and about 550 feet northward from the St. Paul and Duluth Railway depot at *Gladstone, Ramsey County, Minn.*

P. B. M. 39 A.—Is top of iron cap on top of pipe over P. B. M. 39, described above.

P. B. M. 40.—Is top of copper bolt in vitrified clay slab in ground and surmounted by iron pipe. It is in the northeast corner of the lot 11, block 2, of *Gladstone* village, *Ramsey County, Minn.*, and about 50 feet from the northeast corner of the Gladstone House, and 193 feet westward from the St. Paul and Duluth Railway.

P. B. M. 40 A.—Is top of iron cap on top of pipe over P. B. M. 40, described above.

T. B. M. 193.—Is a cross cut on top of the northern corner of the pedestal block supporting the southern post of the fourth bent of iron piers west of the St. Paul and Duluth Railway track, where it passes under the Third Street Viaduct in *St. Paul, Minn.*

P. B. M. 68.—*St. Paul, Minn.* (See page 738.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ESCANABA AND MARQUETTE, MICH.

B. M. 1 (Escanaba) (1874).—The top of the water table of the large brick building of S. Adler, on the northwest corner of Ludington street and Douseman avenue, *Escanaba, Mich.*, on the southeast corner of the building.

B. M. 3 (1876).—Center of small hole in copper bolt leaded into masonry foundation af *Escanaba* light-house, west side of light-house, near northwest corner.

B. M. 4 (1876).—Center of small hole in copper bolt leaded into natural rock on east side of Chicago and Northwestern Railroad, about 36 metres north of switch of siding leading to charcoal kilns at *Maple Ridge*.

B. M. 5 (1876).—Center of small hole in copper bolt leaded into natural rock, about 74 metres east and 53 metres south of switch at north end of siding at *Sands*.

B. M. 6 (1876).—Center of small hole in copper bolt leaded into third course of stones above water table on north side of the Marquette, Houghton and Ontonagon Railroad general freight and ticket office at *Marquette*, about 1 foot from northeast corner.

B. M. 1 (Marquette)(1871).—Southeast corner of the top of the foundation stone of Grace furnace, *Marquette, Mich.*

B. M. 2 (Marquette)(1874).—Cross on the window sill of the *Marquette* city waterworks. It is on the center window, west side of building, and north side of window.

B. M. 3 (Marquette)(1874).—Cross on the window sill of the *Marquette* city waterworks. It is on the north window, east side of building, and 6 inches from north end of sill.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ST. LOUIS AND ST. JOSEPH, MO.

P. B. M. 12.—Nine miles above the *St. Louis* water works. Also called P. B. M. 1. (See page 719.)

P. B. M. 2 = $\frac{1}{4}$.—Is about 1¼ miles below the upper end of *Columbia Bottom*, at point where Columbia Bottom road, running along the foot of the bluff, turns east across the bottom opposite rock quarry, at east road fence, 55 feet south of the corner; being top of copper bolt in a bench-mark stone. (See note 15, page 551.)

P. B. M. 3.—Is at upper extremity of *Columbia Bottom*, at foot of bluff, 40 feet from river bank, 60 feet above rail fence over bluff, at east end of Henry Weisley's orchard, 5 feet south of wire fence, 4 feet above elevation of bottom land, in exposed ledge of rock; being copper bolt. (See note 16, page 552.)

T. B. M. 2.—Is about 95 feet west of P. B. M. 3, 240 feet below west end of Henry Weisley's orchard, on projection of natural ledge, 2 feet from end and 4 feet northwest of a blazed ash 24 inches in diameter.

P. B. M. 4 = $\frac{2}{4}$.—Is at foot of bluff near site of *Fort Bellefontaine;* being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 5.—Is about three-fourths mile below St. Louis, Keokuk and Northwestern Railway bridge, 2 295 feet above mouth of *Cold Water Creek*, in large recess in rock bluff in which there is a small spring flowing out of a circular hole in rock 1 foot in diameter at an elevation of mean stage of river; it is in a vertical cliff, about 20 feet below top of exposed face, and 10 feet above high water; being copper bolt. (See note 16, page 552.)

P. B. M. 6.—Is at *Jamestown Landing*, 1 605 feet above St. Louis, Keokuk and Northwestern Railway Bridge, 118 feet above the mouth of small creek which runs along the west side of Widow Zehe's place, in small recess in bluff bank, 75 feet below point, where rail fence intersects the river bank, 10 feet below top of bank, directly under a 10-inch hackberry, 15 feet above low water and 3 feet west of large detached rock, being copper bolt leaded into natural ledge. (See note 16, page 552.)

P. B. M. 7.—Is 2 210 feet above *Jamestown Landing*, at upper edge of oak grove, 900 feet above Wm. Whittaker's house standing on bluff, 20 feet from top of high-water bank, and 1 foot east of wire fence; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 8.—Is 2 785 feet above *Jamestown Landing*, 500 feet below foot of island tow-head, 575 feet above fence at the upper side of woods at which is located P. B. M. 7, in north exposure of hard limestone ledge; being horizontal furrow in copper bolt. It is the same as P. B. M. 8 of 1887.

P. B. M. 9 = $\frac{3}{1}$.—Is about 2 miles above *Jamestown Landing*, on land owned by Wm. Berger, at foot of bluff, 500 feet from river, 75 feet west of small stream; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 10.—Is directly up the slope from P. B. M. 11, 10 feet to the right of path leading up the bluff, in vertical face of ledge, 1 foot below shelf of same; being a copper bolt. (See note 16, page 552.)

P. B. M. 11.—Is about 2¼ miles below *Musics Ferry*, at foot of bluff 100 feet above Dripping Spring, coming down over side of bluff, of a peculiar porous limestone formation, 90 feet west of point where wire fence joins the bluff, on the property of S. C. Carrico; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 12=old P. B. M. 11 of 1887.—Is 1 200 feet below *Musics Ferry*, on east side of road under overhanging rock, 220 feet below the lower end of stone quarry, 4·5 feet above ground; being a cross cut on vertical face of rock of the same elevation as old copper bolt which was destroyed before 1887.

P. B. M. 13.—Is in same yard as P. B. M. 14, in the southwest corner of the three-story stone house on the east side of wagon road, 1 foot east of corner and 5 feet above ground; being a copper bolt leaded horizontally into wall of house. (See note 16, page 552.)

P. B. M. 14 = $\frac{4}{1}$.—Is at *Musics Ferry*, 500 feet below old stone house, in dooryard of the large three-story stone house, at east fence of road, 19 feet south and 10 feet west of the southwest corner of house; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 15.—Is on the right bank, opposite the center of Charbonnier Island, 2 460 feet above the lower edge of first timber along river above *Musics Ferry*, on north end of rounding point of bluff, at rear of field, 400 feet above the upper end of present timber line running to river, 300 feet from river and 200 feet below road up side of bluff; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 16 = $\frac{6}{1}$.—Is at *Charbonnier Point*, in the dooryard of L. C. Knapp, north of angle in highway, 104 feet from road and 33 feet south of house, at the east yard fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 17.—Is 2¼ miles below *St. Charles* Bridge, in front of George Cleberg's house, 98 feet south of public road, 98 feet north of his house, on east side of driveway, 5 feet south of 10-inch maple; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 18.—Is opposite *St. Charles*, at the east foot of embankment of the Wabash Railway trestle and south side of the St. Charles rock road, 210 feet east of trestle and 45 feet from the road, 8 feet south from the 3½-foot elm; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 19.—Is at the road crossing under track of the east approach of the *St. Charles* Bridge, on the upriver side of trestle, on stone at base of the fourth iron column from the north side of wagon road, in the southeast quarter of stone; being top of copper bolt leaded vertically. (See note 16, page 552.)

P. B. M. 20=old B. M. 17.—Is in the second pier from the east end of *St. Charles* Bridge, on its west face, 2·8 feet south of line between rough and dressed stone, on curved surface at the south end of pier, in center of stone in the sixteenth course of masonry from starling coping of pier; being horizontal furrow in copper bolt.

T. B. M. 23.—Is in *St. Charles*, on the south side of trestlework of St. Charles Bridge, on first column west of west pier, on eighth course of stone from top and fourth above ground on the northeast corner, at offset in masonry; being highest point in square.

T. B. M. 24=gauge B. M.—Is in *St. Charles*, on same stone column supporting trestle as T. B. M. 23, on upstream corner, nearest the river, of second projecting course of masonry from top; being highest point in square.

P. B. M. 21=$\frac{6}{2}$.—Is at *St. Charles*, *Mo.*, 1 310 feet above the St. Charles Bridge, on the north side of Lawrence street and 25 feet west of the center of Missouri, Kansas and Eastern Railway track, in the southeast corner of David Lane's lot, 1 foot west from fence; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 25=city B. M., St. Charles.—Is in *St. Charles*, on the northeast corner of Lawrence and Second streets, on top of foundation at the southwest corner of three-story brick building.

T. B. M. 32.—Is about 557 feet toward *St. Charles* from P. B. M. 22, where branch road from the St. Charles rock road runs northeast, on north end of rock culvert under branch road, on northwest corner of stone; being highest point in square.

P. B. M. 22=$\frac{8}{1}$.—Is on foot of bluff opposite *St. Charles*, 125 feet east of the east side of St. Charles rock road where it enters hills, 540 feet south of road branching to northeast, opposite large brick house, on side of bluff and 30 feet from soft maple, at the northwest corner of Mr. Jones's yard; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 23.—Is 1¾ miles above point where *St. Charles* rock road enters hills, 1 965 feet below where wagon road running north from Vigus leaves the bottom and enters the hills, 95 feet above the ditch running east and west across the bottom, at foot of bluff, 3 feet west of rail fence and 15 feet north of 18-inch sycamore, about 65 feet north of point where rail fence joins bluff; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 24=$\frac{7}{2}$.—Is about 1 965 feet north from the north end of *Creve Cœur Lake*, on the north side and about 607 feet from St. Louis, Kansas City and Colorado Railway, about one-fourth mile S. 83° W. (mag.) from water tank, 15 feet south of east and west wagon road, and 394 feet west of intersection of said east and west road with road running south across track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 25.—Is 425 feet south of *Creve Cœur Lake* station, St. Louis, Kansas City and Colorado Railway, 112 feet north of Boyd's cottage, in southwest corner of field, 65 feet east of center of track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 26.—Is 2 950 feet above *Creve Cœur Lake* station, on St. Louis, Kansas City and Colorado Railway, 1 000 feet above milepost 22, 744 feet above bridge 48, 1 245 feet below road crossing, on bluff side of track, 35 feet from center and 4½ feet above top of rail; being a copper bolt leaded horizontally in vertical face of rock. (See note 16, page 552.)

T. B. M. 45.—Is 1 mile below *Mona* station, 52 feet east of road crossing, in north end of west cap of bridge No. 49; being top of drift bolt over pile marked ⊡.

P. B. M. 27 = $\frac{8}{1}$.—Is at *Mona* station, on line of St. Louis, Kansas City and Colorado Railway, 150 feet above road running from bottom over bluff to Lake post office, at foot of bluff, opposite a point 60 feet above bridge 52; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 28.—Is 2 100 feet below point where Olive Street road crosses the St. Louis, Kansas City and Colorado Railway, at *Drew* station, 800 feet below head block at east end of siding, 1 680 feet above milepost 26, on bluff side of track, 85 feet from center, opposite bridge 61; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 51.—Is at *Drew* station, 98 feet east of depot, in southeast corner of south abutment of iron wagon bridge on Olive Street road over Bon Homme Creek, 30 feet north of center of track; being highest point in square cut on masonry at angle between face of abutment and wing wall, marked U ◻ S.

P. B. M. 29 = $\frac{9}{1}$.—Is at *Gumbo* station, in northeast corner of cemetery, which is 230 feet south of railroad track. A road runs from Gumbo post office over bluff along east edge of cemetery. Top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 30.—Is in *Stevens, Mo.*, 130 feet above road crossing, 110 feet below rail fence, 45 feet below bridge 79, at foot of bluff, 50 feet from track center, 1½ feet south of right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 31 = $\frac{10}{1}$.—Is in *Bon Homme*, 35 feet west of line of road running north across bottom, opposite lower end of railroad platform at foot of bluff, 18 feet east of a 20-inch sugar maple, 15 feet south from center line of road running west along foot of bluff; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 32.—Is 15 feet south of P. B. M. 31, 10 feet west of same, and 9½ feet higher than top of cap; being a copper bolt leaded horizontally in vertical face of ledge. (See note 16, page 552.)

T. B. M. 56.—Is 15 feet west of P. B. M. 31, 5 feet north of a 20-inch sugar maple; being highest point in square on embedded stone, about level with surface of ground.

P. B. M. 33.—Is in *Centaur*, 62 feet east of Centaur Lime Company's store, 30 feet south of St. Louis, Kansas City and Colorado Railroad, opposite east end of railroad platform; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 34.—Is three-fourths mile above *Centaur*, opposite center of wooded lot on river side of track, 10 feet above upper end of bridge 99, bluff side of track, 45 feet from center and about 5 feet above grade; being a copper bolt leaded horizontally into north face of vertical ledge. (See note 16, page 552.)

T. B. M. 61.—Is five-eighths mile below *Port Royal, Mo.*, 75 feet above point of very low bluff ledge, opposite center of small cave, bluff side of track 12·1 feet from center and about level with grade; being highest point in square cut on natural ledge.

P. B. M. 35 = ${}^{1}_{\text{I}}{}^{1}$.—Is in *Port Royal*, 35 feet above bridge 106, in front of section house, 2 feet back from front line and 5 feet from corner of yard fence to property owned by Charles W. Goetz, bluff side of track, 35 feet from center; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 62.—Is near P. B. M. 35, 40 feet above bridge 106, 12 feet from section house and on line with east face of same, river side of track, 15 feet from center; being highest point in square cut on embedded stone projecting about 2 inches above ground.

T. B. M. 63.—Is 3 035 feet above *Port Royal*, 75 feet below limekiln and 15 feet above lower head block of limekiln siding, river side of track, 9·2 feet from the center; being highest point in square cut on rock about 1·3 feet above grade of track.

P. B. M. 36.—Is 1¼ miles above *Port Royal*, 557 feet above milepost 37, 10 feet above west end of bridge 109, bluff side of track, 45 feet from center; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 37.—Is 1⅞ miles above *Port Royal*, ¾ mile above milepost 37, in natural face of bare sandstone bluff, about 20 feet west of square corner of bluff, 16 feet from center of track, and 1 foot above rail; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 38 = ${}^{1}_{\text{I}}{}^{2}$.—Is 450 feet above *St. Albans* station, 197 feet above bridge No. 113, about 60 feet south of St. Louis, Kansas City and Colorado Railway track, in northeast corner of Charles Boker's dooryard, 835 feet S. 85° 30′ W. (mag.) from northeast corner of sec. 10, T. 44, R. 2 E.; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 69.—Is 1 mile below *Becker* station, 315 feet below bridge No. 114, bluff side of track, 10·8 feet from center, 100 feet below upper end of sidehill cut; being highest point in square cut on natural ledge 1 foot above ground, and marked U □ S.

P. B. M. 39.—Is 800 feet above *Becker* station, 1 230 feet below water tank, 75 feet above intersection of track and west road fence produced, bluff side of track, 25 feet from center, opposite cattle guard, 1½ feet from west wing fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 40.—Is ⅜ mile above *Becker*, 250 feet above milepost 42, 200 feet below water tank, on east abutment of bridge No. 116, on north end of first course of stone below bridge-seat course; being top of copper bolt leaded vertically. (See note 16, page 552.)

P. B. M. 41.—Is 1½ miles above bridge over Fiddle Creek, which is just above *Becker* station, on St. Louis, Kansas City and Colorado Railway, 2 865 feet above milepost 43, 33 feet above bridge No. 122, 1 foot inside of south right of way fence, about 50 feet from center of track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 42.—Is at crossing of Missouri Pacific Railroad, above *Labadie* station, on north end of pier on east of Missouri Pacific track, in seventeenth course of masonry from top and in east side of center stone in course; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 43 = ${}^{1}_{\text{I}}{}^{3}$.—Is 2 miles below *Boles*, 2 100 feet below milepost 46, 500 feet below post "One mile to station," opposite west end of deep thorough rock cut, 1 foot inside of north right of way fence, and 50 feet from center of track; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 78.—Is 2 miles below *Boles*, 2 095 feet below milepost 46, 495 feet below post marked "One mile to station," about 20 feet west of west end of deep thorough rock cut, on bluff side of track, 12 feet from center and level with rail; being highest point in square on natural ledge, marked U □ S.

P. B. M. 44.—Is 3 005 feet below *Boles*, 95 feet above milepost 47, 36 feet below small bridge D_2, opposite road crossing, bluff side of track, 15 feet from center and 2 feet above rail; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

T. B. M. 80.—Is 3 018 feet below *Boles*, 82 feet above milepost 47, 49 feet below small bridge D_2, 10 feet east of road crossing, bluff side of track, 8 feet from center; being highest point in square cut on natural ledge and marked U □ S.

T. B. M. 81.—Is 375 feet above *Boles*, 50 feet above west head block for warehouse track, 27 feet above cattle guard, bluff side of track, 10 feet from center and about 1 foot above rail; being highest point in square cut on natural ledge and marked U □ S.

P. B. M. 45.—Is three-quarters of a mile above *Boles*, 616 feet above west head block of siding, near right of way fence corner at right-angle turn of farm road, 2 feet outside of right of way in Mr. Hinkle's field; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 83.—Is 1⅜ miles above *Boles*, 295 feet below milepost 49, 872 feet below post marked "One mile to station," on bluff side of track, 10 feet from center; being highest point in square cut on large embedded bowlder.

T. B. M. 84.—Is 2¼ miles below *South Point*, 623 feet below milepost 50, 115 feet below whistle post, on bluff side of track, 7·2 feet from center and about 1 foot below grade; being highest point in square cut on embedded rock.

T. B. M. 85.—Is 1⅞ miles below lower head block of *South Point* siding and opposite center of coulee, on south end of stone-box culvert, 14·5 feet from center of track, on east side of opening, on large corner stone 5·9 feet below grade; being highest point in square, marked U □ S.

P. B. M. 46=$\frac{14}{1}$.—Is 1⅞ miles below lower head block at *South Point* siding, near upper side of coulee, 100 feet above stone culvert, 30 feet below point of bluff, bluff side of track, 30 feet from center, 1·5 feet north of right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 86.—Is 1⅝ miles below lower head block of *South Point* siding, opposite center of small coulee, on west abutment of culvert; being highest point in square cut in center of south end and marked U □ S.

P. B. M. 47.—Is 1½ miles below lower head block of *South Point* siding, 490 feet above small culvert, opposite center of coulee, bluff side of track, 14 feet from center and 4·6 feet above grade; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

T. B. M. 87.—Is ½ mile below *South Point*, 1 310 feet above signpost marked "Station 1 mile," 4·9 feet below wooden box drain under track, bluff side of track, 12 feet from center and about 1½ feet below grade; being highest point in square on natural ledge.

T. B. M. 88.—Is 853 feet below lower head block of *South Point* siding, on north end of west abutment of bridge No. 14, Missouri Pacific Railway; being highest point in square cut on northeast corner of top course of stone and marked U □ S.

P. B. M. 48.—Is in *South Point, Mo.*, about opposite center of siding, 35 feet below road crossing, bluff side of track 30 feet from center, 6 inches from right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

No. XII.—*South Point, Mo.* (See page 568.)

T. B. M. 89.—Is 250 feet above upper head block of *South Point* siding, on bluff side of track, 10 feet from center and 1 foot below grade; 4 feet west of P. B. M. 49; being highest point in square cut on natural ledge and marked with the letters U. S. about 20 inches above the bench mark.

T. B. M. 90.—Is 7 020 feet below *Washington*, 300 feet above milepost 53; being highest point in square cut on natural ledge.

P. B. M. 50.—Is in *Washington*, 900 feet below depot, on south side of water-works pump house, 9 feet from southwest corner of building; being a copper bolt leaded horizontally into window sill. (See note 16, page 552.)

T. B. M. 92.—Is in *Washington*, on east end of doorsill of south entrance to pumping station, 900 feet below depot; being the highest point in square.

T. B. M. 94=old B. M. 75 of 1879.—Is in *Washington*, at southwest corner of Front and Elm streets; being highest point in square on north end of north doorstep on Elm street.

L_3.—*Washington, Mo.* (See page 568.)

T. B. M. 95.—Is in *Washington*, on south side of Front street, about 400 feet west of depot, on top of stone retaining wall, under fence, on north side of William Miller's lot, 30 feet east of main entrance to house, 3 feet east of entrance to barnyard east of house; being highest point in square marked U □ S.

P. B. M. 51=${}^{L_6}_{1}$.—Is in *Washington*, at northwest corner of William Miller's dooryard, on south side of Front street, and 545 feet N. 71° 40′ W. (mag.), from west end of railroad station, 5 feet southeast from corner post of fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 96=old B. M. 42_a.—Is 3 855 feet above *Washington* depot, on north end of east abutment of bridge, at angle in masonry formed by wing wall; being highest point in square near corner.

T. B. M. 97.—Is 1 mile above *Washington*, 200 feet above sign marked "Water station 1 mile," on south side of track, east end of culvert, on third course of masonry from top; being highest point in square cut on southwest corner of stone.

P. B. M. 52.—Is 2 miles above *Washington*, 2 214 feet below bridge over St. Johns Creek, at lower side of coulee, 125 feet below point of bluff, 35 feet below point where vertical ledge begins to run parallel to track on bluff side of track, 11·5 feet from center and 4·5 feet above grade; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

T. B. M. 98.—Is 2 miles above *Washington*, 2 230 feet below bridge over St. Johns Creek, at upper end of rock cut, on bluff side of track 9 feet from center; being highest point in square cut on natural ledge.

P. B. M. 53.—Is 2⅛ miles above *Washington*, 1 445 feet below east end of bridge over St. Johns Creek, 1 foot inside of south right of way fence, 40 feet from center of track, opposite a farm crossing, at intersection of north and south rail fence with right-of-way fence, and 4 feet west of gate opening into field; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 99=old B. M. 43_a.—Is 2½ miles above *Washington*, on abutment at west end of plate girder span at west end of railroad bridge across St. Johns Creek; being highest point in square cut on southwest corner of bridge-seat course.

T. B. M. 100.—Is 2¾ miles above *Washington*, 150 feet above upper head block of Hootan siding, bluff side of track; being highest point in square cut on natural ledge.

P. B. M. 54=${}^{1}\mathrm{Y}^{6}$.—Is 3¼ miles below *Dundee*, 2 264 feet below milepost 59, 1 345 feet below signpost marked "½ mile to Dewey," 295 feet above upper head block of Dewey siding, at farm crossing, 1 foot inside of south right-of-way fence, 34 feet from center of track, 12 feet west of gate; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 105.—Is 1⅛ miles below *Dundee* station, 1 280 feet below signpost marked "1 mile to station," 1 552 feet below milepost 61, on southeast corner of south wall of stone culvert; being highest point in square.

P. B. M. 55.—Is 1⅛ miles below *Dundee* station, 1 467 feet below milepost 61, 1 194 feet below post marked "1 mile to station," 85 feet above stone culvert, 1 foot inside of south right of way fence, 24 feet from center of track; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 106.—Is 2 950 feet below *Dundee* station, 360 feet below head block at east end of siding, 1 575 feet above milepost 61, at lower end of sidehill rock cut on Missouri Pacific Railway, bluff side of track, 9 feet from center and level with top of rail; being highest point in square cut on natural ledge.

P. B. M. 56.—Is 2 950 feet below *Dundee* station, 400 feet below point of bluff and lower side of coulee, 300 feet below head block at east end of siding, 325 feet above small coulee, bluff side of track, 10 feet from center and 4 feet above grade; being a copper bolt leaded horizontally into vertical ledge. (See note 16, page 552.)

P. B. M. 57=${}^{1}\mathrm{Y}^{7}$.—Is in *Dundee*, 1 640 feet below east end of tunnel, at north fence of small field owned by S. S. Baily, 120 feet south of railroad track, 12 feet southwest of honey locust; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 108=old B. M. 46 (*b*).—Is in *Dundee*, 328 feet below east end of tunnel, bluff side of track, 18·4 feet from center of southwest corner, west end of coping stone of east retaining wall of arch culvert over Little Bœuf Creek; being highest point in square.

T. B. M. 107=old R. R. B. M.—Is in *Dundee*, on same arch culvert over Little Bœuf Creek, north side of track; being the highest point in square formed on southeast quarter of cross and marked B □ M.

T. B. M. 109=old B. M. 46_a.—Is in *Dundee*, 328 feet below east end of tunnel, bluff side of track, 9·2 feet from center, southeast corner east end of coping stone over arch culvert over Little Bœuf Creek; being highest point in square.

T. B. M. 110.—Is at *Kent* siding, seven-eighths mile above Dundee, on bluff side of track, 21·3 feet from center of main track; being the highest point in square cut on southeast corner of masonry over tile-drain under track, 490 feet above signpost marked "Kent."

T. B. M. 111=old B. M. 47.—Is 1¼ miles above *Dundee*, three-eighths mile above Kent, on northeast corner of east abutment of through railroad bridge No. 16, Missouri Pacific Railway over River au Bœuf; being the highest point in square cut on northeast corner of coping stone.

T. B. M. 112.—Is 3¼ miles below *New Haven*, 1 640 feet below signpost marked "Kent ½ mile," 1 257 feet below milepost 64, 262 feet above farm crossing, bluff side of track, 9 feet from center and 6 inches below top of rail; being highest point in square cut in natural ledge.

P. B. M. 58.—Is 2 7/16 miles below *New Haven*, 2 713 feet below milepost 65, west side of coulee, at south right of way fence, 32 feet from center of track, 3 feet west of intersection of north and south rail fence with right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 113.—Is 2⅜ miles below *New Haven*, 2 156 feet below milepost 65, on bluff side of track, 6 feet from center; being highest point in square cut on embedded stone.

P. B. M. 59.—Is 1½ miles below *New Haven*, near center of siding, 633 feet from west head block, on bluff side of track, 9 feet from center and 3½ feet above the rail; being copper bolt leaded horizonally into natural ledge. (See note 16, page 552.)

T. B. M. 114.—Is 1½ miles below *New Haven*, 636 feet below west head block of siding, on bluff side of track, 9 feet from center and 1½ feet above the rail; being the highest point in square cut on natural ledge and marked U S in large letters facing the track.

P. B. M. 60=λ^{8}_{1}.—Is in *New Haven*, at west side, 5 feet from doorway of three-story brick building now owned by Mr. W. G. Warenken, on corner of Olive street and railroad; being copper bolt in bench-mark stone. (See note 15, page 551.)

Top of cap over P. B. M. 60. (The cap is about even with the top of the sidewalk.)

T. B. M. 115.—Is in *New Haven*, on three-story brick building owned by Mr. W. G. Warenken, corner of Olive street and railroad, on north side of building, 2·5 feet from northwest corner; being the highest point in square cut on top of water table.

T. B. M. 116.—Is in *New Haven*, 492 feet above the depot, on north end of east abutment of railroad culvert; being the highest point in square cut into bridge-seat course of masonry, 14 inches from north end, and 25 inches from west face of stone.

P. B. M. 61.—Is 1¾ miles above *New Haven*, 100 feet below lower side of coulee at point where river and bluff meet, 25 feet below center of arch culvert, on bluff side of track, 14 feet from center and 3½ feet above grade; being a copper bolt leaded horizontally into vertical ledge. (See note 16, page 552.)

T. B. M. 118.—Is 1⅞ miles below *Etlah*, at point where river comes back to the bluff, 1 827 feet below milepost 69, at upper end of sidehill rock cut, on south wall of arch culvert, over center of arch; being highest point in square.

P. B. M. 62.—Is 1¾ miles below *Etlah*, 948 feet below milepost 69, 879 feet above stone arch culvert on west side of coulee, at south right of way fence, 32 feet from center of track; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 119.—Is 6 168 feet below *Etlah* station, 2 010 feet above milepost 69, on south end of west wall of open culvert; being the highest point in square.

T. B. M. 120.—Is 2 372 feet below depot at *Etlah*, about 328 feet below head block at east end of siding, 380 feet above milepost 70, on bluff side of track, 8 feet from center, being highest point in square cut on embedded rock.

No. XIV.—*Etlah, Mo.* (See page 568.)

P. B. M. 63=$\frac{19}{1}$.—Is 672 feet above depot at *Etlah*, 60 feet west of road crossing, 40 feet south of track, in corner of fence made by right of way fence and fence on west side of public road; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 122.—Is 1 mile above *Etlah*, 1 850 feet below small iron bridge, 225 feet below post marked "Water station one mile," on bluff side of track 8 feet from center, on same elevation as rail; being highest point in square cut on large embedded piece of ledge, about 6 inches from edge.

T. B. M. 123=old R. R. B. M.—Is about 1⅜ miles above *Etlah*, on south end of east abutment, bridge-seat course, of iron bridge across Berger Creek; being highest point in square found on northeast quarter of cross and marked B ⊡ M.

T. B. M. 125.—Is 2¼ miles below *Berger*, 1 584 feet below milepost 73, at farm crossing, on bluff side of track, 23 feet from center and 2 feet above rail; being highest point in square cut on natural ledge.

P. B. M. 64.—Is 2¼ miles below *Berger*, 1 535 feet below milepost 73, 60 feet above farm crossing, about 75 feet south of Missouri Pacific track, at foot of hill, 5 feet south of east end of gate on private road; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 126.—Is 2$\frac{1}{16}$ miles below *Berger*, 682 feet below milepost 73, at lower end of rock cut, on bluff side of track, 10 feet from center and 1 foot below top of rail; being highest point in square cut on natural ledge.

P. B. M. 65.—Is 2$\frac{1}{16}$ miles below *Berger*, 604 feet below milepost 73, 165 feet above farm crossing on west side of wide coulee at lower end of sidehill work, on bluff side of track 13 feet from center and 4 feet above the rail, 15 inches west of drill scar; being a copper bolt leaded horizontally into vertical ledge. (See note 16, page 552.)

No. XV.—*Berger, Mo.* (See page 568.)

P. B. M. 66=$\frac{20}{1}$.—Is in *Berger*, in southwest corner of Mrs. Schaub's yard, 8 feet west of house, 16 feet north of south fence line, and 5 feet east from west fence line; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 128.—Is 1 mile above *Berger*, 475 feet below bridge F_8, on bluff side of track, 4 feet from rail and about 1 foot below grade; being highest point in square cut on embedded rock.

P. B. M. 67.—Is 4$\frac{1}{16}$ miles below *Hermann* depot, 1 870 feet above bridge over Little Berger Creek, 2 395 feet below post set on county line at road crossing, on upper side of small valley, at foot of bluff, just outside of right of way fence, on south side of track, 56 feet from center and 2 feet east of gate, on land owned by Charley Burns; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 129.—Is 4$\frac{1}{16}$ miles below depot at *Hermann*, 2 277 feet below post set on county line, at lower end of bluff, 110 feet above road crossing, on south side of track, 8 feet from center on level with rail; being highest point in square cut on natural ledge and marked U □ S.

T. B. M. 130.—Is 3⅞ miles below depot at *Hermann*, 2 526 feet above signboard on county line, on bluff side of track, 7½ feet from center and 18 inches above rail; being highest point in square cut on embedded stone, and marked U. S. in large letters.

P. B. M. 68.—Is $1\frac{5}{8}$ miles below depot at *Hermann*, at lower side of wide valley, 1 115 feet above road crossing, 66 feet below wooded point of bluff, on bluff side of the track 50 feet from center, on land of Tobias Larcer; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 132.—Is 8 809 feet below depot at *Hermann*, at lower side of small coulee, on river side of Missouri Pacific track, 11·5 feet from center, in stone over center of stone culvert; being the highest point in square.

P. B. M. 69.—Is 2 290 feet below depot at *Hermann*, 338 feet below upper end of bluff, opposite watchman's house on river bank, 425 feet below road crossing, on bluff side of track, 17 feet from center and 4 feet above rail, 8 inches west of drill scar in rock face of cut; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

T. B. M. 133.—Is 2 297 feet below depot at *Hermann*, 31 feet below P. B. M. 69, 6 inches below base of rail; being highest point in square cut on natural ledge at foot of vertical face of bluff.

P. B. M. $70 = {}^{2}_{1}{}^{1}$.—Is in *Hermann*, in lot of August Wholts, on north side of Front street, 450 feet below railroad bridge over Frame Creek and about 140 feet south of railroad; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 71.—Is in *Hermann*, on north end of east abutment of bridge over Frame Creek, on northwest corner of bridge seat, 5 feet below the track and 10 inches from either face of corner stone; being the top of copper bolt leaded vertically. (See note 16, page 552.)

N_3.—*Hermann, Mo.* (See page 568.)

T. B. M. 135.—Is in *Hermann*, on north side of White House hotel, on northeast corner of lower step of east entrance, 8 feet west of northeast corner of building; being the highest point in square.

P. B. M. 72 = old B. M. 59.—Is at point of bluff at upper end of *Hermann*, 1 148 feet above depot, at lower end of rock cut, on bluff side of track, 10 feet from center and 1 foot above grade, 6 feet west of cattle-guard fence; being horizontal furrow in copper bolt leaded horizontally into natural ledge.

P. B. M. 73.—Is 1½ miles above *Hermann*, 164 feet above post marked "One mile to station," in southeast corner of William Streker's garden, 7 feet east of northeast corner of house and about 110 feet south of railroad track; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 136.—Is 1½ miles above *Hermann*, 358 feet above post marked "One mile to station," on south end of east abutment of small bridge, on top course of masonry, 10 inches from each face; being the highest point in square, marked U □ S.

T. B. M. 137.—Is 2 215 feet below bridge F_4, Missouri Pacific Railway, above *Hermann*, 919 feet below small bridge at lower side of small coulee, bluff side of track 22 feet from center, about 1 foot above grade; being the highest point in square on rock, marked U □ S.

P. B. M. 74.—Is 2 miles above *Hermann*, on north end of east abutment of bridge F_4, on second course of masonry from top, 10 inches from north end of stone; being top of copper bolt leaded vertically. (See note 16, page 552.)

No. XVI.—*Coles Creek, Mo.* (See page 568.)

T. B. M. 139.—Is 3 miles below *Gasconade* Bridge, 3 143 feet above bridge over

Coles Creek, 413 feet below small open culvert, on bluff side of track 9 feet from center, 6 inches above grade; being highest point in square on embedded rock, marked U □ S.

T. B. M. 141.—Is 1¾ miles below *Gasconade* Bridge, on north end west abutment of small bridge, about 500 feet above prominent sandstone point in bluff; being highest point in square.

P. B. M. 75 = $^{2}\mathrm{I}^{2}$.—Is 2½ miles below *Gasconade* Bridge, 46 feet east of arch culvert, 3 458 feet below milepost 86, at west fence of Frank Berke's garden (inside), and about 70 feet south from Missouri Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 140.—Is 2½ miles below *Gasconade* Bridge, 3 419 feet below milepost 86, on east end of south wall of stone arch culvert near Frank Berke's house on southeast corner of large sandstone; being the highest point in square.

P. B. M. 76.—Is 1½ miles below *Gasconade* Bridge, at lower side of coulee and in front of John Uffelman's house, on bluff side of track 31 feet from the center, 10 feet south of right of way fence, 1 foot west of rail fence running south over the bluff; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 142 = old R. R. B. M.—Is 7 628 feet below *Gasconade* Bridge, on north end of stone culvert under Missouri Pacific Railway, near northwest corner; being the highest point in square formed on one angle of a cross, and marked B. –⊡ M.

T. B. M. 143.—Is 4 265 feet below bridge across the *Gasconade* River, 300 feet above milepost 87, Missouri Pacific Railway, 200 feet below signpost marked "Station 1 mile," 7 feet below small boxdrain under track, on projecting rock 1 foot above grade, 11·8 feet from center, on bluff side of track; being highest point in square.

T. B. M. 144, Gasconade survey B. M. of 1879.—Is in *Gasconade*, on south end of first pier from east end of bridge across the Gasconade River; being the highest point of spherical knob cut in stone, 4½ feet from south corner of stone and marked B. M. 6 inches away from point.

No. XVII.—*Gasconade, Mo.* (See page 569.)

P. B. M. 77.—Is in *Gasconade*, on north end of first pier from the west end of bridge across the Gasconade River, 6 inches south of north end of pier; being top of copper bolt leaded vertically. (See note 16, page 552.)

No. XVIII.—*Gasconade, Mo.* (See page 569.)

T. B. M. 145.—Is 1⅛ miles above *Gasconade*, 620 feet above post marked "1 mile to water tank," on bluff side of track 6·5 feet from center and 3 inches above rail; being highest point in square cut on natural ledge and marked U □ S

T. B. M. 146.—Is 1⅝ miles above *Gasconade*, 33 feet below post marked "1 mile to station," on east end of south wall of culvert; being the highest point in square.

P. B. M. 78 = $^{2}\mathrm{I}^{3}$.—Is 1⅝ miles above *Gasconade*, 78 feet above post marked "1 mile to station," inside of north fence of Nicholas Wolz's dooryard, 157 feet from center of track and 10 feet east of small yard gate; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 79.—Is 2 miles above *Gasconade*, near upper side of coulee, on south end of west abutment, in bridge-seat course of bridge F. G. on Missouri Pacific Railway, 7 feet from center of track; being top of copper bolt leaded vertically into stone. (See note 16, page 552.)

T. B. M. 148.—Is 1¾ miles below *Morrison*, on north end of east abutment of bridge G, on north end of bridge seat about 1 foot from corner of stone; being the highest point in square.

T. B. M. 149=old R. R. B. M.—Is 4 855 feet below depot at *Morrison*, on north end of east abutment of culvert; being the highest point in square formed on northeast quarter of cross and marked B.+ M.

P. B. M. 80.—Is 1 608 feet below *Morrison* depot, 869 feet above lower head block of siding, on point of bluff at lower side of coulee and 275 feet below whistle post, 35 feet south of siding, 2 feet north of right of way fence, opposite a two-story frame house standing 400 feet north of track; being copper bolt in bench-mark stone. (See note 15, page 551.

P. B. M. 81.—Is 1 427 feet below *Morrison*, 115 feet below whistle post, 150 feet above point of bluff and small coulee, on bluff side of Missouri Pacific Railway track, 12 feet from center of siding and 4 feet above grade; being a copper bolt leaded horizontally into vertical face of natural ledge. (See note 16, page 552.)

T. B. M. 150.—Is 1 427 feet below *Morrison* depot, 115 feet below whistle post, at upper side of first coulee below station, 140 feet above point of bluff, on bluff side of track, 12 feet from center of siding, on same elevation as base of rail; being highest point in square cut on natural ledge, 3 feet east of P. B. M. 80.

No. XIX.—*Morrison, Mo.* (See page 569.)

T. B. M. 151.—Is 4 593 feet above *Morrison*, on west wall of open culvert over wagon road, on second course of masonry from top, south side of Missouri Pacific track; being highest point in square, 20 inches from south corner and 9 inches from east face of stone.

P. B. M. 82.—Is 1¾ miles above *Morrison*, 1 427 feet above milepost 94, at west end of only bare spot of bluff in vicinity, on bluff side of track, 13 feet from center and about 3 feet above grade; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

P. B. M. $83={}^{2}_{1}{}^{4}$.—Is 2¼ miles above *Morrison*, 1 542 feet below milepost 95, 50 feet west of bridge HI over road, at south fence of Missouri Pacific right of way, 21 feet from center of track, at foot of bluff, on west side of coulee; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 153.—Is 2¼ miles above *Morrison*, 1 597 feet below milepost 95, on south end of east abutment of small bridge HI over road; being highest point in square on top of stone wing wall.

T. B. M. 154.—Is 4¼ miles below *Chamois*, 3 228 feet below milepost 96, Missouri Pacific Railway, on east end of south wall of stone arch culvert; being highest point in square.

T. B. M. 155.—Is 3 miles below *Chamois*, 105 feet below lower head block of Portage siding, Missouri Pacific Railway, in center of stone at north end of west abutment of bridge I; being highest point in square marked U □ S

P. B. M. 84.—Is 2½ miles below *Chamois*, 275 feet above upper head block of Portage siding, 15 feet below small bridge, on bluff side of track, 45 feet from the center; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 157.—Is on right bank, 1⅜ miles below *Chamois*, *Osage County*, *Mo.*, 360 feet above milepost 98, Missouri Pacific Railway, 85 feet above signboard marked

"Portage 1 mile," on bluff side of track, 12 feet from center and 3 feet above grade. It is 246 feet below upper end of sidehill cut; being highest point in square cut on projecting point of natural ledge.

T. B. M. 158.—Is seven-eighths mile below *Chamois* depot, 410 feet above road crossing, 60 feet above milepost 99, 70 feet below sign marked "Yard limits," on extreme north end of west abutment of small bridge, 2 feet from north edge of stone, 20 feet from center of track; being highest point in square cut on masonry.

P. B. M. 85.—Is in *Chamois*, in south end of stone doorstep at east door of saloon on southwest corner of Main and Pacific streets; being top of copper bolt leaded vertically. (See note 16, page 552.)

P. B. M. 86 = $\frac{26}{1}$.—Is in *Chamois*, 544 feet north of railroad station, in southwest corner of lot to brick residence owned by William Cochran, on east side of Main street; being copper bolt in bench-mark stone. (See note 15, page 551.)

O_3.—*Chamois, Mo.* (See page 569.)

T. B. M. 160 = old R. R. B. M.—Is 2 miles above *Chamois*, 480 feet below milepost 102, at north end of east abutment of bridge K; being highest point in square formed on angle of cross and marked

U S
⊡
B M

P. B. M. 87.—Is 1½ miles below *Deer Creek*, 3 miles above Chamois, on lower side of coulee, 20 feet from foot of bluff, 35 feet from center of track, in angle of fence formed by right-of-way fence turning south over bluff; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 161.—Is 30 feet west of P. B. M. 87; being highest point in square cut on large stone.

P. B. M. 88.—Is about 3¼ miles above Chamois depot, 1 mile below *Deer Creek*, opposite center of large coulee 200 feet above log house 200 feet south of railroad, on north end of west abutment of small bridge over road, on fourth course of stone below bridge seat; being top of copper bolt leaded vertically. (See note 16, page 552.)

P. B. M. 89 = old B. M. 74.—Is 1¼ miles below *St. Aubert* station depot, on south end of east abutment of bridge over Deer Creek, at lower side of wide coulee; being horizontal furrow in copper bolt leaded horizontally into first course of masonry below bridge-seat course.

T. B. M. 163.—Is 1¼ miles below *St. Aubert* station depot, on south end of east abutment of iron bridge over Deer Creek, at lower side of wide coulee; being highest point in square cut on end projecting stone on course next above bridge-seat course.

T. B. M. 164.—Is five-eighths mile below *St. Aubert* station depot, 235 feet below head block of siding, bluff side of Missouri Pacific track, 15 feet from center; being highest point in square on projecting ledge.

P. B. M. 90 = $\frac{28}{1}$.—Is in *St. Aubert*, on northwest corner of Main and Morrow streets, inside of fence 300 feet from depot; being copper bolt in bench-mark stone. (See note 15, page 551.)

No. XX.—*St. Aubert, Mo.* (See page 569.)

P. B. M. 91.—Is at *Shipley Landing*, 250 feet below bridge 27, at foot of west end of bluff, east side of coulee, at fence corner, 1½ feet inside of right of way; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 167.—Is at *Shipley Landing*, 1⅜ miles below Isbell, on north end of east abutment of bridge No. 27; being highest point in square marked U □ S

T. B. M. 168.—Is 1 800 feet below east end of *Loose Creek* Bridge, at upper end of first cut below bridge, bluff side of track, 10 feet from center and 2 feet above grade; being highest point in square cut on projecting point of ledge, with letters U. S. cut on vertical face below the bench.

No. XXII.—*Isbell, Mo.* (See page 570.)

P. B. M. 92=${}^{2}\mathrm{I}^{7}$ Isbell.—Is at *Isbell*, 295 feet below center of depot, 300 feet above runway to stock yards, bluff side of track, 35 feet from center, 1½ feet north of right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 93.—Is at *Isbell*, 165 feet above depot, 60 feet above lower end of cut, 15 feet above head block of siding, bluff side Missouri Pacific track, 11·4 feet from center and 3 feet above grade; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

T. B. M. 169.—Is at *Isbell*, 165 feet above west end of depot, 60 feet above lower end of cut, 15 feet above head block of siding on bluff side of Missouri Pacific track, 10·8 feet from center; being highest point in square cut on natural ledge at about the elevation of grade.

T. B. M. 170.—Is 1 mile above *Isbell* depot, 245 feet below bare face of ledge, 1 030 feet above sign "Station one mile," on bluff side of track, 9·5 feet from center; being highest point in square cut on point of projecting ledge, 2 feet above grade and marked U □ S.

T. B. M. 171=Old R. R. B. M.—Is about 2⅛ miles below *Bonnots Mill*, on northwest corner of east abutment of small bridge opposite center of coulee; being highest point in square formed on southeast angle of cross and marked B ⊡ M.

P. B. M. 94.—Is 1¾ miles below *Bonnots Mill* depot, at upper side of coulee, bluff side of Missouri Pacific track, 60 feet from center, 30 feet above bridge N_2, on top of projecting ridge, 20 feet south of south right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 172.—Is in same locality as P. B. M. 94, on south end of west abutment to bridge N_2, at upper side of coulee; being highest point in square cut on third course of stone from top.

T. B. M. 173.—Is ⅞ mile below *Bonnots Mill* depot, on river side of Missouri Pacific track, 11 feet from center, in a small thorough cut; being highest point in square cut on embedded stone.

T. B. M. 174.—Is at *Bonnots Mill*, 65 feet east of door of depot and 10 feet south of center of siding; being highest point in square cut on top of foundation at northeast corner of warehouse.

P_3.—*Bonnots Mill, Mo.* (See page 570.)

T. B. M. 175=Old R. R. B. M.—Is in *Bonnots Mill*, on south end of east abutment to bridge No. P; being highest point in square formed on angle of cross, marked B ⊡ M.

P. B. M. 95=${}^{2}\mathrm{I}^{8}$.—Is in *Bonnots Mill*, 700 feet west of station, 210 feet west of bridge No. P, 45 feet above mill and on opposite side of track, on line with north right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 178=Old B. M. 81.—Is 2¾ miles below east end of *Osage* bridge, on northwest stone column to bridge No. 29 over Evans Creek, Missouri Pacific Railway; being highest point in base of U cut on southwest corner of capstone.

T. B. M. 177=Old B. M. 80.—Is near T. B. M. 178, in column at northeast corner of bridge No 29; being highest point in square cut on northeast corner of capstone, and marked U ⊡ S.

P. B. M. 96.—Is 1¼ miles above *Bonnots Mill*, 815 feet above bridge No. 29, 250 feet above point of bluff, on bluff side of track, 9·2 feet from center and 2 feet above grade; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 179.—Is 2½ miles below east end of *Osage* bridge, 295 feet above milepost 114, on downstream abutment of small bridge, on end of second course of stone from top, next to river, 14 feet from center of track; being highest point in square marked U S.

P. B. M. 97.—Is 1⅞ miles below *Osage City*, 45 feet below bridge P_2, on bluff side of Missouri Pacific track, 43 feet from center, 3 feet outside of right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 180=Old R. R. B. M.—Is 1⅞ miles below *Osage City*, on north end of east abutment of bridge P_2, Missouri Pacific Railway; being highest point in square formed on one angle of cross marked

B M
⊡
U S

P. B. M. 98.—Is at *Osage City*, on north end of east abutment of iron railroad bridge over the Osage River, 16 inches from north end and 9 inches from west face of abutment; being top of copper bolt leaded vertically into coping.

T. B. M. 182=Old R. R. B. M.—Is on south end of east abutment of iron bridge over Osage River; being highest point at extreme southeast corner of coping stone, and marked □ B. M.

P. B. M. 99.—Is in *Osage City*, 60 feet below depot, on line with north side of same, on line of fence running east from depot, 12 feet south of center of siding, 55 feet above west end of ice house; being copper bolt in bench-mark stone. (See note 15, page 551.)

No XXIV.—*Osage City, Mo.* (See page 570.)

T. B. M. 183.—Is in *Osage City*, on west side of upper water tank, on top of wall, near middle, forming foundation for tank, and 8·8 feet from the south side of the tank; being highest point in square.

T. B. M. 184=Old R. R. B. M.—Is seven-eighths mile above *Osage City*, on east abutment of small bridge, 8 inches from face of abutment and 3 feet from north end; being highest point in square formed on one angle of cross marked B ⊡ M.

No. XXV.—Two miles above *Osage City, Mo.* (See page 570.)

P. B. M. 100=$\frac{29}{1}$.—Is at upper end of United States boat yard at *Ewings Landing*, at west end of pond, 100 feet east of northeast corner of field, on line of prolongation of south road fence and about 400 feet from river; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 101.—Is at east of Missouri Pacific tunnel, 3½ miles below *Jefferson City* depot, on south side of Missouri Pacific track and 4 feet above rail; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

P. B. M. 102.—Is 3¼ miles below *Jefferson City* depot, 656 feet above mouth of Missouri Pacific tunnel, at lower end of short cut, on south side of Missouri Pacific track, 39 feet from center, 239 feet below small open stone culvert; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 190.—Is 3⅛ miles below *Jefferson City* depot, 1 233 feet above tunnel, at lower end of side-hill cut, on bluff side of Missouri Pacific track, 15 feet from center; being highest point in square cut on natural ledge.

T. B. M. 191.—Is 2½ miles below *Jefferson City*, on north end of east abutment of bridge No. P_3, 1½ feet from both end and side of stone; being highest point in square marked U □ S.

T. B. M. 192.—Is 1⅝ miles below depot at *Jefferson City*, at lower side of wide center, on south end of east abutment of bridge 34, over stream; marked B + M.

P. B. M. 103.—Is 1⅝ miles below *Jefferson City*, 225 feet above bridge 34, where T. B. M. 192 is located, at large opening in bluff, on a high bench of ground, 35 feet from track on bluff side, 75 feet from a 10-inch white oak, blazed, and 1½ feet north of south right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 193 = Old B. M. 88.—Is at *Jefferson City*, about 7 000 feet below Capitol building, on southwest corner of coping of east abutment of small bridge of Missouri Pacific Railway.

P. B. M. 104.—Is three-fourths of a mile below *Jefferson City* depot, 125 feet above bridge and heavy stone work under track, 60 feet above point of bluff, on upper side of coulee, at lower edge of large rock face of bluff, 10·2 feet from center of track, 2·6 feet above grade; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 194.—Is directly opposite P. B. M. 104, about 50 feet above extreme end of ledge; being highest point in square cut on ledge about level with grade of track.

T. B. M. 195.—Is in *Jefferson City*, at the southwest corner of Jefferson and West Water streets, 10 feet from the northeast corner of stone building, on top of rounding curbstone; being highest point in square.

T. B. M. 196, Gauge B. M. 1st.—Is in *Jefferson City*, at the foot of Jefferson street, on Lohman's warehouse, on east end of east doorsill.

No. XXVII.—*Jefferson City, Mo.* (See page 570.)

No. XXVIII.—*Jefferson City, Mo.* (See page 571.)

City B. M.—Is in *Jefferson City*, at the southeast corner of Jefferson and High streets, on doorstone at the northeast entrance to Merchants' Bank building, on northeast corner of stone, outside of pillar and next to sidewalk, marked +.

T. B. M. 197.—Is in *Jefferson City*, on circular step in front of main entrance to Capitol, on second step from the bottom, about 45 degrees around from north end of step, in center of the sixth stone from the north end; being highest point in square marked U □ S.

P. B. M. 105.—Is in *Jefferson City*, at the northeast corner of inclosure of Capitol grounds, in north face of stone corner column, in center of third course of stone from bottom; being a copper bolt leaded horizontally. (See note 16, page 552.)

Old B. M. 90 (85).—*Jefferson City, Mo.* (See page 570.)

T. B. M. 199.—Is in *Jefferson City*, just above the west side of Capitol grounds, on Missouri Pacific Railway, stone culvert No. 320, on northeast corner of wing wall, on north side of track; being highest point in square cut in top of stone.

T. B. M. 198 = Old B. M. 90_a (C)—Gauge B. M. 2d.—Is in *Jefferson City*, in same culvert as T. B. M. 199, 325 feet west of west end of Capitol grounds, 20 feet east of foot of arch on north face of culvert, 0·2 foot below the top of eleventh course of masonry from top; being knob cut on projection of rock.

T. B. M. 200.—Is in *Jefferson City*, at upper Ferry Landing, opposite W. J. Lemp's St. Louis Beer depot, 52 feet west of the southwest corner of warehouse of the Dulle Milling Co., formerly pork house; being highest point of square cut on natural ledge.

T. B. M. 201 = Old B. M. 90 (*b*), gauge B. M. P. H.—Is near T. B. M. 200, 100 feet west of Dulle Milling Co.'s warehouse, 50 feet north of the Missouri Pacific Railway track, on vertical ledge of rock nearest the river, in an old cellar, 2 feet above ground; being knob cut on projection of ledge.

P. B. M. 107 = $\frac{30}{1}$.—Is in *Jefferson City*, in the east corner of the fourth block above Capitol square, opposite the Ferry Landing and 280 feet from the river, just below Lemp's St. Louis Beer depot; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 202.—Is 282 feet west of city limit of *Jefferson City*, 60 feet below east end of pump house of waterworks, 275 feet above sign, "Jefferson City, one mile," 100 feet above head block of siding, and 6 feet south from center of siding; being square in point of ledge 1 foot above grade.

P. B. M. 108.—Is 2⅜ miles above depot at *Jefferson City*, 197 feet below Missouri Pacific stone culvert, at point of bluff on lower side of coulee, on right of way at south fence, 35 feet south of center of track; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 203 = Old B. M.—Is on lower abutment of same culvert with T. B. M. 204, on north end at side of top course of stone; being southeast angle of cross.

T. B. M. 204.—Is on south end of stone culvert arched with brick, 197 feet above P. B. M. 108 on south end of culvert, on point of capstone; being highest point in square marked U □ S.

P. B. M. 109.—Is ¾ mile below *Grays Creek*, 150 feet above upper end of long tangent above Jefferson City, 30 feet above telegraph pole bearing mile sign 128, 12·5 feet from track center, 492 feet below large rocks at upper end of riprap bank, 45 feet below a triangulation point, 4 feet above ground and 1½ feet above grade of track; being a copper bolt leaded into vertical face of ledge. (See note 16, page 552.)

T. B. M. 205.—Is directly under P. B. M. 109, on bluff side of track 12 feet from center, 1½ feet below grade, on natural ledge; being highest point in square.

T. B. M. 206—Is on line of Missouri Pacific Railway, 410 feet below mouth of *Grays Creek*, 150 feet below whistle post, 15 feet below stone drain under track, on bluff side, 10 feet from center and 1 foot below grade; being square on point of ledge marked U. S. on face of rock just above.

T. B. M. 207, Old R. R. B. M.—Is on west abutment of iron bridge across *Grays Creek*, on downstream side of abutment; being highest point in square.

P. B. M. 110 = $\frac{31}{1}$.—Is about 2 miles above *Jefferson City*, 1 166 feet N. 87° 30′ W. (mag.) of west end of Missouri Pacific bridge over *Grays Creek*, about 88 feet below gate to pasture at foot of bluff, on north side of wagon road in field, 10 feet from fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 209.—Is 4 260 feet above mouth of *Grays Creek*, on right bank of slough, at rocky point of bluff projecting into slough about on center of main point of exposed ledge on upper side; being square on natural ledge 18 inches back from upper quarter of break.

T. B. M. 213.—Is 65 feet below P. B. M. 112, on natural ledge at base of rock point; being highest point in square marked U ☐ S.

P. B. M. 111.—Is 98 feet below P. B. M. 112, 2½ feet above surface of ground on north face of bluff; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 112—Is about 2¼ miles above mouth of Grays Creek, where extreme east road crossing bottom north and south opposite *Claysville* reaches bluff, on south side of wagon road, 144 feet west of gate and 285 feet east of Canaan Cole's house, at foot of bluff, 1 foot from vertical ledge; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 113 = $\frac{32}{1}$.—Is at foot of bluff opposite *Claysville*, at west fence of section-line road between secs. 19 and 20, T. 45, R. 12 W., 1 172 feet south of northeast corner of section 19, on land of F. Martin, 110 feet south of gate where road enters pasture, 10 feet west of wagon road; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 218.—Is 655 feet above *Stanleys Landing*, at foot of bluff directly across road from a 3-foot elm at side of road; being highest point in square cut on rock.

P. B. M. 114.—Is at *Sugar Loaf Rock*, which stands on the side of the bluff about 50 feet from river bank; it is in the northeast face of the rock, 7 feet above the level of a bench below rock, and 2 feet above ground at face of rock; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 115.—Is 4½ miles below *Marion, Mo.*, 2½ miles below Bull Rock, one-fourth mile above Sugar Loaf Rock, 82 feet back from river at mouth of small ravine, 24 feet east of bed of small stream; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 220.—Is very near P. B. M. 115; being highest point in square cut on projecting point of natural ledge.

T. B. M. 223.—Is three-fourths mile below *Bull Rock*, on upper one of three large conspicuous rocks on bank (the only ones near); being highest point in square cut on northwest corner, marked U ☐ S.

P. B. M. 116.—Is in west face of *Bull Rock*, a very prominent pinnacle rock, about 50 feet high, at edge of water, 10 feet north of edge of bluff, 25 feet above long narrow shoulder, upon which is T. B. M. 224, and 15 feet below south end of projecting ridge of rock; being a copper bolt. (This rock is incorrectly called "Sugar Loaf Rock" on map, survey of 1878.) (See note 16, page 552.)

P. B. M. 117.—Is 40 feet west of west face of *Bull Rock*, on top of bench 20 feet north and 30 feet west of foot of upper slope; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 224.—Is 2⅛ miles below *Marion*, on west side of Bull Rock, at about the elevation of high water; being highest point in square cut on shoulder of rock and marked U ☐ S.

T. B. M. 225.—Is 2⅛ miles below *Marion*, one-half mile above Bull Rock, at point of bluff, on upper one of several large flat pieces of rock lying on the bank at an angle of about 45° with the horizontal; being highest point in square cut at about the center of the top surface of rock.

T. B. M. 226.—Is 1⅝ miles below *Marion*, 1⅛ miles above Bull Rock, 459 feet below mouth of Mud Creek, on river side of wagon road, at lower side of coulee, at foot of bluff; being highest point in square cut on small projecting point of natural ledge.

P. B. M. 118 = ${}^{3}_{1}{}^{3}$.—Is in *Marion*, 475 feet from river, in northwest corner of lot No. 30, belonging to T. W. Glenn, just outside of Mr. Glenn's yard, 40 feet from his house, at south fence of road running back from store at landing, where lane runs south in front of Mr. Glenn's house; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 119.—Is 1 705 feet above mouth of small ravine at *Marion*, 39 feet above northwest corner of prominent vertical ledge, and in the continuation of this ledge, 4 feet above high-water mark; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 230.—Is at *Marion*, 39 feet from upper end of vertical ledge of rock at water's edge, 1 705 feet above landing; being highest point in square cut on oval bowlder in water, 12 feet from water's edge at stage, 10 feet below high water.

T. B. M. 232.– Is 1⅛ miles above *Marion*, at mouth of Moniteau Creek, on lower one of two large projecting rocks overhanging bank; being highest point in square.

P. B. M. 120.—Is on west side of road, nearly opposite T. B. M. 234, 65 feet south of small ravine on right bank of *Moniteau Creek*, 98 feet above Murphy's skiff ferry, on field side of wire fence, 10 feet south of gate across private road from Hickman's house to main road to Marion; being copper plate in bench-mark stone. (See note 15, page 551.)

T. B. M. 236.—Is about 1¼ miles below *Sandy Hook Landing*, on C. F. Rosemeller's land, three-eighths mile south of his house, 30 feet from foot of bluff, 16 feet below fence running at right angles to bluff separating pasture from field; being highest point in square cut on embedded rock and marked U □ S.

P. B. M. 121.—Is 4 miles above Marion, seven-eighths mile below *Sandy Hook Landing*, on west side of Factory Creek, opposite T. B. M. 237, in east face of semicircular ledge of rock next to creek; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 122 = ${}^{3}_{1}{}^{4}$.—Is at *Sandy Hook Landing*, 300 feet west of road running south from landing and on north side of road running west over bluff, 3 feet south of southeast corner of William Gentzsch's front dooryard; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 123.—Is 2 953 feet below Cooks Landing, 1 800 feet above *Sandy Hook Landing*, at lower end of bottom, 25 feet north of a point at which a stratum of rock projects out 10 feet from face of bluff, directly under a small projection 10 feet below its top; being a copper bolt leaded horizontally into natural ledge 1 foot above ground. (See note 16, page 552.)

T. B. M. 240.—Is 8 feet north of P. B. M. 123 and 12 feet from vertical face of bluff; being highest point in square on embedded rock.

T. B. M. 241.—Is one-half mile below *Geigers Landing*, 1 017 feet below small creek, 75 feet above lower end of large rock bank at foot of bluff; being highest point in square cut on projecting point of ledge and marked U □ S.

P. B. M. 124.—Is at *Geigers Landing*, on south side of road running west from landing up coulee, about 500 feet from river, at northeast corner of S. V. Cook's shed, at east side of corncrib, 1 foot north of shed; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 125.—Is at *Geigers Landing*, 60 feet north of T. B. M. 242, in projecting point of rock ledge 10 feet high by 8 feet wide; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 242.—Is at *Geigers Landing*, 380 feet above road running west up coulee; between road running parallel to river and bluff, 50 feet from river, 10 feet from bluff, 60 feet south of 2-foot hickory standing at foot of bluff, opposite point of ledge in which copper bolt is placed; being highest point in square cut on top of round embedded rock and marked U □ S.

T. B. M. 243.—Is 1 722 feet above *Geigers Landing*, on river side of farm road, 14 feet from foot of bluff, 16 feet below a ditch; being highest point in square cut in large rough rock and marked U □ S.

P. B. M. 126 = ${}^{3}_{\mathrm{T}}{}^{6}$.—Is 3 miles below *Wolf Point*, 1 mile below upper end of bottom opposite Providence, at mouth of coulee, 150 feet southeast of small frame house on land owned by Mr. Jackson, at east corner of small granary, 1½ feet from building, 25 feet south of fence line; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 127 = ${}^{3}_{\mathrm{T}}{}^{6}$.—Is at *Wolf Point*, at northwest corner of Musick & Redford's general merchandise store, 3 feet from corner of building; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 250.—Is at *Wolf Point*, on southeast corner of chimney on east side of Mr. Redford's house; being highest point in square cut on bottom course of stone.

P. B. M. 128.—Is at *Wolf Point*, 75 feet above lower end of exposed ledge, 25 feet above level of bottom land, 3½ feet north of a point directly under end of fence running back over bluff; being a copper bolt leaded horizontally into vertical face of ledge, 2 feet above ground. (See note 16, page 552.)

P. B. M. 129.—Is at *Mount Vernon Landing*, 1 148 feet below mouth of Petite Saline Creek, 24 feet south of bank of small stream, 184 feet above its mouth on slope of hill; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 253.—Is 984 feet below mouth of Petite Saline Creek, 92 feet above wheat shed at *Mount Vernon Landing*, 20 feet toward river from vertical ledge of rock; being highest point in square cut on natural ledge and marked U □ S.

P. B. M. 130.—Is 964 feet below mouth of Petite Saline Creek, 112 feet above wheat shed at *Mount Vernon Landing;* being a copper bolt leaded horizontally into northeast face of natural ledge having vertical exposure of about 10 feet. (See note 16, page 552.)

P. B. M. 131 = ${}^{3}_{\mathrm{T}}{}^{7}$.—Is nearly opposite middle of *Terrapin Island*, on land owned by H. H. Woolrich, at fence separating pasture and cultivated field, 338 feet east of road leading south through the bluffs. It is 1 460 feet S. 61° 45′ W. (mag.) from northeast corner of southeast quarter of the southeast quarter sec. 23, T. 48, R. 15 W.; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 132.—Is in southwest corner of John Campbell's dooryard, 3 miles below point opposite *Rocheport;* being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 133 = ${}^{3}_{\mathrm{T}}{}^{8}$.—Is 2 miles south of *Overton*, on W. E. Clayton's land, at south fence of small meadow at foot of bluff, 880 feet S. 11° 45′ E. (mag.) from center sec. 5, T. 48, R. 15 W.; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 134.—Is about 9 miles below *Boonville*, 1 mile above road running across bottom toward Rocheport, 175 feet above west side of county road running to river, 187 feet below conspicuous cave in side of high rock bluff, two-thirds of the way up; being a copper bolt leaded horizontally into face of rock bluff 30 inches above ground. (See note 16, page 552.)

P. B. M. 135.—Is 1⅝ miles below *Elliotts Landing*, three-fourths mile below head of large bottom back of slough, 1¼ miles above road running north across the bottom toward the river, 100 feet east of high vertical rock ledge, 20 feet from foot of bluff, on line with rail fence, 25 feet below small creek from spring, 6 feet east of a 2-foot slippery elm blazed; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 136.—Is at *Elliotts Landing*, 108 feet below wooden warehouse; being a copper bolt leaded horizontally into face of solid rock bluff, about 2¼ feet above ground. (See note 16, page 552.)

P. B. M. 137 = $\frac{39}{1}$.—Is at *Elliotts Landing*, at head of Diana Island, about 6·2 miles below Boonville, in the northeast corner of orchard and 1 060 feet S. 45° W. (mag.) from house owned by J. E. Elliott, 575 feet back from the river, 82 feet southwest from wagon bridge over small creek, at southeast corner of yard surrounding a log house, on west side of wagon road; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 271.—Is 1 mile below foot of *Franklin Island*, on point of bluff 705 feet below small creek, at lower side of coulee, about one-fourth mile below vertical rock ledge, at top of vertical rock bank on projecting point of ledge, about 2 feet below standard high water; being highest point in square marked U □ S.

P. B. M. 138.—Is 3·8 miles below *Boonville*, opposite foot of Franklin Island, 100 feet below small creek, in rock ledge forming high-water bank, 3 feet above surface of ground, 40 feet from low-water shore line; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

P. B. M. 139.—Is 3$\frac{1}{10}$ miles below *Boonville*, three-fourths mile above foot of Franklin Island, 590 feet above very prominent point of vertical ledge of rock, 30 feet below very small stream, at foot of bluff about 1 foot above mean high water; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 276.—Is 1⅝ miles below Main street, *Boonville*, at lower end of bottom where bluff comes back to river, 1 720 feet below Marietta Creek, 328 feet above head of chute, 65 feet above a spring at base of rock; being highest point in square cut on natural ledge and marked U. S. on face of ledge 1 foot above point.

P. B. M. 140 = $\frac{40}{1}$.—Is 1¼ miles below Main street, *Boonville*, on upper side of coulee, near mouth of Marietta Creek, 25 feet above wagon road running up coulee, on bottom land at foot of bench of bluff, near a group of small elms, on land owned by Mr. Storm; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 279.—Is in *Boonville*, on west side of Main street, between Levee and Water streets, on southeast corner of stone monument, 20 inches by 5 inches, on top marked high water 1844; being highest point in square cut on top of stone.

High-water mark, 1844.—Is on same stone as T. B. M. 279, being center of mark parallel to and 6 inches below top of stone, cut across its east face. The stone has been disturbed and its mark is no longer horizontal. The middle of the line was taken as the high-water mark. The stone is marked on top $\boxed{\begin{array}{c}\text{High water}\\ \boxdot\ \text{mark.}\end{array}}$ and on the east face $\boxed{\begin{array}{c}\text{June 1st,}\\ \hline \text{A. D. 1844.}\end{array}}$

P. B. M. 144=old B. M. 121.—Is in *Boonville*, on river side of abutment to Missouri, Kansas and Texas Railroad bridge, north of Missouri Pacific track, at about the middle of the north face, 2 feet below surface of ground, 5 feet below point of arrow cut in stone; being a copper bolt leaded horizontally. (See note 16, page 552.)

United States Signal Service gauge.—Is in *Boonville*, on first pier from right bank of Missouri, Kansas and Texas Railroad bridge, downstream end, south side; being staff gauge cut in rock reading to feet and tenths. Elevation of its zero.

High water, 1844.—Is in *Boonville*, on downstream end of first pier from right bank of Missouri, Kansas and Texas Railroad bridge; being center of horizontal line of black paint thus: —44— (Line is not perfectly horizontal.) East end of line at nose of pier was taken.

P. B. M. 141.—Is in *Boonville*, at northwest corner of a three-story brick building occupied by Boonville Flouring Mills, owned by C. W. and J. Sombast, facing levee, 200 feet east of Main street, on north face of top corner stone of foundation, 6 inches east of corner and 3·5 feet above ground; being a copper bolt leaded horizontally.

P. B. M. 142=40½ Boonville.—Is in *Boonville, Mo.*, on west side of Main street between Levee and Water streets, 1 foot west of stone curbing at lower edge of stone marking high water 1844; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 280.—Is on shore pier at south end of Missouri, Kansas and Texas Railroad bridge at *Boonville*, on downstream end of pier, on side of downstream pedestal next to track, and almost in line with north edge of bed plate; being highest point in square cut on coping.

P. B. M. 143.—Is in shore pier at south end of Missouri, Kansas and Texas Railroad bridge at *Boonville*, 21¼ inches west of bed plate, 16½ inches northwest from northwest corner of stone wall, 22 inches south of north side of pier, and 30½ inches from west end; being copper bolt leaded vertically into coping stone. (See note 16, page 552.)

P. B. M. 145.—Is in shore pier at north end of Missouri, Kansas and Texas Railroad bridge across the Missouri River at *Boonville*, in upstream end of pier, 14¼ inches from northwest corner of bedplate and 1½ inches north of a point in line with north edge of same, 15 inches from west and 30½ inches from south bevel edge of pier; being top of copper bolt leaded vertically into coping stone. (See note 16, page 552.)

P. B. M. 146.—Is about one-half mile west of *Franklin* station, 902 feet northwest of second bend in road after crossing Missouri, Kansas and Texas Railroad on line with south fence of east-and-west branch road, 50 feet east of fence corner on opposite side of road and 6 inches east of east fence of north-and-south Boonville road, on land owned by Joseph B. Baker; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 147=$\frac{41}{3}$ (new position).—Is 3 miles above *Boonville*, at point where road running south branches off from east-and-west road, 348 feet above a point directly in front of Mrs. Kate Chancellor's house, 49 feet below point opposite east end of barn; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 286.—Is 4½ miles above *Boonville*, 2 920 feet below road running southeast to river, 820 feet below two large lone cottonwoods by roadside, on small knoll on bluff side of road; being highest point in square cut on flat embedded rock.

P. B. M. 148.—Is 5½ miles above *Boonville* bridge, at lower end of Kings Lake, 2 130 feet above branch road running across bottoms to river, opposite W. E. Saddler's house on river side of road leading to Boonville and on line with road fence along John Tinsley's land, between an elm above and a honey locust below; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 149.—Is 5½ miles below *Lisbon*, 1 mile below branch road leading west, 900 feet south of house occupied by Ed Smith (owned by Clark Brothers), 125 feet south of fence running east over bluff, 50 feet north of large elm, on east side of road next to Steve Cooper's land; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 150.—Is about 4 miles below *Lisbon*, 1 640 feet above branch road leading west, 252 feet north of east-and-west fence, 20 feet east of center of road leading to Boonville and 2½ feet above grade of same; being top of copper bolt leaded vertically into projecting ledge 6 inches back from vertical face. (See note 16, page 552.)

P. B. M. 151=$\frac{4}{3}{}^{3}$.—Is 3¼ miles below *Lisbon*, 2 000 feet north of schoolhouse, district No. 4, 430 feet north of Fairbanks's weighing scales, 275 feet southeast of John Step's house, 230 feet east from wagon road; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 295.—Is 2¼ miles below *Lisbon*, 590 feet below William Marshall's barn at mouth of coulee, 145 feet below large rock lying by roadside at foot of bluff, on east side of wagon road leading to Boonville; being highest point in square on inclined embedded rock, and marked U □ S.

P. B. M. 152=$\frac{4}{3}{}^{4}$.—Is 2 295 feet below *Lisbon*, 1 310 feet below creek at lower end of town, 133 feet above fence corner, on river side of wagon road, 59 feet from center, 15 feet from river bank, at east side of large embedded rock; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 297.—Is 2 295 feet below *Lisbon*, 1 310 feet below creek at lower end of town, 50 feet west of wagon road, 20 feet east of river, 33 feet north of P. B. M. 152, 8 feet southwest of blazed elm; being highest point in square cut on natural ledge, and marked U □ S on west face of ledge.

P. B. M. 153.—Is 1 mile above *Lisbon*, 2 050 feet above first bridge over creek above Lisbon, 60 feet above a point directly east of and across slough from John McCorkle's log barn or shed, on east side of wagon road, 2 feet above surface of ground; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

T. B. M. 300.—Is 1 mile above *Lisbon*, 2 050 feet above first bridge over creek above Lisbon, 460 feet north of prominent rock point, east side of wagon road, 50 feet south of south end of small coulee, and 1 foot above ground; being highest point in square cut on natural ledge.

P. B. M. 154=$\frac{4}{3}{}^{6}$.—Is 1¼ miles above *Lisbon*, ⅝ mile above the second highway bridge above Lisbon, three-fourths mile below John W. Goe's log house, which stands by road, 275 feet below prominent point of rock bluff, by rail fence on west side of wagon road; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 301.—Is 275 feet above P. B. M. 154, on east side of wagon road, at prominent point of rock bluff, on natural ledge; being highest point in a square, marked U □ S.

T. B. M. 302.—Is 2¼ miles above *Lisbon*, 616 feet above John W. Goe's house, about 50 feet above small stream flowing from spring on the east side of point of bluff, on the upper side of small coulee, on east side of wagon road, on natural ledge; being highest point in square, marked U □ S.

T. B. M. 303.—Is $3\frac{1}{16}$ miles above *Lisbon*, 3 000 feet below highway bridge over Richland Creek, on the west side, and 8 feet from wagon road and 9 feet from fence; being highest point in square on large flat rock, marked U □ S.

T. B. M. 304.—Is 1¾ miles below *Bluffport*, ½ mile below Mrs. J. Cropp's house, at the upper side of a small creek, 40 feet east of black walnut standing on the west side of road, at east roadside; being a square on embedded rock.

P. B. M. 155.—Is about 1 mile above *Richland Creek*, on line of wagon road above and 230 feet in direct line from house of Mrs. Blanche Cropp, and 230 feet above small stream, at the upper side of coulee, opposite a point 8 feet below the lower outcropping of ledge; being a copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 156.—Is about 1⅛ miles below *Bluffport*, 95 feet above P. B. M. 155, 87 feet above end of bare bluff, 3½ feet above ground, on east side of wagon road; being a copper bolt leaded horizontally in face of ledge. (See note 16, page 552.)

T. B. M. 305.—Is in the same locality as P. B. M. 155, 230 feet above Mrs. Blanche Cropp's house, 260 feet above creek and 35 feet above the lower end of bare ledge, 1½ feet above surface of ground; being the highest point in square on natural ledge.

P. B. M. 157=$^{4}_{8}{}^{6}$.—Is on left bank; 2 miles below *Glasgow*, 175 feet above the mouth of the first creek below Hurricane Creek, on level spot of ground just back of fence at foot of bluff, 20 feet from river bank, and 40 feet below the lower end of high rock ledge; being a copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 309.—Is about 50 feet above P. B. M. 157, 29½ feet above the lower extremity of sandstone ledge, under twin lime tree, on natural ledge, 3 inches back of face; being highest point in square.

P. B. M. 159=$^{4}_{3}{}^{7}$.—Is in *Glasgow, Mo.*, at the west side of the second pier from the east abutment of the Chicago and Alton Railroad bridge, opposite center of pier and 2 feet from its face; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 160.—Is in *Glasgow*, in the first lowland pier, just below wagon road at the east end of the Chicago and Alton Railroad bridge, in the first course of stone under capstone, in east face, 10 inches north of southeast corner of pier, 6 feet above ground; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 314.—Is in *Glasgow*, at the Chicago and Alton Railroad bridge, at the base of same pier as P. B. M. 160, in the center of south face, 3 feet east of the southwest corner of pier, on projecting stone, at about the same elevation as the surface of ground; being highest point in square.

T. B. M. 315=old B. M. 141(a).—Gauge bench mark in *Glasgow* is on top of ridge joint between the columns of the third pier from the east abutment of the Chicago and Alton Railroad bridge.

P. B. M. 161.—Is opposite *Glasgow, Mo.*, on the Chicago and Alton Railroad bridge, on the first high double pier from the right bank, at the west end of high truss, on downstream end and top of pier, 17 inches from the southeast corner of bedplate and just south of anchor bolt, 7½ inches from either beveled edge at the southeast corner of pier; being top of copper bolt leaded vertically, (See note 16, page 552.)

P. B. M. 158=$\frac{47}{2}$.—Is on the right bank three-fourths mile below the west abutment of *Glasgow* bridge and 1 960 feet from river bank and 1 960 feet south from the Chicago and Alton Railroad tracks, in south fence of road in front of house, 195 feet east of a 2-foot oak tree; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 162.—Is 2 miles south of *Cambridge*, *Mo.*, and 5 miles west of Glasgow, where wagon road crosses the Chicago and Alton Railroad track just as it enters bluffs going west, about three-eighths mile from the river bank, 47·5 feet south from the center of track, on west side of wagon road, at corner of fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 163.—Is in *Cambridge*, *Mo.*, on the east side of warehouse of W. D. Woolridge, near river end, 4·4 feet south of the north corner, and 3 feet above ground; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 325.—Is in *Cambridge*, on same warehouse as P. B. M. 163, at east side, 10 feet south from its north end, on projecting course of stone; being highest point in square.

P. B. M. 164=$\frac{48}{1}$.—Is in *Cambridge*, *Mo.*, 623 feet above the landing at foot of Main street, on a low point of bluff just above spring, 245 feet west of fence, 15 feet above elevation of bottom land; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 326.—Is 82 feet west of P. B. M. 164, on the east side of small ravine, on a natural ledge of rock; being highest point in square, marked U □ S.

P. B. M. 165.—Is 2¼ miles below *Salt Creek*, about three-fourths mile from the bank of the river, on old river bank, 150 feet west of bank of large slough, on west side of wagon road to Cambridge, in line with fence, on land of Judge Gillum, across slough and 490 feet from his house, 180 feet south of the exceedingly large cottonwood tree 9 feet in diameter; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 166=$\frac{49}{1}$.—Is at the upper end of *New Frankfort*, 885 feet south of river bank, 213 feet north of point where road running west turns north, 65 feet south of and across road from house of R. M. Elliott, 2 feet west of the west fence and 300 feet south of center of bridge over small creek; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 167.—Is 3 miles above *New Frankfort*, at old site of sawmill, where old road running west along foot of bluff turns south over the bluff and from which point a lane runs north about one-half mile to Mr. Campbell's house, 328 feet above prominent ledge of rock, on north side of road and east side of lane; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 168=$\frac{50}{1}$.—Is opposite *Buckhorn Point*, at foot of bluff, 98 feet west of line between secs. 27 and 28, T. 53, R. 20 W., on land of Samuel Wood, north of barn on top of bluff, 3 feet south of east-and-west fence running along foot of bluff, 820 feet east of the old "mulberry corner;" being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 169.—Is on *Cromwell Point*, at foot of Brunswick Island, three-eighths mile north of Mr. Downing's house, above mouth of creek, below bridge where road between Downing and Andy Campbell crosses creek, 22 feet south of high bank, 18 feet north of gate, on the west side of fence, at the northwest corner of Cyrus Downing's field, where road leaves creek and enters field; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 170=$\frac{61}{Y}$.—Is opposite the mouth of *Grand River*, 20 feet west of the southwest corner of the NE. ¼ of NE. ¼, sec. 24, T. 53, R. 21 W., on the south side of the east-and-west lane between Mr. White's house on the west and Mr. Sullivan's house on the east, 130 feet west of large blazed elm at edge of woods on north and field on south, 49 feet south from a small elm blazed; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 171=$\frac{62}{Y}$.—Is opposite *De Witt, Mo.*, on line running east and west through center of sec. 22, T. 53, R. 21 W., 60 feet west of quarter post between sections 22 and 23, about 820 feet west of S. W. Wood's house, at south road fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 172.—Is 2½ miles below *Miami, Mo.*, in the southeast corner of Miami and De Witt road, where the road turns north, 459 feet south of Mr. Davenport's two 1-story frame houses, 5 feet south of east-and-west fence between Davenport's and Wilson's fields, 1 foot east of the east road fence; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 173.—Is about 1 640 feet below the flouring mill at *Miami*, 295 feet above upper bank of creek, 5½ feet above surface and 6 feet from edge of water at a medium stage, in face of ledge; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 357 = B. M. C. of 1878.—Is on east side of road from landing to town, on west bank of small stream, 25 feet from river bank at Smith & Boyer's warehouse; being top of knob chiseled in rock ledge. It is said to be of the same elevation as high water of 1881.

P. B. M. 175.—Is in *Miami*, at the ferry landing, on the west side of street, 40 feet from river, at the northeast corner of flouring mill of J. G. Guthrie; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 358.—Is in *Miami, Mo.*, at same place as P. B. M. 175, on foundation of brick flouring mill owned by J. G. Guthrie, at its northeast corner; being highest point in square.

P. B. M. 176.—Is 2 885 feet above the present landing at Miami, 295 feet above creek at old Miami ferry landing, 4 feet above surface of water at a medium stage and 7 feet from shore, in west face of rock; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 359.—Is in the same locality as P. B. M. 176, 130 feet below it, about 1 foot above surface of ground and 3 feet from shore at medium stage; being highest point in square cut on natural ledge, marked U □ S.

T. B. M. 360.—Is three-fourths mile above *Miami*, 2,950 feet below the creek which is outlet to Lake Teteseau, at foot of bluff, 15 feet from river, 34·5 feet below path running over bluff to Miami, on largest bowlder in this vicinity; being square cut on top of shoulder at its base, on river side, marked U □ S.

P. B. M. 177 = $\frac{54}{Y}$.—Is 2¾ miles above *Miami*, where the road running to Laynesville leaves the bluff, 65 feet E. 10° N. of small bridge where road crosses discharge ditch, 230 feet above the southeast corner of field, about 20 feet west of center of road and 60 feet from foot of bluff; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 178.—Is south of the center of *Teteseau Bend*, about 1 700 feet from the river, at the east side of Joseph Hilderbrand's yard, 125 feet north of house, 80 feet east of east road fence, and 40 feet south of south farm lane fence; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 179 = ${}^{6}_{2}{}^{6}$.—Is in *Saline County, Mo.*, 1 mile southeast of *Laynesville*, at north fence of road between townships 51 and 52, 4 379 feet west of the southeast corner of sec. 33, T. 52, R. 22 W., and 120 feet east of bridge over Davies Lake; being top of copper bolt in bench-mark stone set 3 feet below surface of ground. (See note 15, page 551.)

P. B. M. 180.—Is at *Malta Bend Landing*, 300 feet west of house occupied by S. Hugh, in west line of road, on land owned by Charles Von Stone; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 181.—Is 2 miles above *Malta Bend Landing*, in front of Grand Pass Lake, three-fourths mile back from present river bank, 360 feet back from road that follows old river bank, in Fred Ayer's front yard, 18 feet from its northwest corner and 6 inches south from front fence, 6 feet above small gate, and 72 feet from the northwest corner of house; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 182. = ${}^{6}_{1}{}^{6}$.—Is about $5\frac{2}{6}$ miles below *Waverly*, 158 feet east of point in road in front of house owned by S. H. Moore, now occupied by John Plattern, 4 feet north of south fence of section-line road between secs. 5 and 8, T. 51, R. 23 W., 1 106 feet west of southeast corner of sec. 5; being copper bolt in bench-mark stone 3 feet underground. (See note 15, page 551.)

P. B. M. 183.—Is 3 miles below *Waverly, Mo.*, at foot of bluff, 147 feet from center of track, at west side of wagon road, 1 foot east of fence south of the west end of Gilhams Lake, 230 feet from bridge No. 62 and 219 feet from west cattle guard at road crossing Missouri Pacific track; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 389.—Is $1\frac{7}{8}$ miles below *Waverly, Mo.*, 738 feet west of line between Lafayette and Saline counties, 230 feet above bridge No. 59, on river side of track, 15 feet from center; being highest point in square cut in rock.

P. B. M. 184 = ${}^{6}_{1}{}^{7}$.—Is $1\frac{1}{4}$ miles below *Waverly, Mo.*, 984 feet north of track, on land owned by Charles Walton, in corner of field, 177 feet S. 59° 30′ E. (mag.) from a point on section line between secs. 12 and 13, T. 51, R. 24 W., which point is 460 feet west of quarter post between said sections; being top of copper bolt in bench-mark stone. (See note 15, page 551).

T. B. M. 392.—Is five-eighths mile below *Waverly* depot and 770 feet below highway crossing, on bluff side of Missouri Pacific track, 12 feet from center; being highest point in square cut on a rock.

P. B. M. 185 = ${}^{6}_{1}{}^{8}$.—Is in *Waverly, Mo.*, about one-third mile below depot, 60 feet south of Missouri Pacific track, in northwest corner of lot owned by W. Milnor, 20 feet south of north line of lot and 10 inches east of west fence; being copper bolt in bench-mark stone. (See note 15, page 551).

P. B. M. 186.—Is 1 mile above *Waverly*, on east end of bridge No. 55, Missouri

Pacific Railway, on south end of bridge-seat stone, 6 inches west from retaining wall and 8 inches back from face of bridge-seat stone; being top of copper bolt leaded vertically. (See note 16, page 552).

T. B. M. 396.—Is near P. B. M. 186, on north end east abutment of same bridge 9 inches east of northwest corner and 8 inches back from face; being highest point in square cut on capstone of retaining wall, and marked U □ S.

P. B. M. 187.—Is 1½ miles above *Waverly*, on south end of east abutment bridge east course of bridge No. 54, Missouri Pacific Railway, 6 inches west of retaining wall and 6 inches back from face; being top of copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 397.—Is near P. B. M. 187, on north end of same abutment, 14 inches east from northwest corner of stone and 3 inches back from face; being highest point in square, marked U □ S.

P. B. M. 188.—Is about 1⅝ miles above *Waverly, Mo.*, 10·5 feet east of the east end of bridge No. 52, on south side Missouri Pacific track and 30 feet from bank of small stream, 3·3 feet east of 10-inch elm, at foot of bluff, on flat spot of ground; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 189 = $^{6}_{1}{}^{0}$.—Is 4 miles above *Waverly*, 2¼ miles below Edwards, 50 feet above bridge 47, Missouri Pacific Railway, bluff side of track, 100 feet from center and 40 feet northeast of a cluster of six lime trees (blazed). (See note 15, page 551.)

P. B. M. 190.—Is 1½ miles below *Edwards, Mo.*, at point of bluff, 738 feet below bridge No. 46, Missouri Pacific Railway, on south side of track, 12·4 feet from center and 3·9 feet above grade; being a copper bolt leaded horizontally into natural ledge. (See note 16, page 552.)

T. B. M. 402.—Is 1½ miles below *Edwards*, 785 feet below bridge No. 46, on south side of track, 10 feet from center; being highest point in square cut on natural ledge.

P. B. M. 191.—Is at *Edwards, Mo.*, in north face of foundation of old mill, 33 inches west of east window and 3 feet below top of foundation; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 192.—Is at *Edwards, Mo.*, 730 feet below depot, 130 feet north of northwest corner of Edwards Mill, 154 feet southeast of railroad bridge No. 42, 95 feet SSW. of lower head dock of siding, 33 feet above road crossing, 72 feet south of center of Missouri Pacific track, and 1½ feet north of south right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 403.—Is 620 feet below depot at *Edwards*, 45 feet below bank of small creek under bridge No. 42, Missouri Pacific Railway, on south side of track, 59 feet from center; being highest point in square cut on embedded rock.

P. B. M. 193 = $^{6}_{T}{}^{0}$.—Is 3 miles below *Dover* depot, 164 feet south of Missouri Pacific track, in NW. ¼ of SE. ¼ of sec. 9, T. 51, R. 25 W., in W. D. Ballard's yard, between house and well, in line with north side of house, and 14 feet from the northwest corner; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 407.—Is about 2⅜ miles below *Dover*, seven-eighths mile below water tank, 574 feet below bridge No. 35, bluff side of Missouri Pacific track, 20 feet from center; being highest point in square cut on rock.

T. B. M. 408.—Is 1½ miles below *Dover*, on stone foundation of water tank, at the southeast corner; being highest point in square.

P. B. M. 194.—Is at *Dover*, 39 feet west from the road crossing, at the southeast corner of depot platform, 48·5 feet east of the east end of depot, on south side of track, 12 feet from center; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 195 = $\frac{61}{T}$.—Is in *Berlin, Mo.*, 580 feet north 87° west from Y. E. Gray's brick house on bluff, on bluff side of track, 145 feet from center, 425 feet below bridge No. 26 and 1 030 feet above bridge No. 27; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 196.—Is in *Berlin*, in south end of east stone abutment to bridge No. 26, 3 feet below grade of track; being top of copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 411.—Is very close to P. B. M. 196, on south end of west abutment; being highest point in square, marked U □ S.

P. B. M. 197.—Is 1 mile below *Northrup, Mo.*, on south end of west pier of iron bridge No. 25 across Big Tabo Creek, in line with west side of pedestal, 1 foot south of same; being copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 412.—Is near P. B. M. 197, on south end of east pier; being highest point in square, marked U □ S.

P. B. M. 198.—Is 1 460 feet above section house at *Northrup, Mo.*, 328 feet below east bank of sidehill cut, on bluff side of track, 75 feet from center; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 415.—Is about seven-eighths mile above section house at *Northrup*, 1 785 feet below Missouri Pacific bridge No. 22, 288 feet below sign "station one mile," on sandstone ledge; being highest point in square.

P. B. M. 199 = $\frac{62}{T}$.—Is 5⅛ miles below *Lexington, Mo.*, near the center of wide bottom land 1¼ miles below point where bluff leaves river, in the northeast corner of NW. ¼ of NW. ¼ of sec. 29, 639 feet south of the Missouri Pacific track, 100 feet southwest of the southwest corner of a small log house owned by William Mayfield, 2 feet west of a north-and-south fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 419.—Is 4⅛ miles below *Lexington, Mo.*, 820 feet above end of bridge No. 21, Missouri Pacific Railway, and about 325 feet above end of long sidehill cut, on bluff side of track, 12 feet from center; being highest point in square cut in natural ledge.

P. B. M. 200.—Is 3½ miles below *Lexington, Mo.*, on south end of west abutment, bridge-seat course, of Missouri Pacific Railway bridge No. 19, 9 inches east of retaining wall and 14 inches north from face; being top of copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 420.—Is about 3 miles below *Lexington, Mo.*, at Missouri Pacific Railway bridge No. 17, on north end of west abutment, in northwest corner of coping stone; being highest point in square cut on rock, and marked U □ S.

P. B. M. 201.—Is about 2½ miles below *Lexington, Mo.*, about in middle of 1 200-foot tangent on Missouri Pacific track, at foot of bluff, 32·8 feet from track center, 150 feet below bridge No. 15, on east side of small coulee and 8 feet south of right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 202.—Is about 2¼ miles below foot of Pine street, *Lexington, Mo.*, on south side of west abutment of bridge No. 14, Missouri Pacific Railway, on bridge-seat course, 8 inches from retaining wall and 8 inches from face; being top of copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 422.—Is 1 1/8 miles below foot of Pine street, *Lexington*, 540 feet below head block of switch to coal mine, 15 feet north of Missouri Pacific track, near river bank, on large embedded bowlder, being highest point in square.

P. B. M. 203 = ${}^{6}\text{Y}^{3}$.—Is in lower part of *Lexington*, 1 770 feet below Missouri Pacific bridge No. 8, at foot of Pine street, 130 feet from the northeast end of Missouri Pacific bridge No. 10, on bluff side of track, by wire fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 423.—Is 1 900 feet below Missouri Pacific bridge No. 8, at foot of Pine street, 180 feet above J. S. Walter's house, 262 feet below Missouri Pacific bridge No. 10, on bluff side of track, 40 feet from center; being highest point in square cut on rock.

P. B. M. 204.—Is in *Lexington, Mo.*, at the foot of Pine street, in north face of retaining wall, 13 feet west of the east end and 30 feet below center of stream running over top of this wall; it is in the third course of masonry from top, 3·3 feet below same; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 424.—Is in *Lexington*, 1 foot lower and 1 foot farther downstream than P. B. M. 204; being highest point in square cut on top of fourth course of masonry from top, in retaining wall.

P. B. M. 205 = old B. M. 190.—Is in *Lexington, Mo.*, in point of bluff on west side of Pine street, 210 feet from river and 19·5 feet west of west fence along Pine street; being horizontal furrow in copper bolt leaded horizontally into natural ledge.

T. B. M. 425 = old B. M. 191.—Is 1 1/8 miles above ferry landing at *Lexington*, 655 feet above city limits, at north end of rock arch bridge over Grahams Creek, directly over arch, near top of parapet wall, on top at the southeast corner of cut rock inscribed Crum and Hackett, 1858. A cross is cut in the south face (road side) of the stone, which at the intersection is 1 inch below the bench.

P. B. M. 206.—Is on same bridge as old B. M. 191, between the two branches of the Missouri Pacific track, 2 345 feet below the *Junction* depot, 40 feet west from the east end of wall, on north face, 4 1/2 feet above ground and 3 feet below coping stone, 30·5 inches east from center of arch; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 207.—Is about 2 1/2 miles above the ferry landing at *Lexington*, 410 feet below siding to J. C. McGrew's coal mine, 150 feet below house occupied by Edward Rosewell on land owned by Reed and Taylor families, directly opposite small bridge on wagon road and culvert on railroad, on bluff side of track, 80 feet from center and 25 feet from wagon road; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 208.—Is 2 1/2 miles below *Wellington, Mo.*, 1 605 feet below the east end of Missouri Pacific bridge No. 145 over Little Sny Creek, one-fourth mile above the mouth of slough at foot of Wolf Island, 490 feet north of forks of road, at foot of hill, on roadside, 10 feet northeast of a lone red oak 20 inches in diameter, 4 feet from corner of field, and 62 feet east of track center; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 429, old B. M. 194.—Is 2 miles below *Wellington, Mo.*, on the line of the Missouri Pacific Railway, opposite bridge No. 145, 328 feet below milepost 249, at the northeast corner of the east abutment of wagon bridge over Little Sny Creek; being + cut in top of stone.

P. B. M. 209 = $^{6}_{1}{}^{4}$.—Is 1 950 feet below *Wellington* mill, 1 655 feet above west end of Missouri Pacific bridge No. 149, over Big Sny Creek, 250 feet above bridge No. 150, 55 feet above upper end of coal dump, at point of bluff where bluff recedes, 35 feet south of center of Missouri Pacific tracks; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 210.—Is in *Wellington, Mo.*, 400 feet below the depot, at the northeast corner of mill, 5 inches south from the corner and 25 inches above ground; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 431.—Is in *Wellington*, 400 feet below depot, at the southeast corner of mill, being highest point in square cut on stone 2 inches above ground, and marked U □ S.

P. B. M. 211.—Is 3 690 feet below *Waterloo*, 226 feet above coal mine of Mr. Hartmann, 30 feet west of gate through which road leads from coal mine up the bluff, 10 feet north of wagon road, directly north of a one-story frame house on edge of bluff, 62 feet south from Missouri Pacific track center, 2 feet outside of right of way; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 212 = $^{6}_{1}{}^{6}$.—Is at *Napoleon, Mo.*, 220 feet south of depot, at foot of bluff, 90 feet east of small creek under trestle No. 161, Missouri Pacific Railway, and about 75 feet south of wagon road; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 436.—Is about 1 mile above *Napoleon*, 1 840 feet below house of F. P. Ellis, 10 feet east of east end of open culvert, and 8 feet south of center of Missouri Pacific track; being highest point in square cut on natural ledge.

P. B. M. 213.—Is 2 miles above *Napoleon, Mo.*, 390 feet below the line between Jackson and Lafayette counties, 150 feet below farm crossing, 1 400 feet below bridge 164, 72 feet in direct line from bridge 163, 59 feet south of center of track, on point of land between old Lexington and Napoleon roads owned by Mr. Johnson, 8·6 feet northeast from an elm tree 30 inches in diameter; being copper bolt in bench-mark stone. (See note 15, page 551).

P. B. M. 214 = $^{6}_{1}{}^{7}$.—Is about 2 miles below Sibley bridge, at *Matthews Landing*, 390 feet south of river bank, in southwest corner of young orchard, 202 feet west from southwest corner of D. O'Donnell's house, at the east side of north-and-south road and on north side of lane leading past house; being copper bolt in bench-mark stone. (See note 15, page 551).

T. B. M. 445, old bench 210.—Is at *Matthews Landing*, 2 miles below Sibley bridge, on the house of D. O'Donnell, east side of road, at the northwest corner of foundation; being the highest point in square cut on northwest quarter of cross.

P. B. M. 215.—Is 1 mile below station at *Sibley, Mo.*, at the south end of Sante Fe bridge across the river, 108 feet back from top of river bank, at foot of bluff, 75 feet east and 23 feet north of the northwest corner of land pier; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 216.—Is at *Sibley, Mo.*, on right bank in land pier of the Sante Fe bridge, at the top and southwest corner of pier, 6 inches back from each beveled edge; being top of copper bolt leaded vertically. (See note 16, page 552.)

P. B. M. 217.—Is on bottom land just above *Sibley*, 2 800 feet north of bridge over small creek at foot of bluff, where T. B. M. 452 is located, 400 feet south of Keller and Angel's house, 360 feet north of small box culvert and road running east through field at east edge of brush on the west side of north-and-south county road, 1½ feet east of fence; being top of cap over old B. M. $\frac{68}{\text{T}}$.

P. B. M. 218.—Is near the river on line of Santa Fe Railroad, about 2¾ miles above *New Sibley*, on line with center of road running up bluff, 125 feet below Auld's sawmill, opposite the upper end of bridge No. 603, just above wing fence, bluff side of track, 30 feet from center; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 457.—Is 3¾ miles above *New Sibley*, at the first point of bluff above Auld's sawmill, at upper end of cut, 30 feet below milepost 435, on bluff side of track, 25 feet from center, and 3 feet above grade; being highest point in square cut on large rock in side of slope, and marked U □ S.

T. B. M. 458.—Is 705 feet below east end of railroad bridge No. 605 over Little Blue River, 230 feet below milepost 436, 20 feet north from center of track; being highest point in square cut on a rock at foot of bank, and marked U □ S.

P. B. M. 219 = $\frac{69}{\text{T}}$.—Is on right bank, opposite *Missouri City*, five-eighths mile above the Santa Fe bridge over the Little Blue River, 2 295 feet above road crossing, 820 feet north of railroad track, on the north side of wagon road, about 2 feet inside of Mr. Sullivan's field, about 200 feet above a small one-story house on south side of road and 30 feet below two small plum trees growing close together on the north side of road; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 220.—Is in *Atherton, Mo.*, 1 185 feet below depot, 245 feet below section house, 328 feet above road crossing, 215 feet below lowest head block of siding and 49 feet below tool house, directly opposite and northwest from Joseph Sample's house, 49 feet north from center of track at south side of right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 221.—Is near old B. M. 227, about 1½ miles below Blue Mills Landing, 2¼ miles above *Atherton*, 328 feet south from Santa Fe track, 200 feet west of section line, on land owned by George Hendrick, 35 feet east from levee, near creek from spring and path leading down from Mr. Hendrick's house, on small point of bluff, 10 feet above level of bottom land; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 465.—Is at *Blue Mills Landing*, 1 330 feet below railroad bridge No. 609, in small railroad cut, 72 feet below old mill at the ferry landing to which the road leads, and 115 feet above road crossing, 7 feet north from center of track; being highest point in square cut on natural ledge, and marked U □ S.

T. B. M. 466=old B. M. 33 of 1878.—Is at *Blue Mills Landing*, on the river bank, at the northeast corner of old mill (now gone), on the top of a ledge of rock, 14 inches from the north edge and 3 inches from east edge, marked +.

T. B. M. 467=old B. M. 228.—Is at *Blue Mills Landing*, at the northeast corner of site of old mill, in the river face of ledge of rock, 7·1 feet below the top and 6·5 feet from the east face of ledge; being center of cavity from which horizontal copper bolt had been extracted.

P. B. M. 222.—Is at *Courtney, Jackson County, Mo.*, 12 feet east of southeast corner, on line with south side of depot, in the southwest corner of plat of ground at angle in platform; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 470.—Is five-eighths mile above *Courtney* station, 1 400 feet above highway crossing, on first curve above town, 15 feet below sign, "Station," at foot of bluff, 10 feet from center of track, on white embedded rock; being highest point in square, marked U □ S.

T. B. M. 471.—Is 1⅛ miles below pump house of *Independence* waterworks and one-half mile below road crossing, at old Wayne Landing, on bluff side of track, 20 feet from center; being highest point in square cut on projecting point of natural ledge, and marked U □ S.

P. B. M. 223=Y^{1}.—Is at old *Wayne Landing*, five-eighths mile below pump house of *Independence* waterworks, 82 feet below group of cottonwoods, on river side of track, 80 feet from center, on south edge of wagon road, 39 feet below old stone-wall foundation standing at right angles to track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 224.—Is in *Wayne*, between railroad track and the river, at the southwest corner of pump house of Independence waterworks, on the south face, 5 inches east of the west corner, 65 inches above ground; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 225.—Is near *Wayne*, about 2 460 feet below Santa Fe bridge No. 616 over Rock Creek and 525 feet above bridge No. 615, between two small ravines which are about 850 feet apart, 48 feet south from center of track, and 2 feet north of right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 226.—Is about 2½ miles above *Independence*, *Mo.*, at the crossing of Atchison, Topeka and Santa Fe and Missouri Pacific tracks, at foot of iron post of Santa Fe bridge standing between Missouri Pacific and Kanas City and Independence tracks; being top of anchor bolt through northwest corner of shoe. The letters U. S. are cut into cast pedestal, one on each side of nut to anchor bolt.

P. B. M. 227.—Is on the right bank of *Big Blue River*, near its mouth, 98 feet up that stream from the south end of Missouri Pacific Railroad bridge No. 69, upon pier of which bridge is located No. LVIII. It is 2 feet outside of right of way fence and 18·5 feet back from the top bank of Big Blue River.

No. LVIII.—Is 5⅛ miles below Grand Avenue depot, *Kansas City*, *Mo.* (See page 575.)

P. B. M. 228=Y^{2}.—Is about 3½ miles below Hannibal Bridge, at *Kansas City*, five-eighths mile southeast of Crescent elevator, about 2 295 feet north of tile factory, at northwest corner of intersection of two country roads, 120 feet S. 65° W. of Lizzie Wright's house; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 478=old B. M. 240.—Is in *Kansas City*, *Mo.*, 1¾ miles below the Hannibal Bridge, at the Kansas City distillery, at northwest corner of one-story brick fermenting house, 2·5 feet east of corner, on top of the stone foundation; being the highest point in the northeast angle of cross.

T. B. M. 479.—Is in *Kansas City*, *Mo.*, 1 mile below the Hannibal Bridge, at the northeast corner of Zenith Mills, on top of foundation; being the highest point in square. This is in the same place as old B. M. 241, the masonry upon which that was located having been replaced.

P. B. M. 229.—Is in *Kansas City*, *Mo.*, seven-eighths mile below the Hannibal Bridge, 60 feet north from the Chicago and Alton track, on the south side of the retort room of gas works, in water table 50 inches west of the southeast corner; being top of copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 480=old B. M. 242.—Is in *Kansas City*, *Mo.*, on the northwest corner of First and Main streets, at the southeast corner of the three-story brick occupied by the Pabst Brewing Company; being a cross cut in top of stone step. This bench was partly destroyed and a new point was taken instead on the same surface 2 inches nearer the river, between two parallel lines cut in the stone.

P. B. M. 230=$\frac{73}{1}$.—Is in *Kansas City*, *Mo.*, 50 feet east of the shore pier of the Hannibal Bridge and 10 feet from river bank; being copper bolt in bench-mark stone. (See note 16, page 552.)

Old B. M. 244=P. B. M. 231.—*Kansas City*, *Mo.* (See page 575.)

Old B. M. 243=P. B. M. 232.—*Kansas City*, *Mo.* (See page 575.)

T. B. M. 481.—Is directly under P. B. M. 232, at northeast corner of abutment; being highest point in square cut on projecting stone.

P. B. M. 233.—Is in *Kansas City*, *Mo.*, at the foot of Fourth street, in stone pier of wagon bridge over tracks, the south face of the north one of two small piers on river side of Missouri Pacific main track, 5 feet above ground and 9½ inches back from the southwest corner of pier; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 482.—Is in the same locality as P. B. M. 233, at the northwest one of three iron struts forming a rectangle with the south one of two small piers on river side of track, on top of capstone supporting this strut; being highest point in square.

P. B. M. 234.—Is in *Kansas City*, *Kans.*, on the southeast corner of James street and Lyon avenue, in the stone foundation of police station No. 2, on James street face, 22½ inches from its northwest corner, in second course of stone from top, 3½ feet above sidewalk; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 483.—Is in *Kansas City*, *Kans.*, on the southeast corner of James street and Lyon avenue, in front of police station No. 2, on the east side of James street, 23.5 feet south from the northwest corner of sidewalk; being highest point in square cut on curbstone, and marked U □ S.

P. B. M. 235.—Is on the left bank of *Kaw River*, in the same pier as T. B. M. 484, in west face, 7·2 feet south of north corner, in third course of masonry from ground, 2 feet below grade of Missouri Pacific track; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 484.—Is on the left bank of the *Kaw River*, at the third bridge above the mouth, over which the cable cars cross, on the first pier east of the west abutment, on west face of pier at north corner; being highest point in square cut on top of projection of second course of stone above ground, and marked U □ S.

T. B. M. 485=old B. M. 248.—Is in *Kansas City*, *Kans.*, on the northeast corner of Third street and Wyandotte avenue, on the south face, next to the southwest corner of a two-story brick, on the outer edge, next to corner-stone pillar of iron doorsill.

T. B. M. 486=City B. M.—Is at the northwest corner of Third street and Minnesota avenue; being top north nut in rim of hydrant.

T. B. M. 487.—Is in *Kansas City*, *Kans.*, between the Missouri Pacific and Kansas City, Wyandotte and Northwestern Railway tracks, 460 feet below their crossing, at the southeast corner of old gas factory, on top of foundation; being highest point in square.

P. B. M. 236.—Is at the upper end of *Kansas City*, *Kans.*, 300 feet below the K. T. brick works, opposite the lower head block of switch, 50 feet east from center of track, by right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 237.—Is in the west side of *Kansas City* and Wyandotte waterworks pump house, between two windows, 1 foot north of south one, 14 feet south of the northwest corner of wall and 4·3 feet above ground; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 238 = ${}^{7}_{1}{}^{4}$.—Is about one-half mile below old town of *Quindaro*, 2 295 feet above Kansas City and Wyandotte waterworks pump house, 285 feet below bridge No. 73¾, on river side of track, 80 feet from center; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 492.—Is 1¼ miles above Kansas City waterworks, 738 feet above old town of *Quindaro*, 1 705 feet below bridge No. 74¼, 900 feet above bridge No. 74, on bluff side of Missouri Pacific track, 7 feet from center; being highest point in square cut on natural ledge.

P. B. M. 239.—Is one-half mile below *Nearman* station, 1⅞ miles above Quindaro, Kans., directly opposite Parkville, 275 feet below road crossing, on line with west side of road running north toward Parkville, 50 feet north of track center; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 240.—Is 2¼ miles below *Pomeroy*, *Kans.*, at the first small stream 1 630 feet below water tank, 2 145 feet above road crossing, on southwest corner of east abutment of railroad bridge. A small wagon bridge spans the hollow a little higher up the bluff. It is top of copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 495.—Is at the same bridge as P. B. M. 240, on the northwest corner of top stone of east abutment; being highest point in square marked U □ S.

P. B. M. 241.—Is 1⅞ miles below *Pomeroy*, *Kans.*, directly opposite the center of water tank and 25 feet north from center of track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 242.—Is in *Pomeroy*, *Kans.*, in foundation of F. H. Betton's house, the first residence on the west side of street running south from depot, in the northeast face of foundation under bow window on the east end of house, in center of stone in second course of masonry from top; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 243.—Is in *Pomeroy*, *Kans.*, about 195 feet south of depot, in northeast corner of lot owned by I. C. Henderson, in which the old post office building stands, 18 feet south of the southeast corner of the post office and 2 feet from angle of stone wall; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 244 = Old B. M. 260.—Is five-eighths of a mile above *Pomeroy*, 960 feet above east end of trestle over Marshall Creek, 125 feet from river, 75 feet south from railroad, and 21 feet above grade of same; being center of cavity in disintegrated rock ledge from which the copper bolt had been extracted.

T. B. M. 499.—Is five-eighths of a mile above *Pomeroy*, *Kans.*, 1 810 feet above milepost 296, 655 feet above end of railroad bridge over Marshall Creek, on bluff side of track, 8 feet from center; being highest point in square cut on rock.

P. B. M. 245 = ${}^{7}_{1}{}^{6}$.—Is at *Connors*, *Kans.*, 350 feet east of railroad depot, on river side of track, 240 feet from center, in the northwest corner of lot owned by Mr. Max-well, and 15 feet northeast from the north corner of Eli Davis's house; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 246.—Is in *Connors, Kans.*, in foundation wall at the southeast corner of public schoolhouse, on its east face, 6 inches north from corner and 20 inches above ground; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 247.—Is about 2½ miles above *Connors, Kans.*, 1 265 feet below first road crossing below Pope's Siding, 1 315 feet below bridge No. 79, over small creek, and 220 feet above center of small bridge where the Gillman or bottom road turns east away from the track (Mr. E. Piper and Mr. Tull live on this road about one-half mile east of track). It is 33 feet west of track center, on line of right of way; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 506.—Is at *Popes Station, Kans.*, Missouri Pacific Railway, 720 feet above milepost 302, 443 feet above Mr. Pope's house, 394 feet above upper head block of siding on east end of upper abutment of small culvert; being highest point in square marked U □ S.

P. B. M. 248=$^{3}\Upsilon^{7}$.—Is 2 miles below *Leavenworth Junction, Kans.*, opposite foot of Spar Island, 970 feet above milepost 303, 1 610 feet above railroad trestle No. 81, on second bench of bluff from foot, 120 feet from Missouri Pacific track; being top of copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 249.—Is at *Leavenworth Junction, Kans.*, 93 feet above center of depot, 100 feet above head block at junction, 18 feet east of center of track, 29·5 feet above lower head block of siding; being copper bolt in bench-mark stone. (See note 15, page 551).

T. B. M 513.—Is 2¾ miles below *Leavenworth* depot, 230 feet above small coulee, 246 feet above bridge on bluff side of track, 12·5 feet from center; being highest point in square cut in flat piece of ledge about 2 feet below grade of track and marked U □ S.

T. B. M. 514.—Is 1¾ miles below *Leavenworth* depot, 820 feet above coal mine, 39 feet below whistle post, on bluff side Missouri Pacific track, 8 feet from center, at foot of side-hill cut; being highest point in square cut on embedded rock and marked U □ S.

P. B. M. 250=$^{7}\Upsilon^{8}$.—Is on shelf of bluff, 1⅝ miles below *Leavenworth* depot, opposite East Leavenworth, on lower side of small ravine, 200 feet from river and 20 feet west from center of siding leading to coal mine; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 515.—Is seven-eighths of a mile below *Leavenworth* depot, 344 feet above runway to coal mine over tracks, on bluff side of Union Pacific track, 7 feet from center, at foot of side-hill cut; being highest point in square cut in well-embedded rock.

P. B. M. 251.—Is in *Leavenworth*, on north side of the Great Western Stove Company's brick building, one block south of Union Depot, 3·4 feet west from northeast corner and 5 feet above ground; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 252.—Is in *Leavenworth, Kans.*, in brick building occupied by Rohlfing Brothers, grocers, on southeast corner of Third and Cherokee streets, on west end of stone window sill, Cherokee street side; being top of copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 516=Old B. M. 270.—Is in *Leavenworth, Kans.*, at riverward foot of arch forming main entrance to north side of old Union Depot; being cross cut in top of water table.

P. B. M. 253.—Is in *Leavenworth*, in retaining wall at northwest corner of Main and Cherokee streets, 59 feet north of south end of wall, 78 feet south of south end of depot; being a copper bolt leaded horizontally into fourth course of masonry above ground. (See note 16, page 552.)

T. B. M. 517.—Is in *Leavenworth*, on east side of Union Depot, on south end of doorstep to first door south of main entrance; being highest point in square marked U □ S.

T. B. M. 518.—Is thirteen-sixteenths of a mile above *Leavenworth* depot, 85 feet below milepost 310, 500 feet above coal mine, 8 feet below head block of switch, on bluff side of Chicago, St. Paul and Kansas City track, 7 feet from center and on level with grade of same; being highest point in square cut on embedded rock.

P. B. M. 254=$^{7}\mathrm{T}^{9}$.—Is 30 feet below south face of west abutment of Chicago, Rock Island and Pacific bridge at *Fort Leavenworth*, 27 feet from center of Missouri Pacific track, and 8 feet above grade; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 255.—Is in west abutment of Chicago, Rock Island and Pacific bridge at *Fort Leavenworth*, in south side 3·5 feet back from east face; being a copper bolt leaded horizontally into fourth course of masonry above ground at southeast corner. (See note 16, page 552.)

T. B. M. 520.—Is at southeast corner of west abutment of Chicago, Rock Island and Pacific bridge at *Fort Leavenworth*, 12 feet from center of Missouri Pacific track on same level; being highest point in square cut on inclined rock and marked U □ S.

T. B. M. 521=gauge B. M.—Is on southeast corner of west abutment of Chicago, Rock Island and Pacific bridge at *Fort Leavenworth*, on second course of masonry from ground and 26 inches north of south face; being bottom surface of a notch cut in top of stone.

P. B. M 256.—Is in *Fort Leavenworth*, at northeast corner of Government stone ice house on river bank, 7 inches west from east face, and 5·2 feet above ground; being a copper bolt leaded horizontally into building. (See note 16, page 552.)

P. B. M. 257.—Is three-fourths of a mile above *Fort Leavenworth*, 1¼ miles above Chicago, Rock Island and Pacific Railway bridge across Missouri River, 525 feet below wagon road crossing, 505 feet below center of bridge across small creek at lower edge of wagon road, 150 feet below point of bluff, on bluff side of track, 28 feet from center; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 258.=$^{8}\mathrm{T}^{9}$.—Is about 2¼ miles above Chicago, Rock Island and Pacific bridge at *Fort Leavenworth*, 350 feet above lower head block of Wade Siding, on bluff side of track, 2 feet inside of right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 525.—Is 613 feet above lower head block of *Wade* Siding, 2¼ miles above Chicago, Rock Island and Pacific bridge at Fort Leavenworth, 262 feet above P. B. M. 258, on river side of track, 30 feet from center; being highest point in square cut on rock at top of river bank.

P. B. M. 259.—Is 1¾ miles below *Kickapoo*, *Kans.*, 9 feet above upper end of bridge No. 95 over Salt Creek, Missouri Pacific Railway, on bluff side of track, 24 feet from center; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 260.—Is one-fourth mile below *Kickapoo, Kans.*, 885 feet below trestle, 1 035 feet above milepost 316, 85 feet above upper end of small bridge over drain for cut, on bluff side of track, 9·7 feet from center and 2·5 feet above grade; being a copper bolt leaded horizontally into face of natural ledge. (See note 16, page 552.)

T. B. M. 529=Old B. M. 278.—Is 912 feet below west end of trestle at *Kickapoo, Kans.*, on bluff side of track, 7·5 feet from center and 3·5 feet above grade, 10 feet above P. B. M. 260; being horizontal furrow in copper bolt leaded horizontally into northwest exposure of cut rock.

T. B. M. 530.—Is one-fourth mile below *Kickapoo, Kans.*, 880 feet below lower end of trestle, 1 035 feet above milepost 316, 100 feet above small bridge, bluff side of track, 10 feet from center, on level with grade; being highest point in square cut on natural ledge.

P. B. M. 261=$\frac{81}{T}$.—Is at *Kickapoo, Kans.*, on upper side of small ravine, 30 feet from vertical bank of small stream, bluff side of track, 80 feet from center; George Sharp's house bears S. 88° W. (mag.) 130 feet distant; copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 531.—Is at *Kickapoo, Kans.*, opposite upper end of bridge No. 96, Missouri Pacific Railway, bluff side of track, 15 feet from center and 4 feet below grade; being highest point in square cut on natural ledge with letters U S cut on vertical face of ledge just below the bench.

P. B. M. 262.—Is 1⅞ miles below *Oak Mills, Kans.*, 70 feet below center of railroad bridge over small creek coming out of valley, on bluff side of track, 3 feet east from wire fence directly opposite south point of bluff; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 263.—Is in *Oak Mills*, in northwest side of stone building facing the northeast, 65 feet southeast of John Davitz's store, 6 feet above ground and 8 inches from front face of building; being a copper bolt leaded horizontally. (See note 16, page 552.)

P. B. M. 264=$\frac{82}{T}$.—Is at *Oak Mills*, in John Davitz's front yard, 19 feet below his store and 2 feet inside of tight board fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 265.—Is 2⅓ miles above *Oak Mills*, seven-eighths mile above Little Walnut Creek, 180 feet below railroad bridge No. 99, 16 feet toward the river from wagon road running parallel to river, near forks in the road, on bluff side of track, 65 feet from center; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 540.—Is about 3 miles above *Oak Mills*, 413 feet below Joseph Silk's house, 16 feet above whistle post, on bluff side of track, 12 feet from center; being highest point in square cut on embedded rock, and marked U □ S.

P. B. M. 266 = $\frac{83}{T}$.—Is about 5½ miles below *Atchison, Kans.*, 30 feet below lower end of iron bridge across Walnut Creek, on bluff side of track, 68 feet from center and 45 feet north of T. B. M. 541; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 542.—Is 4¼ miles below Union Depot at *Atchison*, 242 feet below milepost 326, 742 feet below south end of railroad bridge No. 103, on bluff side of track, 14 feet from center and 15 feet east of wagon road; being highest point in square cut on embedded rock.

P. B. M. 267.—Is at prominent point 3 miles below Union Depot at *Atchison*, 130 feet below milepost 327, on bluff side track, 59 feet from center, 10 feet above grade, 16 feet toward river from wagon road, and 8 feet southeast of 10-inch crab-apple tree; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 543.—Is about 3 miles below Union Depot at *Atchison*, 985 feet above railroad bridge No. 104 over small creek, 108 feet below milepost 327, on bluff side of track, 15 feet from center; being highest point in square cut on rock, and marked U □ S.

P. B. M. 268 = Old B. M. 287.—Is about 1¾ miles below Union Depot at *Atchison*, 1,900 feet below bridge No. 106 over creek, just below ice house, on west side of track, 35 feet from center; being horizontal furrow in copper bolt leaded horizontally into natural ledge.

P. B. M. 269 = $\frac{84}{1}$.—Is in *Atchison*, on west side of Gillespie street, 710 feet south of its intersection with Park street, at foot of bluff and 35 feet west of bank of White Clay Creek; being top of copper bolt leaded vertically into natural ledge about 4 feet below surface of ground and surmounted by an iron pipe.

T. B. M. 548 = *Atchison* City B. M.—Is on Miller's Hotel, on southeast corner of Third and Commercial streets, on Commercial street side, 15 inches back from Third street side; being highest point in square cut in water table, and marked U □ S.

P. B. M. 270.—Is in *Atchison*, at northwest corner of Fifth and Santa Fe streets; in the southwest corner of tower at south entrance of First Presbyterian Church; being a copper bolt leaded horizontally into second course of stone from ground. (See note 16, page 552.)

T. B. M. 549.—Is in *Atchison*, on northeast corner of Fifth and Santa Fe streets; being highest point in square cut in curbstone, 1 foot east of east building line, and marked U □ S.

T. B. M. 550 = old gauge B. M.—Is in *Atchison*, on northeast corner of west abutment of Atchison bridge; being highest point in square formed on southwest angle of cross, thus ⊡+.

P. B. M. 271.—Is in *Atchison*, in southeast corner of Burlington and Missouri River Railroad freight depot, 41 inches west from corner and 2 inches from south face of water table; being top of copper bolt leaded vertically. (See note 16, page 552.)

P. B. M. 272.—Is in north end of east abutment of *Atchison* bridge across Missouri River, in top course of masonry, northwest corner, 5 inches from either bevel edge of stone; being top of copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 551.—Is in north retaining wall of east abutment of *Atchison* bridge, on second course of masonry from top; being highest point in square, marked U □ S.

P. B. M. 273 = $\frac{84}{2}$.—Is 1½ miles east of *East Atchison*, one-half mile south of Kansas City Railroad track, on section line, 325 feet south of section corner 19, 20, 29, 30, T. 55 N., R. 37 W., and 325 feet south of wagon road; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 274.—Is about 2 miles below *Rushville, Mo.*, three-quarters mile above water tank, one-half mile above Mud Lake, in northwest corner of field owned by Jasper Allison, due south of house occupied by S. H. Fisher, owned by Mrs. Osborne; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 275 = $\frac{85}{3}$.—Is at point of bluff at south side of *Rushville*, one-quarter mile above junction of Chicago, Rock Island and Pacific Railway, 98 feet below road crossing in same road, 20 feet up the side of bluff from large lone elm, on which T. B. M. 558 is located; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 276 = ${}^{8}_{2}{}^{6}$.—Is about 2 miles below *Halls* station, on bluff side of track, where railroad comes to the bluff at the corner of bluff road and road to Halls, in line with Halls road, where it crosses the tracks opposite bridge 186 on Santa Fe Railroad, about 80 feet from T. B. M. 562, 23 feet northwest from a 30-inch elm, 17 feet north from a 20-inch elm, and 16 feet S. 15° E. of a large black walnut; being copper bolt in bench-mark stone at an elevation of about 15 feet above the bottom land. (See note 15, page 551.)

P. B. M. 277.—Is at *Halls* station, about 185 feet above T. B. M. 566, 1 590 feet above the station and 310 feet above the upper head block of Missouri Pacific siding, 98 feet above small bridge and 82 feet above the north end of wing fence, on the north side of track, on right of way in line with telegraph poles; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 278 = ${}^{8}_{2}{}^{7}$.—Is in the northeast corner of sec. 28, T. 56 N., R. 36 W., 2 000 feet northeast of *Kenmoor* station and about 250 feet northeast of house of Warren Samuels, about 240 feet above T. B. M. 569; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 279.—Is 6¾ miles below *St. Joseph, Mo.*, 1¾ miles below Lakes Siding, near T. B. M. 573, in the southwest corner of dooryard owned by A. Roche, at east side of wagon road and about 100 feet east from Chicago, Rock Island and Pacific track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 280 = ${}^{8}_{2}{}^{8}$.—Is on left bank of Missouri River, 4¾ miles below Hannibal and St. Joseph Railroad bridge, about one-half mile east of the railroad, near quarter post on the north side of sec. 12, T. 56 N., R. 36 W., 304 feet southeast of Nelson Hawley's house, in the highway, at east fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 281.—Is in *St. George, Mo.*, on east side of railroad track, in southwest corner of yard to hotel owned by Nick Byrnes, on Missouri avenue, 18 feet west of southwest corner of hotel porch; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 579.—Is in *St. George*, on east side of St. Joseph Stockyards Exchange building, on stone doorstep of south door; being highest point in square cut on south end of step, and marked U □ S.

T. B. M. 580.—Is at the southern part of *St. Joseph, Mo.*, on the southwest corner of Fifth and Cedar streets, on brick building of the Water Gas Company, on the south window sill on Fifth street, 8 inches south of the south side of the window; being the highest point in square, marked U □ S.

P. B. M. 282.—Is in *St. Joseph*, in the north end of the east pier of the Hannibal and St. Joseph Railroad bridge across Missouri River, being the pier at east end of draw, 15 inches north of bed plates and in line with the west row of bolts through plate, 2 feet south from the north edge of pier; being copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 582 = old B. M. 313.—Is same as B. M. 34 (1879), at southwest corner of Fourth street and railroad, on Henry Krugg's packing house, at the northeast corner of foundation, on the west side of arched entrance; being outer end of cross, thus: □+.

T. B. M. 583 = old B. M. 312.—Is on the east pier of Hannibal and St. Joseph bridge at *St. Joseph*, 126 feet south of north edge of coping pier; being highest point in southwest angle of cross marked ⊡.

P. B. M. 283 = $\frac{8\,9}{3}$.—Is in south end of *St. Joseph*, *Mo.*, at northeast corner of Duncan and Bartlett streets, about 1 100 feet east of east end of Hannibal and St. Joseph bridge; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 284.—Is in *St. Joseph*, on west side of Union Depot, in window sill of second window south of south entrance to waiting room, 4½ inches back from vertical face of sill and 7 inches north of south end; being top of copper bolt leaded vertically. (See note 16, page 552.)

T. B. M. 584.—Is in *St. Joseph*, on west side of Union Depot, on north end of stone doorstep of door to barber shop, being first door north of passageway through building; being highest point in square.

P. B. M. 285.—Is in *St. Joseph*, at the southeast corner of Edmond and Eighth streets, on the northeast corner of post office building, 12 feet west from corner, on window sill of window just east of entrance on Edmond street, 8 inches west from east end of sill; being copper bolt leaded vertically. (See note 16, page 552.)

P. B. M. 286.—Is in *St. Joseph*, at southeast corner of Felix and South Second streets, in the northwest corner of city hall, 1 foot east of corner of building on Felix street and 5 feet above sidewalk; being a copper bolt leaded horizontally. (See note 16, page 552.)

T. B. M. 585, City B. M.—Is near P. B. M. 286, on water table at northwest corner of city hall; being highest point in notch.

T. B. M. 586.—Is in *St. Joseph*, at upper end of town, on southwest corner of Francis street, and just east of north end of Kansas City, St. Joseph and Council Bluffs depot; being highest point in square cut on curbstone, and marked U □ S.

P. B. M. 287=89½.—Is at United States boat yard above *St. Joseph*, one-eighth of a mile above Mr. Duprée's house, just behind top of revetment, near the north line of sec. 1, T. 57 N., R. 36 W., about 800 feet east of the northwest corner of the section. It is 16 feet north from the north line of ways and 85 feet west of west end, 196 feet below track of ways; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 288.—Is 2¾ miles above *St. Joseph*, at foot of bluff, 48 feet from center of track, at east right of way fence, and on line with the fence on north side of Upper French Bottom road, 15 feet south of small railroad bridge; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 589.—Is near P. B. M. 288, 100 feet below small railroad bridge at foot of bluff, 70 feet east from track center, 27 feet from east right of way fence, on a small rock lying midway between two large rocks; being highest point in square, marked U □ S.

P. B. M. 289.—Is about 3½ miles above *St. Joseph*, at pump house of waterworks, on west side of pump room, 18 feet north from southwest corner, 10 feet north from door, 35 feet south from tall chimney, on south end of stone window sill, 1½ inches back from west face; being copper bolt leaded vertically. (See note 16, page 552.)

P. B. M. 290=$\frac{1\,0}{8}$.—Is 3¾ miles above *St. Joseph*, 720 feet above pump house of St. Joseph waterworks, at foot of bluff, 70 feet from center of Kansas City, St. Joseph and Council Bluffs track, 20 feet east of east right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ST. JOSEPH, MO., AND SIOUX CITY, IOWA.

P. B. M. 291.—Is about 4¼ miles south from the depot at *Amazonia*, *Andrew County, Mo.*, 1 650 feet northward from bridge 7, section 14, 2 605 feet south of milepost 73, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 292 = $^{9}_{S}{}^{1}$.—Is about 1¾ miles south of the depot at *Amazonia*, 436 feet northeast of the north end of the truss of the railway bridge over Dillon Creek, and 328 feet east, measured along public road from the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 293.—Is 1 270 feet west of the depot at *Amazonia*, 46 feet north from the Kansas City, St. Joseph and Council Bluffs Railway track, and 10 feet west of the west fence of public road; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 294 = $^{9}_{S}{}^{2}$.—Is about 2¼ miles west of *Amazonia*, 492 feet north of the Kansas City, St. Joseph and Council Bluffs Railway track, 156 feet southeast of Lewis Payne's dwelling, and 40 feet south of an 18-inch sugar-maple tree; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 295.—Is about one-third mile west of depot at *Nodaway*, *Andrew County, Mo.*, in top of coping forming the bridge seat of the southwest corner of the Kansas City, St. Joseph and Council Bluffs Railway bridge over Nodaway River, and 0·85 foot east of the bedplate under the inclined end post of the bridge; being top of copper bolt leaded vertically in stone.

P. B. M. 296 = $^{9}_{S}{}^{3}$.—Is about 2¼ miles west of the railway bridge over *Nodaway River*, in Holt County, Mo., on land of Shirley heirs, 361 feet east of milepost 84, 164 feet northwest of bridge 4, section 17, 102 feet north of the Kansas City, St. Joseph and Council Bluffs Railway track, on a small knoll about 10 feet high; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 297.—Is about 1½ miles east of the depot at *Forbes*, *Holt County, Mo.*, 666 feet east of M. Sipes's dwelling, 33 feet north of Kansas City, St. Joseph and Council Bluffs Railway track, and 16 feet south of wagon road; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 298 = $^{9}_{S}{}^{4}$.—Is 1 424 feet west from depot at *Forbes* and 45 feet north of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 299.—Is about 2 miles south of the depot at *Curzons*, *Holt County, Mo.*, 55 feet from center of public road and railroad crossing, 190 feet west from J. B. Payne's house, occupied by B. F. Martin, and 45 feet west of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 300 = $^{9}_{S}{}^{5}$.—Is 2 860 feet south of the east end of the siding at *Curzons*, 435 feet southeast of Mrs. Comis's house, 125 feet north of the Kansas City, St. Joseph and Council Bluffs Railway track, and about 6 feet above the level of the road; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 632.—Is about 2 miles south of *Forest City*, *Holt County, Mo.*, at railroad bridge No. 4, over Mill Creek; being a cross cut on the northwest corner of the south bridge seat.

P. B. M. 301 = ${}^{96}_{2}$.—Is 1½ miles southeast of *Forest City*, 600 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track at foot of bluffs, 50 feet west of W. T. Davies's house; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 302.—Is in *Forest City*, at the southeast corner of Grand avenue and B street, 8 feet from the northwest corner of store building owned by G. W. Quick, in top surface of water table, flush with doorsill; being top of copper bolt leaded vertically in stone.

P. B. M. 303.—Is about 2½ miles north of the depot at *Forest City*, 1 076 feet north of milepost 98, 144 feet north of railway bridge No. 3, over Kinzie Creek, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 304.—Is 627 feet south of the depot at *Napier*, *Holt County*, *Mo.*, 287 feet south of the head block of the Burlington and Missouri River, and the Kansas City, St. Joseph and Council Bluffs Railway junction, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 305.—Is about 2⅓ miles south of *Bigelow*, *Holt County*, *Mo.*, 2 713 feet north of milepost 103, 1 998 feet north of a public road crossing, and 44 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 306.—Is in *Bigelow*, in Peter Nelson's lot, 249 feet northeast of the northeast corner of the railway water tank; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 307.—Is 13 957 feet north of the depot at *Bigelow*, opposite a curve to right in track going south; the tangent toward Bigelow, if prolonged northward, would pass through the bench mark. It is 43 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 308.—Is about 1¾ miles south of the depot at *Craig*, *Holt County*, *Mo.*, in top of the west end of the north pier of the Kansas City, St. Joseph and Council Bluffs Railway bridge over the county ditch, 1·42 feet from the south face of the stone and 1·08 feet east of the bedplate under the inclined end post; being top of copper bolt leaded vertically in stone.

P. B. M. 309.—Is 1 726 feet south of the depot at *Craig*, 153 feet south of a section tool house, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 310.—Is one-fourth mile north of depot at *Craig*, in the pedestal block forming the bridge seat under the southwest inclined end post of the Kansas City, St. Joseph and Council Bluffs Railway bridge over Tarkio Creek, and 0·62 foot from the southeast corner of the stone; being top of copper bolt leaded vertically in stone.

P. B. M. 311.—Is about 2 miles south of the depot at *Corning*, *Holt County*, *Mo.*, 38 feet south of a public road crossing, 74 feet southeast of south cattle guard, 16 feet south of milepost 117, and 45 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 312.—Is in *Corning*, 459 feet north of the depot, in water table under south window in west wall of Danker Brothers' one-story brick building on east side of East street; being top of copper bolt leaded vertically in stone.

P. B. M. 313.—Is about 2½ miles north of depot at *Corning*, 525 feet north of milepost 121 and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 314.—Is at *Nishnabotna*, *Atchison County*, *Mo.*, in the northwest corner of R. E. Christian's orchard, 810 feet south of the depot and 52 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 315.—Is 1½ miles north of depot at *Nishnabotna*, in top of pedestal block forming the bridge seat, under the northeast inclined end post of the Kansas City, St. Joseph and Council Bluffs Railway bridge over Nishnabotna River, 0·66 foot south of the north face of the pedestal, and 0·56 foot from the west face of the stone; being top of a copper bolt leaded vertically in stone, and projecting 0·02 foot above the surface of the stone.

P. B. M. 316.—Is about 2 miles south of depot at *Langdon*, *Atchison County*, *Mo.*, 525 feet north of milepost 127, adjacent to land of Frederick Meyerkorth and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 317.—Is 2 miles south of depot at *Phelps*, *Atchison County*, *Mo.*, 3 120 feet south of a road crossing 2 861 feet north of railway bridge No. 3, section 26, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 318$=\frac{108}{3}$.—Is at *Phelps*, in the northeast corner of the Methodist churchyard and 33 feet from the northeast corner of the church; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 319.—Is 2¼ miles south of the depot at *Watson*, *Atchison County*, *Mo.*, 102 feet south of the south end of a farm gate, 233 feet southwest of a dwelling, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 320$=\frac{101}{2}$.—Is one-half mile west of *Watson*, in the southwest corner of barnyard on the estate of Hay's heirs and 27 feet north of the northeast corner of the SE. ¼ of sec. 4, T. 65 N., R. 42 W.; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 321.—Is 722 feet south of the depot at *Watson*, 39 feet south of a public road crossing and 47 feet east of Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 322.—Is about 2¾ miles north of the depot at *Watson*, about 656 feet north of Joseph Kometzer's house, 92 feet south of a jog in the east right of way fence, and 34 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 323.—Is about 1½ miles south of the depot at *Hamburg*, *Iowa*, in the pedestal block forming the bridge seat at the west end of the south pier of the Kansas City, St. Joseph and Council Bluffs Railway bridge over the Nishnabotna River in Atchison County, Mo., and 0·67 foot south of the south edge of the bedplate under the inclined end post, and 10 feet west of the track center; being copper bolt leaded vertically in stone.

P. B. M. 324.—Is 1 998 feet north of the depot at *Hamburg* and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. $325=\frac{110}{2}$.—Is about 3¾ miles north of *Hamburg*, in the southeast corner of W. H. Frake's dooryard, 46 feet southeast of the southeast corner of Frake's dwelling, and 52 feet southwest of the southwest corner of a schoolhouse, and about 328 feet west of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 326.—Is about 1¼ miles south of depot at *Nebraska City Junction*, *Fremont County*, *Iowa*, 384 feet west of house occupied by Johnson Gibson, 35 feet north of the north end of a farm gate, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 327.—Is 3 884 feet north of the depot at *Nebraska City Junction* and 45 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track, on a sand knoll; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 328.—Is about 3 miles south of depot at *Percival*, *Fremont County*, *Iowa*, 13 feet north of a farm gate, 627 feet north of a road crossing, and 45 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 329.—Is 784 feet north of the center of the depot at *Percival* and 46 feet east of Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. $330=\frac{114}{3}$.—Is about 1⅓ miles southwest of depot at *McPaul*, *Fremont County*, *Iowa*, 656 feet north and 26 feet west of the southeast corner of the SW. ¼ of sec. 5, T. 69 N., R. 42 W., on land of William Woods, and is 3 feet west of a hedge on west side of public road; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 331.—Is 4 941 feet north of *McPaul* depot, 46 feet south of center of a public road, 13 feet south of a fence corner, and 48 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 332.—Is 6 522 feet south of the depot at *Bartlett*, *Fremont County*, *Iowa*, 1 214 feet south of L. M. Gannon's house, 82 feet east of center of public road, and 45 feet west of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 333.—Is in *Mills County*, *Iowa*, 6 486 feet north of the depot at *Bartlett* and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. $334=\frac{118}{3}$.—Is about 2½ miles south of *Haynies* siding, *Mills County*, *Iowa*, on east side of a public road, on land of Bruce Collier, about 984 feet south of Thomas Collier's house, and 1 099 feet west of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 335.—Is at *Haynies* siding, 174 feet northwest of the south head block, 43 feet south of a fence corner of west right of way fence, and 45 feet west of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 336=$^{1}\tfrac{1}{3}{}^{1}$.—Is about 1½ miles southwest of *Pacific Junction*, *Mills County*, *Iowa*, on land owned by Charles Kroon, 32 feet east and 51 feet south of the northwest corner of the NE. ¼ of the NE. ¼ of sec. 32, T. 72 N., R. 42 W.; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 337.—Is 4 455 feet north of the railway crossing at *Pacific Junction*, 1 151 feet south of the railway bridge over the old channel of Keg Creek, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 338.—Is about 2½ miles south of *Hentons* depot, *Mills County*, *Iowa*, on section line between secs. 5 and 8, T. 72 N., R. 43 W., 308 feet east of the quarter-section corner and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; land on the east side belongs to J. Martin; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 339.—It at *Hentons* station, in the northeast corner of James Meisner's dooryard, 3 feet from each fence and 259 feet northeast of the depot; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 340.—Is about 2½ miles north of depot at *Hentons*, 741 feet south of bridge No. 11, section No. 38, 427 feet west of Hans Schroeder's house, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 341.—Is 1 148 feet south of depot at *Island Park*, *Pottawattamie County*, *Iowa*, 164 feet south of a public road crossing, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 342.—Is about 4 miles southeast of the Kansas City, St. Joseph and Council Bluffs depot at *Council Bluffs*, 615 feet south of railway bridge over Mosquito Creek, and 49 feet east of the Kansas City, St. Joseph and Council Bluffs Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 343.—Is at *Council Bluffs*, in the stone doorsill of the Chicago, Milwaukee and St. Paul Railway roundhouse, 0·33 foot from east side of door frame and same from front face of sill, and is 8 feet from the southwest corner of the building; being top of copper bolt leaded vertically in stone.

City B. M., *Omaha*.—Is at the southeast corner of the post office building, at Fifteenth and Dodge streets; being top of small projection on top surface of the third course of stone above the sidewalk.

P. B. M. 344.—Is at *Omaha*, on the upper surface of the water table of the post office building, corner of Fifteenth and Dodge streets, and 5·71 feet east of the southwest corner of the building; being top of a copper bolt leaded vertically in stone.

P. B. M. 345.—Is in *Omaha*, in the top of the pedestal block supporting the first iron post on north side and west of the cylindrical piers at the west end of the Omaha and Council Bluffs wagon bridge; being top of copper bolt leaded vertically in stone.

P. B. M. 346=gauge B. M.—Is at *Omaha*, 59 feet south of the south cylindrical pier next to the river, 137 feet southeast of the south cylindrical pier next to the approach abutment at west end of the Union Pacific Railway bridge over the Missouri River, and 39 feet east of the east switch track of the Burlington and Missouri River Railway; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 804.—Is near *Omaha*, 3 976 feet east of the east portal of the Union Pacific Railway bridge over the Missouri River, midway between the two tracks of the Union Pacific Railway; being a cross cut on top of a stone post.

P. B. M. 347.—Is in the *Council Bluffs* Union Depot, in window sill of the second window west of the northeast corner of the depot, 0·39 foot from the east jamb and 0·33 foot from the face of the sill; being top of a copper bolt leaded vertically in stone.

P. B. M. 348 = $\frac{121}{2}$.—Is in *Council Bluffs*, in the southwest corner of the courthouse yard, 3 feet from the west fence and 3 feet from the south fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 349 = $\frac{122}{2}$.—Is at *Council Bluffs*, 197 feet above the upper end of the ways of the United States boat yard, 112 feet from the river bank, and 3 feet from the northwest corner of the boat-yard storehouse; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 350.—Is about 4 miles above *Council Bluffs*, 62 feet south of the south end of bridge No. 1066, 404 feet north of milepost 4, and 28 feet east of the Chicago and Northwestern Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 351.—Is about 6 miles north of *Council Bluffs* union depot, 630 feet north of the shore end of the upper Government dike, 367 feet north of the south end of bridge No. 1043, and 16 feet west of the Chicago and Northwestern Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 352.—Is at *Crescent*, *Pottawattamie County*, *Iowa*, 183 feet south of the depot, 15 feet east of the Chicago and Northwestern Railway track, and is in a small park belonging to the railway company; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 353.—Is about 1¾ miles south of *Honey Creek* depot, *Pottawattamie County*, *Iowa*, 112 feet north of the north end of railway bridge No. 1007, 1 936 feet south of milepost 12, and 49 feet east of the Chicago and Northwestern Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 354.—Is near *Honey Creek* depot, in the west end of the south bridge seat of the plate-girder bridge No. 998, over Honey Creek, and 4 feet west of the south end of the west girder; being top of a copper bolt leaded vertically.

P. B. M. 355.—Is 2 miles north of *Honey Creek* depot, 2 730 feet south of milepost 16 and 46 feet east of the Chicago and Northwestern Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 356.—Is at *Loveland*, *Pottawattamie County*, *Iowa*, on the southwest corner of the Chicago and Northwestern Railway bridge No. 979, over Boyer Creek, 0·33 foot east of the bedplate under the inclined end post, and 2·5 feet from the north edge of the abutment; being top of a copper bolt leaded vertically in stone of abutment.

P. B. M. 357.—Is about 2¼ miles south of *Missouri Valley*, *Harrison County*, *Iowa*, 300 feet south of the south end of railway bridge No. 978, 90 feet south of milepost 20, and 46 feet east of the Chicago and Northwestern Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 358.—Is in *Missouri Valley*, at the northwest corner of Second and Erie streets; being center of copper bolt leaded horizontally into the southeast corner of Kreder's billiard hall. It is 7½ inches west of the east face of the building and 1·23 feet above the sidewalk.

P. B. M. 359.—Is about 3 miles west of *Missouri Valley*, 335 feet east of the east end of railway bridge No. 4, 886 feet west of milepost 3, and 47 feet north of Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 360 = $\frac{121}{3}$.—Is 758 feet east of the depot at *California Junction*, *Harrison County*, *Iowa*, in the northwest corner of A. W. Smith's orchard, 3 feet from each fence, and 56 feet south of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 361.—Is about 1¾ miles north of *California Junction* depot, 70 feet south of a public road crossing, and 44 feet east of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 362.—Is three-fourths of a mile south of *Modale*, *Harrison County*, *Iowa*, 195 feet north of railway bridge No. 10, and 46 feet east of Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 363.—Is about 1 mile north of *Modale*, 2 320 feet north of milepost 11, 60 feet south of highway crossing, and 46 feet east of Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 364.—Is 2 miles south of *Mondamin*, *Harrison County*, *Iowa*, 7 feet west of the west right of way fence, and 54 feet west of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 365.—Is in *Mondamin*, 246 feet east of the Sioux City and Pacific Railway track; being center of copper bolt leaded horizontally in center of a sandstone block in southwest corner of brick building occupied by D. Ganet & Co., and 0·71 foot from the west wall of building.

P. B. M. 366.—Is 2 238 feet north of *Mondamin* depot, 889 feet south of public road crossing, 33 feet south of milepost 17, and 46 feet east of Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 367 = $\frac{130}{2}$.—Is about 2¼ miles north of *Mondamin*, 246 feet north of public road crossing, 299 feet north of dwelling of Joseph Krummel, and 105 feet east of Sioux City and Pacific Railway track, and is in corner of field; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 368.—Is about 2½ miles south of *River Sioux* depot, *Harrison County*, *Iowa*, 3 553 feet north of milepost 20, and 51 feet east of Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 369 = $\frac{131}{3}$.—Is 1 260 feet south of *River Sioux* depot, 541 feet south of milepost 23, and 45 feet east of Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 370.—Is about 2¼ miles north of *River Sioux* depot, 1 634 feet north of milepost 25, and 47 feet east of Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 371.—Is about 4½ miles south of *Blencoe*, *Monona County*, *Iowa*, 165 feet south and 92 feet east of P. B. M. 372, 1 345 feet south of milepost 28, and 46 feet east of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 372 = $\frac{132}{4}$.—Is about 4½ miles south of *Blencoe*, 1 148 feet south of milepost 28, and 46 feet west of Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 373.—Is about 1¾ miles south of *Blencoe*, 1 483 feet north of milepost 30, 1 305 feet south of railway bridge No. 25, and 46 feet east of the Sioux City and Pacific Railway track: being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 374 = $\frac{133}{4}$.—Is 623 feet north of the depot at *Blencoe*, 525 feet west of the Sioux City and Pacific Railway track, 25 feet north and 58 feet east of the northeast corner of Isaac Fleener's house; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 375.—Is about 4 miles south of *Onawa* depot, *Monona County, Iowa*, 44 feet east of Sioux City and Pacific Railway track, on line with south side of E. S. Cody's farmhouse, and 259 feet east of same; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 376.—Is about 2¼ miles south of *Onawa*, 1 585 feet south of milepost 37, 1 056 feet south of east and west road crossing, and 45 feet east of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 377.—Is at *Onawa*, at the Iowa avenue entrance of the courthouse, 1·12 feet from the face of sill, and 0·43 foot from the west jamb; being top of copper bolt leaded vertically in west end of stone doorsill.

P. B. M. 378 = $\frac{134}{5}$.—Is in *Onawa*, in the northwest corner of the German Lutheran churchyard, corner of Granite and Maple streets, 3 feet from the alley fence, and 3 feet from the southwest corner of a stable; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 379.—Is about 2¼ miles north of *Onawa* depot, 810 feet north of milepost 41, 180 feet north of the north end of railway bridge No. 40, and 44 feet east of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 380.—Is about 2¾ miles south of *Whiting* depot, *Monona County, Iowa*, 958 feet south of milepost 44, 46 feet east of the Sioux City and Pacific Railway track, 3 feet from east right of way fence, and 6 feet south of the south fence of road crossing; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 381.—Is 1 050 feet south of *Whiting* depot, 66 feet south of the south head block at Whiting, and 46 feet east of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 382.—Is about 2½ miles north of *Whiting* depot, 282 feet south of milepost 49, 46 feet east of the Sioux City and Pacific Railway track, and opposite Daley's dwelling; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 383 = $\frac{138}{5}$.—Is about 3 miles south of *Sloan* depot, in *Monona County, Iowa*, 1 345 feet south of milepost 52, and 47 feet west of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 384.—Is 1 335 feet south of *Sloan* depot, 47 feet west of the Sioux City and Pacific Railway track, and 3 feet south of the south side of an east and west public road; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 385.—Is on the corner of Fourth and Evans streets, *Sloan*; being cross cut on the northeast corner of stone doorsill of the State Bank.

P. B. M. 386 = $\frac{139}{5}$.—Is 5 256 feet north of *Sloan* depot, 879 feet south of milepost 56, and 49 feet west of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 387.—Is about 2½ miles south of *Salix* depot, *Woodbury County*, *Iowa*, 240 feet south of a farm crossing, and 46 feet east of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 388.—Is 1 270 feet south of *Salix* depot, 144 feet north of south head block at Salix siding, and 46 feet east of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. This bench mark was formerly B. M. $\frac{140}{3}$. It had been established in a low, swampy place, and also had been disturbed. It was taken up and reestablished as described above. (See note 15, page 551.)

P. B. M. 389.—Is about 2¾ miles north of *Salix* depot, 623 feet north of a road crossing, 361 feet north of C. W. Wheeler's house, 47 feet east of the Sioux City and Pacific Railway track, and is on the south side of the old river bed; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 390.—Is about 2¾ miles south of *Sargents Bluff* depot, *Woodbury County*, *Iowa*, 1 900 feet south of milepost 66, 656 feet north of a road crossing, 1 352 feet north of Louis Godferson's house, and 46 feet east of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 391 = $\frac{142}{3}$.—Is in *Sargents Bluff*, in lot 1, block 2, 10 feet from the southwest corner of E. T. Berry's house, and 52 feet from the northwest corner of Tenth and Walnut streets; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 392.—Is about 3 miles north of *Sargents Bluff*, 47 feet east of the Sioux City and Pacific Railway track, 1 476 feet south of a road crossing, and about 2 feet west of east right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 393.—Is in *Sioux City*, 558 feet south of the Missouri River bridge, 148 feet north of railway bridge No. 60, and is 20 feet east of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 394.—Is in *Sioux City*, in the northwest corner of the east pier of the Missouri River bridge, 2 feet above the ground; being center of copper bolt leaded horizontally into the seventeenth course of masonry below the coping course.

P. B. M. 395; gauge B. M.—Is in *Sioux City*, 103 feet west of the west side of the eastern or shore pier of the Missouri River bridge, and almost vertically under the north truss of the east span, and is 69 feet west of the Sioux City and Pacific Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 396 = $\frac{143}{3}$.—Is in *Sioux City*, in the southwest corner of the courthouse yard, 72 feet from the southwest corner of the courthouse, and 135 feet from the southeast corner of the same; being copper bolt in bench-mark stone. (See note 15, page 551.)

T. B. M. 996.—Is in *Sioux City*, about 39 feet north of the northeast corner of Fifth and Pierce streets; being top of ring bolt set vertically in sidewalk stone.

P. B. M. 397.—Is about 3½ miles above *Sioux City* and about one-fourth mile north of the electric railway power house at Riverside Park, and 121 feet north of north head block, and is at foot of bluff, 52 feet east of the Chicago, Milwaukee and St. Paul Railway track; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 398.—Is about 6 miles above *Sioux City*, 515 feet south of the south end of the railway bridge over Big Sioux River, and 3 feet east of the west right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

P. B. M. 399.—Is about 6 miles above *Sioux City* on land of Mrs. Rose Pacquette, 50 feet west of Chicago, Milwaukee and St. Paul Railway track, 190 feet south of the south end of the railway bridge over the Big Sioux River, and about 5 feet west of the right of way fence; being copper bolt in bench-mark stone. (See note 15, page 551.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN GIBRALTAR AND LAKEPORT, MICH., 1877.

U. S. B. M. Fort Gratiot 1877.—Center of small hole in head of copper bolt set in upper course of masonry in south foundation wall of brick dwelling attached to light-house at *Fort Gratiot, Mich.* It is 0·65 metre from the southeast corner and 0·18 metre below the water table.

B. M. 2 (1875).—A cross cut in the stone on the east side of the engine house of the gristmill at *Lakeport, Mich.*, and at the southeast corner.

B. M. 3 (1875).—The highest point of the top stone of the foundation of the milk house of Mr. Cole, Second street, at the southeast corner of the building, in *Lakeport, Mich.*

Gibraltar 1877.—*Gibraltar, Mich.* (See page 653.)

B. M. 2 (1875).—*Gibraltar, Mich.* (See page 653.)

U. S. B. M. Trenton 1877.—Is in *Trenton, Mich.*, on the southeast corner of Washington avenue and St. Joseph street, in the northwest corner of Commercial Hotel, in west face, second stone from corner, and in first course below water table; being center of small hole in copper bolt leaded horizontally.

U. S. B. M. Wyandotte 1877.—Is in *Wyandotte, Mich.*, 2 700 feet west of Biddle avenue, on south side of Oak street, in Union School building, on north side of foundation, in third course of masonry below the water table, inclosed by fire-escape wire screen; being center of small hole in head of copper bolt leaded horizontally, and marked

U S
P B M

U. S. B. M. Detroit Junction 1877.—Center of small hole in head of copper bolt leaded into capstone of foundation wall of planing mill and machine shop of the Michigan Central Railroad at *Detroit Junction, Mich.*, about 3 metres from southeast corner on east side of shop.

U. S. B. M. Detroit 1871.—A cross cut on the new light-house depot at *Detroit, Mich.*, 8·2 feet below the outer edge of the water table in the southern projection of the southeast door, on the cut-stone foundation.

U. S. B. M. New Haven 1877.—Center of small hole in head of copper bolt set horizontally in water table on north side of station house of Grand Trunk Railroad at *New Haven, Mich.*, 0·88 metre from northwest corner.

U. S. B. M. Pine River 1877.—Top of copper bolt set vertically in center of upper surface of capstone at south end of west abutment of Grand Trunk Railroad bridge over *Pine River, Mich.*

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN GIBRALTAR AND FORT GRATIOT, MICH., 1898–99.

U. S. B. M. Gibraltar 1877.—*Gibraltar, Mich.* (See page 653.)

B. M. 2 of 1875.—*Gibraltar, Mich.* (See page 653.)

U. S. P. B. M. 1.—*Gibraltar, Mich.* (See page 653.)

U. S. B. M. Trenton 1877.—*Trenton, Mich.* (See page 842.)

P. B. M. 2.—Is in *Trenton, Mich.*, on the northwest corner of St. Joseph street and Washington avenue, in stone base of store building belonging to Joseph Anderson, 5 feet 4 inches north of north side of door and 4¾ inches south of north pillar and 4 inches back from face; being top of brass bolt leaded vertically and marked U. S. P. B. M.

P. B. M. 3.—Is 2 525 feet above Sibley's stone quarry (crushing plant), on the north side of Mud street and 354 feet west of center of south road, in foundation of F. B. Sibley's residence, in first course below baseboard and 1·5 feet above ground, 18·9 feet south of the northeast corner; being center of punch mark in brass bolt leaded horizontally, and marked

U S
□
P B M

P. B. M. 4.—Is in *Wyandotte, Mich.*, on west side of Biddle avenue, 171 feet south of south side of Oak street, in south pedestal stone of south pillar of brick store used as meat market, owned by J. P. Debo. It is 8½ inches east of face of building and 4½ inches north of north face of pillar; being top of brass bolt leaded vertically, and marked

U S
P B M

U. S. B. M. Wyandotte 1877.—*Wyandotte, Mich.* (See page 842.)

P. B. M. 5.—Is in *Ecorse, Mich.*, on the east side of River Road, at the foot of Labadie street, on Mr. W. D. Smith's residence, in the east face of foundation, 10½ inches from the southeast corner, in the seventh course of brick below the baseboard; being center mark of brass bolt leaded horizontally.

P. B. M. 7.—Is in *Delray, Mich.*, at the northeast corner of River and Louis streets, on the west side of first entrance east from Louis street, on the southwest corner of pedestal stone of west pillar of doorway; being the corner of stone marked by two lines cut at right angles with each other and forming a square.

P. B. M. 8.—Is in *Detroit, Mich.*, at Fort Wayne, in the southwest quarter of the grounds, on the river front of building No. 60, Officers' quarters, in the center of water-table course, 20 inches east from vertical center line of front of building and 3 feet 5 inches above ground; being center of brass bolt leaded horizontally, and marked

U S
P B M

P. B. M. 9.—Is in *Detroit, Mich.*, on the south side of Atwater street, east, one block and a half east of Woodward avenue, on the office building of the city electric lighting plant, on the west end of door stone of front entrance, 5 inches east of west face and 4 inches north of south face; being top of brass bolt leaded vertically and marked the same as P. B. M. 8.

P. B. M. 10.—Is in *Detroit*, *Mich.*, at the northeast corner of Wight street and Mount Elliott, on the north end of the doorstep of west entrance to Ireland & Matthews Manufacturing Company, 5 inches from north end of step, and 3¾ inches from front edge of stone; being top of brass bolt leaded vertically, marked the same as P. B. M. 8.

P. B. M. 11.—Is at *Detroit* Waterworks, on stand-pipe tower, on side facing the river, on southwest end of door stone of entrance to tower, 5 inches northeast from vertical face and 4 inches from edge of stone; being top of brass bolt leaded vertically and marked the same as P. B. M. 8.

P. B. M. 12.—Is at *Windmill Point* light-house station, on the southwest corner of keeper's house, 2 feet 5 inches east from sloping corner, in third course of masonry below water table, and 3½ feet above ground; being center mark in brass bolt leaded horizontally and marked the same as P. B. M. 8.

Old B. M. W.—Is at *Windmill Point*, in foundation of light-house tower, in its north by east face, in fifth course of the masonry below the cut-stone water table; being a horizontal groove cut in stone slab 2½ by 1⅝ inches, on face set in flush with masonry.

P. B. M. 13.—Is at *Grosse Pointe*, Cottage Grove post office, on the southwest corner of Charles Seitz's house, 7½ feet west of corner and 4½ inches below west end of stone window sill and 2 feet 2½ inches above stone work of foundation, in second course of brickwork below window sill; being center of brass bolt leaded horizontally.

P. B. M. 41.—Is center punch mark on ¼-inch brass bolt cemented horizontally in hole drilled in sandstone water table on the west side of brick residence of J. Reimold, 1 mile east of *Mount Clemens*, *Mich.*, on south bank of Clinton River, 0·9 metre above surface of ground 0·7 metre north of bay window. Set June 26, 1899.

P. B. M. 40.—Is center punch mark on ¼-inch brass bolt cemented horizontally in hole drilled in sandstone of foundation at northwest corner of Detroit, Lake Shore and Mount Clemens Railway power house, 200 metres west of McSweeney's club house, 5 metres above ground, 32 metres south of northwest corner. Mark on stone is $\genfrac{}{}{0pt}{}{40}{\text{U S}}$. Set June 22, 1899.

P. B. M. 39.—Is center punch mark on ¼-inch brass bolt cemented horizontally in hole drilled in foundation stone of tower of Catholic church, situated at station *L'Anse Creuse*, *Mich.*, on the Detroit, Lake Shore and Mount Clemens Railway, on north buttress, 0·2 metre from corner, 0·3 metre above ground, 4¾ miles southwest from McSweeney's club house. Set June 19, 1899.

P. B. M. 38.—Is top of knob on southeast corner of stone monument of Lake St. Clair Harbor Line, marked Harbor Line Reference point c, situated on the prolongation of south line of east and west road and on east side of north and south road, at *Milk River Point*. Established June 19, 1899.

P. B. M. 37.—Is top of knob on top and near northwest side of large bowlder (1½ by 1¾ by ¾ metres) situated in front of residence of Victor Vemier, 33 metres, S. 40° W. from the southwest corner of Lake Side House, 3¾ miles north from the Country Club House, and 1½ miles south from *Milk River Point*, on Lake Shore road. Set June 14, 1899.

P. B. M. 36.—Is center punch mark on ¼-inch brass bolt cemented horizontally in hole drilled in limestone of foundation at southeast corner of Catholic Academy of the Sacred Heart, at the village of *Grosse Pointe Farms*, on the face of the building, 0·5 metre north of southeast corner, and 0·2 metre above ground, three-fourths mile northeast from Country Club House, on Lake Shore wagon road. Set June 12, 1899.

P. B. M. 35.—Is center punch mark on ¼-inch brass bolt cemented horizontally in hole drilled in sandstone water table of Catholic church at village of *Grosse Pointe Farms*, on north side of buttress at northeast corner of church, 1·2 metres above ground, 0·7 metre west of corner, three-fourths mile from Country Club house, on Lake Shore wagon road. Set June 12, 1899.

P. B. M. 34.—Is in southwest end of *New Baltimore*, *Mich.*, on the Lake front, on the northwest side of Main street, in the front face of foundation of house owned by heirs of Edward Rose, 7 inches west of cellar window and 5 inches below water table; being center mark of brass bolt leaded horizontally, and marked

U S
P B M

P. B. M. 33.—Is in *New Baltimore*, *Mich.*, at the southwest corner of Main and Washington streets, on the corner building owned by William Baker, north side, in the window base of west window, 9 inches east of west end of stone and 4 inches from its front edge; being top of brass bolt leaded vertically, and marked

U S
P B M

P. B. M. 32.—Is in *New Baltimore*, *Mich.*, about 1 900 feet above Washington street, on east side of Main street, at the northwest corner of Henry C. Schnoor's residence, in water table, 6 inches east of its west end; being center mark of brass bolt leaded horizontally, and marked

U S
P B M

P. B. M. 31.—Is 1 mile west of *Fair Haven*, *Mich.*, and about a half mile east of Swan Creek, at the southwest corner of Mrs. C. Rose's house, south face, in the foundation, fourth course above ground, second course below water table; being center mark of brass bolt leaded horizontally, and marked

U S
P B M

P. B. M. 30.—Is in *Fair Haven*, *Mich.*, on Lake front, at Henry C. Schnoor's stave mill, in the south face of brick chimney near the boiler-room door, in the tenth brick east from west face and in the twenty-second course of brick above the ground; being center mark of brass bolt leaded horizontally.

P. B. M. 29.—Is in *Algonac*, *Mich.*, in foundation of public school, at the northeast corner of east wing, in north face of corner stone; being center mark of brass bolt leaded horizontally, and marked

U S
P B M

P. B. M. 28.—Is in *Algonac, Mich.*, in the foundation of the town hall, on its east face, sixth brick south from the northeast corner and in the eighth course of brick above stone foundation; being center mark of brass bolt leaded horizontally.

P. B. M. 27.—Is a half mile north of *Roberts Landing*, on the river front, on the house owned by D. B. Shier and A. S. Freeman, on the north face in the corner brick at the northwest corner of kitchen, in the sixteenth course above ground; being center mark in brass bolt leaded horizontally.

P. B. M. 26.—Is in *Marine City, Mich.*, on the southeast corner of Water and Union streets, in the Marine City Stave Company's store, near northwest corner, on stone base under window, 8 inches south of north end, and 2½ inches from front edge; being top of brass bolt leaded horizontally, and marked

U S
P B M

P. B. M. 25.—Is in *Marine City, Mich.*, at northwest corner of Main and Broad streets, on the city hall, near its southeast corner, at the window entrance to corridor, 2 feet 5 inches above the ground, 5 inches south of the north jamb; being the top of a brass bolt leaded vertically, and marked

U S
P B M

P. B. M. 24.—Is in upper part of *Marine City, Mich.*, at city waterworks building, on west face, 5 inches north from the southwest corner and 2½ feet above ground; being center mark of brass bolt leaded horizontally.

P. B. M. 23.—Is in *East China, Mich.*, a half mile above Ricord's dock, on river front, in foundation of Rankin's house, south side, between kitchen and cellar doors, 26 inches east of east kitchen door jamb, 7¾ inches below weatherboard and 18 inches above ground; being center mark of brass bolt leaded horizontally, and marked

U S
P B M

P. B. M. 22.—Is in *St. Clair, Mich.*, lower part of town, on river front, at John Schlinkert's coal yard, in brick wall of old storehouse, 7¼ inches north from the southeast corner and 4.1 feet above ground, and in the 21st course of brick below woodwork of gable; being center mark in brass bolt leaded horizontally.

P. B. M. 21.—Is in *St. Clair, Mich.*, at the city waterworks, 5 feet 7½ inches south of south end of doorstone at main entrance, in water table; being top of brass bolt leaded vertically, and marked

U S
P B M

P. B. M. 20.—Is in *St. Clair, Mich.*, on top of north hill, on west side of Front street, in foundation of Mr. Mark Hopkins's residence, in the east face, in second stone south of the northeast corner, top course of masonry; being center mark in brass bolt leaded horizontally, marked

U S
P B M

P. B. M. 19.—Is in *Marysville, Mich.*, diagonally opposite Marysville Hotel, in foundation of N. B. Mills's store, in second brick east from west corner, and in seventh course above stone foundation; being center mark in brass bolt leaded horizontally.

P. B. M. 18.—Is in *Marysville, Mich.*, at the upper mill (Sanburn sawmill) on chimney bearing stone marked 1871, in west end of south face in corner brick, seventeenth course above the stone foundation; being center mark in brass bolt leaded horizontally.

P. B. M. 17.—Is about 2 miles below Black River, *Port Huron, Mich.*, on river at Alverson & Dunford's dry dock, in south face of the boiler house of pumping station, in top course of stone foundation, 10 inches west from west face of coal door, and 6 inches below top of stone; being center mark of brass bolt, leaded horizontally, and marked

U S
P B M

P. B. M. 16.—Is in *Port Huron, Mich.*, 290 feet south of Black River, on west side of Military street, on the Opera House block, at center post of front entrance, on the extreme southeast corner of iron plate, being surfaced inside of square 1 inch on a side.

P. B. M. 15.—Is in *Port Huron, Mich.*, on courthouse, on the stone doorstep of the northeast basement door, 4½ inches south of south jamb, and 3¼ inches from front edge; being top of brass bolt leaded vertically, and marked

U S
P B M

P. B. M. 14.—Is in *Port Huron, Mich.*, at city waterworks, at the south end of coal shed, 66 feet south of south face of main building, on coping stone of the south retaining wall, 6 inches from its south face and 6 inches from its east end, at which point wall of south end of coal shed rises vertically 3 feet to upper coping; being top of brass bolt leaded vertically, and marked

U S
P B M

U. S. B. M. Fort Gratiot 1877.—*Fort Gratiot* light-house, *Mich.* (See page 842.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN PORT COLBORNE AND PORT DALHOUSIE, ONTARIO.

B. M. Custom house.—Top of point of iron bolt set in masonry of stone foundation of custom house, west side, southwest corner, at *Port Colborne, Ontario.*

B. M. Baptist Church.—Top of point of iron bolt in east end of window sill in basement of steeple, south side of Baptist Church, *Port Colborne, Ontario.*

B. M. Church of England.—Top of point of iron bolt in stone foundation, lower tier of stones in south side of Church of England (street front, east side of entrance), at *Port Colborne, Ontario.*

B. M. A.—Top of stone post buried under sidewalk, corner of Canal and Lock streets, 10½ feet from southeast corner of Wood House, on perpendicular to east side of Wood House toward canal, about 110 feet west of heel post of west gate of north end of canal lock, at *Port Dalhousie, Ontario.*

B. M. B.—Edge of cut in top course of masonry in north recess in east wall of canal, 20 feet north of northeast gate of lock, at *Port Dalhousie*, *Ontario*.

B. M. C.—Cross cut into stone of foundation of customs collector's office, at *Port Dalhousie*, *Ontario*, third course of stones from top, north side, 1·4 feet from northwest corner.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN GREENBUSH AND OSWEGO, N. Y.

B. M. Gristmill.—A cross cut on the northwest side of the northeast corner of stone foundation of steam gristmill at *Greenbush*, *N. Y.*

B. M. (1875).—Upper side of head of copper bolt leaded into springing stone of north arch of culvert of Boston and Albany Railroad, a few rods south of bridge over Second avenue, *Greenbush*, *N. Y.* The bench mark is on north side of culvert and west side of railroad.

B. M. 1 (1875).—Point on top of east shoulder of northeast end of southeast pier of upper railroad bridge across Hudson River at *East Albany*, *N. Y.*, marked B. M.

Miter sill.—Miter sill of southwest or lower lock of Lock No. 1 of Erie Canal at *Albany*, *N. Y.*

B. M. 2 (1875).—Top of stone at center of cross cut into top of masonry at southwest corner of east wall of west lock (Lock No. 1) at *Albany*, *N. Y.*, marked B. M. U. S.

B. M. 3 (1875).—Top of coping at southeast end of northwest wall of northwest lock (*Lock No. 2*, *Erie Canal*). It is 16 feet southeast from heelpost of gate and 1 foot from west face of wall, marked B. M. U. S.

B. M. 5 (1875).—Cross cut in second stone from south corner of fourth tier of stones of west abutment of horse-car bridge across canal at *West Troy*, *N. Y.*

B. M. 5a (1875).—Cross cut into east face of third stone step on north wing of west abutment of horse-car bridge across canal at *West Troy*, *N. Y.*, marked B. M.

B. M. 6 (1875).—Cross cut in top of northwest end of east foot iron on southeast end of southwest wall of southwest lock of *Lock No. 4*, *Erie Canal*.

B. M. 6a (1875).—Southwest corner of heel of wall separating the two locks of *Lock No. 4*, *Erie Canal* (southeast corner of northeast wall of southwest lock), marked by three converging lines cut in stone.

B. M. 7 (1875).—Cross cut in top of middle foot iron at south end of west wall of west lock of *Lock No. 6*, *Erie Canal*.

B. M. 7a (1875).—Top of screw bolt fastening down iron collar of south gate of west lock of *Lock No. 6*, *Erie Canal*.

B. M. 8 (1875).—Cross cut on top of second foot iron (clamp) on east wall (south end) of west *Lock No. 15*, *Erie Canal*.

B. M. 8a (1875).—Top of point of coping southwest corner of east wall of west Lock No. 15, at *Cohoes*, *N. Y.*

B. M. 9 (1875).—Cross cut on southwest face of south wing of east abutment of bridge across canal, near *Cohoes*, *N. Y.* Cross is on third course of stones close to the corner, 3 feet above ground.

B. M. 9a (1875).—Highest point of corner of stone, southeast face, southeast corner of same wing wall. Stone marked B. M. It is near *Cohoes*, *N. Y.*

B. M. 10 (1875).—Top of projecting point of stone in third course of masonry, on northeast face, 1 foot from east corner of east wing wall of southeast abutment of canal bridge, near *Cohoes*, *N. Y.*, marked B. M.

B. M. 10a (1875).—Top of projecting point of stone in second course of masonry in southeast abutment of canal bridge, near *Cohoes*, *N. Y.*, marked B. M.

B. M. 11 (1875).—Top of projecting stone in second course of masonry in southeast abutment of canal bridge, near *Cohoes*, *N. Y.*, marked B. M.

B. M. 11a (1875).—Top of projection of stone in bottom course of masonry in east wing of wall of southeast abutment of same bridge, about 3 feet from corner of abutment, marked B. M.

B. M. 12 (1875).—Top of projection of stone on second course of masonry at east corner of south abutment of second canal bridge below Lock No. 19, 6½ miles east of *Rexford*, *N. Y.*

B. M. 12a (1875).—Top of projection of stone on second course of stones at east corner of east wing wall of south abutment of same bridge.

B. M. 13 (1875).—On top of corner of stone in second course of stones on southeast wing wall of southwest abutment of first bridge across canal at *Vischers Ferry*, *N. Y.*

B. M. 13a (1875).—Cross on southeast corner of same abutment of same bridge.

B. M. 14 (1875).—Coping stone on south corner of east wall of west Lock No. 20, 2½ miles east of *Rexford*, *N. Y.*

B. M. 14a (1875).—Top of screw bolt fastening down collar of southwest gate of west Lock No. 20, 3½ miles east of *Rexford*, *N. Y.* Top of bolt with cross.

B. M. 15 (1875).—On coping 1·5 feet from south corner of west abutment of Rexford feeder bridge, 4 miles east of *Schenectady*, *N. Y.*

B. M. 15a (1875).—On east corner of coping of north wall of south *Lock No. 21*, *Erie Canal.* Top of stone steps.

B. M. 16 (1875).—On northwest abutment of New York Central Railroad bridge across canal at *Schenectady*, *N. Y.* Top of corner stone in third course of stones on the northeast corner.

B. M. 16a (1875).—On same abutment, top of corner stone in third course of stones on southwest corner.

B. M. 18 (1875).—Top of projection of stone (fourth stone from northwest corner) in second course of stones in face of northeast abutment of canal bridge, near *Schenectady*, *N. Y.*, marked B. M.

B. M. 18a (1875).—Top of stone projection in second course of stones in face of southeast wing wall of northeast abutment of same bridge, marked B. M.

B. M. 19 (1875).—Top of projection of stone in third course of stones in southeast wing wall of east abutment of canal bridge next below *Lock No. 25*, *Erie Canal*, marked B. M.

B. M. 19a (1875).—Top of projection of middle stone of bottom course of masonry in face of east abutment of same bridge, marked B. M.

B. M. 20 (1875).—Top of coping on corner of east wing wall of north abutment of canal bridge at *Pattersonville*, *N. Y.*, marked B. M.

B. M. 20a (1875).—Top of coping, corner of west wing wall of north abutment of same canal bridge, marked B. M.

B. M. 21 (1875).—On east corner of south wall of north *Lock No. 26*, *Erie Canal*, marked B. M.

B. M. 21a (1875).—On east corner of north wall of south *Lock No. 26*, *Erie Canal*, marked B. M.

B. M. 23 (1875).—On top stone of east wall of waste gate, near *Lock No. 27*, *Erie Canal*, marked B. M.

B. M. 23a (1875).—On top stone at northwest corner of west wall of waste gate, marked B. M.

B. M. 24 (1875).—Point on east end of north wall of north *Lock No. 28*, *Erie Canal*, marked B. M.

B. M. 24a (1875).—Top of iron bolt in top of coping on east wall of space between the two locks. Head of bolt marked with cross.

B. M. 25 (1875).—Cross on corner stone, fifth course of stones, northeast corner of northwest abutment of first bridge above *Schoharie Creek* aqueduct, marked B. M.

B. M. 25a (1875).—Cross on southwest corner, fifth course of stones of same abutment, marked B. M.

B. M. 26 (1875).—Top of projection of stone in fourth course of stones in east wing of northeast abutment of bridge in *Fultonville, N. Y.*

B. M. 26a (1875).—Top of projection of stone in bottom course, third stone from west corner of the same abutment. Face of abutment.

B. M. 28 (1875).—On top of corner of corner stone, third course of stones, east wing of north abutment of bridge.

B. M. 28a (1875).—On top of projection of stone, second course of stones, face of north abutment of same bridge.

B. M. 29 (1875).—On top of iron bolt, west wing of north abutment of second bridge above Lock No. 31, at *Sprakers Basin*.

B. M. 29a (1875).—Top of projection of stone in face of north abutment of same bridge. Third stone from east corner in second course of stones.

B. M. 30 (1875).—On projection of stone in second course of stones northwest corner of northeast abutment of bridge.

B. M. 30a (1875).—On top of projection of stone on southeast corner of same abutment, second course of stones.

B. M. 31 (1875).—Cross cut on corner stone at east corner, second course of stones from top, on south face of stone foundation of old barn near upper footbridge across canal at *Canajoharie, N. Y.*

B. M. 31a (1875).—Cross cut on corner stone, second course of stones, west corner of same face of same barn.

B. M. 32 (1875).—On corner of coping of southeast wing wall of northeast abutment of bridge.

B. M. 34 (1875).—Top of projection of stone in second course of stones, east wing, north abutment of first bridge above *Lock No. 33*, *Erie Canal*.

B. M. 34a (1875).—On top of projection of stone in second course of stones, west wing of same abutment of same bridge.

B. M. 35 (1875).—On top of projecting point of stone in second course of stones on southeast wing of northeast abutment of bridge.

B. M. 35a (1875).—On top of projecting point of stone in second course of stones on northwest wing of abutment of same bridge.

B. M. 36 (1875).—On top of projection of stone, third course of stones, northwest wing of northeast abutment of bridge, about half a mile above *Lock No. 35*, *Erie Canal.*

B. M. 36a (1875).—On top of projection of stone, third course of stones, face of abutment of same bridge.

B. M. 37 (1875).—Top of iron bolt in coping of southeast end of northeast wall of northeast *Lock No. 36*, *Erie Canal.* Bolt marked with cross in top.

B. M. 37a (1875).—Top of corner at southeast end of southwest wall of northeast *Lock No. 36*, *Erie Canal.*

B. M. 38 (1875).—Top of coping at corner of east wing of north abutment of bridge.

B. M. 38a (1875).—On top of coping at corner of west wing wall of north abutment of same bridge.

B. M. 39 (1875).—On top of corner of east wing of north abutment of first bridge above *Lock No. 41*, *Erie Canal.*

B. M. 39a (1875).—On top of corner of west wing of north abutment of same bridge.

B. M. 40 (1875).—On top of corner of southeast wing of northeast abutment of bridge next above *Lock No. 43*, *Erie Canal.*

B. M. 40a (1875).—On top of corner of northwest wing of same abutment.

B. M. 41 (1875).—On top of projection of stone in bottom course of stones on southeast corner of northeast abutment of bridge next below Lock No. 45, in *Frankfort, N. Y.*

B. M. 41a (1875).—Cross cut in corner stone, sixth course of stones, northwest corner of same abutment.

B. M. 42 (1875).—Top of projection of stone, second course of stones, southeast wing of northeast abutment of bridge.

B. M. 42a (1875).—Top of projection of stone, second course of stones, northwest wing of same abutment.

B. M. 43 (1875).—On top of projection of stone, lower course of stones, southwest wing of northeast abutment of bridge.

B. M. 43a (1875).—On top of projection of stone, second course of stones, northwest wing of same abutment.

B. M. 44 (1875).—Cross cut on northwest corner of northeast abutment of bridge, about 2 000 feet below Lock No. 46, at *Utica, N. Y.* Bench mark in third course of stones.

B. M. 44a (1875).—On corner of fourth step of northwest wing of northeast abutment of bridge.

B. M. 45 (1875).—Cross cut on south corner of east abutment of bridge, third course of stones.

B. M. 45a (1875).—Cross cut on north corner of same abutment, fourth course of stones.

B. M. 46 (1875).—On top of projection of stone in second course of stones, east wing of north abutment of bridge.

B. M. 46a (1875).—On top of projection of stone, bottom course, face of abutment of same bridge.

B. M. 47 (1875).—Top of projection of stone in face of north abutment of bridge, second course of stones.

B. M. 47a (1875).—Top of projection of stone, second course of stones, west wing of same abutment.

B. M. 48 (1875).—Projection of stone, second course of stones, east wing of north abutment of bridge in *Rome*.

B. M. 48a (1875).—Projection of stone, second course of stones, west wing of same abutment.

B. M. 49 (1875).—Top of projection of stone, second course of stones, east wing of north abutment of bridge.

B. M. 49a (1875).—Top of projection of stone, third course of stones, face of abutment of same bridge.

B. M. 51 (1875).—Top of projection of stone, bottom course, east wing of north abutment of bridge about 1 mile below *Higginsville*, *N. Y.*

B. M. 51a (1875).—Top of projection of stone, second course of stones, face of north abutment of same bridge.

B. M. A. (*Oswego*).—Top of iron bolt in top of masonry of old Government pier, 0·5 foot from east face of pier, 3·5 feet north of northwest corner of United States Engineers' storehouse, on United States reservation at foot of Third street, marked

U S
+
B M

B. M. B. (*Oswego*).—Top of stone post in prolongation south of west face of old stone pier. The stone marks southwest boundary of United States reservation, is 8 feet south of masonry of pier, 28 feet west of southwest corner of Engineers' storehouse, and surface is flush with ground. Marked U. S.

B. M. C. (*Oswego*).—Cross cut on shop of Dry dock of Marine Railway, on corner of Lake and Second streets. Cross in third course of stones from ground on west side of shop, 3 feet from southwest corner.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ST. REGIS, QUEBEC, AND CAPE VINCENT, N. Y.

P. B. M. A, St. Regis.—Center-punch mark in ¼-inch brass bolt cemented into west side of the northwest corner of tower of *St. Regis*, *Quebec*, Catholic Church, 10 inches from said corner and about 19 inches above the surface of the ground. Church was built about 1796. The letters U. S. A. are cut into the stone.

P. B. M. B, St. Regis.—Center-punch mark in ¼-inch brass bolt cemented into south face and 6 inches from the southwest corner of the priest's house, opposite the Catholic Church at *St. Regis*, *Quebec*. The bolt is 6 inches above the surface of the ground. The house was built in 1796. The letters U. S. B. are cut into the foundation stone.

P. B. M. P, Hogansburg.—Center-punch mark in ¼-inch brass bolt cemented into the northeast face of the east buttress of the main tower of St. Patrick's Catholic Church, in *Hogansburg*, *Franklin County*, *N. Y.* The bolt is 21 inches below the water table and about 18 inches above ground. The letters U. S. P. are cut into the stone.

P. B. M. C, Hogansburg.—Center-punch mark in ¼-inch brass bolt cemented into southeast face 1 foot from east corner of Catholic convent, *Hogansburg*, *Franklin County*, *N. Y.* The bolt is in the limestone water table about 2 feet above surface of ground, and the letters U. S. C. are cut into the stone.

P. B. M. 1.—Top of a round-headed brass bolt set in a concrete base about 350 feet northwest of the northwest bank of the *Racket River* and 20·5 feet southeast of a large white-pine tree 9 feet in circumference, and blazed 12 by 17 inches. The tree is the largest pine tree near the mouth of the Racket River and the blaze is marked same as the concrete base, U. S. P. B. M. 1. The mark is covered by 1·2 feet of earth.

P. B. M. 2.—Top of a round-headed brass bolt set into a concrete base on the north side of Grass River road just east of the mouth of the *Grass River*. The bench is 3 feet south of north fence line of road and on the west fence line of house lot of William Tucker. The bench is marked as above, and was set 1·2 feet under ground.

P. B. M. 3.—Top of a round-headed brass bolt set into a concrete base 3 feet south of fence on north side of the river road and in center of north-and-south road branching off from river road opposite farm of John Wood. The bench is 25 feet east of a honey locust hedge on west line of said farm, and is 1·3 feet under surface of ground. The concrete base is marked as above.

P. B. M. 4.—Top of a round-headed ¼-inch brass bolt set into a concrete base 1·4 feet underground, and situated on the south side of river road on line of a stone fence running north and south opposite barnyard of Frank Polly's farm. The bench is 5·5 feet from the south fence of road and 420 feet east of *Pollys Creek*, and marked as above.

P. B. M. 5.—Top of a round-headed ¼-inch brass bolt set into a concrete base 1·2 feet below surface of ground, and situated on north side of the river road at the corner of the fence in turn of road at the house of Norman Hopson. The bench is 2·8 feet from fence corner, and is marked as above.

P. B. M. 6.—Top of a round-headed ¼-inch brass bolt set into a concrete base 1·3 feet underground, 3 feet north of south fence line of the river road and 58·5 feet east of the east face of Isaac Richard's residence at *Richards Landing*. The bench is marked as above.

P. B. M. Louisville Landing.—Center punch mark in ¼-inch brass bolt cemented into west face of hotel of R. B. Matthews, at *Louisville Landing*, 2·6 feet from northwest corner of building in a foundation stone 0·9 foot above ground, marked U. S.

P. B. M. 7.—Top of a round-headed ¼-inch brass bolt set into a concrete base 1·4 feet underground, and situated on the north side of the river road, 22·7 feet west and on west fence line of Charles Whalen's house. The bench is 3 feet east of said Whalen's fence and on the north fence line of river road, and marked as above.

P. B. M. 8.—Top of a round-headed ¼-inch copper bolt set into the top of a large granite bowlder in the orchard on north side of river road, on crest of hill, 6·8 feet ——— of north fence line of river road, opposite house of William Bradford, on *Bradfords Hill*. The bowlder is marked as above.

P. B. M. 9.—Top of a round-headed ¼-inch brass bolt set into a concrete base 1·2 feet below ground, on the north side of the river road abreast of Egg Island (or Rutherfords or Carrs Island), in *Coles Creek*. The bench is nearly on said north road line, and 5·8 feet south of the south corner of a large wooden barn of William Hosmer, and marked as above.

P. B. M. 10.—Top of a round-headed ¼-inch brass bolt set into a concrete base, covered by 1·2 feet of earth and situated on the north side of the river road, 4·2 feet south of north fence line and on the property line between the Dartis and Scott lots, abreast of *Murphys Island*. The concrete is marked as above.

P. B. M. 11.—Center punch mark in ¼-inch brass bolt cemented into upper foundation stone, 3 inches from south corner and 24 inches above ground, on the southwest face of St. Paul's Episcopal Church, at *Waddington, N. Y.* Erected 1818. The letters U. S. 11 are cut into the stone.

P. B. M. A, Waddington.—Center punch mark in ¼-inch brass bolt cemented into south buttress of the steeple, 12 feet northeast from center of main entrance, 1·6 feet from outer corner of said buttress and 1·5 feet above ground, on Presbyterian Church, at *Waddington, N. Y.;* marked U. S. A.

P. B. M. B, Waddington.—Center punch mark in ¼-inch brass bolt cemented into foundation masonry on northeast face, 1·9 feet from north corner and 0·8 foot above ground, on the town hall, at *Waddington, N. Y.;* marked U. S. B.

P. B. M. 12.—Top of a round-headed ¼-inch brass bolt cemented into the top of a large granite bowlder on the south side of the river road at the turn just west from *Point Three Points* (better known as White House Point or Waddells Point). The bowlder is marked as above.

P. B. M. 13 A.—Top of a round-headed ¼-inch brass bolt cemented into the top of a bowlder on the north side of the river road and on the east property line of *Tilden, N. Y.*, post office, just opposite Iroquois Point. The bowlder is marked as above.

P. B. M. 13.—Center punch mark in ¼-inch brass bolt cemented into foundation stone of *Tilden, N. Y.*, post office, situated on the north side of the river road on the town line between Lisbon and Waddington, N. Y. The mark is on the southeast face of the building, 7·2 feet from the south corner and 0·8 foot above ground. The letters U. S. are cut into the stone.

P. B. M. 14.—Top of round-headed ¼-inch brass bolt set into a concrete base, covered by 1 foot of earth, on the north side of the river road, at a turn in the fence on the east property line of Silas Samon's property. The bench is 7 feet west from a large sugar-maple tree, blazed and marked U. S. The concrete is marked U. S. P. B. M. 14.

P. B. M. 15.—Center-punch mark in ¼-inch brass bolt cemented into the corner stone on the west corner of the Episcopal stone church at *Lisbon, N. Y.*, post office, 7 miles below Ogdensburg, N. Y. The church is on the south side of the river road. The bench is on the north face of the church, 10 inches from the west corner, and 28 inches above ground, marked U. S. 15.

P. B. M. 16.—Center-punch mark in ¼-inch brass bolt cemented into red sandstone coping on north side of Infirmary Building, rear, in New York State Hospital grounds, below *Ogdensburg, N. Y.* The mark is 12·7 feet from west corner of said building and 50·5 feet from center of doorway on north side, and is 4 feet above ground. The letters U. S. are cut into said coping stone over the mark.

P. B. M. A, Ogdensburg.—Center-punch mark in center of ¼-inch brass bolt cemented into a 12 by 18 inch red sandstone on the southwest corner of the Armory Building, Ford street, *Ogdensburg, N. Y.*, 34 inches above surface of ground. The letters U. S. A. are cut into the masonry.

P. B. M. B, Ogdensburg.—Center-punch mark in ¼-inch brass bolt cemented into a 12 by 18 inch foundation stone on the southeast face of the town hall and opera house, corner of Ford and Caroline streets, *Ogdensburg, N. Y.* The mark is on the west half of said face and 6·25 feet from southwest corner of building, and 2·25 feet above the surface of the ground. The letters U. S. B. are cut into the masonry.

P. B. M. C, Ogdensburg.—Center-punch mark in ¼-inch brass bolt cemented into a coping corner stone on the northeast corner of the United States custom-house, State street, *Ogdensburg*, *N. Y.* The mark is 7½ inches west of said corner of building, on the north face, 4 feet one-half inch above sidewalk. The letters U. S. C. are cut into the coping stone.

P. B. M. D, Ogdensburg.—Center-punch mark in ¼-inch brass bolt cemented into coping stone on north face of United States light-house on west pier at mouth of Oswegatchie River, *Ogdensburg*, *N. Y.* The mark is 48½ inches southwest of the north corner of the house and 32½ inches above the surface of the ground. The letters U. S. D. are cut into said coping stone.

P. B. M. 17.—Top of round-headed ¼-inch brass bolt set into a concrete base, 12 inches below surface of ground, 31·7 feet south of center of track of Utica and Black River Railroad, near Nevins Point, 3 miles above Seymour House, *Ogdensburg*, *N. Y.* The bench is 25·5 feet north of a large elm tree (30 inches diameter), blazed and marked U. S., also about 200 feet south of a stone ice house, and about 250 feet northeast of a stone barn. The concrete is marked U. S. P. B. M. 17. The same letters are cut into a large bowlder in corner of the fence about 10 feet northwest from the bench.

P. B. M. 18.—Top of a square-headed ¼-inch brass bolt cemented into bed rock, 6 inches under ground, about 900 feet northwest from the house of Le Rock, 45·6 feet northwest of the center of track of Utica and Black River Railroad, 292·5 feet northeast of section post No. 23–24 of said railroad, 6 miles above Seymour House, *Ogdensburg*, *N. Y.* The bench is 124 feet west from a wagon road leading from Le Rock's house to the St. Lawrence River, and about 200 feet southwest from a small stone boat-house on the river bank. A telegraph pole about 70 feet south of bench is blazed and marked U. S. The letters U. S. P. B. M. 18 are cut into the bed rock.

P. B. M. 19.—Top of a round-headed ¼-inch brass bolt cemented into bed rock, 25.8 feet northwest from center line of track of Utica and Black River Railroad, 52 feet southeast of a ledge of rock on St. Lawrence River bank, on *Dows Point*, 20° northwest, a distance of about 1 000 feet from residence of George Beattie, 9 miles above Ogdensburg and about 2 miles below Morristown. The bench is 331 feet southwest from southwest corner of summer cottage Rock Ledge, east 5° south from Brookville Asylum, Canada, and 60 feet northwest from a blazed telegraph pole. The letters U. S. P. B. M. 19 are cut into the bed rock, which is covered by 6 inches of earth.

P. B. M. A, Morristown.—Center-punch mark in ¼-inch brass bolt cemented into coping stone on northwest corner of lumber office of the Gillies Brothers Company, Limited, in northwest end of *Morristown*, *N. Y.* The building is of limestone and is owned by Frank Chapman, Ogdensburg. The bench mark is on the north face of said building, 6 inches from the northwest corner, and about 18 inches above ground. The bench is marked U. S. A.

P. B. M. B, Morristown.—Center punch mark in ¼-inch brass bolt cemented into a corner stone of the foundation masonry of a stone warehouse, 68 feet west and across the road from P. B. M. A, *Morristown*, *N. Y.* The bench is on the east face of said building, 8 inches from the southeast corner, and the letters U. S. B. are cut into the stone. The bench is also 79·5 feet from the north side of the United States custom house and 117 feet east of center of main track of Utica and Black River Railroad.

P. B. M. C, Morristown.—Center punch mark in ¼-inch brass bolt cemented into masonry on east face of the south wing of the residence of Henry Chapman, on the west side of bay at *Morristown, N. Y.* The bench mark is 39 inches north of the southeast corner of said wing and 17 inches above the surface of the ground. The letters U. S. C. are cut into the masonry.

P. B. M. 20.—Top of a round-headed ¼-inch brass bolt cemented into a slab of limestone rock embedded in sand and gravel near the shore of St. Lawrence River, on the east side of a small bay 1·63 miles above U. S. P. B. M. C, *Morristown;* also on range with the upper end of Old Mans Island and Umbrella Island. The bench is at the foot of a ledge of rock at Rowleys or Homes Point, 6 feet from face of ledge and about 180 feet north of the river road. The letters U. S. P. B. M. 20 are cut into the rock.

P. B. M. 21.—Top of a round-headed ¼-inch brass bolt cemented into the top of a bowlder (5 by 3 feet) projecting 2 feet above surface of ground and situated on the north side of the river road in a turn of said road and opposite the center of a crossroad running southeast from the river road, about three-fourths mile east of town line between the towns of *Morristown* and Hammond, 2½ miles northeast from Oak Point, or 1 000 metres northeast from the crossroad known as the Blackstone road. The above letters are cut into the bowlder.

P. B. M. 22.—Top of a round-headed ¼-inch brass bolt cemented into sandstone bed rock, 6 inches below the surface of the ground, and 3 feet from south fence line of river road, and 71 feet from the southeast fence corner of intersection of said river road and the road going north into Oak Point Village. The bench is N. 32° E. from intersection of center lines of said river road and said Oak Point road, on the crest of the hill, one-fourth mile south of *Oak Point Village, N. Y.* The bench is marked as above.

P. B. M. O. P.—Top of a round-headed ¼-inch brass bolt cemented into sandstone bed rock, 18 inches below the surface of the ground, on the west side of road to Oak Point Village and 22 metres northwest from the intersection of river road and said Old Point road, on the crest of the hill, one-fourth mile south of *Oak Point Village, N. Y.* The bench is 39 metres west from P. B. M. 22 and 1·7 metres south from a large bowlder marked U. S. P. B. M. O. P., with an arrow pointing to the bench. The same letters are also cut into the bed rock.

P. B. M. 23.—Top of a round-headed ¼-inch brass bolt cemented into sandstone bed rock in valley of Chippewa Creek, south 70° west 375 metres from iron bridge over said creek, and about 50 metres south of creek. The bench is northeast from the stone residence of Alexander and Robert More, in Chippewa Valley, and 3¼ miles from *Oak Point Village, N. Y.*, by the Chippewa road. The bench is also 25 metres south from a 30-inch white oak, blazed, and 2 metres west from a bare surface in the rock, into which the letters U. S. P. B. M. 23 are cut, with an arrow pointing to the mark. The mark is covered by about 6 inches of earth, and the same letters are cut into the rock around it.

P. B. M. 23 A.—Horizontal line cut in the center of a smoothed square surface on the south face, 1·3 inches east of the southwest corner and 22 inches above ground of the stone dwelling house of Alexander and Robert More, in Chippewa Creek Valley, and about 2¼ miles east of *Chippewa Village, N. Y.*, on the river road. The letters U. S. 23 A. are cut into the masonry around the mark.

P. B. M. C. V.—Center punch mark in ¼-inch brass bolt cemented into a corner stone on the north face of the northeast corner of schoolhouse of district No. 11, in *Chippewa Village, N. Y.* The schoolhouse is built of sandstone masonry, and is founded on bed rock. The mark is 18 inches west from the northeast corner of said schoolhouse and 38 inches above bed rock. The letters U. S. C. V. are cut into the masonry near the bolt.

P. B. M. 24.—Top of a round-headed ¼-inch brass bolt cemented into bed rock 4·8 feet north of the northwest corner of a barn on property of Mrs. Alexander Wilson (of Brockville), and is 130 feet west from the house on said farm, near *Chippewa Village, N. Y.* The bench is 400 metres southwest from P. B. M. C. V., and is covered by 3 inches of soil. The above letters are cut into the bed rock.

P. B. M. 25.—Top of a round-headed ¼-inch brass bolt cemented into bedrock about three-fourths mile northeast from the county line between Jefferson and St. Lawrence counties, N. Y., near the Callaboga road, on the property of George Schermerhorn, situated about 3½ miles above *Chippewa Village, N. Y.* The bench is at the southwest end of a stone fence forming the road fence for the property of William Catlin, and is about half way between the dwellings of said Schermerhorn and Catlin. It is 11·8 feet northwest of the fence, on northwest side of the Callaboga road, and 69·1 feet west from a blazed 14-inch elm tree on the south side of said road, in front of property C. Catlin. The letters U. S. P. B. M. 25 are cut into the bed rock, and the bench is covered by 6 inches of earth.

P. B. M. 26.—Top of a round-headed ¼-inch brass bolt cemented into bed rock on property of George Springer, 111 feet south of the center line of river road and 836 feet northeast from intersection of river road and northwest and southeast road to Redwood, N. Y., which intersection is about 5½ miles northeast from *Alexandria Bay, N. Y.*, and three-fourths mile southwest from Springers Mill, on Crooked Creek. The bench is 238 feet southeast from a white frame house on north side of river road and 141·7 feet south from the barn of said house. The bench is on a flat surface of the bed rock just where the surface drops off toward Cranberry Creek. The above letters are cut into the rock.

P. B. M. 27.—Top of a round-headed ¼-inch brass bolt cemented into bed rock on the property of C. M. Tamblin, 50·5 feet south of the south fence line of the river road, about 1½ miles east from *Alexandria Bay, N. Y.* The mark is on a ledge of bed rock raised above the surrounding ground, and about 300 feet east from the barn of C. M. Tamblin, and 193·5 feet southeast from a small frame house on the north side of the river road. The above letters are cut into the rock at the bench, which is covered by 6 inches of earth. The same letters are also cut into the exposed rock adjacent to the bench, and two arrows cut into the rock point to the position of the bench.

P. B. M. A, Alexandria Bay.—Center punch mark in end of a ¼-inch brass bolt cemented into the water table or coping stone on west side and 8 inches from the southwest corner of the stone building known as "General store" of Cornwall Brothers, *Alexandria Bay, N. Y.* The mark is 2·3 feet above the surface of the ground, and the letters U. S. A. are cut into the masonry.

P. B. M. B, Alexandria Bay.—Center punch mark in end of a ¼-inch brass bolt cemented into a stone on the front of the Reform Church at *Alexandria Bay, N. Y.* The mark is 0·64 metre above the surface of the ground and 1·79 metres northwest of the east corner of the church. The letters U. S. B. are cut into the masonry.

P. B. M. 28.—Top of a round-headed ¼-inch brass bolt cemented into bed rock about 2 miles southwest of *Alexandria Bay, N. Y.*, and one-fourth mile east of George Clyde's residence. The bench mark is 10 feet southeast of a fence which runs south 66° east from the east corner of a large barn on southeast side of road, and is 161·5 feet from the east corner of the barn, 450 feet from a crossroad leading to river, and 225 feet southeast of the southeast fence line of Clayton-Alexandria Bay road. The letters U. S. P. B. M. 28 are cut on the bed rock. Surface marks in the rock indicate the position of the bench.

P. B. M. 29.—Top of a round-headed ¼-inch brass bolt cemented into bed rock 6 inches below the surface of the ground, in front of Mrs. Toms's residence, 2·3 feet southeast of fence, 36 feet northeast of north fence corner at crossroad to Fishers Landing, 72·6 feet from the south corner of Mrs. Toms's residence, and 131 feet northwest of the west corner of a house in the opposite side of road. The letters U. S. P. B. M. 29 are cut on the bed rock.

P. B. M. 30.—Top of a round-headed ¼-inch brass bolt cemented into bed rock on the north side of road opposite the property of Fetterly, 16 feet from the fence line, 144 feet west of a culvert over a dried-up creek about 3 miles northeast of *Clayton, N. Y.*, 43 feet east of the southeast corner of Fox property, 277 feet west of the northwest corner of a frame house south of the road, about one-fourth mile west of a schoolhouse located on top of the ridge east of the valley. The letters U. S. P. B. M. 30 are cut on the bed rock.

P. B. M. A, Clayton.—Center punch mark in end of a ¼-inch brass bolt cemented into corner stone of water table, 6 inches from southwest corner and on south side of Catholic Church, a large stone building, in *Clayton, N. Y.* The church is on the east side of James street, 200 feet southwest of the intersection with Mary street. The bench mark is about 6 inches east of the southwest corner of the church. The letters U. S. A. are cut on the water table.

P. B. M. B, Clayton.—Center punch mark in end of a ¼-inch brass bolt cemented into corner stone of water table on front of house, 8 inches from the northwest corner of the stone residence of E. C. Porter, on the east side of John street, between Jane and Hugunin streets, in *Clayton, N. Y.* The letters U. S. B. are cut on the water table.

P. B. M. C, Clayton.—Center punch mark in end of a ¼-inch brass bolt cemented into stone of masonry wall on the west side of the stone residence of Hall B. Dewey, in *Clayton, N. Y.*, at the southwest corner of Hugunin and Merrick streets, and one block south of the St. Lawrence River, also one block southwest of the New York Central and Hudson River Railroad station. The bench mark is 3·5 feet from the northwest corner of the building and 2·3 feet above the surface of the ground. The letters U. S. C. are cut on the masonry.

P. B. M. 31.—Top of a round-headed ¼-inch brass bolt cemented in a large sandstone bowlder, which is set firmly in the ground and which is 5 feet in diameter at the surface of the ground, 52 feet south of an angle in the road about 3 miles southwest of *Clayton, N. Y.*, on timber line at the southwest end of a clearing, or about 500 feet southeast of a log cabin, 3·5 feet north of a spike driven in a blaze (facing bench mark) on a 14-inch oak tree. The letters U. S. P. B. M. 31 are cut on the bowlder.

P. B. M. 32.—Top of a round-headed ¼-inch brass bolt cemented into bed rock, 1 metre west of vertical ledge of rock along a creek and 46·3 metres south 25° east from center of an arch bridge over the creek, about 6 miles southwest of *Clayton, N. Y.;* 10·3 metres south 20° west from a 14-inch elm east of the creek and 11·0 metres north 20° west from an 18-inch elm west of creek. The letters U. S. P. B. M. 32 and two arrows pointing toward the bench mark are cut on the bed rock.

P. B. M. 33.—Top of a round-headed ¼-inch brass bolt cemented into bed rock about 800 feet east of the west end of *Dodges Bay, N. Y.*, on the north side of road, 22 feet from the ledge of rock at the shore, 30·4 feet west of a 10-inch ash tree, 64·3 feet north from a nail driven in a blaze facing mark on a maple tree situated on fence line south of the road, 66·3 feet north of the intersection of fence along south side of road, with a division line fence to the south. The letters U. S. P. B. M. 33 are cut on the bed rock. Arrows cut into the surface of the rock point to the bench, which is slightly covered with sod and earth.

P. B. M. 34.—Top of a round-headed ¼-inch brass bolt cemented into bed rock in a pasture north of road, 520 feet north 57° east from a large bowlder on north fence line, which bowlder is 215 feet west of 10-foot plank bridge over a dried-up creek and 344 feet west of a crossroad leading south to a frame house, at foot of a hill in Hesler Woods, 3·5 miles below *Cape Vincent, N. Y.* Bench mark is 37 feet east from spike on blaze of a 12-inch elm tree. The letters U. S. P. B. M. 34 are cut on the bed rock.

P. B. M. A, Cape Vincent.—Center punch mark in the end of a ¼-inch brass rod cemented in corner stone at the southwest corner of the United States fish hatchery (a stone building), at *Cape Vincent, N. Y.* The mark is on the east side of the building, 0·38 meter from the corner and 1·04 meters above the surface of the ground. The letters U. S. A. are cut on the same stone.

P. B. M. B, Cape Vincent—A 1-inch square smooth level surface cut on top of water table 12 inches south of the northwest corner of the Jerome House, a brick hotel, situated at the northeast corner of a street intersection two blocks south of the Cleveland Seed Company's dock and warehouse at *Cape Vincent, N. Y.* The stone of the water table has cut on it the letters U. S. B.

P. B. M. C, Cape Vincent.—Center-punch mark in the end of a ¼-inch brass rod cemented in corner stone 39 inches west of the northeast corner of tower of Catholic Church, a large stone building, in *Cape Vincent, N. Y.* The letters U. S. C. are cut on the corner stone.

P. B. M. 35.—Center-punch mark in the end of a ¼-inch brass rod cemented in foundation stone on the north side of *Tibbetts Point* light-house tower, on Tibbetts Point, on shore of Lake Ontario. The mark is 6 inches above the surface of the ground. The letters U. S. P. B. M. 35 are cut on the foundation stone.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN DUNKIRK AND ELMIRA, N. Y.

598 Dunkirk 1899.—*Dunkirk, N. Y.*, St. Mary's Home and School, Washington avenue, between Third and Fourth streets; in water table 20 feet from northeast corner; aluminum table marked "598 Dunkirk 1899."

Nelson Block.—*Dunkirk, N. Y.*, Nelson Block, extreme northwest corner of; top of water table.

871 D.—*Forestville, N. Y.*, 530 feet west of entrance in waiting room of Erie station; in bridge seat at northeast corner of iron bridge over highway; 7 feet north of center of track; bronze tablet marked "871 D."

1097 D.—*Smiths Mills, N. Y.*, 2·3 miles east of; 10½ feet north of center of railway track in foundation stone under west end of overhead highway bridge; bronze tablet marked "1097 D," 1898.

1322 D.—*Dayton, N. Y.*, Erie station at; 950 feet north of; 37½ feet east of center of track; coping of tunnel underneath Erie track; second stepstone from top; bronze tablet marked "1322 D."

1401 D.—*Cattaraugus, N. Y.*, Union school building at; in water table at right of main entrance to; bronze tablet marked "1401 D."

1593 D.—*Little Valley, N. Y.*, Cattaraugus County courthouse at; foundation wall at southwest corner of; aluminum tablet marked "1593 D."

1413 D.—*Salamanca, N. Y.*, 3¼ miles west of; bridge seat of iron girder bridge, southwest corner of; bronze tablet marked "1413 D."

1391 Dunkirk 1899.—*Salamanca, N. Y.*, Union school building on Maple street at; in water table at right of main entrance; aluminum tablet marked "1391 Dunkirk 1899." (Originally set in 1897 and marked "1396 S.")

1393 D.—*Carrollton, N. Y.*, 475 feet east of Erie station at; west pier of Buffalo, Rochester and Pittsburg Railway iron bridge crossing over Erie tracks; bronze tablet marked "1393 D."

1408 D.—*Allegany, N. Y.*, 1·8 miles west of Erie station; stone arch culvert under Erie Railroad, 75 feet east of road crossing, south end of, next to top step; bronze tablet marked "1408 D." (Originally set in 1897 and marked "1415 S.")

1450 D.—*Olean, N. Y.*, city hall and post office building on State street at; northwest corner of; stone next under water table; bronze tablet marked "1450 D." (Originally set in 1896 and marked "1457.")

1508 D.—*Hinsdale, N. Y.*, 2¼ miles east of; bridge seat of small girder bridge, 9½ feet northwest of center of track; bronze tablet marked "1508 D."

1515 D.—*Cuba, N. Y.*, one-half mile east of Erie station at; south end of pier of stone arch bridge over Union street; aluminum tablet marked "1515 D." (Originally a bronze tablet set in 1896 and marked "1522."

1520 D.—*Friendship, N. Y.*, Union school building at; water table at right of main entrance; aluminum tablet marked "1520 D."

1351 D.—*Belvidere, N. Y.*, two-thirds mile east of; south end of wing wall of abutment at east end of railway bridge over Van Campen Creek; 28 feet south of center of track; bronze tablet marked "1351 D."

1416 D.—*Belmont, N. Y.*, southeast corner of Allegany County jail; in stone foundation; aluminum tablet marked "1416 D."

1519 D.—*Wellsville, N. Y.*, Union school building at; northeast corner entrance; in footstone of arch over entrance; aluminum tablet marked "1519 D."

1373 D.—*Andover, N. Y.*, 3 miles west of; iron girder, railroad bridge No. 8, stone step of; bronze tablet marked "1573 D."

1675 D.—*Andover, N. Y.*, 2 miles east of; stone foundation at southeast corner of small railway bridge; bronze tablet marked "1675 D."

1610 D.—*Alfred, N. Y.*, Erie station; water table under front office window, facing track; aluminum tablet marked "1610 D."

1383 D.—*Almond, N. Y.*, 950 feet east of Erie station; bridge foundation at northwest corner of small railroad bridge over highway; aluminum tablet marked "1383 D."

1141 D.—*Hornellsville, N. Y.*, 0·7 mile east of Erie station; foundation wall at northeast corner of iron railroad bridge; aluminum tablet marked "1141 D."

1113 D.—*Canisteo, N. Y.*, 2·1 miles east of; bridge seat of iron girder bridge No. 87, northeast corner of; aluminum tablet marked "1113 D."

1080 D.—*Adrian, N. Y.*, 3·7 miles east of; in face of rock cliff on east side of Erie Railroad and highway, 400 feet northeast of highway bridge across Canisteo River, 25 feet from east rail; bronze tablet marked "1080 D."

1048 D.—*Cameron, N. Y.*, 180 feet west of Erie station at; in stone foundation of railroad water tank; bronze tablet marked "1048 D."

1006 D.—*Rathbone, N. Y.*, general merchandise store of F. G. Martin (building owned by O. O. Whittemore), foundation stone at right of main entrance; bronze tablet marked "1006 D."

1021 D.—*Addison, N. Y.*, 0·4 mile east of Erie station and 750 feet northwest of tracks; Union school building at right of main entrance to; aluminum tablet marked "1021 D."

935 D.—*Painted Post, N. Y.*, 0·8 mile west of; in masonry wall of open culvert; east wall of culvert and south side of railroad track; bronze tablet marked "935 D."

City Hall.—*Corning, N. Y.*, city hall at corner of Erie avenue and Cedar street; foundation stone under water table at right of Cedar street entrance.

899 D.—*Big Flats, N. Y.*, 1¼ miles west of; in bridge seat at Erie Railroad bridge No. 67A, at southwest corner of; bronze tablet marked "899 D."

901 D.—*Horseheads, N. Y.*, 0·35 mile southwest of Erie station; on pier of Lackawanna Railroad bridge at crossing of Northern Central Railway, 50 feet south of center of north-bound track of Northern Central Railway; aluminum tablet marked "901 D."

Station.—*Horseheads, N. Y.*, Northern Central Railway station; northeast corner of stone doorsill of men's waiting room.

857 Albany.—*Elmira, N. Y.*, city hall, corner of Church and Lake streets; stone pedestal of lamp-post at left of Lake street entrance; aluminum tablet marked "857 Albany."

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ELMIRA AND SCHENECTADY, N. Y.

Erie Station.—*Elmira, N. Y.*, one-half mile east of Erie station at; + chisel mark on head of iron bolt set in stone foundation at west end of Erie Railroad bridge across Chemung River. Bolt in between tracks and nearest east-bound track.

824 A.—*Wellsburg* station, *N. Y.*, 1 800 feet west of; coping stone of abutment wall at southeast corner of bridge No. 55; aluminum tablet marked "824 A."

804 A.—*Chemung* station, *N. Y.*, 1 mile west of; coping stone of abutment wall at northeast corner of bridge No. 53 across Chemung River; aluminum tablet marked "804 A."

840 A.—*Waverly, N. Y.*, city hall building on Broad street; stone column between doorways; aluminum tablet marked "840 A."

798 A.—*Barton, N. Y.*, 1·2 miles east of; coping stone of abutment at southeast corner of bridge No. 40; aluminum tablet marked "798 A."

815 A.—*Owego, N. Y.*, 2¼ miles west of Erie station at; coping stone of abutment at southeast corner of bridge No. 37; aluminum tablet marked "815 A."

812 A.—*Owego, N. Y.*, 2¾ miles east of Erie station at; coping stone at northwest corner of bridge No. 33; aluminum tablet marked "812 A."

825 A.—*Union, N. Y.*, 1·4 miles east of; coping stone of wing wall of abutment at northeast corner of bridge No. 31, across Nanticoke Creek; bronze tablet marked "825 A."

867 A.—*Binghamton, N. Y.*, Broome County courthouse, west end of, at left of basement entrance from Collier street; aluminum tablet marked "867 A."

959 A.—*Port Crane* station, *N. Y.*, 3¼ miles west of; 900 feet west of road crossing; parapet wall at east end of culvert under railway; bronze tablet marked "959 A."

1126 A.—*Sanitaria Springs* station, *N. Y.*, one-third mile east of; coping stone of abutment at northeast corner of bridge No. 107, over highway; bronze tablet marked "1126 A."

1384 A.—*Tunnel* station, *N. Y.*, one-half mile west of; coping stone of abutment at southeast corner of bridge No. 104, crossing over road; bronze tablet marked "1384 A."

1051 A.—*Harpersville* station, *N. Y.*, 1 250 feet west of; coping stone of abutment at southwest corner of iron trestle bridge No. 97; bronze tablet marked "1051 A."

973 A.—*Afton* station, *N. Y.*, 1 050 feet east of; coping stone of abutment at northeast corner of iron girder bridge No. 90¼, crossing over highway; bronze tablet marked "973 A."

978 A.—*Bainbridge, N. Y.*, 2 miles west of; foundation stone at northeast corner of small cattle-pass opening; bronze tablet marked "978 A."

989 A.—*Bainbridge, N. Y.*, 2¾ miles east of; coping stone of bridge abutment at southeast corner of bridge No. 84; bronze tablet marked "989 A."

1024 A.—*Unadilla, N. Y.*, Union school building at; foundation wall at left of main entrance to; aluminum tablet marked "1024 A."

1047 A.—*Wells Bridge, N. Y.*, Delaware and Hudson station at; about 300 feet west of; coping stone of abutment at northeast corner of highway bridge across Susquehanna River; bronze tablet marked "1047 A."

1051 A.—*Otego, N. Y.*, 1 mile east of; southeast corner of culvert, third step from top; bronze tablet marked "1051 A."

1232 A.—*Oneonta* State Normal School, in face of west pillar at main entrance of; aluminum tablet marked "1232 A."

Oneonta.—*Oneonta, N. Y.*, Delaware and Hudson station; southwest corner of doorsill of door into waiting room and dining hall; door faces track and is east of office window.

1119 A.—*Colliers, N. Y.*, seven hundred feet east of; bridge No. 54, across Susquehanna River; northeast corner of coping stone of east abutment; bronze tablet marked "1119 A."

1170 A.—*Maryland, N. Y.*, 1·9 miles west of; southeast corner of bridge No. 51, across Schenevus Creek; parapet wall; bronze tablet marked "1170 A."

1272 A.—*Schenevus, N. Y.*, Delaware and Hudson station, one-fourth mile east of; coping stone of abutment at southeast corner of bridge across Schenevus Creek; bronze tablet marked "1272 A."

1311 A.—*Worcester, N. Y.*, Delaware and Hudson station; 80 feet west of west end of; railroad water-tank foundation; third course of stone east side of bank; aluminum tablet marked "1311 A."

1406 A.—*East Worcester, N. Y.*, three-fourths mile west of; center pier of railroad bridge or large culvert; capstone at north end; aluminum tablet marked "1406 A."

1224 A.—*Richmondville, N. Y.*, 0·6 mile west of; Delaware and Hudson Railroad bridge No. 31; coping stone of east abutment wall at northeast corner of bridge; bronze tablet marked "1224 A."

Cobleskill.—*Cobleskill, N. Y.*, 1 mile west of; □ chisel mark on south end of culvert at west side of road crossing.

930 A.—*Cobleskill* union school building, stone foundation at northwest corner of; bronze tablet marked "930 A."

Barnerville.—*Barnerville Crossing, N. Y.*, □ chisel mark on rock 50 feet north of railroad at.

731 A.—*Howes Cave, N. Y.*, 1·2 miles east of; bridge seat at northwest corner of small bridge or open culvert; bronze tablet marked "731 A."

753 A.—*Esperance, N. Y.*, Delaware and Hudson station, 1 250 feet west of; coping stone at north end of stone culvert under Delaware and Hudson Railroad; bronze tablet marked "753 A."

681 A.—*Duanesburg, N. Y.*, Delaware and Hudson station, 1 000 feet west of north end of east abutment; bronze tablet marked "681 A."

410 A.—*Kelleys, N. Y.*, 1¾ miles east of; coping stone at east abutment of cattle and wagon pass, 750 feet east of highway; bronze tablet marked "410 A."

242 A.—*Schenectady, N. Y.*, New York Central and Hudson River Railroad bridge over Erie Canal; northeast corner of coping stone of abutment wall; bronze tablet marked "242 A."

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN SCHENECTADY AND COHOES, N. Y.

B. M. 15 (1875).—Near *Schenectady, N. Y.* (See page 849.)

B. M. 14 (1875).—Near *Rexford, N. Y.* (See page 849.)

B. M. 14a (1875).—*Rexford, N. Y.*, 3½ miles east of; top of screw bolt fastening down collar of southwest gate of west Lock No. 20.

B. M. 12 (1875).—Near *Rexford, N. Y.* (See page 849.)

Mohawk Aqueduct.—*Cohoes, N. Y.*, 3½ miles west of; lower Mohawk Aqueduct, east end of; southwest corner of parapet wall marked ⊕ with chisel.

Mill race.—*Cohoes, N. Y.* On top of wall west side of mill race, between locks 15 and 16, 6 inches from northeast corner of small brick building between mill race and towpath, marked + with chisel.

B. M. 8 (1875).—*Cohoes, N. Y.* (See page 848.)

B. M. 8a (1875).—*Cohoes, N. Y.* (See page 848.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN ERIE, PA., AND FRANKLIN, PA.

B. M. 1 (1873).—*Erie, Pa.* Highest point of a stone post 336 feet from the nearest point of the pier on which the gauge is situated, and on north side. Reported in 1899 as disturbed.

U. S. Engs. B. M.—*Erie, Pa.* Chisel mark on southwest corner of foundation of light keeper's dwelling, Erie Harbor.

635 Pittsburg 1899.—*Erie, Pa.* Aluminum tablet in water table northwest corner of hospital wing of Soldiers' Home, marked "635 Pittsburg 1899."

685.—*Erie, Pa.* Top of foundation of water tank at junction of Pittsburg and Erie and Lake Shore Railroad, marked "685."

1103 Pittsburg 1899.—*Belle Valley, Pa.*, 1·1 miles south of; aluminum tablet set in north end east side of foundation of bent of overhead highway bridge, marked "1103 Pittsburg 1899."

1214 Pittsburg 1899.—*Samson, Pa.*, 0·8 mile south of; aluminum tablet set in top of creek masonry north end east side of railroad bridge No. 8, marked "1214 Pittsburg 1899."

P. R. R. No. 85.—*Samson, Pa.*, 0·8 mile south of; Pennsylvania B. M. No. 85, bridge No. 8, copper bolt.

P. R. R. No. 82.—*Samson, Pa.*, 4·3 miles south of; Pennsylvania B. M. No. 82, bridge No. 14.

1193 Pittsburg 1899.—*Leboeuf, Pa.*, 1·5 miles west of, on New York, Pennsylvania and Ohio Railroad; aluminum tablet set in creek masonry on north side of railroad, marked "1193 Pittsburg 1899."

1148 Pittsburg 1899.—*Millers, Pa.*, 0·9 mile west of; aluminum tablet set in top of southwest end of creek abutment 2·5 miles east of Cambridge Spring, marked "1148 Pittsburg 1899."

1128 Pittsburg 1899.—*Venango, Pa.*, 0·8 mile west of; bronze tablet set in southeast end of bridge abutment, marked "1128 Pittsburg 1899."

1109 Pittsburg 1899.—*Saegerstown, Pa.*, 0·7 mile west of; bronze tablet set in east abutment south side of railroad bridge, marked "1109 Pittsburg 1899."

1071 Pittsburg 1899.—*Meadville, Pa.*, 1·8 miles west of; bronze tablet set in creek abutment north side of railroad, east end, marked "1071 Pittsburg 1899."

1062 Pittsburg 1899.—*Cochranton, Pa.*, 1 000 feet north of; bronze tablet set in abutment of railroad iron bridge north end, east side, marked "1062 Pittsburg 1899."

1038 Pittsburg 1899.—*Utica, Pa.* Bronze tablet set in east abutment north side of highway bridge 300 feet south of station, marked "1038 Pittsburg 1899."

1013 Pittsburg 1899.—*Sugar Creek, Pa.*, 1 200 feet south of; bronze tablet set in northeast end abutment of railroad iron bridge, marked "1013 Pittsburg 1899."

989 Pittsburg 1899.—*Franklin, Pa.* Aluminum tablet set in northeast corner of belt course of Erie depot, marked "989 Pittsburg 1899."

987 Pittsburg 1899.—*Franklin, Pa.*, Allegheny Valley Railway station; 90 feet west of center of track, at point 60 feet north of north end of station, in second step below coping stone at end of south-wing wall of east abutment of road bridge across Allegheny River, aluminum tablet marked "987 Pittsburg 1899."

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN OIL CITY, PA., AND PITTSBURG, PA.

970 Pittsburg 1899.—*East Sandy, Pa.*, Allegheny Valley Railway station, 650 feet north of; coping stone of abutment at southwest corner of 2-span steel truss bridge across East Sandy Creek, 1·2 feet below top of rail 10½ feet west of center of track; bronze tablet marked "970 Pittsburg 1899."

957 Pittsburg 1899.—*Brandon, Pa.*, Allegheny Valley Railway station, 1·35 miles south of; face of rock ledge 20 feet southeast of center of track, 3·4 feet above top of rail, 1 100 feet south of milepost 112; bronze tablet marked "957 Pittsburg 1899."

941 Pittsburg 1899.—*Kennerdell, Pa.*, Allegheny Valley Railway station, 1½ miles south of; 300 feet west of milepost 106, large bowlder 10 feet north of center of track, 2·4 feet above rail; bronze tablet marked "941 Pittsburg 1899."

925 Pittsburg 1899.—*St. George Station, Pa.*, 0·3 mile south of; bronze tablet set in rock on west side of track, 25 feet west of rail, 150 feet south of whistling post, marked "925 Pittsburg 1899."

919 Pittsburg 1899.—*Rockland, Pa.*, 0·1 mile south of; bronze tablet set in northwest wing abutment of small creek, 600 feet south of station, on west side of railroad, marked "919 Pittsburg 1899."

905 Pittsburg 1899.—*Dotter, Pa.*, 600 feet north of; bronze tablet set in north abutment west wing of railroad bridge, marked "905 Pittsburg 1899."

898 Pittsburg 1899.—*Emlenton, Pa.*, 0·4 mile south of; bronze tablet set in wing wall of railroad bridge abutment, south end, west side, marked "898 Pittsburg 1899."

883 Pittsburg 1899.—*Parker, Pa.* Bronze tablet set in top of abutment of road bridge at station, east abutment, south side, marked "883 Pittsburg 1899."

869 Pittsburg 1899.—*Monterey, Pa.*, 900 feet south of station; bronze tablet set in bridge abutment, north end, east side, marked "869 Pittsburg 1899."

885 Pittsburg 1899.—*Lower Hillville, Pa.*, 1 miles south of; bronze tablet set in top of culvert wall of small stream, northeast side, marked "885 Pittsburg 1899."

852 Pittsburg 1899.—*East Brady, Pa.* Bronze tablet set in east abutment, wing wall of steel highway bridge, marked "852 Pittsburg 1899."

844 Pittsburg 1899.—*Red Bank, Pa.* Bronze tablet set in north abutment of Allegheny Valley Railway bridge, 600 feet south of station, north side of abutment, marked "844 Pittsburg 1899."

820 Pittsburg 1899.—*Rimerton, Pa.*, 2 miles south of; bronze tablet set in north abutment, west side of iron bridge, marked "820 Pittsburg 1899."

806 Pittsburg 1899.—*Mosgrove, Pa.* Bronze tablet set in north abutment, east end of railroad bridge, 900 feet north of station, marked "806 Pittsburg 1899."

803 Pittsburg 1899.—*Kittanning, Pa.*, bronze tablet set in front face northwest corner of public school on corner of McKain and Vine streets, marked "803 Pittsburg 1899."

786 Pittsburg 1899.—*Rosston, Pa.*, 0·2 mile south of; bronze tablet set in east abutment of bridge over river, marked "786 Pittsburg 1899."

788 Pittsburg 1889.—*West Penn Junction, Pa.*, bronze tablet set in foundation wall of turntable of Allegheny Valley Railway and West Pennsylvania Railroad, marked "788 Pittsburg 1899."

P. R. R. No. 26.—*West Penn Junction, Pa.*, copper bolt set in turntable wall of Allegheny Valley Railway, marked "788·85."

764 Pittsburg 1899.—*Edgecliff, Pa.*, 1 000 feet south of; bronze tablet set in north abutment, east side, of bridge over creek, marked "764 Pittsburg 1899."

770 Pittsburg 1899.—*Blacks Run, Pa.*, bronze tablet set in face of stone milepost, marked "P. 13 & O. C. 119·5," 300 feet south of Bessemer Railroad bridge over Allegheny River, marked "770 Pittsburg 1899."

P. R. R.—*Wildwood, Pa.*, copper bolt in doorsill of Penn Water Co.'s house, west door.

745 Pittsburg 1899.—*Brilliant, Pa.*, 0·3 mile south of; bronze tablet set in wall of small culvert south side of railroad, marked "745 Pittsburg 1899."

P. R. R. No. 99.—*Pittsburg*, Liberty street; south side of foundation of Washington street foot bridge; copper bolt.

738 Pittsburg 1899.—*Pittsburg, Pa.*, aluminum tablet set in foundation of Seventh Avenue Hotel, north side, at main entrance to, marked "738 Pittsburg 1899."

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN GRAFTON, W. VA., AND PITTSBURG, PA.

M.—*Grafton, W. Va.* (See p. 562.)

986 Pittsburg 1899.—*Valley Falls, W. Va.*, 2·9 miles east of; bridge seat at northeast corner of girder bridge No. 104, 7 feet east of center of track, 4 feet below top of outer rail of curve; bronze tablet marked "986 Pittsburg 1899."

899 Pittsburg 1899.—*Powells, W. Va.*, flag station, two-thirds mile west of; stone arch bridge No. 108, coping stone of wall 1·1 feet below top of rail, 7 feet north of center of track; aluminum tablet marked "899 Pittsburg 1899."

885 Pittsburg 1899.—*Benton Ferry, W. Va.*, 160 feet west of signboard at; bridge seat at southeast corner of small girder bridge No. 111, 4½ feet below top of rail and 18½ feet south of center of track; bronze tablet marked "885 Pittsburg 1899."

885 Pittsburg 1899.—*Fairmont, W. Va.*, Baltimore and Ohio station, 1¼ miles north of; Baltimore and Ohio bridge No. 371 across Monongahela River, coping stone at north end of east abutment; bronze tablet marked "885 Pittsburg 1899."

873 Pittsburg 1899.—*Catawba, W. Va.*, 0·8 mile south of; Baltimore and Ohio one-span truss bridge No. 369, coping stone at north end of east abutment, 3 feet below rail and 8 feet north of; bronze tablet marked "873 Pittsburg 1899."

859 Pittsburg 1899.—*Little Falls, W. Va.*, 1⅓ miles northwest of; face of rock bluff 9½ feet west of west rail and 4 feet above same, one-half mile north of bridge 366; bronze tablet marked "859 Pittsburg 1899."

828 Pittsburg 1899.—*Uffington, W. Va.*, station, 400 feet north of; coping stone of abutment at northwest corner of one-span truss bridge No. 364, 3 feet below top of rail and 7 feet north of rail; aluminum tablet marked "828 Pittsburg 1899."

821 Pittsburg 1899.—*Morgantown, W. Va.*, Baltimore and Ohio station, 480 feet south of; coping stone of abutment at northwest corner of truss bridge over Deckers Creek; bronze tablet marked "821 Pittsburg 1899."

U. S. E. B. M.—NOTE.—United States Engineer Corps bench mark at same place is 0·009 foot lower than tablet.

815 Pittsburg 1899.—*Van Vorhis, W. Va.*, 1 mile south of; bridge seat at southeast corner of steel girder bridge No. 359; bronze tablet marked "815 Pittsburg 1899."

813 Pittsburg 1899.—*Point Marion, Pa.*, one-fourth mile north of; coping stone at east end of north pier of six-span truss and girder bridge No. 356 across Cheat River; bronze tablet marked "813 Pittsburg 1899."

1084 Pittsburg 1899.—*Outcrop, Pa.*, flag station, 0·2 mile south of; north end of Baltimore and Ohio tunnel, east side of track, 3·7 feet above rail; bronze tablet marked "1084 Pittsburg 1899."

1065 Pittsburg 1899.—*Fairchance, Pa.*, Baltimore and Ohio station, 550 feet north of; bridge seat at southeast corner of small girder bridge No. 338; aluminum tablet marked "1065 Pittsburg 1899."

999 Pittsburg 1899.—*Uniontown, Pa.*, Fayette County courthouse, corner of Main and Court streets, foundation wall 4 feet above ground between Main street entrance and southwest corner of building; aluminum tablet marked "999 Pittsburg 1899."

920 Pittsburg 1899.—*Upper Middletown, Pa.*, flag station, 675 feet north of; face of rock in place, 26 feet east of center of track and 4·2 feet higher than top of rail; bronze tablet marked "920 Pittsburg 1899."

868 Pittsburg 1899.—*Tippecanoe, Pa.*, flag station, one-half mile south of; bridge seat at southwest corner of small girder bridge 15 feet long, over roadway at south of truss road bridge over Redstone Creek; bronze tablet marked "868 Pittsburg 1899."

778 Pittsburg 1899.—*West Brownsville Junction, Pa.*, one-fourth mile south of; four-span truss bridge across Monongahela River, bridge seat at east end of north abutment; bronze tablet marked "778 Pittsburg 1899."

P. R. R. No. 54.—At west end of same abutment.

764 Pittsburg 1899.—*Woods Run, Pa.*, flag station, one-half mile south of; bridge seat at east end of north abutment of open culvert, 25 feet south of milepost 47; bronze tablet marked "764 Pittsburg 1899."

760 Pittsburg 1899.—*Charleroi, Pa.*, station, one-half mile south of; 150 feet south of city pumping station, coping stone at northwest corner of large stone arch culvert; bronze tablet marked "760 Pittsburg 1899."

Lock No. 4.—Chisel mark in circle on coping stone near heel of west gate at south end of west lock.

755 Pittsburg 1899.—*Baird, Pa.*, flag station, 150 feet south of station signpost; second step below coping stone of stone arch culvert, north side of track, and 4·8 feet below top of rail; bronze tablet marked "755 Pittsburg 1899."

753 Pittsburg 1899.—*River View, Pa.*, flag station, 0·3 mile north of; large stone arch culvert, south end of; west side of track, second step below coping stone, 2½ feet below top of rail; bronze tablet marked "753 Pittsburg 1899."

740 Pittsburg 1899.—*Peters Creek, Pa.*, flag station, one-fourth mile south of; large, two-span, stone arch culvert, first step below coping stone at southeast corner of, 12 feet below top of rail; bronze tablet marked "740 Pittsburg 1899."

P. R. R. No. 19.—*Coal Valley, Pa.*, county bridge over creek, square on coping stone of wall.

767 Pittsburg 1899.—*Thomson, Pa.*, flag station, 125 feet south of signal tower at; 25 feet west of south-bound track, 4 feet above top of rail, north-wing wall of west abutment of double-track truss bridge of Union Railway crossing over tracks of Pennsylvania Railroad; bronze tablet marked "767 Pittsburg 1899."

P. R. R. No. 11.—*Thomson, Pa.*, flag station, one-third mile south of; copper bolt in coping stone at south end of west abutment of Port Perry Railroad bridge across Monongahela River.

760 Pittsburg 1899.—*Bessemer, Pa.*, station, Pennsylvania Railroad, about 1 mile east of; east end of north abutment of double-track bridge of Union Railway over main line of Pennsylvania Railroad, in face of abutment; bronze tablet marked "760 Pittsburg 1899."

P. R. R. No. 88.—*Braddock, Pa.*, station, copper bolt in door sill of door to ladies' waiting room.

P. R. R. No. 92.—*Homewood, Pa.*, station, copper bolt in door sill of.

818 Pittsburg 1899.—*Benvenue, Pa.*, station, one-fourth mile west of; bridge seat at south end of west abutment of girder bridge over Pittsburg Junction Railway tracks; bronze tablet marked "818 Pittsburg 1899."

738 Pittsburg 1899.—*Pittsburg, Pa.* (See page 866.)

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN HARRISBURG AND BRADDOCK, PA.

P. R. R. No. 1.—*Harrisburg, Pa.* Harrisburg passenger station, shelf northeast corner.

No. XXIX.—*Harrisburg, Pa.* (See page 560.)

P. R. R. No. 2.—*Harrisburg, Pa.* D. E. office, square on sill of east front window.

364, Harrisburg, 1899.—*Harrisburg, Pa.* Aluminum tablet in southwest corner front face of State library, marked "364 Harrisburg 1899."

P. R. R. No. 4.—Canal bridge. Copper bolt, south end of east bridge seat.

P. R. R. No. 5.—Susquehanna River bridge. Copper bolt, northeast wing wall.

P. R. R. No. 6.—Susquehanna River bridge. Copper bolt, northwest wing wall.

P. R. R. No. 7.—*Fishing Creek* arch. Copper bolt, southwest end of coping.

P. R. R. No. 8.—*Perdix.* Copper bolt, east abutment, south end of open culvert, 1 000 feet west of station.

P. R. R. No. 9.—*Cove.* Copper bolt, south end of box culvert.

P. R. R. No. 10.—*Cove.* Square in doorsill of brick schoolhouse, 1 500 feet west of *Cove.*

P. R. R. No. 11.—Copper bolt in south end of box culvert, 600 feet east of C-K Tower.

P. R. R. No. 12.—Copper bolt in north end of *Cove Creek* arch.

P. R. R. No. 13.—Copper bolt in northeast wing wall of *Shermans Creek* bridge.

P. R. R. No. 14.—Square in front wall of freight station at *Duncannon.*

P. R. R. B.—*Juniata bridge.* Doorsill of station.

P. R. R. No. 15.—Copper bolt in north end of box culvert 0·8 mile west of *Juniata Bridge* station.

P. R. R. No. 16.—Copper bolt in north end of box culvert 1 700 feet east of *Aqueduct.*

P. R. R. No. 17.—Square in south wing wall of canal aqueduct at *Aqueduct.*

P. R. R. No. 18.—Copper bolt in east abutment, north end of back wall, *Alters Run* bridge.

P. R. R. No. 19.—*Loshs Run* bridge. Copper bolt in north end of arch.

P. R. R. No. 20.—Copper bolt in north end of box culvert 0·7 mile west of *Loshs Run* station.

P. R. R. No. 22.—Copper bolt in south end of box culvert 300 feet east of station *Bailey.*

P. R. R. No. 23.—Copper bolt in north end of box culvert 1·1 miles west of *Bailey* station.

P. R. R. No. 24.—Copper bolt in northeast wing wall of arch culvert 700 feet east of tower at *Trimmers Rock.*

P. R. R. No. 25.—Copper bolt in northeast wing wall of *Little Buffalo Creek* bridge.

P. R. R. No. 26.—Square in front wall of tank house at *Newport.*

P. R. R. No. 27.—Copper bolt in *Big Buffalo Creek* bridge, north parapet, 14 feet east of east springing line.

P. R. R. No. 28.—Copper bolt in north end of box culvert 2 miles west of *Newport.*

P. R. R. No. 29.—Copper bolt in north end of arch culvert 0·3 mile east of *Old Ferry* station.

P. R. R. No. 31.—Shelf, northwest corner of north abutment of overhead bridge at *Millerstown.*

P. R. R. No. 32.—Copper bolt in north end of box culvert 0.8 mile east of *Durward.*

P. R. R. No. 33.—Copper bolt in north end of triple box culvert at *Durward.*

P. R. R. No. 34.—Copper bolt in north end of arch culvert 0·8 mile west of *Durward.*

P. R. R. No. 35.—Shelf, north abutment of overhead bridge at *Thompsontown.*

P. R. R. No. 36.—Copper bolt in north end of box culvert 0·6 mile west of *Thompsontown.*

P. R. R. No. 37.—Copper bolt in north end of box culvert 1·9 miles west of *Thompsontown.*

P. R. R. C.—*Vandyke* station; east end of doorsill.

P. R. R. No. 39.—Copper bolt in south end of pier, double box culvert, 0·5 mile west of *Vandyke* station.

P. R. R. No. 40.—Square in foundation offset, northwest corner of tower at *Tuscarora.*

P. R. R. No. 41.—Copper bolt in north end of east bridge seat under grade road crossing at *Mexico.*

P. R. R. No. 42.—Square in south end of box culvert 1·1 miles east of *Port Royal* station.

P. R. R. No. 43.—Copper bolt in east end of south parapet, *Port Royal* bridge.

P. R. R. No. 45.—Copper bolt in north end of box culvert 100 west of road crossing, 0.3 mile east of *Mifflin* station.

P. R. R. No. 46.—*Mifflin* coal tipple; shelf, north face of pier.

P. R. R. No. 47.—Copper bolt in south end of box culvert 1 mile west of *Mifflin* station.

P. R. R. No. 49.—Copper bolt in south parapet of arch culvert 450 feet east of station *Denholm.*

P. R. R. No. 50.—Copper bolt in north end of box culvert 1·5 miles west of *Denholm* station.

P. R. R. No. 51.—Copper bolt in northeast wing wall of box culvert 0·7 mile west of *Narrows* station.

P. R. R. No. 52.—Copper bolt in north end of box culvert 1·5 miles west of *Narrows* station.

P. R. R. No. 53.—Copper bolt in retaining wall at west end of troughs at *Bixler* water station.

P. R. R. No. 54.—Square in foundation of tower at *Lewistown Junction.*

P. R. R. No. 57.—Copper bolt in second step of northwest wing wall of *Mayes* bridge.

P. R. R. No. 58.—Copper bolt in north end of arch culvert 1 500 feet west of station *Granville*.

P. R. R. No. 59.—*Anderson;* copper bolt in arch culvert 1 200 feet west of passenger station.

P. R. R. No. 61.—Copper bolt in south end of box culvert 0·1 mile east of *Longfellow* station.

P. R. R. No. 62.—Copper bolt in east bridge seat of cattle pass 0·3 mile east of *Horingford* station, 7 feet from south end.

P. R. R. No. 63.—Copper bolt at south end of box culvert 1·2 miles west of *Horingford* station.

P. R. R. No. 64.—Square in window sill of ticket office at *McVeytown*.

P. R. R. No. 65.—Copper bolt in north end of arch bridge No. 141, 1·1 miles west of *McVeytown*.

P. R. R. No. 66.—Copper bolt in north end of box culvert 1·9 miles west of *McVeytown*.

P. R. R. No. 67.—Copper bolt in north end of box culvert 1·1 miles east of *Ryde* station.

P. R. R. No. 68.—*Ryde;* copper bolt in north parapet of Shanks Run arch.

P. R. R. No. 69.—Copper bolt in south abutment, east end of overhead bridge 0.8 mile west of *Ryde*.

P. R. R. No. 70.—Copper bolt in southeast corner, west abutment of *Manayunk* bridge.

P. R. R. No. 71.—Copper bolt in south end of box culvert 1 mile west of *Vineyard* station.

P. R. R. No. 72.—Copper bolt in east end of retaining wall 2 miles west of *Vineyard* station.

P. R. R. No. 73.—Copper bolt in north end of west bridge seat 0·8 mile east of *Newton Hamilton*.

P. R. R. No. 74.—Square in foundation offset, northwest corner of station porch at *Newton Hamilton*.

P. R. R. No. 75.—Copper bolt in south end of west abutment *Mount Union* bridge.

P. R. R. No. 76.—*Mount Union;* on east end of marble window sill, front of bay window of brick house 200 feet east of station.

P. R. R. No. 77.—Copper bolt in west end of retaining wall, 200 feet east of Lock No. 33, 1·4 miles west of *Mount Union* station.

P. R. R. No. 78.—Copper bolt in north end of culvert, 200 feet east of *Jackstown* water station.

P. R. R. No. 79.—Copper bolt in doorsill, east end of freight station at *Mapleton*.

P. R. R. No. 80.—Copper bolt, south parapet, east end of *Vandevander's* bridge.

P. R. R. No. 81.—Copper bolt in south end of box culvert, 500 feet west of canal bridge at *Bridgeport*.

P. R. R. No. 82.—Square in front wall of station at *Mill Creek*.

P. R. R. No. 83.—Copper bolt in south end of arch culvert, 3 000 feet west of *Mill Creek*.

P. R. R. No. 84.—Copper bolt in south end of pier, plate girder, bridge No. 156, 1·7 miles west of *Mill Creek.*

P. R. R. No. 85.—Copper bolt in north end of culvert, 300 feet west of station *Ardenheim.*

P. R. R. No. 86.—Copper bolt in east end of south parapet, *Standing Stone Creek* bridge.

P. R. R. No. 87.—Square in east window sill, women's room, passenger station, *Huntingdon.*

P. R. R. No. 88.—Copper bolt in south end of head-race arch at *Huntingdon.*

P. R. R. D.—Square on rock in borrow pit, 0·7 mile east of *Warrior Ridge* water station.

P. R. R. No. 90.—Copper bolt in doorsill of *Warrior Ridge* pump house.

P. R. R. No. 91.—Copper bolt in south end of box culvert, 1·4 miles east of *Petersburg* station.

P. R. R. No. 92.—Copper bolt in doorsill of freight room at *Petersburg.*

P. R. R. No. 93.—Copper bolt on retaining wall 20 feet west of *Neff's* overhead bridge.

P. R. R. No. 94.—Shelf in southwest wing wall of overhead bridge, public road.

P. R. R. No. 95.—Square in northwest wing wall of *Shuman's* bridge.

P. R. R. No. 96.—Square, 50 feet from west end of rock cut, 0·3 mile east of *Barree* station.

P. R. R. No. 97.—Copper bolt in south end of box culvert, 0·4 mile west of *Barree* station.

P. R. R. No. 98.—Shelf, north side, east end of *Tunnel.*

P. R. R. No. 99.—Shelf, south side, west end of *Tunnel.*

P. R. R. E.—Copper bolt in rock 30 feet east of back wall, east abutment of *Little Juniata Bridge No. 1.*

P. R. R. No. 101.—Copper bolt in north end of back wall, west abutment of *Little Juniata Bridge No. 2.*

P. R. R. No. 102.—Copper bolt in culvert, north end of arch, Arch Run, *Union Furnace.*

P. R. R. No. 103.—Copper bolt in rock 90 feet east of back wall, east abutment of *Little Juniata Bridge No. 6.*

P. R. R. No. 104.—Iron bolt in north end of east abutment of undergrade road crossing at *Shoenberger.*

P. R. R. No. 105.—Copper bolt in west end of south parapet, *Little Juniata Bridge No. 10.* (Raised 1 foot.)

P. R. R. No. 106.—Copper bolt, north end of arch, 200 feet east of *Birmingham.*

P. R. R. No. 107.—Copper bolt, west end of south parapet, *Little Juniata Bridge No. 11.*

P. R. R. No. 108.—Copper bolt, west end of south parapet, *Little Juniata Bridge No. 12.*

P. R. R. No. 109.—Copper bolt in north end of box culvert, *Tyrone* water station.

P. R. R. No. 110.—Shelf, base course, front of passenger station at *Tyrone.*

P. R. R. No. 111.—Copper bolt in south end of box culvert, 0·7 mile west of *Tyrone* station.

P. R. R. No. 112.—Copper bolt, east abutment wall, south end of bridge seat, *Little Juniata Bridge No. 13*.

P. R. R. F.—Square in rock, south side, about 1 000 feet west of west abutment, *Little Juniata Bridge No. 13*.

P. R. R. No. 113.—Copper bolt, south end arch, bridge No. 182, 0·6 mile west of *Grazierville*.

P. R. R. No. 114.—Square in front wall of station, *Tipton*.

P. R. R. No. 115.—Copper bolt in north end of arch, bridge No. 184, 0·2 mile east of *Fostoria*.

P. R. R. No. 116.—Shelf in south abutment of overhead road bridge, *Bellwood*.

P. R. R. No. 117.—Copper bolt, north wing wall, east abutment, Sugar Run bridge, 1·2 miles west of *Bellwood* station.

P. R. R. No. 118.—Copper bolt, north end of east bridge seat, undergrade farm road, *Elizabeth Furnace*.

P. R. R. No. 119.—Copper bolt, south end of back wall, east abutment, girder bridge, milepost 233 from Broad Street station.

P. R. R. No. 120.—Copper bolt in doorsill of station, *Blair Furnace*.

P. R. R. No. 121.—Shelf, north abutment of *Red Bridge*.

P. R. R. No. 122.—Copper bolt, north end of arch, *Haggerty Run*.

P. R. R. No. 123.—Copper bolt, south doorsill of roundhouse at *Altoona*.

P. R. R. No. 124.—Shelf, Fourth street bridge, north pier, at *Altoona*.

P. R. R. No. 125.—Shelf, south pier, Seventh street bridge at *Altoona*.

P. R. R. No. 126.—Copper bolt in doorsill of passenger station at *Altoona*.

P. R. R. No. 127.—Shelf, north abutment, Seventeenth street bridge at *Altoona*.

P. R. R. No. 2.—Copper bolt in rock opposite watchhouse, *Kittanning Point*.

P. R. R. No. 3.—Copper bolt in rock 30 feet north of center line, east end of cut, 400 feet west of *Allegrippus*.

P. R. R. No. 4.—Copper bolt in rock in south side of cut, 650 feet east of *Bennington*.

P. R. R. No. 5.—Copper bolt in second course, north side, east end of *Allegheny Tunnel*.

P. R. R. No. 6.—Copper bolt in doorsill of supervisor's house at *Gallitzin*.

P. R. R. No. 7.—Copper bolt in south parapet of road arch at *Cresson*.

P. R. R. No. 8.—Copper bolt in north parapet of arch culvert, 1 mile east of *Lilly*.

P. R. R. No. 9.—Copper bolt in bridge seat, west abutment, between track No. 3 and siding, girder bridge 800 feet west of *Lilly*.

P. R. R. No. 12.—Shelf, rock in south side of cut 870 feet east of *Portage*.

P. R. R. No. 13.—Shelf, rock in south side of cut 1·15 miles west of *New Portage* station.

P. R. R. No. 14.—Square in front wall of station, *Wilmore*.

P. R. R. No. 15.—Copper bolt, north parapet, east end of *Little Conemaugh Bridge No. 1*.

P. R. R. No. 16.—Copper bolt in north parapet, east end of *Little Conemaugh Bridge No. 3*.

P. R. R. No. 17.—Copper bolt in east end of retaining wall at *Ehrenfeld*.

P. R. R. No. 18.—Copper bolt in east end of north parapet, *Little Conemaugh Bridge No. 5*.

P. R. R. No. 20.—Copper bolt, east end of south parapet, *Conemaugh Viaduct.*

P. R. R. No. 21.—Copper bolt in doorsill of station, *Mineral Point.*

P. R. R. No. 22a.—Shelf, east face of rock, 1·3 miles west of *Mineral Point* station.

P. R. R. No. 23.—Square, corner of coping, Cambria Iron Company's dam, 1·52 miles west of *Mineral Point* station.

P. R. R. No. 24.—Square, west end of south parapet, *Little Conemaugh Bridge No. 6.*

P. R. R. No. 26.—Copper bolt in doorsill at east end of roundhouse, *Conemaugh.*

P. R. R. No. 27.—Shelf, north pier, Third street bridge at *Woodvale.*

P. R. R. No. 28.—Shelf, window sill of ticket office, passenger station, *Johnstown.*

P. R. R. No. 28a.—Copper bolt in west end of north parapet, *Johnstown* bridge.

P. R. R. No. 30a.—Copper bolt in rock at spring, south side, 0·09 mile east of *Sang Hollow.*

P. R. R. No. 31.—Shelf, east end of retaining wall, *Sang Hollow.*

P. R. R. No. 34.—Copper bolt, rock in cut, south side, 0·11 mile east of N–R tower.

P. R. R. No. 36.—Copper bolt, east end of arch, south parapet, *Big Spring Run.*

P. R. R. No. 36a.—*Piney Run;* copper bolt, north parapet, east end of arch, bridge No. 226, 0·17 mile west V–K tower.

P. R. R. No. 36b.—Copper bolt in south end of double box culvert, 1·7 miles east of *New Florence* station.

P. R. R. No. 37.—Copper bolt, arch, northeast end of parapet, 0·57 mile east of *New Florence* station.

P. R. R. No. 37a.—Square, doorsill of brick hotel at *New Florence.*

P. R. R. No. 40.—Copper bolt, box culvert, north end J. D. tower.

P. R. R. No. 41.—Shelf, rock, south side of cut, opposite milepost 292, 1·2 miles east of *Lockport.*

P. R. R. No. 42.—Square, doorsill, *Lockport* station.

P. R. R. No. 43.—Copper bolt, south end, west end parapet, road arch, *Bolivar Junction.*

P. R. R. No. 44.—Copper bolt, northeast wing wall *Bolivar* Viaduct.

P. R. R. No. 44a.—Copper bolt, southwest wing wall *Bolivar* Viaduct.

P. R. R. No. 45.—Copper bolt, rock, south side, 0·09 mile west of I–J tower.

P. R. R. No. 46.—Square, rock 30 feet north of center line, 600 feet west of station, *Pack Saddle.*

P. R. R. No. 46a.—Shelf, rock 50 feet east watchhouse, south of tracks, *Pack Saddle.*

P. R. R. No. 47.—Square, stone monument, 26·5 feet south of tool house, *Blairsville Intersection.*

P. R. R. No. 48.—Copper bolt, arch, east end of north parapet, 1·1 miles west of *Blairsville Intersection.*

P. R. R. No. 51.—Shelf, north abutment, overhead bridge, *Millwood.*

P. R. R. No. 52.—Copper bolt, arch culvert, south end, 0·47 mile west of *Millwood* station.

P. R. R. No. 53.—Copper bolt, north end of pier, open bridge, *Derry.*

P. R. R. No. 54.—Square, base course on east side roundhouse, *Derry.*

P. R. R. No. 56.—Square, rock on north side, 300 feet west of station, *Bradenville.*

P. R. R. No. 56a.—Square, rock on south side, 500 feet west of station, *Bradenville.*

P. R. R. No. 57.—Square, north pier, overhead bridge, *Loyalhanna.*

P. R. R. No. 58.—Square, doorsill, passenger station, *Latrobe*.

P. R. R. No. 58a.—Square, northeast wing wall, county bridge, Loyalhanna Creek, *Latrobe*.

P. R. R. No. 59.—Shelf, north abutment, overhead bridge, 1·48 miles west of *Latrobe*.

P. R. R. No. 60.—Square, front wall, freight station, *Beatty*.

P. R. R. No. 61.—Shelf, rock at tool house, *Carney*.

P. R. R. No. 62.—Shelf, west end, south side, *Carrs Tunnel*.

P. R. R. No. 63.—Square, south pier, overhead bridge, *George*.

P. R. R. No. 65.—Shelf, east end, north side, *Greensburg Tunnel*.

P. R. R. No. 66.—Square, east wall, freight station, *Greensburg*.

P. R. R. No. 67.—Shelf, 8 feet inside east end new tunnel, *Radebaugh*.

P. R. R. No. 68.—Shelf, west end old tunnel, south side, *Radebaugh*.

P. R. R. No. 68a.—Shelf, 10 feet inside west end new tunnel, *Radebaugh*.

P. R. R. No. 69.—Square, northwest wing wall, double box culvert, *Radebaugh*.

P. R. R. No. 69a.—Square, west end, box culvert, east leg of "Y," *Radebaugh*.

P. R. R. No. 70.—Copper bolt, south end, box culvert, 0·83 mile east of *Grapeville*.

P. R. R. No. 71.—Square, base course in west bay window, brick dwelling 300 feet east of station, *Grapeville*.

P. R. R. No. 72.—Square, stone monument opposite station, 34 feet from center line, *Penn*.

P. R. R. No. 72a.—Square, 120 feet east of retaining wall, south side of rock cut, 0·58 mile west of *Penn*.

P. R. R. No. 73.—Copper bolt, east end of south parapet, Brush Creek bridge, 0.28 mile east, *Manor*.

P. R. R. No. 76a.—Copper bolt, west end of north back wall Youghiogheny Railroad bridge, *Irwin*.

P. R. R. No. 77a.—Shelf, retaining wall, north side, 0·58 mile west of *Larimer*.

P. R. R. No. 78.—Copper bolt, west end, north parapet, Brush Creek bridge, 600 feet west of *Ardara*.

P. R. R. No. 81.—Square, stone monument, 75 feet south of center line, at station, *Moss Side*.

P. R. R. No. 82.—Square, stone monument, east side of station, *Wall*.

P. R. R. No. 84.—Square, 33 feet south of center line, 625 feet east, *Turtle Creek*.

P. R. R. No. 85.—Shelf, pier, overhead bridge, 0·23 mile west of East Pittsburg, *Brinton*.

P. R. R. No. 86.—Square, doorsill of station, *Brinton*.

P. R. R. No. 88.—*Braddock, Pa.* (See page 868.)

THE ORTHOMETRIC CORRECTION.

As the orthometric correction has not been applied in deriving the adopted elevations given on pages 472–548, it is in order to explain the reason for the omission.

The mean surface of the sea is approximately an ellipsoid of the revolution which may be considered to be generated by the rotation of an ellipse about its shorter axis which is in coincidence with the axis of the earth. Any other equipotential surface above mean sea level is a similar ellipsoid of revolution. The distance between the sea surface considered produced under the land, and a given equipotential surface above it, necessarily increases as the equator is approached. If, then, a line of levels run along a median indicates that a series of bench marks are all at the same level, said bench marks all lie, except for errors of observation, in the same equipotential surface, but the bench marks on the southern end of the line are farther from sea level than those on the northern end.

The correction to differences of elevation observed with the leveling instrument, which is known as the orthometric correction, and is due to this convergence of the equipotential surfaces toward the north, may be expressed by the formula $-5^{mm}.22h \, \Delta \phi \sin (\phi_1 + \phi_2)$, in which h is the mean elevation in metres of the line of levels; $\Delta \phi = \phi$ of higher point minus ϕ of lower point, expressed in radians; and ϕ_1 and ϕ_2 are the latitudes of the two points. The formula applies strictly only to points which are near each other. For points at great distances apart the correction must be obtained by integration of the small corrections to the separate short portions of the level line between them.

From the formula it is evident that the correction is zero on an east and west line. For a level line along a meridian the effect of the correction is always to increase the computed elevations at the northern end of the line. The correction is proportional to the mean elevation of the line of levels; tends to be greatest in latitude 45°, and is in millimetres per kilometre greater for a line along a meridian than for one in any other direction.

Two lines of thought have lead to the decision to ignore the orthometric correction. Firstly, though this correction is familiar to geodesists, it is not well known among other engineers, and is likely to be misunderstood by them. Indeed, as seen from the ordinary point of view of the engineer, the application of this correction would lead to apparent absurdities. Secondly, though to apply the correction it is necessary to do a large amount of computing, the outcome would be to change the final elevations resulting from the net adjustment by amounts which would be nearly, if not always, less than the probable errors of those elevations.

To illustrate the apparent absurdities to which the application of the orthometric correction may lead, let us suppose that a long series of simultaneous readings of two gauges have been made at the Straits of Mackinac and at Port Huron, on Lake Huron, and that these readings indicate that two bench marks near the respective gauges are at the same elevation. If now the formula given above be used to correct for the convergence of the mean lake surface and the mean sea surface toward the northward, it will be found that the bench mark at Port Huron is really 45·7 millimetres[1] farther from mean sea level than the one at the Straits of Mackinac, and its corrected elevation will be greater by that amount. The apparent result of the computation is to indicate that the water flows up a grade from the Straits of Mackinac to Port Huron. Such a paradox is liable to be misunderstood unless one is thoroughly familiar with all the ideas concerned.

The orthometric corrections to the transcontinental line of levels from Sandy Hook to Denver would everywhere be very small, because the line is nowhere far from the thirty-ninth parallel of latitude. On the other hand the total orthometric correction to the elevation of bench mark V, at Odin, Ill., as derived from the line run almost due north from Biloxi to Odin, the direction which tends to give the maximum correction

[1] In making this computation the elevation of the surface of Lake Huron is assumed to be 177 metres and the latitudes of the points named to be 45° 50′ and 43° 00′.

is only -68 millimetres,[1] or only $-0·06$ millimetre per kilometre of distance run. The maximum orthometric correction expressed in millimetre per kilometre, on any of the lines yet leveled in the United States, occurs on the line Colorado Springs to Denver, where it amounts to -158 millimetres[2] on 121 kilometres or about $-1·3$ millimetres per kilometre. In view of the fact that the greatest extension of the level net is from east to west; that but few lines east of Kansas City are above an elevation of 300 metres, and that the mean latitude of the tidal connections is very nearly the same as the mean latitude of the net, it makes very little difference in the elevations resulting from the adjustment of the net whether the orthometric correction is applied before making the adjustment or is ignored. There are probably but few points in the net east of Kansas City of which the elevation would be changed by as much as 5 centimetres if a new adjustment were made after applying the orthometric correction, and on all lines except those in Colorado and Wyoming the change in the relative elevations would be much less than 1 millimetre per kilometre. The maximum change in elevation produced by applying the orthometric correction would occur at Rock Creek, Wyoming, where it would be about 0·5 metre.

EXPLANATION OF ERROR WHICH IS SYSTEMATIC WITH RESPECT TO DIRECTION.

In the preceding pages the fact that an error which is systematic with respect to direction exists in the old Coast and Geodetic Survey leveling, and the quantitive expression of that error have both been established by a purely inductive method, by an appeal to the observed facts without reference to any theory. It is now proposed to set forth a rational explanation for the existence of this systematic error. It is interesting to note that this order of treatment of the subject corresponds with the order in which the actual investigation was made. It was first established by an appeal to the facts that said law of error existed, and the explanation of the law was discovered later.

It is desirable at this point to get the subject into proper perspective by noting the extreme smallness of the errors to be explained. The maximum value of the error according to the constants given on page 446 is only 1·25 millimetres per kilometre. This corresponds to a vertical angle of only $0''·25$. The maximum correction in millimetres per kilometre to any line in the final general adjustment, as shown by columns 7 and 8 on pages 439-440, namely, 1·65 millimetres per kilometre on the line Corinth to Meridian corresponds to a vertical angle of only $0''·33$. When one considers that two stars separated by such an angular interval are distinguishable as separate stars only by very powerful telescopes of much larger dimensions than the level telescope, one begins to realize the accuracy of the leveling. When it is considered that a reading on a line of the diaphragm as seen projected against the rod may be, and often is, in error from all causes by as much as 3 millimetres on a sight of 50 to 100 metres, it will be realized that the errors on long lines commented on above indicate success in balancing errors against each other and in their elimination. Finally, if one notes that among the 21 Engineers' lines, including water levels on the Great Lakes, the maximum rate of correction given by the final adjustment, which occurs on the line Rayville to Vidalia, is

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[1] This value was computed by dealing with the separate short sections of the line and adding results.

[2] This value has not been computed accurately, but is the result of applying the formula to the whole line at once with the assumption that the mean elevation of the line = 1 860 metres and the two latitudes are 38° 49′ and 39° 46′.

only 0·17 millimetre per kilometre, corresponds to a vertical angle of only 0″·03, one is inclined to wonder at the accuracy attained rather than to look for explanations of the exceedingly small outstanding errors.

It will probably be conceded by all who are familiar with instruments of precision, and with the particular instruments herein described and the conditions under which they are used in the field, that unequal though small changes of temperature are continually taking place in different parts of the leveling instrument while in use; that these unequal changes of temperature produce continual small changes in the relative positions of the different parts of the instrument; that all portions of the instrument on the side from which the greatest amounts of heat are being received tend to assume higher temperatures than those on the opposite side, and that in general the instrument receives more heat from the side toward the sun at any given time than from other directions, even though the immediate source of heat is not the sun (from the direct rays of which the instrument is always protected), but inner surface of the tent or umbrella, surrounding ground, etc. Changes of the kind outlined above, occurring in parts of the instrument which are below the line of collimation of the telescope, can be shown to have but little influence upon the final results, while similar changes taking place above that line can be shown to have marked effects.

One effect of unequal changes of temperature occurring above the line of collimation is to change the angle between the tangent to the level vial at its middle point and the line of collimation. As soon as the telescope and striding level are placed in a given position the parts which are toward the source of heat (the sun) tend to assume a higher temperature than the opposite parts, and the effect of the unequal expansion of the collars of the telescope and of the legs of the striding level, and of distortion of the level vial itself, is to cause the bubble to crawl slowly toward the source of heat. If later the telescope or striding level is reversed, a new set of unequal changes of temperature commences, of which the effect again is to make the bubble move toward the source of heat. Thus the bubble always tends to be nearer the sun than it would be if all parts of the instrument were always at the same temperature. The ultimate effect of this is to tend to make all readings upon rods toward the sun from the instrument too small after correction for T—H (measured angle between target and horizon) and all readings upon rods away from the sun too large after correction for T—H. These errors combine in their effect upon the computed elevations and tend to make all elevations carried toward the sun too great, and vice versa.

Is this explanation quantitatively sufficient to account for the systematic errors which have been put in evidence? Do the laws of error corresponding to this explanation agree with the actual results of the leveling?

To study this matter in detail let it be supposed that a level line is being run directly toward the sun and that the programme of observation is that shown on page 417, for a double simultaneous line using rods P and Q, Q always being read last, and let the effects of unequal expansion of the telescope collars, of unequal expansion of the legs of the striding level, and of distortion of the level vial, be considered separately.

As soon as the telescope is placed in position for the backsight the object-end collar begins to acquire a temperature lower than that of the eye-end collar. This makes the reading on the back rod after correction for T—H (angle between target and horizon as measured with the micrometre) greater than it would be if the collars remained of the same temperature. This excess will continue to increase throughout the programme for the backsight, as there is and can be no interchange of collars. It will therefore be greater during the readings on the Q rod than during those upon the P rod. As soon as the telescope is placed in position for the foresight the object-end collar, now toward the sun, tends to become the larger and the corrected rod reading tends to become smaller than it would be with collars of equal temperature. Here again the error on the Q rod will be greater than that on the P rod and of the same sign. The effects on the backsight and foresight combine to make the derived elevation from each line for the case in hand too great, and to make the error greater for the Q line than for the P line.

To avoid circumlocution, the separate rod readings have been compared above with what they would have been with an instrument maintaining a uniform temperature. But it is evident that the whole change in the relative temperature of the two collars between a backsight and the corresponding foresight is effective in producing errors.

A numerical result of the error from this source may be made. The radius of the collar of Coast and Geodetic Survey level No. 5 is 18 millimetres, the distance between the collars is 165 millimetres, the coefficient of expansion of the collar (bell metal) is about 0·000018 per degree Centigrade. A change of 0·1 degree Centigrade in the relative temperature of the two collars between the backsight and the foresight will change the angle between the line of collimation and the tangent at the middle point of the level vial by

$$tan^{-1}\frac{(18)\ (0{\cdot}000018)\ (0{\cdot}1)}{165}=0''{\cdot}04.$$

This systematic error of 0″·04 corresponds to 0·2 millimetres per kilometre.

During the readings upon the back rod the striding level is reversed four times, as shown in the programme. As soon as the striding level is put in a given position the leg toward the sun tends to become longer. Although the frequent reversals tend to keep the two legs at the same temperature, the average temperature of the object-end leg during the backsight will be less than that of the eye-end leg, and during the foresight will tend to be greater than that of the eye-end leg. This will make the corrected readings on the back rod too great and on the front rod too small, and these two results combine to make the reduced elevations too great in the case under consideration. The only difference between the P rod and the Q rod readings with respect to this error is that the first level reading corresponding to the Q rod is taken after the level has had more time to accumulate error since the last change in its position than it had had when the corresponding level reading for the P rod was taken (see programme, page 417). The error from this cause on the Q line will tend therefore to be of the same sign and a little greater than on the P line.

On Coast and Geodetic Survey level No. 5, the distance between the legs of the level is 165 millimetres; the height from the points of contact of the legs with the collars and the axis of the level vial is about 45 millimetres, and the coefficient of expansion of the legs is about 0·000018 per degree Centigrade. If the average relative temperature of the object-end and eye-end legs during the foresight differs by 0°·1 Centigrade from the corresponding quantity during the backsight, the change in the average angle between the line of collimation and the tangent at the middle point of the level vial is about

$$tan^{-1}\frac{(45)\ (0{\cdot}000018)\ (0{\cdot}1)}{165}.=0''{\cdot}10.$$

This systematic error of 0″·10 corresponds to 0·5 millimetre per kilometre.

One may easily convince himself by direct experiment with a level vial that the effect of a source of heat placed near one end of it is to make the bubble crawl toward that end, even without any change of temperature in the metal supports of the vial. Such movements of the bubble, due to distortion of the vial itself, are, therefore, of the same sign as those due to expansion and contraction of the legs of the level, and will therefore simply serve to increase the errors due to temperature changes in the legs. In this case again the tendency will be for the Q line to be slightly more in error than the P line.

To sum up, the errors due to unequal expansion of the telescope collars and of the legs of the striding level and to distortion of the level vial are all systematic; they all tend to make deduced elevations too great when running toward the sun, and vice versa. These errors tend to be greater for the Q line than for the P line and of the same sign for both.

If it be assumed on a given line of levels that the distortion of the level vial produces errors half as great as those produced by the unequal expansion of the legs of the striding level, that the average temperature of the leg of the striding level toward the sun is $0^\circ.04$ Centigrade higher than the temperature of the other leg, and that the average temperature of the collar toward the sun is $0^\circ.1$ Centigrade higher than the other collar, then the systematic error introduced by these three causes will be 1 millimetre per kilometre.

During the progress of the leveling along the given line the sun is steadily changing in azimuth during each day, and the systematic error at present under consideration is undergoing corresponding changes. The systematic error remaining in the final result from a long line of levels will be that corresponding to the average direction of the level line and the average effective azimuth of the sun during the hours of observation. This average effective azimuth will be a little west of south, both because the afternoon period of observation is upon an average slightly longer than the forenoon period and because of heat reflected from the ground and other objects toward the instrument from the direction of the sun will be much greater during the comparatively dry afternoon hours than during the moist morning hours. This agrees with the fact that the zero line for the systematic correction as derived from the observations is a little north of west. (See p. 446.)

These systematic temperature errors should be expected to be much smaller in cloudy than in sunny weather; much smaller on the line run in the shade of trees or over grass than on the line unshaded from the sun or over the bare ballast of a railroad track, and should be expected to depend intimately upon the care taken to protect the instrument from the sun and from reflected heat from surrounding objects. The resulting systematic errors on various lines due to this cause may therefore be expected to vary widely.

The explanation given on the preceding pages indicates not only that the errors should be numerically greater on the Q line than on the P line, and of the same sign, but also that the divergence between the Q line and the P line should be systematic with respect to the direction of the line just as the error of the mean line is systematic with respect to direction. Do the facts agree with these necessary consequences of the explanation put forward?

There are four of the Coast and Geodetic Survey lines on which the programme indicated on page 417 was used for which the true correction is known with a fair degree of accuracy. For these the relation between the correction to the P line and the correction to the Q line is shown below.

Line.	Discrepancy, P–Q.	Required correction.		
		To mean.	To P line.	To Q line.
Richmond to Georgetown, 1895	+102	+266	+215	+317
Limon-Roswell-Denver-Limon	+191	+292	+197	+388
St. Augustine to Cedar Keys, 1893	− 20	−237	−227	−247
Vicksburg to Meridian	+104	+314	+262	+366

The corrections stated for the first and third lines are those necessary to make the leveling agree with the tidal observations. The correction stated for the fourth line is that resulting from the final adjustment of the level net. The correction to the second line is that necessary to make the circuit close. These four lines are the only ones available for this test in which the program on page 417 was used on the whole of the line between the points at which the corrections to the elevations are known. It will be noted that in each one of the four cases shown the corrections to both lines are of the same sign, and in every case the Q line has the greater correction, in accordance with the theory of the systematic error stated on the preceding pages.

A careful examination of all the available lines was made to determine whether the relation between the total discrepancy, P–Q, on a line and the direction of the line was that called for by the theory stated above. The theory indicates that the sign of the total discrepancy, P–Q, on any line should be plus for the line running a little east of north, and minus for a line in the opposite direction; that the discrepancy expressed in millimetres per kilometre should be a maximum in these directions, and on lines at right angles to these directions the discrepancy, P–Q, should be very small. The details of the investigation are too voluminous to be given here. A total of nearly 2 400 kilometres of line was examined and of these lines 57 per cent showed the discrepancy, P–Q, in agreement with the theory, and 43 per cent disagreed with the theory. The discrepancies of those lines which agreed with the theory were, however, about three times as large as for those lines which disagreed.

A second test of the same matter of the relation between the discrepancy, P–Q, and the direction of the line was made by examining these same lines[1] by separating them into sections at points where there were marked changes in the general direction of the line, and comparing the rate of divergences of the P and Q lines on each section with the rate of divergence on the preceding and following sections. If the theory advanced is correct, whenever the direction of the line changes in such a way as to approach the direction 12° west of south, the minus rate of divergence between the P and Q lines should increase, and if the change of direction is such as to make it approach 12° east of north, the plus divergence should increase. The examination showed that out of 2 300 kilometres examined 82 per cent agreed with the theory and 18 per cent disagreed.

[1] The Richmond-Georgetown line was omitted in this test because its direction is nearly constant.

SETTLING AND RISING OF RODS AND INSTRUMENT.

The literature of precise leveling indicates that in general a systematic settling of the instrument and of the rods has been feared. A minority have also expressed a suspicion that a systematic rising of instrument and rods may also occur.

If a rod settles after a foresight is taken upon it and before the backsight is taken, the computed elevations beyond this point of the line will be too great by the amount of the settling, for in the computation the same elevation is ascribed to the rod after the settling actually took place as before. Similarly, if the instrument settles between a backsight and the corresponding foresight taken afterwards, the computed elevation will be too great beyond this point for the same reason. So for the ordinary programs of observation in which the backsight is taken at each instrument station before the foresight, the effect of settling of either the instrument or rods will be to make all computed elevations too great in the direction in which a line was run, irrespective of the grades. If then a line is run forward and backward independently the sign of the divergence of the elevations, forward minus backward (F–B) should be plus, if a systematic settling of instrument and rods is its principal cause. Even if systematic settling is an important source of such divergence, though its effects are partially concealed on each separate line by other larger errors, the mean value of F–B from many lines should still have the plus sign.

The following tables were compiled for the purpose of determining whether there is a systematic tendency for the instruments and rods to settle:

Errors due to settling.

UNITED STATES COAST AND GEODETIC SURVEY.

Lines.	Length.	F – B
	km.	*mm.*
Corinth–Memphis	151	− 99·5
Etlah, Mo.–Jefferson City	195	− 48·6
Beilas Landing, La.–Millikens Bend, La	102	− 2·2
Millikens Bend, La.–Greenville, Miss	168	+ 31·3
Citronelle, Ala.–Quitman, Miss	110	− 2·9
Quitman, Miss.–Meridian, Miss.	27	+ 19·2
Annapolis–Washington	60	*a*−114·0
Wilkersons Landing, Miss.–Little Rock, Ark	184	+ 87·6
Jefferson City–Holliday, Kans.	481	− 43·0
Okolona, Miss.–Greenfield, Tenn	265	−114·5
Greenfield, Tenn.–Villa Ridge, Ill	128	*a*−309·6
Sandy Hook–Red Bank, N. J.	27	− 11·1
Red Bank, N. J.–South Amboy, N. J	53	− 23·0
South Amboy, N. J.–Fort Wadsworth, N. Y.	81	− 5·6
Fort Wadsworth, N. Y.–Hunters Point, N. Y.	105	− 0·3
Hunters Point, N. Y.–Dobbs Ferry, N. Y	144	+ 0·8
B. M. 55, N. Y.–Elizabethport, N. J	92	+ 16·4
Mobile–New Orleans	232	+ 1·6
Sums.	2 605	−617·4

F − B is + in 6 cases and − in 12.

The average value of F − B = $\frac{-617·4}{2\,605}$ = − 0·24 millimetre per kilometre.

a Even if these two values, which seem abnormally large, are omitted the average value of F − B = $\frac{-193·8}{2\,417}$ = − 0·08 millimetre per kilometre.

Errors due to settling—Continued.

UNITED STATES ENGINEERS.

Lines.	Length.	F − B
	km.	*mm.*
Decatur, Ala.-Corinth, Miss	173	− 2·2
Riverton, Ala.-Pittsburg Landing, Tenn	78	− 12·3
Carrollton, La.-Biloxi, Miss	140	− 68·4
Grafton, Ill.-Cairo, Ill	345	−219·8
Keokuk, Iowa-Grafton, Ill	242	− 62·8
Keokuk, Iowa-Fulton, Ill	267	+ 29·6
New Orleans-South Pass	164	− 63·8
St. Joseph, Mo.-Mouth of Missouri	618	− 4·1
Sioux City, Iowa-St. Joseph, Mo	370	+184·3
St. Paul, Minn.-Savanna, Ill	485	− 30·4
Duluth-St. Paul	251	− 37·4
Fulton, Ill.-Chicago	261	+ 12·6
Sums..	3 394	−274·7

F − B is + in 3 cases and − in 9.

The average value of $F - B = \frac{-274{\cdot}7}{3\ 394} = -0{\cdot}08$ millimetre per kilometre.

These tables show a slight indication that there is more of a systematic tendency for the instruments and rods to rise than to settle. It is probable that under certain sets of conditions there is a systematic tendency to settle and under other conditions to rise. In either case an error will be introduced into the computed elevations. To properly guard against such errors, regardless of whether the systematic tendency is to settle or to rise, it is evident that the proper precaution is to run independently in the forward and back direction over each section of the line before the conditions have had much time to change, say within a few days. The precaution of taking the foresights at alternate stations before the corresponding backsights will have a decided tendency to eliminate on each running of the line any error which might otherwise be caused by systematic rising or settling of the instrument, but no such precaution is available against the systematic movements of the rods.

GENERAL INFORMATION IN REGARD TO COAST AND GEODETIC SURVEY LINES PREVIOUS TO 1899.

Besides the investigations indicated in the preceding test, various other attempts were made to determine the laws governing the systematic errors in the old Coast and Geodetic Survey leveling, each of which gave a negative or inconclusive result. The following tables giving various items of information in regard to Coast and Geodetic Survey leveling will serve to enable one to make various such tests. A study of these tables in connection with the corrections shown by the general adjustment of the level net will indicate, for example, that the marked improvements made in the rods apparently were not followed by an appreciable increase in accuracy. This indicates that the principal errors were not those due to the rods. Similarly, an examination of the table indicates that the lines which were run continuously in one direction are not appreciably less accurate than those which are run independently in the forward and back direction, or of which alternate sections were run in opposite directions. This indicates that the errors due to rising or settling of instrument and rods did not predominate over other errors. It is not conclusive, however, as an indication that errors due to rising or settling do not exist in these observations, for the other errors involved are so large that they might effectually mask an error even as great as 0·2 millimetre or 0·3 millimetre per kilometre.

Line.	Date.	Observer.	Method.	Instrument.	Rods.
Carrollton, La., to Red River Landing, La.	1879–80	A. B.	D. S.	1	A, B
Red River Landing, La., to Biela's Landing, La.	1880–81	A. B.	D. S.	1	A, B
Biela's Landing, La., to Millikens Bend, La.	1880–81	J. B. W	F. and B.	3	E, F
Millikens Bend, La., to Greenville, Miss.	1880	O. H. T J. B. W	F. and B.	3, 36	C, D, E, F
Wilkersons Landing, Miss., to Little Rock, Ark.	1887–88	J. E. McG. J. N	F. and B.	2	A, B
Little Rock, Ark., to London, Ark.	1888	I. W P. A. W	F. and B.	2, 3	B, C, D
London, Ark., to Van Buren, Ark.	1889	I. W J. H. G F. A. Y	F. and B.	5, 6	L, M, O
Van Buren, Ark., to Chester, Ark.	1893	I. W	D. S.	5	I, K
Chester, Ark., to Lamar, Mo.	1894	I. W	D. S.	5	I, K
Lamar, Mo., to Olathe, Kans.	1893	I. W	D. S.	5	I, K
Old Point Comfort, Va., to Richmond, Va.	1884	J. B. W	D. S.	1	E, F
Old Point Comfort, Va., to Richmond, Va.	1891–92	I. W	F. and B.	5, 6	I, K
Richmond, Va., to Washington, D. C.	1883–84	J. B. W	D. S.	1	E, F
Richmond, Va., to Washington, D. C.	1895	I. W	D. S.	5	P, Q
Washington, D. C., to Annapolis, Md.	1875	F. W. P.	F. and B.	21	(?)
Washington, D. C., to Hagerstown, Md.	1883	J. B. W	D. S.	1	A, B
Corinth, Miss., to Memphis, Tenn.	1890–91	I. W F. A. Y	F. and B.	5, 6	N, O
St. Augustine, Fla., to Cedar Keys, Fla.	1892	I. W F. A. Y	F. and B.	5, 6	I, K, N, O
St. Augustine, Fla., to Cedar Keys, Fla.	1893	I. W	D. S.	5	N. O
St. Augustine, Fla., to Cedar Keys, Fla.	1894	I. W	D. S.	Van Orden.	Van Orden.
Vicksburg, Miss., to Meridian, Miss.	1896–97	I. W	D. S.	5	P, Q
St. Louis, Mo., to New Haven, Mo.	1882	A. B.	D. S.	1	E, F
New Haven, Mo., to Jefferson City, Mo.	1888	G. B. I. W	F. and B.	2	A, B, C, D
Jefferson City, Mo., to Olathe, Kans.	1891	I. W F. A. Y	F. and B.	5, 6	N, O
Holliday, Kans., to Salina, Kans.	1895	I. W	D. S.	5	P, Q
Salina, Kans., to Ellis, Kans.	1896	I. W	D. S.	5	P, Q
Ellis, Kans., to Hugo, Colo.	1897	I. W	D. S.	5	P, Q
Hugo, Colo., to Colorado Springs, Colo.	1898	I. W	D. S.	5, 6	P, Q
Colorado Springs, Colo., to Limon, Colo.	1898	I. W	D. S.	5, 6	P, Q

Line.	Date.	Observer.	Method.	Instrument.	Rods.
Sandy Hook, N. J., to St. Louis, Mo.	1878-82	A. B.	D. S.	1	A, B, E, F
Odin, Ill., to Villa Ridge, Ill.	1885	J. B. W	D. S.	1	E, F
Villa Ridge, Ill., to Greenfield, Tenn.	1888-89	I. W P. A. W.	F. and B.	2, 3	C, D
Greenfield, Tenn., to Okolona, Miss.	1889-90	I. W F. A. Y	F. and B.	5, 6	L, M, N, O
Okolona, Miss., to Meridian, Miss.	1884	J. B. W	D. S.	1	E, F
Meridian, Miss., to Quitman, Miss.	1886	J. B. W J. B. W	F. and B.	3	E, F
Quitman, Miss., to Citronelle, Ala.	1887	J. E. McG	F. and B.	3, 2	E, F
Citronelle, Ala., to Mobile, Ala.	1884	J. B. W	D. S.	1	E, F
Mobile, Ala., to Biloxi, Miss.	1885-86	J. B. W	F. and B.	1	E, F
Biloxi, Miss., to New Orleans, La.	1886	J. B. W	F. and B.	3	E, F

D. S.—Double simultaneous. F. and B.—Forward and back. Observers—A. B., Andrew Braid; J. B. W., J. B. Weir; I. W., Isaac Winston; J. H. G., J. H. Gray; F. A. Y., F. A. Young; J. E. McG., J. F McGrath; O. H. T., O. H. Tittman; J. N., John Nelson; P. A. W., P. A. Welker; F. W. P., F. W. Perkins; G. B., Gershom Bradford.

JUSTIFICATION OF CHANGES IN METHOD AND INSTUMENT IN 1899.

As radical changes were made in the method of observation at the beginning of 1899 an explanation of the reasons for making these changes would seem to be desirable. In view of the many facts and special investigations studied in the preceding pages of this appendix, an explanation in detail is hardly needed, however. It should be evident from what has already been said that the change was from a well-tried method which was known to be subject to large systematic errors, to an equally well-tried method having accidental errors of about the same magnitude as the abandoned method, but subject to little or no discoverable systematic error. The change was from a method having 25 entries in the record book per station to one having only 7 per station on a single line, and with a corresponding simplification in the computations.

The true justification for the change must be the results of the change. With the old method 50 miles per month of double simultaneous line upon an average during a season was seldom exceeded. With the new method during its first season, of three parties, two averaged 45 miles per month of completed forward and back line, and the third party averaged 63 per month. It has been estimated that other things being equal it requires 40 per cent longer to complete a forward and back line than to complete the same line by the double simultaneous method if the same program of observation is used in both cases.

While the new method is substantially that used by the Engineers it is believed that improvements in the details of the work and in the instrument have secured a much higher average speed at a lower cost, with little or no sacrifice of accuracy.

The change from the double simultaneous lines to the more costly forward and back line needs no further justification than that outlined on pages 879-880, indicating that on the old double simultaneous lines the mean of the two lines was ordinarily farther from the truth than the line first observed alone; together with the two general considerations (which are forcible even if the particular systematic error inherent in the old work has been greatly reduced or eliminated), that the two components of a double simultaneous line are dependent upon the same conditions, and that any systematic errors which are functions of the time occupied by readings at a station, whether due to temperature or not, affect the second line more seriously than the first.

A comparison of the changes made in the instrument as stated on page 418 with the explanation of the systematic error as given on pages 876–879 will show that several of the changes were designed primarily to eliminate systematic errors due to temperature changes. The ratio of the distance between the level vial and the line of collimation to the length of the striding level was reduced one-half; the coefficient of expansion of the metallic parts of the telescope and striding level was reduced to about one-fourth its former value, and the level vial itself was protected more thoroughly from sudden changes of temperature than before. The change in the method of observation also reduced greatly the interval between the foresight and the backsight at a station.

To ascertain if possible in a single season whether these precautions had been entirely effective, and also to serve as a basis for an examination as to the possible existence of other systematic errors, the observers in 1899 were required to insert notes in the record showing for each short section of a line the time of day, the weather conditions with reference to sun and wind, and the relative directions of running on each short section and of the sun and wind. By the use of the notes in regard to the sun it is possible to apply a test which is competent to detect the systematic temperature error if it still exists unless it is exceedingly small. If the forward and backward runnings on a certain section of the line were made at such times that in both cases the progression was directly toward the sun, it is evident that the tendency of the systematic temperature error being to make both lines run high toward the sun, the discrepancy B–F between the two runnings would tend to be of the minus sign. Similarly, if in both cases the line progressed away from the sun the sign of B–F should be plus. In short, though, for certain cases, as for instance when the forward line was run toward the sun and the backward line from it the systematic error would not tend to affect the discrepancy B–F, yet for most combinations of circumstances the sign of this effect on B–F may be predicted. The actual signs and magnitudes of the B–F discrepancies may therefore be used as a means of detecting the systematic error. Such a test was applied carefully and in detail to each of the three lines run in 1899. The test indicates that the systematic temperature error still affects observations, but to a very small extent only. Indeed, the apparent evidence of the continued existence of the error is so slight that it may be only the chance combination of accidental errors.

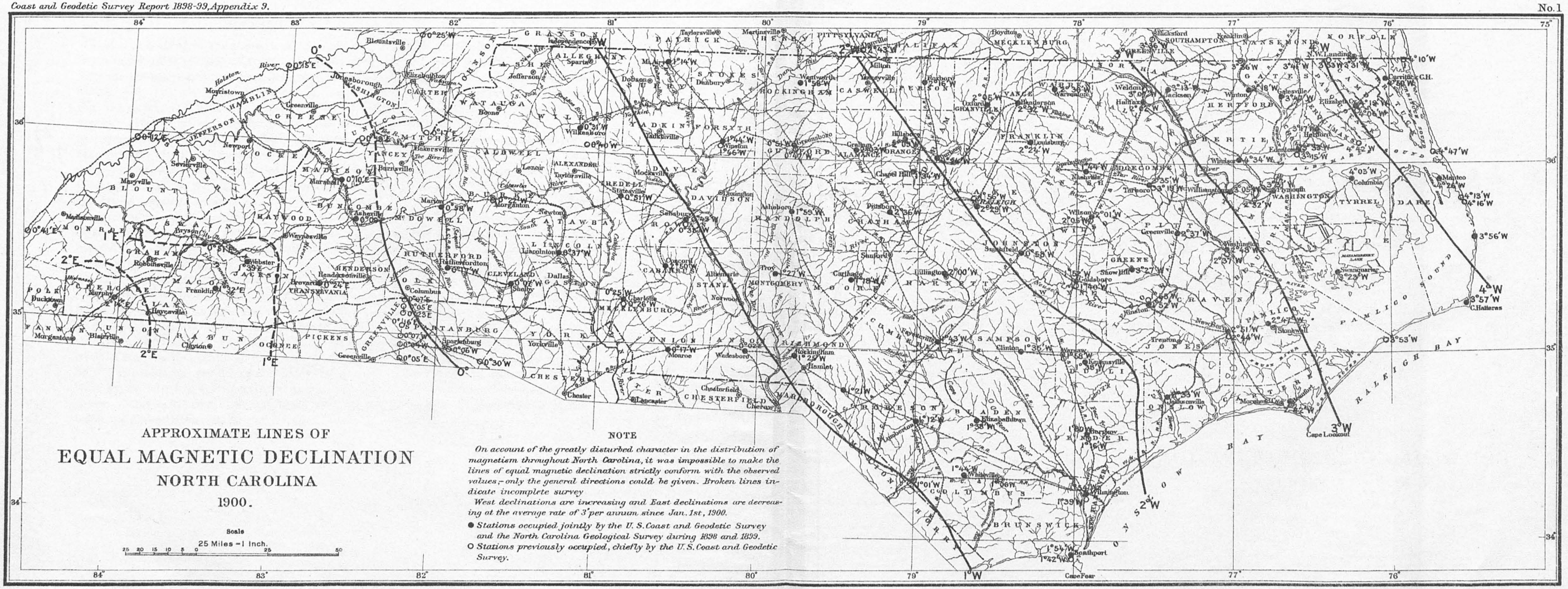
A careful test similar to that indicated above was also applied to one of the lines to determine whether an error which is systematic with respect to the direction of the wind is inherent in the observations. The test failed to detect such an error.

The average cost of the field work for the leveling done in 1899 was $13.55 per mile of completed line ($8.42 per kilometre). This represents the actual cost of the field work with the exception of the original cost of the instruments and the office repairs to them, and the cost of stationery supplied to field parties. These items are difficult to obtain and are relatively very small. The cost given includes all payments for services, including the salary of chief of party and such traveling expenses to and from the field as were paid by the Government. For the line between Solomon, Kans., and Norfolk, Nebr., the average cost of the field work was $11 per mile ($7 per kilometre). The cost of making the final computation of the three lines and preparing results for the printer was $1.53 per mile (= $0.95 per kilometre). The total average cost of leveling in 1899 for both field and Office work, of which the outcome was manuscript ready for the printer, was $15.08 per mile (= $9.37 per kilometre).

NEW INSTRUMENTS TO BE USED IN 1900.

It was decided in the summor of 1899 to build two new leveling instruments to be put into use in the season of 1900. No steps were taken toward constructing the new instruments and not even toward designing them until January, 1900, because it was desirable to wait until the computation of the 1899 leveling was nearly completed, in order that the experience gained in 1899 could be fully utilized in designing the new instruments. After a careful study of the 1899 leveling it seemed desirable that the new instruments should be planned with special reference to avoiding errors due to temperature changes; that the measures being differential rather than absolute a fixed level should be substituted for the striding level, and that the dimensions and power of the telescope should be increased since the evidence indicated that the major portion of the accidental errors in 1899 leveling were due to accidental errors of rod readings. The instrument was then designed by Mr. E. G. Fischer, Chief of the Instrument Division, in accordance with these ideas and at the date of this writing is being constructed. The opportunity was also utilized to introduce into these instruments many improvements which are the result of the long experience of the designer.

The distinguishing peculiarities of the new instrument are that it stands low on the tripod head, being much lower than the old instrument, though its telescope is larger and longer; the level vial is fixed relatively to the telescope and is placed as near as possible to the line of collimation, being in fact countersunk into the barrel of the telescope; the telescope does not rest in wyes, but instead is supported by trunnions in front of the middle point and by a micrometer screw near its eye end; and the middle half of the telescope including the level vial is completely shielded by an outer metallic tube within which it is free to move as constrained by its trunnions and the micrometer screw. The nickel-iron alloy has been used almost entirely in the construction of the telescope and adjacent parts.



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APPENDIX No. 9.

REPORT 1898-99.

GENERAL REPORT ON THE MAGNETIC SURVEY OF NORTH CAROLINA.

By JAMES B. BAYLOR AND DANIEL L. HAZARD,

UNDER THE DIRECTION OF

L. A. BAUER,

Chief of Division of Terrestrial Magnetism.

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ILLUSTRATIONS.

APPENDIX No. 9. 1898-99.

GENERAL REPORT UPON THE MAGNETIC SURVEY OF NORTH CAROLINA, WITH A BRIEF HISTORICAL SKETCH OF THE FUNDAMENTAL PHENOMENA OF THE EARTH'S MAGNETISM.

INTRODUCTION.

A magnetic survey was conducted during the spring, summer, and fall of 1898 and 1899, under the joint auspices of the United States Coast and Geodetic Survey and the North Carolina Geological Survey. The three magnetic elements, declination, inclination, and horizontal intensity, were determined at each station. True north and south lines were located at the various county towns, and standards of length for testing surveyors' chains were marked at some convenient place in the court-house.

At the instance of the State geologist of North Carolina, the Superintendent of the United States Coast and Geodetic Survey detailed an officer with the necessary instrumental outfit to carry out the survey, his excellency the governor of the State having requested this detail.

The State geologist furnished, during 1898, all the funds required for the field work other than the salary of the officer engaged in making the survey. During the spring and summer and part of the fall of 1899, both the salary and board of the observer were paid by the United States Coast and Geodetic Survey, funds for all other field expenses having been furnished by the State geologist.

Wherever the honorable board of county commissioners could be induced to do so, the State geologist has obtained from each county the State's share in the field expenses of the work. Many of the counties have refunded the money advanced by the State geological survey for this work, amounting to not over $25 for any county.

The State geologist of North Carolina, Prof. J. A. Holmes, at all times and in all seasons has labored for the successful completion of the survey. Through his untiring energy and interest, counties were induced to make subscriptions.

Valuable assistance was rendered by county commissioners, registers of deeds, surveyors, and others in the selection of suitable locations for the meridian stones at the various county towns. Wherever the local surroundings permitted it, these meridian stones were placed in the court-house square, and in every case, with one single exception, they were located on *public property*.

Time signals, wherever practicable, were obtained from the Western Union Telegraph Company at noon, seventy-fifth meridian time.

To all those who have aided in the furtherance of the object of this survey, the observer wishes herewith to make suitable acknowledgment.

This preliminary report will be devoted exclusively to the consideration of one of the elements of the Earth's magnetism, the declination, or, as surveyors frequently call it, the variation of the compass, and especially to its application to land surveys. The utility of true meridian lines when established and permanently marked, how they should be used by land surveyors, etc., will be explained.

The Division of Terrestrial Magnetism of the United States Coast and Geodetic Survey has projected upon the map of North Carolina the "isogonic lines," or lines of equal magnetic declination (variation), giving the most probable positions for these lines for January 1, 1900, as derived from observations made at the county towns during the progress of the magnetic survey, and embodying with them other observations made with the same class of instruments near the boundary lines of adjoining States.

Tables have also been prepared by this Division giving the most probable magnetic declination (variation) at the county seats for every ten years between 1750 and 1910. These quantities will be given for the surveyor's convenience in degrees and minutes.

The prime object of this preliminary report will be to furnish a short manual for the use and convenience of land surveyors in North Carolina. As an introduction to the report some account, therefore, of the leading phenomena of the Earth's magnetism, when and by whom discovered, will not be out of place.

Mr. L. A. Bauer, in his "First Report Upon Magnetic Work in Maryland," has fully explained the purposes of magnetic surveys, and in connection with it has published an historical account of the fundamental facts bearing on the Earth's magnetism. It is proposed to embody in this short manual some of the most interesting features of his report.

The respective authorship of the various chapters is as follows:

Mr. Daniel L. Hazard has prepared the two chapters on "The Secular Variation of the Magnetic Declination of North Carolina" and on "The Distribution of the Magnetic Declination in North Carolina for 1900," while Mr. James B. Baylor has prepared the remaining chapters. Mr. Hazard has furthermore revised all of the observers' computations and has prepared the results for final publication, and has constructed with their aid the lines of equal magnetic declination given on Plates I and III.

HISTORICAL SKETCH OF THE FUNDAMENTAL PHENOMENA OF THE EARTH'S MAGNETISM.

THE MAGNETIC DECLINATION (VARIATION OF COMPASS).

There are few places on the Earth's surface where the magnetic needle points true north. Where it does point north, at any particular time (year, day, hour, or even minute), it will not long remain in this direction. "As true as the needle to the pole" is a false simile of speech, and does much to mislead the uninitiated.

In the United States proper the needle changes its relationship to the true north from 21 degrees *west* of north, in the eastern part of Maine, to 23 degrees *east* of north, in the extreme northwestern part of Washington. In North Carolina the needle changes its direction from 4 degrees west of north in the extreme eastern part of the State to 2 degrees east of north in the extreme western part of the State. There are places on the Earth's surface where the needle, far from being "true to the pole," points due *east* and *west*. Again there are other places between the magnetic north pole and the true north pole where the "north" end of the needle actually points *south*.

The magnetic declination or variation of compass may be defined as "the angle between the true north and south line and the magnetic north and south line as pointed out by a compass needle, i. e., a magnetized needle so mounted as to swing freely about a vertical axis."

After the introduction of the compass in Europe it was several centuries before it was discovered that the needle was not "true to the pole." This, Mr. Bauer believes, was probably due to the fact that the deviation of the needle from the north, according to his investigations, appears to have been small at that time in the Mediterranean Sea. It was Columbus on his famous voyage of discovery who first found out that the compass needle had a "variation or declination" from the true north. On September 13, 1492, Columbus appears to have crossed the line of no magnetic declination, or variation, situated at that time a little west of Fayal Island of the Azores. Before this time his compass had pointed east of north, but subsequently it bore west of north and by an ever increasing amount as he sailed westward. The discovery of Columbus that the magnetic needle had a declination, or "variation," was not generally accepted until the middle of the sixteenth century, the declination of the compass being generally believed to be due to mechanical defects of the compass itself. And so the compass cards of that time were frequently roughly corrected for the amount of magnetic declination.

The earliest land observations of the declination of the needle were made in the early part of the sixteenth century at Rome by George Hartmann, vicar of Nuremburg. In the year 1600 Dr. William Gilbert, of Colchester, physician-in-ordinary to Queen Elizabeth, published his great treatise on magnetism, "De Magnete." He first announced that "The terrestrial globe itself is a great magnet." To-day all that can be said is that the globe itself acts as a magnet. We can not say with certainty whether the Earth's magnetism is permanent, like that of a bar magnet, or is induced by currents of electricity.

Secular Variation of the Magnetic Declination.

It was left for a professor of mathematics, Henry Gellibrand, of Gresham College, England, to discover that the needle did not continue to have the same direction at the same place year after year, but that it changed its direction with the lapse of time. The observations upon which this discovery was based were made at Deptford, near London, in 1634. Gellibrand found that the needle bore 4° 6′ east, while Gunter in 1622 had found 5° 56′ east, and Boroughs in 1580 11° 15′ east. There was, therefore, no mistaking the fact that the needle was changing its direction from year to year.

This progressive change of the compass needle from year to year is known as the "secular variation of the magnetic declination." It is called secular for the reason that it may require several hundred years before the needle returns approximately to the same position it had occupied at some previous time. At London, England, for example, the needle varied from 11° east in 1580 to nearly 25° west in 1812, a change of 36° in two hundred and thirty-two years. It now points about 17° west at London.

While this secular change has not been so great for places in the United States, still in the central portion of North Carolina it amounts to a change of about 4⅓° between the beginning and the end of the nineteenth century. (See p. 906.)

The cause of this secular variation can no more be positively announced at the present time than when Professor Gellibrand first made his discovery in the sixteenth century. The fact that the magnetic declination is subject to this variation, as is evident, has a most important bearing upon all directions obtained with a magnetic needle, whether observed at sea or on land.

The directions of most land boundaries have been recorded from the earliest days in this country by the compass needle. On account of its practical bearing, many observations have been taken at various places to determine both the declination of the needle and its secular change. This country is peculiarly rich in data for determining the amount of secular change in the magnetic declination since 1700. Magnetic observations are being collected and published as never before. The declination may be called the first element of the Earth's magnetism.

THE MAGNETIC INCLINATION (DIP).

When a magnetic needle is permitted to swing freely in a vertical plane, it does not remain horizontal, but dips from the horizontal plane. The angle of dip is smallest when the needle swings in the vertical plane containing the magnetic meridian and this particular angle is termed the "magnetic inclination." The dip measured in a plane at right angles to the plane of the magnetic meridian amounts to 90°, i. e., the needle stands vertical, with the north end down in our hemisphere. The dip is different in different localities and is also subject to secular change. In the surveyor's compass the dip of the magnetic needle is counteracted by a small bit of brass attached (in the northern hemisphere) to the south end of the needle. A mathematical instrument maker, Robert Norman, of London, first definitely announced to the world, in 1576, that the magnetic needle had a dip. George Hartmann had observed the dip of the needle as early as 1544, but he failed to accurately determine the angular amount.

At what is commonly called the "magnetic equator" the dipping needle remains horizontal. As we advance from this so-called magnetic equator, either north or south, along a magnetic meridian, we will find that the needle dips, increasing its dip as we advance, until we reach two points on the Earth's surface, one in the northern hemisphere, the other in the southern hemisphere, where the needle will stand vertical, not only in the plane of the magnetic meridian, but in all other vertical planes. These points are commonly called the "magnetic poles," a very misleading term, as they are not poles in the sense of those of a bar magnet, but are simply places on the Earth's surface where the direction assumed by the dipping needle coincides with that of the plumb line and to which the compass needle points. So far only two such points are known to us; here the compass needle may point in any direction, from 0° to 360°. While only two "magnetic poles" are known to us, there are *four* foci of maximum magnetic force (intensity), two in the northern and two in the southern hemisphere, none of which coincide with the magnetic poles. The Earth is not homogeneously magnetized, hence the so-called magnetic poles do not lie diametrically opposite to each other, and the lines of equal declination (isogonic lines) are not straight lines leading to the "magnetic poles," but far from it. Knowing both the magnetic declination and the dip at any given place, we know the *direction* in which the Earth's magnetism acts at that place.

The dip may be called the second of the elements of the Earth's magnetism.

THE INTENSITY OF THE EARTH'S MAGNETIC FORCE.

There remains now but one more element of the Earth's magnetism to be considered, the *intensity* of the attractive force which the Earth, as a magnet, exerts on a magnetic needle. This may be called the third element of the Earth's magnetism.

William Whiston, the famous translator of Josephus, made the first observations on the intensity of the Earth's magnetism. A prize offered about 1720 for the best method of determining the longitude at sea first turned Whiston's attention to terrestrial magnetism, and led to his making observations which greatly increased our knowledge of the Earth's magnetism of that day. Whiston only determined the *relative* intensity of the Earth's magnetism, i. e., he ascertained how much stronger the force was at other places than at London. It was left for Gauss to determine *absolutely* the intensity of the Earth's magnetism and to establish the necessary formulæ.

The *absolute* horizontal intensity of the Earth's magnetism is now determined, in a magnetic survey like that of North Carolina, by vibrating a magnet of certain weight, figure, and distribution of magnetism, and then by determining the effect of this magnet upon another magnet suspended in its place, at certain fixed distances. Knowing the horizontal intensity and dip, we can then determine, by calculation, the vertical force and total force of the Earth's magnetism.

THE DIURNAL VARIATION OF THE EARTH'S MAGNETISM.

In 1722 another London instrument maker, Graham, made an important discovery in terrestrial magnetism, viz, that the needle has a daily change as well as an annual and secular change. This applies to the declination, dip, and force (intensity) of the Earth's magnetism. The precise cause of these daily changes can not be positively given. We know that the Sun plays an important part.

THE ELEMENTS INVOLVED IN MAGNETIC SURVEYS.

No magnetic survey is complete without having determined, at each place where observations are made, the three elements—declination, dip, and intensity. At every station in North Carolina all three elements have been obtained, and they will all be ultimately published.

Every civilized country in the world is now having some such surveys made. Thus only can we expect to increase our knowledge of the magnetism of the Earth and hope to know the *causes* of some of the remarkable phenomena of the Earth's magnetism above described, and which Helmholtz has well said are the most puzzling of natural phenomena.

MAGNETISM AND GEOLOGY.

Aside from any irregularity in the form of the lines of equal magnetic declination due to the heterogeneous condition of the earth's magnetism, there are other marked irregularities in the form and location of these lines, due to the geological formations of the places where observations are made.

There may be a direct relationship between geology and terrestrial magnetism. Unexpected and marked magnetic deflections, at any particular place, where the surface geological strata and local surroundings do not indicate the presence of disturbing influences, lead us at once to believe there are hidden geological causes below the surface of the earth. Thus, a magnetic survey of a State may have a very important bearing on the geological survey of the same region, and reveal the presence of substances attracting the needle and which lie some distance below the surface of the earth.

Prof. A. W. Rücker, of England, in his "Recent researches on terrestrial magnetism," an account of which is published in Terrestrial Magnetism for March, 1898, has traced out from the magnetic surveys of Great Britain "ridge lines" of concealed masses of magnetic rocks "which are the foundations upon which the deposits studied by geologists have been laid." These concealed ridge lines have not only been located by magnetic surveys in England but have been carried across the British Channel and likewise traced out by magnetic surveys in France. We can safely say that in every country there is a network of these magnetic ridge lines which should be located by magnetic surveys, and that the geological conformation of the country should be studied in connection with them.

On account of these ridge lines of local magnetic influence it is impossible to construct an isogonic chart upon any scale which shall cover so large an area as the State of North Carolina, and give with accuracy the exact magnetic declination (variation) in any particular locality as taken from this chart of equal magnetic declinations. The chart of Lines of Equal Magnetic Declination can give but an approximation to the true variation of the compass at any given place and for any specified time. The greater the number of stations where observations have been made the more closely can the surveyor be furnished with the true variation of his compass.

Where any of the county meridian lines, as located in this survey, are so situated as to be surrounded by ridge lines of marked local influence quite different from the magnetic conditions in other sections of the county, they still can be made extremely useful to the county surveyor, as will be explained later.

GENERAL ACCOUNT OF THE MAGNETIC SURVEY OF NORTH CAROLINA.

Magnetic Instruments.

The Superintendent of the Coast and Geodetic Survey, Dr. Henry S. Pritchett, having detailed Mr. James B. Baylor, Assistant of the Survey, to carry out the magnetic work in North Carolina, put the following instrumental outfit at his disposal:

Theodolite and magnetometer, No. 20, and stand;
Dip circle, No. 5676;
Mean-time chronometer, No. 1507;
Magnetic tent;
Fifty-foot steel tape (standardized), No. 218.

A short description of these instruments will not be out of place. In the accompanying plate (No. 2) are shown the magnetic instruments used in the work. The mean-time chronometer used in connection with the astronomical (Sun) observations, and also in determining the rapidity with which a collimator magnet vibrated at a given place, is not shown in the plate. The time of one complete vibration of the magnet is necessary,

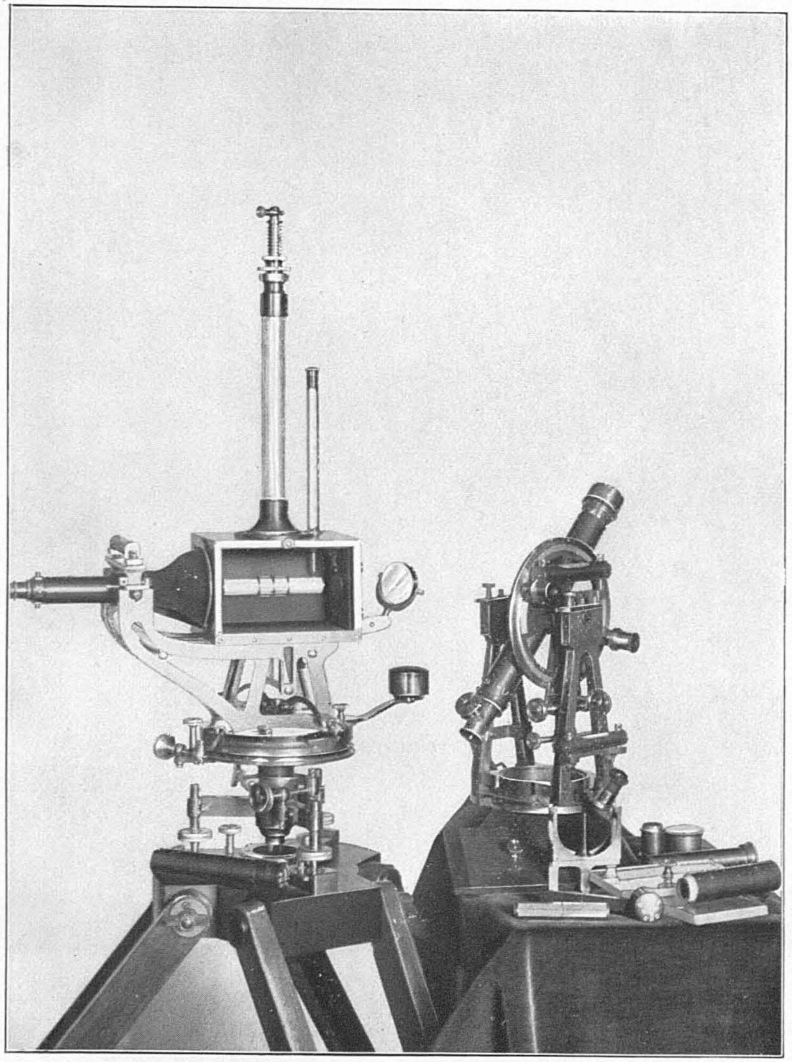

Fig. 1.—MAGNETOMETER NO. 20.

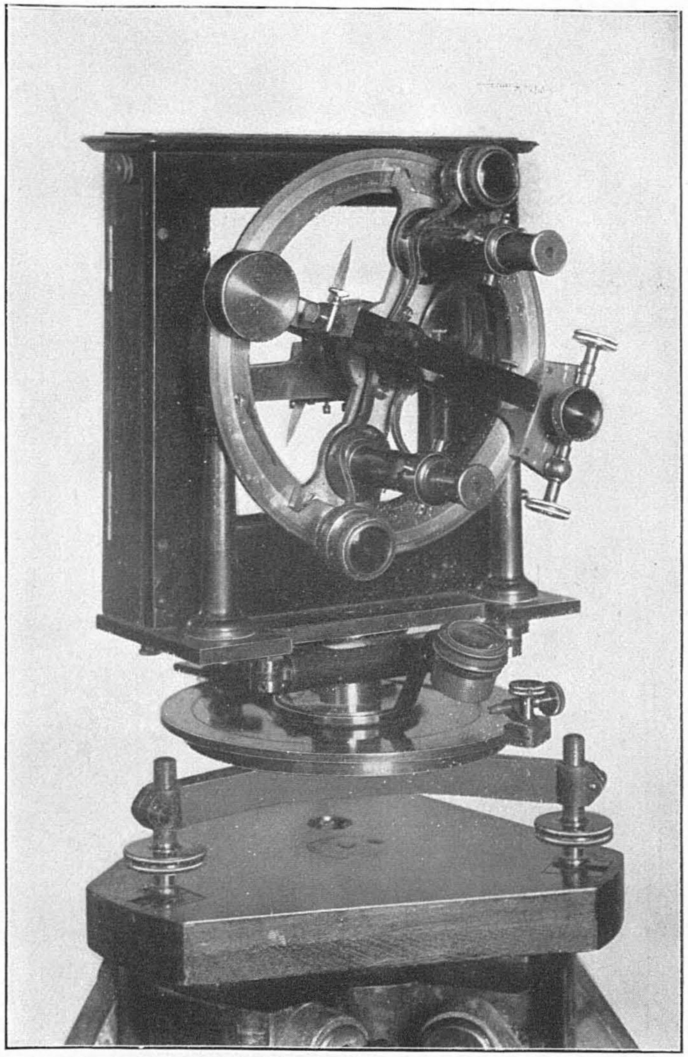

Fig. 2.—KEW DIP CIRCLE.

as we have already seen, for determining the horizontal force (intensity) of the Earth's magnetism.

The magnetometer is a combination instrument—magnetometer and theodolite combined. It was constructed at the Coast and Geodetic Survey Office, and answered all purposes admirably in the magnetic survey. The theodolite, with its prismatic eyepiece, just as it was used in the Sun (astronomical) observations for determining the true meridian, is shown on the right of the magnetometer. A specimen of these observations, with the accompanying computations, will be given in this chapter. The magnetometer proper, ready for determining the magnetic declination, is shown on the left of the theodolite.

The collimator magnet used with this magnetometer is an octagonal, hollow steel bar about 3 inches long and nearly one-half inch in diameter. It is used in the place of the magnetic needle in the surveyor's compass. Instead of having a needle swinging on a pivot with friction, we have here a magnet suspended in mid-air by one or two delicate silk fibers and swinging in a horizontal plane with all friction practically eliminated.

These fibers are hung in the glass tube above the box in which the magnet swings. In the plate (No. 2, Fig. 1) one side of the box is removed, so as to reveal the magnet. At the lower end the silk fibers are tied to a copper stirrup made to fit the collimator magnet. At the upper end they are fastened to an adjustable torsion head, permitting the raising and the lowering of the magnet to the proper height. The torsion of the silk fibers is eliminated by first using a copper bar of the same weight and figure as the collimator magnet and turning the torsion head until this nonmagnetic copper bar remains parallel to the sides of the box, when the telescope points in the direction of the magnetic meridian.

The effect of dip, removed in the ordinary surveyor's compass by a bit of brass attached to the arm of the needle, is here counteracted by causing the point of suspension to be considerably raised above the center of gravity of the magnet, so that it swings practically in a horizontal plane.

When observing the magnetic declination, the observer stands north of the instrument and looks south through the small telescope and hollow magnet and takes his reading on a scale etched on the glass closing the south end of the magnet. This scale is divided into 60 equal parts, each part representing an angle of 2 minutes. One-tenth of a space can be estimated, thus enabling pointings to one-fifth of a minute being made. On the north end of the magnet is a small lens, so shaped as to bring the scale into the focus of the small observing telescope when the latter has been focused on a distant reference mark. The telescope is mounted eccentrically and is provided with collimation and wye adjustments and a striding level. The box in which the magnet swings is centered over the vertical axis of the horizontal circle of the magnetometer.

The azimuth, or reference mark, can be seen with the telescope through this box before the magnet is raised into position by turning aside the glass window which covers the small round hole in the end of the box farthest from the end of the telescope. A dark hood is fastened to the other end of the box, fitting tightly over the telescope tube and shutting out all air currents.

The magnetic axis of the collimator magnet and the central line of the scale can not be made to accurately correspond. And if the mechanician did succeed in securing exact coincidence, it would not remain so on account of the inevitable jarrings and loss of magnetism to which the magnet is subjected in the course of the work. It thus becomes necessary to determine the correction, due to the fact that the geometric axis and the magnetic axis of the magnet do not coincide. The reading of the magnetic axis on the scale of the collimator magnet can be determined at any time by simply inverting the magnet in its stirrup, reading the scale in the direct and in the inverted position, and combining the results to a mean. To the scale reading of the magnetic axis thus obtained, all observations for magnetic declination are reduced. As intimated, the scale reading of the magnetic axis changes from time to time, as the magnet itself changes its magnetic conditions. In its frequent and accurate determination, we have a means of eliminating an error that can not be removed in determining a magnetic declination with the ordinary surveyor's compass.

The small tube shown on the right of the glass tube containing the suspension fibres is a centigrade thermometer for noting the temperature of the inside of the box, to be used in computing the observations for horizontal intensity of the Earth's magnetism.

The upper part of the magnetometer, bearing the box and its telescope, can be removed from the horizontal circle, to which it is attached by two screws, and the upper part of the theodolite, bearing the vertical circle, can then be quickly fastened in its place.

This theodolite was used in determining the true astronomical directions, the local mean time, and latitude, the Sun being used for this purpose. Its horizontal circle is 11·2 centimetres (4·4 inches) in diameter and its vertical circle 9·8 centimetres (3·86 inches) in diameter. Each circle is graduated to half degrees and read by opposite verniers to minutes of arc.

The horizontal circle is graduated, in the direction of the motion of the hands of a watch, from 0° to 360°, while the vertical circle is graduated, in the opposite direction and from 0° to 90°, in each quadrant, giving in one direction the altitude of an object and in the reversed position the zenith distance of the object, thus making it possible to eliminate all index errors of the vertical circle when the telescope is reversed.

In the intensity observations, the collimator magnet, above described, is used to deflect, at fixed distances, another collimator magnet suspended in the stirrup in its place. Wooden arms are inserted under the box of the magnetometer, with riders supporting the deflecting magnet at the same height as the suspended (auxiliary) magnet.

On the extreme right of this same plate (No. 2, Fig. 2) we have an illustration of the instrument used in determining the magnetic inclination or dip. This instrument is of the Kew pattern. The magnetic needles which go with it are 3½ inches long, flat, and taper to points. These needles are so mounted as to swing freely in a vertical plane, and their pivots rest on agate planes carefully ground and which can be accurately leveled. The needle, when in position, is inclosed in a glass case to shut out the currents of air, and the instrument is provided with a lifter for raising the needle off the agates and letting it down before observing.

There is a vertical circle for reading the angle of the dip. The pointings on the needle are made with the two microscopes. The box and vertical circle can be turned in azimuth and set in the vertical plane of the magnetic meridian by means of the horizontal circle. The circles of this instrument are about 5 inches in diameter. The vertical circle is provided with two opposite verniers reading to minutes of arc, and the horizontal circle is read with the vernier to minutes of arc.

With the dip circle are two "bar magnets" used in reversing the polarities of the dipping needles. We can thus, by combining to a mean, eliminate any error due to the fact that the center of gravity of the needle may not lie quite in the axis of suspension of the needle.

I. Example of the Astronomical (Sun) Observations and Computations Made at the County Seats.

INSTRUMENTS.

The theodolite of the magnetometer (No. 20) and the mean time chronometer (time piece) No. 1507 were used. These instruments have already been described. The diaphragm of the telescope of the theodolite has a simple + in it.

ASTRONOMICAL SYMBOLS.

$\odot$ = Symbol for the Sun.
$\underline{\odot}$ = Apparent lower limb of the Sun observed.
$\overline{\odot}$ = Apparent upper limb of the Sun observed.
$\vdash\!\overline{\odot}$ = Apparent upper and left-hand limb of the Sun observed.
$\overline{\odot}\!\dashv$ = Apparent upper and right-hand limb of the Sun observed.
$\vdash\!\underline{\odot}$ = Apparent lower and left-hand limb of the Sun observed.
$\underline{\odot}\!\dashv$ = Apparent lower and right-hand limb of the Sun observed.
D = Telescope of the theodolite in direct position.
R = Telescope of the theodolite in reversed position.

OBSERVATIONS FOR LATITUDE.

To determine the latitude of a place, the Sun's altitude was measured at intervals of a minute for a short time before and after apparent noon. The Sun's upper limb with telescope direct and lower limb with telescope reversed were observed alternately, the reading of the vertical circle giving zenith distance in the latter case. The theodolite was carefully leveled and adjusted.

Station: Wentworth, N. C. Date: Tuesday, September 26, 1899.

Telescope.	$\odot$	Chronometer time.			Vertical circle.		Remarks.
		h.	*m.*	*s.*	°	′	
D.	$\underline{\odot}$	12	14	00	51	48.5	Clear and calm.
R.	$\overline{\odot}$		15	00	37	18.0	
D.	$\underline{\odot}$		16	00	51	50.0	
R.	$\overline{\odot}$		17	00	37	17.5	
D.	$\underline{\odot}$		18	00	51	50.0	
R.	$\overline{\odot}$		19	00	37	17.0	
D.	$\underline{\odot}$		20	00	51	50.0	
R.	$\overline{\odot}$		21	00	37	17.0	
D.	$\underline{\odot}$		22	00	51	50.0	
R.	$\overline{\odot}$	12	23	00	37	18.0	

FIELD COMPUTATION OF LATITUDE.

For the purposes of the field computation we may assume that the Sun reaches its maximum altitude at apparent noon. This maximum altitude, corrected for parallax in altitude and atmospheric refraction, is combined with the Sun's declination at the same time to find the latitude of the place. The Sun's declination is taken from the American Ephemeris and Nautical Almanac.

Wentworth, N. C., Tuesday, September 26, 1899.

	°	′
Sun's observed altitude at apparent noon	52	16·5
Correction to observed altitude for refraction and parallax		−0·7
Sun's corrected altitude at apparent noon	52	15·8
Sun's zenith distance (Z) at apparent noon	37	44·2
Sun's north polar distance (P) at apparent noon	91	20·6
$P—Z$ = colatitude	53	36·4
Hence, approximate latitude (φ)	36	23·6

In the Office at Washington a more elaborate method of computation is employed, use being made of all of the observations, instead of simply the maximum altitude, as was done above.

OBSERVATIONS FOR DETERMINING THE TRUE NORTH AND SOUTH LINE.

Below are specimens of observations for ascertaining the true north and south line or azimuth of the "mark" or range from which the true meridian is laid off. The theodolite is carefully adjusted and centered over the "reference monument." The altitude or zenith distance of the Sun and its bearing with reference to the range or mark, and the time by chronometer are observed simultaneously. This is done when the Sun is at least 2½ hours from apparent noon; so that both the altitude and azimuth of the Sun are changing with sufficient rapidity. Four independent sets of observations are taken; two in the morning and two in the afternoon. The same sets of observations also give the approximate longitude of the place.

From the apparent time of observation the local mean time is found by applying the "equation of time" as taken from the American Ephemeris and Nautical Almanac. The difference between the chronometer time of observation and the local mean time thus found gives the correction of the chronometer on local mean time. Its correction on seventy-fifth meridian time is found by means of Western Union Telegraph Company time signals received at 12 o'clock. The difference between these two corrections, converted into arc (1 minute of time equals 15 minutes of arc) gives the difference of longitude from the seventy-fifth meridian.

Observations for Azimuth of Mark at Wentworth, N. C.

Tuesday, September 26, 1899, P. M.						Wednesday, September 27, 1899, A. M.					
Set.	Tel.	Object.	Chronometer time.	Horizontal circle.	Vertical circle.	Set.	Tel.	Object.	Chronometer time.	Horizontal circle.	Vertical circle.
			h. m. s.	° ′	° ′				h. m. s.	° ′	° ′
I	D	Mark.		156 40·0		III	D	Mark.		157 02·0	
				336 39·0						337 00·0	
	D	☉	4 50 00	45 43·0	16 36·0		D	☉	7 20 00	251 26·0	11 18·0
		☉	4 51 00	45 54·0	16 23·5			☉	7 21 00	251 36·0	11 31·0
	R	☉	4 53 00	225 36·0	73 06·0		R	☉	7 23 00	71 15·0	78 18·5
		☉	4 54 00	225 45·0	73 18·5			☉	7 24 00	71 25·0	78 05·0
	R	Mark.		336 37·0			R	Mark.		336 57·5	
				156 36·0						156 57·0	
II	R	Mark.		336 36·0		IV	R	Mark.		336 57·5	
				156 36·0						156 57·0	
	R	☉	5 04 00	227 22·0	75 16·0		R	☉	7 28 00	72 04·0	77 19·5
		☉	5 05 00	227 32·0	75 29·0			☉	7 29 00	72 13·0	77 07·5
	D	☉	5 07 00	48 28·0	13 17·0		D	☉	7 31 00	253 09·0	13 28·0
		☉	5 08 00	48 38·0	13 05·0			☉	7 32 00	253 18·0	13 39·0
	D	Mark.		156 41·0			D	Mark.		157 02·0	
				336 40·0						337 00·0	

MEANS.

Set.	No. of observation.	Chronometer time.	Horizontal circle.	Altitude of ☉	Mark.
		h. m. s.	° ′	° ′	° ′
I	1 and 4	4 52 00	45 44·0	16 38·75	156 38·0
	2 and 3	4 52 00	45 45·0	16 38·75	
II	1 and 4	5 06 00	48 00·0	13 54·50	156 38·2
	2 and 3	5 06 00	48 00·0	13 54·00	
III	1 and 4	7 22 00	251 25·5	11 36·50	156 59·1
	2 and 3	7 22 00	251 25·5	11 36·25	
IV	1 and 4	7 30 00	252 41·0	13 09·75	156 59·1
	2 and 3	7 30 00	252 41·0	13 10·25	

Computation of azimuth observations at Wentworth, N. C.

The formulæ used in the computation of the azimuth or bearing of the "mark" and in the computation of the local mean time of observation are as follows:

$$\tan^2 \tfrac{1}{2} A = \frac{\sin (s-\varphi) \sin (s-h)}{\cos s \cos (s-p)}$$

$$= \sec s \sec (s-p) \sin (s-h) \sin (s-\varphi)$$

$$\tan \tfrac{1}{2} t = \frac{\sin (s-h) \sec (s-p)}{\tan \tfrac{1}{2} A}$$

A = azimuth of Sun, east of north in the morning, west of north in the afternoon.
φ = latitude of the place.
h = altitude of the Sun corrected for refraction and parallax in altitude.
p = Polar distance of the Sun, at the time of observation, taken from the American Ephemeris and Nautical Almanac.
$s = \frac{1}{2}(h+\varphi+p)$.
t = The hour angle of the Sun or apparent time of observation expressed in arc.

COMPUTATION.

Date, 1899	September 26, p. m.		September 27, a. m.	
Set	I.	II.	III.	IV.
	° ′	° ′	° ′	° ′
Observed altitude	16 38·8	13 54·2	11 36·4	13 10·0
Refraction and parallax	− 3·1	− 3·8	− 4·5	− 4·0
h	16 35·7	13 50·4	11 31·9	13 06·0
φ	36 23·6	36 23·6	36 23·6	36 23·6
p	91 25·0	91 25·3	91 39·2	91 39·3
$2s$	144 24·3	141 39·3	139 34·7	141 08·9
s	72 12·1	70 49·6	69 47·3	70 34·4
$s-p$	− 19 12·9	− 20 35·7	− 21 51·9	− 21 04·9
$s-h$	55 36·4	56 59·2	58 15·4	57 28·4
$s-\varphi$	35 48·5	34 26·0	33 23·7	34 10·8
log. sec. s	0·51477	0·48357	0·46158	0·47810
log. sec. $(s-p)$	0·02490	0·02868	0·03242	0·03009
log. sin $(s-h)$	9·91655	9·92352	9·92963	9·92590
log. sin $(s-\varphi)$	9·76721	9·75239	9·74068	9·74958
log. tan² ½ A	0·22343	0·18816	0·16431	0·18367
log. tan ½ A	0·11171	0·09408	0·08215	0·09185
	° ′	° ′	° ′	° ′
½ A	52 17·4	51 09·5	50 23·2	51 00·8
A from north	104 34·8	102 19·0	100 46·4	102 01·6
⊙ reads	45 44·5	48 00·0	251 25·5	252 41·0
North reads	150 19·3	150 19·0	150 39·1	150 39·4
Mark reads	156 38·0	156 38·2	156 59·1	156 59·1
Mark east of north	6 18·7	6 19·2	6 20·0	6 19·7
log. sin $(s-h)$ sec. $(s-p)$	9·94145	9·95220	9·96205	9·95599
log. tan ½ t	9·82974	9·85812	9·87990	9·86414
	° ′ ″	° ′ ″	° ′ ″	° ′ ″
½ t	34 02 45	35 48 12	37 10 35	36 10 54
t in arc	68 05 30	71 36 24	74 21 10	72 21 48
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
t in time	4 32 22·0	4 46 25·6	− 4 57 24·7	− 4 49 27·2
E	− 8 48·7	− 8 48·9	− 9 00·9	− 9 01·0
Local mean time	4 23 33·3	4 37 36·7	6 53 34·4	7 01 31·8
Chronometer time	4 52 00·0	5 06 00·0	7 22 00·0	7 30 00·0
Chronometer fast on local mean time	28 26·7	28 23·3	28 25·6	28 28·2

Recapitulation of the astronomical data at Wentworth, N. C., 1899.

Date and set.	Mark east of true north.	Chronometer No. 1 507 fast on local mean time.
	° ′	m. s.
Sept. 26, p. m., set I	6 18·7	28 26·7
Sept. 26, p. m., set II	19·2	23·3
Sept. 27, a. m., set III	20·0	25·6
Sept. 27, a. m., set IV	19·7	28·2
Mean	6 19·4	28 26·0

By properly laying off the angle, 6° 19′·4, the meridian line was determined and permanently marked by two substantial granite posts.

Computation of the approximate longitude.

Chronometer fast on local mean time	$28^m\ 26{\cdot}0^s$
Chronometer fast on seventy-fifth meridian time	$9^m\ 17{\cdot}8^s$
Local time fast on seventy-fifth meridian time	$19^m\ 08{\cdot}2^s$
In arc	4° 47′
Longitude=75° 00′+4° 47′	79° 47′

II. EXAMPLE OF THE OBSERVATIONS NECESSARY TO DETERMINE WITH A MAGNETOMETER THE MAGNETIC DECLINATION, TOGETHER WITH THE COMPUTATION OF THE SAME. SIMILAR OBSERVATIONS AND COMPUTATIONS MADE AT OTHER COUNTY SEATS.

A small observing tent is pitched over the point of observation to protect the instrument and the observer from the wind and weather.

Theodolite No. 20 is converted into magnetometer No. 20, as already described in this report.

Magnetometer No. 20 is carefully adjusted and leveled over the reference monument. The "mark" selected in the Sun observations, is pointed on through the little box in which the collimator magnet will swing. As an additional check pointings are also made on the center of the range monument which is in the true meridian. The horizontal circle is read and recorded in each case. The instrument is then turned around its vertical axis until the sides of the box are approximately parallel to the magnetic (compass) meridian and the telescope points south (magnetic).

The copper weight is then inserted in the stirrup and the torsion of the silk fibers carefully eliminated in a manner as already described. The long collimator magnet (L 20) is then used to replace the copper weight. This magnet is so delicately suspended that it is never entirely at rest and has to be brought approximately to rest with a knife blade or a small bit of iron, which is then removed.

The instrument is then turned about its vertical axis until the middle division of the scale of the magnet oscillates equally to right and left of the vertical line on the diaphragm of the telescope. The horizontal circle is then clamped and read. Then at intervals of five or ten minutes the scale readings of the magnet at the extremities of a swing are recorded with the corresponding times.

These observations are started early enough in the morning and continued long enough (about an hour) to enable us to observe the eastern elongation of the needle, i. e., when the north end of the needle points nearest to the East during the day. This takes place somewhere between 7.30 a. m. and 9 a. m., local mean time, the precise time varying with the season of the year and with meteorological conditions.

The observations are begun again in the afternoon in time to include the western elongation, i. e., the time when the north end of the needle points its nearest to the West during the day. This usually takes place between 1 and 2 p. m., local mean time, the precise time varying as before with the season of the year and with the meteorological conditions. The mean of these two extreme positions of the needle is taken as the average position for the day. This method of obtaining the average value for the day, sufficing for all practical purposes, must at present be employed in regions where there are no magnetic observatories in operation.

The magnetic axis of the magnet is determined by inverting the magnet in the stirrup, as already described. The horizontal circle is carefully read and the torsion tested from time to time.

Magnetic observations—Declination.

Date, September 27th, 1899.
Station, Wentworth, N. C.; reference monument.
Instrument, magnetometer No. 20.
Magnet, L 20 suspended, scale erect—i. e., scale readings increasing from apparent right to apparent left. Facing south.
Line of detorsion, 5°.

Local time. a. m.	Scale readings. Left.	Right.	Mean.	Azimuth circle, A. 304° 41'·0, B. 124° 42'·0
h. m.	*d.*	*d.*	*d.*	
6 40	30·0	31·0	30·50	Remarks: Weather, clear and calm. Thermometer, 15° C.
45	30·0	31·2	30·60	
6 50	29·0	32·3	30·65	
7 00	30·0	31·0	30·50	
				Magnetometer converted into a theodolite and sun observed, a. m. sets.
8 00	30·0	30·7	30·35	Magnetometer remounted.
05	29·0	31·7	30·35	
10	29·0	31·3	30·15	
8 15	29·0	31·0	30·00	
8 30	29·0	30·4	29·70	
p. m.	Line of detorsion, 3°. Torsion carefully tested.			Azimuth circle, A. 304° 41'·0, B. 124° 42'·0
12 20	25·0	27·0	26·00	Remarks: Weather, clear and pleasant. Wind, very light from north. Thermometer, 23° C.
25	25·0	27·0	26·00	[A decreased reading of the scale of the collimator magnet shows a movement of the north end of the magnet to the *west*.]
30	24·8	27·0	25·90	
35	24·8	26·8	25·80	
40	25·0	25·9	25·45	
45	25·3	25·5	25·40	
12 50	25·2	25·4	25·30	
1 00	25·3	25·3	25·30	
05	25·0	25·7	25·35	
10	25·0	25·8	25·40	

Magnetic observations--Declination—Continued.

	Reading of azimuth mark.	Range monument.
	° ′	° ′
At beginning of observations, A	132 57·0	126 37·0
B	312 56·0	306 37·0
At end of observations, A	132 57·0	
B	312 56·0	
Mean.	132 56·5	

Observer, J. B. Baylor.

Computation.

Determination of scale value of magnet.			Determination of axis of magnet.				
Scale.	Circle readings, mean of verniers.	Value of divisions.	Scale.	Scale readings.	Mean.	Alternate mean.	Axis.
				d. *d.*	*d.*	*d.*	*d.*
One division of the scale of the collimator magnet equals two minutes of arc, as measured on the horizontal circle.			E	25·0 27·6	26·30		
			I	31·0 32·4	31·70	26·30	29·00
			E	25·0 27·6	26·30	31·72	29·01
			I	31·0 32·5	31·75	26·28	29·02
			E	25·0 27·5	26·25		
Value of one div'n of scale = 2·00′			Scale reading of axis				29·01

Mean scale reading of east and west magnetic elongation (30·65) (25·30)			27·98
	° ′		
Reduction to axis	— 2·1	= diff. =	1·03
Azimuth circle reads	304 41·5		
Magnetic south meridian reads	304 39·4	Daily range in the declination = 10′·7.	
Mean reading of mark	132 56·5		
Azimuth of mark east of true north *a*	6 19·4		
True south meridian reads	306 37·1		
Magnetic declination	1 57·7	West of true north.	

a From sun observations and computations.

THE VARIATIONS OF THE MAGNETIC DECLINATION.

As already stated, the pointing of the compass needle is forever changing. The term "variations" will be used hereafter exclusively to denote the *changes* which take place in the value of the magnetic declination. Surveyors would do well were they likewise to use the word "variation" only in this sense, for they have, unfortunately, fallen into the habit of using the term "variation" in two different senses, first, to denote the quantity by which the compass points away from the true north—i. e., the *magnetic declination;* secondly, to denote the *amount of change* in the magnetic declination for a certain period of years. This has given rise to considerable confusion in land surveys. The Division of Terrestrial Magnetism of the United States Coast and Geodetic Survey has difficulty at times in properly interpreting letters from surveyors regarding the "magnetic variation."

The chief variations of the magnetic declination concerning the surveyor may be classified as "the secular variation," "the daily or the diurnal variation," and the disturbance variation, due to magnetic storms.

It will be the special purpose of this chapter to show in a practical way the effect of these variations on land surveys in North Carolina made with a compass needle, and to furnish tables which may be useful to the surveyor in eliminating some of these errors.

THE SECULAR VARIATION.

In the last one hundred years the compass needle has changed its relationship to the north line in the central portion of North Carolina about $4\frac{1}{3}°$ of arc. This means that in the central portion of North Carolina a surveyor starting from the same corner used in 1800, and retracing at the present time (1900) a line, say, 1 mile long, between two contiguous properties, using the compass bearing of 1800, the corner at the other end of the line would be shifted 399 feet from its original position.

During the last ten years the compass needle has changed its direction on an average in North Carolina about 3′ of arc each year. If this quantity is not taken into account it causes an error in the mile line of 4·6 feet for each year. Not knowing the causes which operate to produce the secular variation, we can not predict with certainty the amount of these changes.

A surveyor in North Carolina, by making use of the county meridians, as he is required by law to do, should determine for himself the amount of the secular change, and not be guided in the future solely by the changes in the compass bearings of old lines when they are retraced. The original bearing of an old line and the date of the survey may have been recorded wrong; the ends of the line as recovered may be in error and thus an erroneous value of the amount of change in the magnetic declination obtained.

Judge J. W. Bowman, of Mitchell County, N. C., in retracing numerous old lines estimates that in the last one hundred years the north end of the compass needle has moved westward just about 5° in Mitchell County, N. C.

Prof. William Cain, of the North Carolina State Univerity, from observations made in the vicinity of Chapel Hill, Orange County, N. C., estimates that the north end of the compass needle moved westward 2° 54′ between 1852 and 1895.

Tables giving the amount of change in declination between any two years between 1750 and 1910, for the various county seats, are given in the special chapter on this very important subject.

THE DIURNAL VARIATION.

A magnetic needle which swings freely in a horizontal plane changes its bearing from hour to hour. The range of this daily change is quite different in different months in the same year. It is greater in the Summer than in the Winter.

In the month of August the north end of the needle will point in North Carolina at 8 a. m. as much as 10′ of arc, on the average, nearer the east than it does at 1 p. m.

This means that in a mile line traced out with compass in August at 8 a. m. and retraced at 1 p. m. on the same day, there would be a difference in the location of a corner of 15.3 feet.

The following table gives the correction to an observed magnetic declination for diurnal variation for every month and for every hour from 6 a. m. to 6 p. m. The time given in this table is local mean time. Everywhere in North Carolina the local time for any place is slow on the time used. A surveyor in using this table should correct the railroad time to local time. For every degree of longitude he is west of the seventy-fifth meridian he should substract four minutes of time from the railroad time. The table should then be entered with the time as corrected.

TABLE I.—*Corrections of an observed magnetic declination for diurnal variation.*

[Apply the tabular quantities to the observed westerly declination with the sign as affixed, and with the reversed sign for easterly declination.]

Month.	6 a. m.	7.	8.	9.	10.	11.	Noon.	1.	2.	3.	4.	5.	6 p. m.
	′	′	′	′	′	′	′	′	′	′	′	′	′
January	−0.1	+0.2	+1.0	+2.1	+2.4	+1.2	−1.1	−2.5	−2.6	−2.1	−1.3	−0.2	+0.2
February	+0.6	+0.7	+1.5	+1.9	+1.4	−0.1	−1.5	−2.1	−2.5	−2.0	−1.2	−0.8	−0.4
March	+1.2	+2.0	+3.0	+2.8	+1.6	−0.6	−2.5	−3.4	−3.7	−3.3	−2.3	−1.2	−0.5
April	+2.5	+3.1	+3.4	+2.6	+0.8	−2.1	−4.0	−4.1	−4.2	−3.6	−2.3	−1.2	−0.2
May	+3.0	+3.8	+3.9	+2.6	+0.1	−2.4	−4.0	−5.0	−4.5	−3.6	−2.3	−0.9	+0.1
June	+2.9	+4.4	+4.4	+3.3	+1.1	−2.0	−3.6	−4.5	−4.5	−3.8	−2.6	−1.2	−0.2
July	+3.1	+4.6	+4.9	+3.9	+1.8	−1.2	−3.4	−4.4	−4.7	−4.2	−2.8	−1.3	−0.3
August	+2.9	+4.9	+5.4	+3.7	+0.4	−2.8	−4.7	−5.1	−4.9	−3.7	−1.9	−0.6	+0.3
September	+1.8	+2.8	+3.4	+2.5	+0.3	−2.7	−4.4	−4.6	−4.2	−4.0	−1.4	−0.3	−0.1
October	+0.5	+1.6	+3.1	+2.8	+1.4	−1.0	−2.7	−3.3	−3.4	−2.4	−1.3	−0.4	−0.4
November	+0.5	+1.2	+1.7	+1.8	+1.1	−0.5	−2.0	−2.7	−2.6	−1.8	−1.0	−0.2	+0.2
December	+0.2	+0.3	+0.8	+1.8	+1.8	−0.0	−1.6	−2.4	−2.3	−1.8	−1.1	−0.3	+0.1

These figures represent the mean results of the continuous magnetic observations made at the old site of the Washington Magnetic Observatory—the old Naval Observatory grounds—during the four years 1888–1891.

THE DISTURBANCE VARIATION IN THE MAGNETIC DECLINATION. (MAGNETIC STORMS.)

There are variations in the direction of the compass needle due to spasmodic fluctuations in the Earth's magnetism. During the prevalence of these abnormal conditions the compass needle is occasionally in error as much as one-fourth of a degree and sometimes even more.

Magnetic storms are more frequent in the Summer than in the Winter. Fortunately about 75 to 90 per cent of the disturbances produced by magnetic storms are very small, and occur at times when they will not appreciably affect the surveyor's work.

MINOR PERIODIC FLUCTUATIONS.

There are other changes affecting the value of the magnetic declination than those already mentioned, which are known as "minor periodic fluctuations." These depend upon the declination of the Sun, upon its period of rotation, and upon the position of the Moon with reference to the Sun and Earth. These changes are too minute to be noted by the surveyor.

SECULAR VARIATION OF THE MAGNETIC DECLINATION IN NORTH CAROLINA.

While we can not say that the secular motion of the magnetic needle is strictly periodic, i. e., that after a certain long period of years the needle will return to the same position and exactly retrace the course it had previously followed, yet it has been shown by the investigations of Mr. Charles A. Schott, of the United States Coast and Geodetic Survey, and others, that the secular variation of the magnetic declination for the past two hundred years may be represented very closely by an algebraic expression based on the assumption of such a periodic motion. The observations at a great many stations in the United States have been treated in this way by Mr. Schott, and the latest results are published in Appendix I of the Coast and Geodetic Survey Report for 1895.

The only place in North Carolina where we have a sufficient number of observations to warrant a discussion of the secular variation of the magnetic declination is Newbern, and even there our results only go back to 1750. We may, however, supplement the data at Newbern by the observations at Cape Henry, Virginia, and Charleston, S. C. At each of these stations the observations cover the period from 1700 to 1895. The individual values of declination for each of these three places are given below, together with the secular-variation expression derived therefrom, and a comparison of the declinations computed from the formula with the observed quantities. The addition of Mr. Baylor's observation at Newbern in 1898 necessitated a new discussion for that station. With this exception the material is taken directly from the above-mentioned Appendix, pages 227–230.

COLLECTION OF THE MAGNETIC DECLINATIONS OBSERVED AT CAPE HENRY, VA.

[Latitude=36° 55′·6. Longitude=76° 00′·4 west of Greenwich.]

No.	Date.	Declination.			Reference and remarks.
		°	′		
1	1700	4		W.	Edmund Halley's Tabula Nautica.
2	1728, Mar. 6	3		W.	W. Byrd at head of Currituck Sound. Reduction to Cape Henry, +20′.
3	1732	4	42	W.	W. Hoxton, 7 miles from Cape Henry. Reduction, −10′.
	1732	4	40	W.	Douglass. Not used.
4	1750	1	47	W.	Value deduced from observations at 19 stations.
	1775	5	00	W.	Des Barres's Atlantic Neptune. Not used.
5	1809	0	00		President Madison at Norfolk. Reduction doubtful.
6	1832, June 9, 11	0	45	W.	Prof. J. N. Nicollet.
7	1856, Sept. 11, 12	1	28	W.	C. A. Schott, U. S. C. S. Near the light-house.
8	1874, Nov. 26–28	2	39·4	W.	Dr. T. C. Hilgard. Near the light-house.
9	1879, May and June	2	32	W.	Lieut. S. W. Very, U. S. N., at the Rip-Raps. Reduction, +10′.
10	1881, June 16	3	11	W.	Lieut. C. P. Perkins, U. S. N. Reduction, +5′.
11	1883, Jan. 2	3	10	W.	Lieut. G. A. Norris, U. S. N. Reduction, +5′.
	1883, June 30	3	06	W.	Lieut. C. Belknap, U. S. N.
	1883, Aug. 29	3	35	W.	Lieut. H. W. Lyon, U. S. N. Reduction, −5′.
	1883, Dec. 10	3	39	W.	Lieut. C. Belknap, U. S. N.
12	1884, May 10	3	37	W.	Lieut. F. Hanford, U. S. N. Reduction, −15′.
	1884, Oct. 10	2	55	W.	Lieut. C. C. Cornwell, U. S. N. Reduction, +5′.
13	1887, Apr. 14–16	3	20·1	W.	J. B. Baylor, U. S. C. and G. S. Near old light-house.
14	1895, June 13, 14	3	56·5	W.	Do.

From these observations has been derived the formula

$$D = +2°\cdot42 + 2°\cdot25 \sin (1\cdot47\, m - 30°\cdot6),$$

in which $m = t - 1850$, t being the time of observation expressed in years and decimals. The agreement of the observed and computed quantities is shown in the following table, the plus sign standing for *west* declination and "*C.* — *O.*" for "computed minus observed value:"

Date.	Observed *D.*	Computed *D.*	*C.*−*O.*	Date.	Observed *D.*	Computed *D.*	*C.*−*O.*
	°	°	°		°	°	°
1700·0	+ 4·00	+ 4·55	+0·55	1874·9	+ 2·66	+ 2·66	0·00
1728·2	3·33	3·60	+0·27	1879·4	2·70	2·91	+0·21
1732·5	4·53	3·31	−1·22	1881·4	3·27	3·02	−0·25
1750·0	1·78	2·33	+0·55	1883·5	3·37	3·14	−0·23
1809·5	0·00	0·17	+0·17	1884·5	3·18	3·19	+0·01
1832·4	0·75	0·54	−0·21	1887·3	3·34	3·34	0·00
1856·7	+ 1·47	+ 1·62	+0·15	1895·5	+ 3·94	+ 3·75	−0·19

COLLECTION OF THE MAGNETIC DECLINATIONS OBSERVED AT NEWBERN, N. C.

[Latitude = 35° 06′. Longitude = 77° 02′ west of Greenwich.]

No.	Date.	Declination.	Reference and remarks.
		° ′	
1	1750	0.3 W.	Value deduced from observations at 19 stations.
2	1779	1 59 E.	H. A. Brown, letter of Nov. 6, 1893. From 3 bearings of streets in 1779 and 1810, at which epochs they were the same.
3	1796	2 40 E.	J. Price.
4	1806	2 00 E.	Do.
5	1809	1 45 E.	Do.
6	1810, Apr. 23	1 59 E.	H. A. Brown, see above. Difference of bearings between 1810·3 and 1893·8 was 4° 23′·3. For 1893·8 assume 2° 24′ W.
7	1840	0 00	Sir E. Sabine's isogonic chart for 1840.
8	1874, Dec. 21, 23, 24	1 20·4 W.	J. B. Baylor, U. S. C. S., in national cemetery.
9	1887, Mar. 19, 20	1 54·4 W.	Do.
10	1898, July 9	2 46·6 W.	J. B. Baylor, U. S. C. and G. S., in Cedar Grove Cemetery.

$$D = +0°\cdot54 + 2\cdot64 \sin (1\cdot45\, m - 16°\cdot1).$$

Date.	Observed *D.*	Weight.	Computed *D.*	*C.*−*O.*	Date.	Observed *D.*	Weight.	Computed *D.*	*C.*−*O.*
	°		°	°		°		°	
1750·0	+0·3	½	−0·32	−0·62	1810·3	−1·98	1	−1·99	−0·01
1779·5	−1·98	1	−1·78	+0·20	1840·0	0·00	½	−0·80	−0·80
1796·5	−2·67	1	−2·09	+0·58	1875·0	+1·34	1	+1·44	+0·10
1806·5	−2·00	1	−2·05	−0·05	1887·2	+1·91	1	+2·16	+0·25
1809·5	−1·75	1	−2·01	−0·26	1898·5	+2·78	1	+2·68	−0·10

COLLECTION OF THE MAGNETIC DECLINATIONS OBSERVED AT CHARLESTON, S. C.

[Latitude=32° 47′. Longitude=79° 56′.]

No.	Date.	Declination.	Reference and remarks.
		° ′	
1	1700	½ E.	Edmund Halley's Tabula Nautica.
	1700	½ W.	Deduced from observations at 17 stations. Not used.
	1742	5 23 E.	English Pilot, 1794. Not used.
2	1750	1 39 E.	Deduced from observations at 19 stations.
3	1775	3 48 E.	Des Barres's Atlantic Neptune.
	1777	3 48 E.	From a chart. Not used.
4	1784, February	5 15 E.	J. Purchell.
5	1785, October	5 45 E.	Do.
6	1824-25	3 45 E.	Lieutenant Sherburne, U. S. N.
7	1833·0	4 00 E.	P. Barlow's isogonic chart.
8	1837	2 54 E.	Captain Missroom.
9	1840	2 44 E.	Dr. C. Davies.
10	1841, May	2 24 E.	Barnet.
11	1847, October	2 15 E.	Parker.
12	1849, Apr. 1-22	2 16·5 E.	C. O. Boutelle, U. S. C. S. At Breach Inlet.
13	1874, May 27, 28, 29.	0 58·2 E.	C. O. Boutelle, U. S. C. S. At Fort Marshall.
14	1880, Jan. 21, 22	0 25·6 E.	J. B. Baylor, U. S. C. and G. S. At Fort Marshall.
15	1885, Dec. 29, 30	0 14·2 E.	J. B. Baylor, U. S. C. and G. S. Near Breach Inlet.
16	1895, June 5, 6	0 19·3 W.	Do.

$$D = -1^\circ{\cdot}82 + 2{\cdot}75 \sin (1{\cdot}40\,m - 12^\circ{\cdot}1).$$

Date.	Observed D.	Weight.	Computed D.	$C.-O.$	Date.	Observed D.	Weight.	Computed D.	$C.-O.$
	°		°	°		°		°	°
1700·0	−0·50	½	+0·06	+0·56	1840·5	−2·73	1	−2·99	−0·26
1750·0	−1·65	1	−3·10	−1·45	1841·4	2·40	1	2·93	−0·53
1775·5	−3·80	1	4·28	−0·48	1847·8	2·25	1	2·53	−0·28
1784·1	−5·25	1	4·48	+0·77	1849·3	2·28	1	2·43	−0·15
1785·8	−5·75	1	4·51	+1·24	1874·4	0·97	1	0·76	+0·21
1825·0	−3·75	1	3·83	−0·08	1880·1	0·43	1	0·42	+0·01
1833·0	−4·00	1	3·42	+0·58	1886·0	−0·24	1	−0·08	+0·16
1837·5	−2·90	1	−3·17	−0·27	1895·4	+0·32	1	+0·33	+0·01

We have, then, the three expressions:

For Cape Henry, Va., $D = +2^\circ{\cdot}42 + 2^\circ{\cdot}25 \sin (1^\circ{\cdot}47\,m - 30^\circ{\cdot}6)$.

For Newbern, N. C., $D = +0^\circ{\cdot}54 + 2^\circ{\cdot}64 \sin (1^\circ{\cdot}45\,m - 16^\circ{\cdot}1)$.

For Charleston, S. C., $D = -1^\circ{\cdot}82 + 2^\circ{\cdot}75 \sin (1^\circ{\cdot}40\,m - 12^\circ{\cdot}1)$.

In these formulæ the plus sign indicates west declination, the minus sign east declination. The first term of the second member represents the average value of the declination during an entire period. The constant multiplier of the second term is one-half the range in declination. Accordingly, for Cape Henry the maximum declination would be $2^\circ{\cdot}42 + 2^\circ{\cdot}25 = +4^\circ{\cdot}67$, or 4° 40′ west, and the minimum declination $2^\circ{\cdot}42 - 2^\circ{\cdot}25 = +0^\circ{\cdot}17$, or 0° 10′ west.

It will be noticed that the three expressions agree in their general characteristics, though differing in detail. Of course the first term varies with the distribution of declination, but the variation in the second term may be due more to imperfect data than to differing conditions. Accordingly, an expression derived by taking the mean of the three will be used for the eastern part of North Carolina in preference to the expression for Newbern. It is $D = x + 2^\circ.55 \sin(1^\circ.44\,m - 19^\circ.6)$ in which x is found for any place by means of the observed declination.

It is known that the phases of secular variation of declination occur, in general, later as we go west. From a comparison of the secular variation discussion for stations in various longitudes, it is estimated that the phases would occur ten years later in the western part of North Carolina than in the eastern. The above expression may accordingly be modified to suit other portions of the State, as follows:

I. To longitude 78° 00′ $D = x + 2^\circ.55 \sin(1.44\,m - 19^\circ.6)$.
II. 78° 00′ to 79° 30′ $D = x + 2.55 \sin(1.44\,m - 23.2)$.
III. 79° 30′ to 81° 00′ $D = x + 2.55 \sin(1.44\,m - 26.8)$.
IV. 81° 00′ to 82° 30′ $D = x + 2.55 \sin(1.44\,m - 30.4)$.
V. 82° 30′ westward $D = x + 2.55 \sin(1.44\,m - 34.0)$.

The values of the portions of these expressions which vary with the time, viz, the second terms, are given for various epochs in the following table. The tabular quantities refer to the 1st of January of the corresponding date.

Auxiliary table used in constructing the secular variation table for the county seats.

Year.	Limits of longitude.				
	75° 30′ to 78° 00′.	78° 00′ to 79° 30′.	79° 30′ to 81° 00′.	81° 00′ to 82° 30′.	82° 30′ to 84° 20′.
	° ′	° ′	° ′	° ′	° ′
1750	−0 43	−0 34	−0 24	−0 15	−0 05
1760	−1 18	−1 10	−1 01	−0 52	−0 43
1770	−1 49	−1 42	−1 34	−1 26	−1 18
1780	−2 12	−2 07	−2 01	−1 55	−1 49
1790	−2 27	−2 24	−2 21	−2 17	−2 12
1800	−2 33	−2 32	−2 31	−2 29	−2 27
1810	−2 29	−2 31	−2 32	−2 33	−2 33
1820	−2 16	−2 20	−2 24	−2 27	−2 29
1830	−1 54	−2 01	−2 06	−2 11	−2 16
1840	−1 26	−1 33	−1 41	−1 48	−1 54
1850	−0 51	−1 00	−1 09	−1 18	−1 26
1860	−0 14	−0 23	−0 33	−0 42	−0 51
1870	+0 24	+0 15	+0 05	−0 04	−0 14
1880	+1 01	+0 52	+0 43	+0 34	+0 24
1890	+1 34	+1 26	+1 18	+1 10	+1 01
1900	+2 01	+1 55	+1 49	+1 42	+1 34
1910	+2 21	+2 17	+2 12	+2 07	+2 01

N. B.—The *surveyor* not to use this table, but Table No. II.

SECULAR VARIATION TABLE FOR THE COUNTY SEATS.

The manner in which the table was constructed will be readily understood from the following remarks:

To derive a secular variation table for a particular station, find by interpolation from the proper column of the foregoing table the value for the date of observation. The difference between that quantity and the observed declination must then be applied as a constant correction to that column. For example, the declination observed at Chapel Hill, March 25, 26, 1898, was $+1° 28'.6$. The value for that date from Column II of the table is $+1° 50'.2$. Hence the quantities in that column must be diminished (algebraically) by 22′ to be applicable to Chapel Hill. As before stated, a *plus* sign indicates *west* declination, a *minus* sign *east* declination. In this way the quantities in the following table have been derived for each place where a meridian line was established and magnetic observations made. The arrangement of the columns is alphabetically by counties.

For the county seats where meridian lines have not yet been established and where magnetic observations have not yet been made—indicated in the table by an asterisk (*)—estimated values of the magnetic declination for January 1, 1900, as derived from observations in the vicinity of the county seats, were utilized in the construction of the respective columns. Whatever errors these estimated values may be subject to will not affect the use of the columns for determining the change in the magnetic declination between any two periods of time, as all of the quantities in a particular column will be affected by the same error.

As soon as magnetic observations have been made at the remaining county seats, surveyors, by applying to the Superintendent of the United States Coast and Geodetic Survey, can obtain the precise corrections to the estimated values referred to above.

EXAMPLE OF THE PRACTICAL APPLICATION OF THE TABLE.

The following table will be of special value in finding the *change* in the magnetic declination at any place in the county. Suppose it were desired to retrace in May, 1900, a boundary line in Wake County, which bore magnetically N. 76° E. in July, 1813. From the table for Raleigh we find that the magnetic declination was 1° 53′ east in 1813 and 2° 30′ west for the later date. Consequently the change in the interval is 4° 23′ to the westward, and a line which bore N. 76° E. in 1813 should be rerun in May, 1900, with the magetic bearing N. 80° 23′ E.

Our information regarding the distribution of declination in the United States in the eighteenth century is so uncertain, owing to the small amount of data available and the inferior instruments then in use, that the portions of our secular variation tables covering that period may be in error by as much as half a degree, and an uncertainty of a quarter of a degree may be assigned to the values for the early part of the nineteenth century. These facts should be borne in mind when using the tables.

TABLE II.—*Values of the magnetic declination at the county seats from 1750 to 1910.*

Year.	County and town.								
	Alamance, Graham.	Alexander, Taylorsville.*	Alleghany, Sparta.*	Anson, Wadesboro.†	Ashe, Jefferson.*	Beaufort, Washington.	Bertie, Windsor.	Bladen, Elizabethtown.	Brunswick, Southport.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	0 26 E	1 17 E	1 00 E	2 15 E	1 12 E	0 04 W	1 50 W	0 51 E	0 35 E
1760	1 02	1 54	1 37	2 52	1 49	0 31 E	1 15	1 27	1 11
1770	1 34	2 28	2 11	3 25	2 23	1 02	0 44	1 59	1 43
1780	1 59	2 57	2 40	3 52	2 52	1 25	0 21	2 24	2 08
1790	2 16	3 19	3 02	4 12	3 14	1 40	0 06	2 41	2 25
1800	2 24	3 31	3 14	4 22	3 26	1 46	0 00	2 49	2 33
1810	2 23	3 35	3 18	4 23	3 30	1 42	0 04	2 48	2 32
1820	2 12	3 29	3 12	4 15	3 24	1 29	0 17	2 37	2 21
1830	1 53	3 13	2 56	3 57	3 08	1 07	0 39	2 18	2 02
1840	1 25	2 50	2 33	3 32	2 45	0 39	1 07	1 50	1 34
1850	0 52	2 20	2 03	3 00	2 15	0 04 E	1 42	1 17	1 01
1860	0 15 E	1 44	1 27	2 24	1 39	0 33 W	2 19	0 40	0 24 E
1870	0 23 W	1 06	0 49	1 46	1 01	1 11	2 57	0 02 E	0 14 W
1880	1 00	0 28 E	0 11 E	1 08	0 23 E	1 48	3 34	0 35 W	0 51
1890	1 34	0 08 W	0 25 W	0 33	0 13 W	2 21	4 07	1 09	1 25
1900	2 03	0 40	0 57	0 02 E	0 45	2 48	4 34	1 38	1 54
1910	2 25 W	1 05 W	1 22 W	0 21 W	1 10 W	3 08 W	4 54 W	2 00 W	2 16 W

Year.	County and town.								
	Buncombe, Asheville.	Burke, Morganton.*	Cabarrus, Concord.	Caldwell, Lenoir.*	Camden, Camden.*	Carteret, Beaufort.	Caswell, Yanceyville.*	Catawba, Newton.*	Chatham, Pittsboro.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	1 48 E	1 35 E	0 37 W	1 22 E	1 26 W	0 02 E	0 15 E	1 19 E	0 07 W
1760	2 26	2 12	0 00	1 59	0 51	0 37	0 52	1 56	0 29 E
1770	3 01	2 46	0 33 E	2 33	0 20 W	1 08	1 25	2 30	1 01
1780	3 32	3 15	1 00	3 02	0 03 E	1 31	1 52	2 59	1 26
1790	3 55	3 37	1 20	3 24	0 18	1 46	2 12	3 21	1 43
1800	4 10	3 49	1 30	3 36	0 24	1 52	2 22	3 33	1 51
1810	4 16	3 53	1 31	3 40	0 20	1 48	2 23	3 37	1 50
1820	4 12	3 47	1 23	3 34	0 07 E	1 35	2 15	3 31	1 39
1830	3 59	3 31	1 05	3 18	0 15 W	1 13	1 57	3 15	1 20
1840	3 37	3 08	0 40	2 55	0 43	0 45	1 32	2 52	0 52
1850	3 09	2 38	0 08 E	2 25	1 18	0 10 E	1 00	2 22	0 19 E
1860	2 34	2 02	0 28 W	1 49	1 55	0 27 W	0 24 E	1 46	0 18 W
1870	1 57	1 24	1 06	1 11	2 33	1 05	0 14 W	1 08	0 56
1880	1 19	0 46	1 44	0 33 E	3 10	1 42	0 52	0 30 E	1 33
1890	0 42	0 10 E	2 19	0 03 W	3 43	2 15	1 27	0 06 W	2 07
1900	0 09 E	0 22 W	2 50	0 35	4 10	2 42	1 58	0 38	2 36
1910	0 18 W	0 47 W	3 13 W	1 00 W	4 30 W	3 02 W	2 21 W	1 03 W	2 58 W

* At these county seats meridian lines have not yet been established nor magnetic observations made. See text, page 912, regarding constant errors that may affect these columns.

† Based upon magnetic observations made on May 27 and 28, 1900, by G. R. Putnam, of the Coast and Geodetic Survey, at a place 91 yards east of meridian line established by him. See description of station, page 932.

TABLE II.— *Values of the magnetic declination at the county seats from 1750 to 1910*—Continued.

Year.	County and town.								
	Cherokee, Murphy.	Chowan, Edenton.	Clay, Hayesville.*	Cleveland, Shelby.	Columbus, Whiteville.	Craven, Newbern.	Cumberland, Fayetteville.	Currituck, Currituck.	Dare, Manteo.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	3 53 E	0 49 W	3 39 E	1 50 E	0 45 E	0 07 W	0 46 E	2 06 W	1 42 W
1760	4 31	0 14 W	4 17	2 27	1 21	0 28 E	1 22	1 31	1 07
1770	5 06	0 17 E	4 52	3 01	1 53	0 59	1 54	1 00	0 36
1780	5 37	0 40	5 23	3 30	2 18	1 22	2 19	0 37	0 13 W
1790	6 00	0 55	5 46	3 52	2 35	1 37	2 36	0 22	0 02 E
1800	6 15	1 01	6 01	4 04	2 43	1 43	2 44	0 16	0 08
1810	6 21	0 57	6 07	4 08	2 42	1 39	2 43	0 20	0 04 E
1820	6 17	0 44	6 03	4 02	2 31	1 26	2 32	0 33	0 09 W
1830	6 04	0 22 E	5 50	3 46	2 12	1 04	2 13	0 55	0 31
1840	5 42	0 06 W	5 28	3 23	1 44	0 36	1 45	1 23	0 59
1850	5 14	0 41	5 00	2 53	1 11	0 01 E	1 12	1 58	1 34
1860	4 39	1 18	4 25	2 17	0 34 E	0 36 W	0 35 E	2 35	2 11
1870	4 02	1 56	3 48	1 39	0 04 W	1 14	0 03 W	3 13	2 49
1880	3 24	2 33	3 10	1 01	0 41	1 51	0 40	3 50	3 26
1890	2 47	3 06	2 33	0 25 E	1 15	2 24	1 14	4 23	3 59
1900	2 14	3 33	2 00	0 07 W	1 44	2 51	1 43	4 50	4 26
1910	1 47 E	3 53 W	1 33 E	0 32 W	2 06 W	3 11 W	2 05 W	5 10 W	4 46 W

Year.	County and town.								
	Davidson, Lexington.*	Davie, Mocksville.*	Duplin, Kenansville.	Durham, Durham.	Edgecombe, Tarboro.	Forsyth, Winston-Salem.	Franklin, Louisburg.	Gaston, Dallas.*	Gates, Gatesville.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	1 03 E	1 13 E	1 06 E	1 05 E	0 51 W	0 29 E	0 05 E	1 27 E	1 03 W
1760	1 40	1 50	1 41	1 41	0 16 W	1 06	0 41	2 04	0 28 W
1770	2 13	2 23	2 12	2 13	0 15 E	1 39	1 13	2 38	0 03 E
1780	2 40	2 50	2 35	2 38	0 38	2 06	1 38	3 07	0 26
1790	3 00	3 10	2 50	2 55	0 53	2 26	1 55	3 29	0 41
1800	3 10	3 20	2 56	3 03	0 59	2 36	2 03	3 41	0 47
1810	3 11	3 21	2 52	3 02	0 55	2 37	2 02	3 45	0 43
1820	3 03	3 13	2 39	2 51	0 42	2 29	1 51	3 39	0 30
1830	2 45	2 55	2 17	2 32	0 20 E	2 11	1 32	3 23	0 08 E
1840	2 20	2 30	1 49	2 04	0 08 W	1 46	1 04	3 00	0 20 W
1850	1 48	1 58	1 14	1 31	0 43	1 14	0 31 E	2 30	0 55
1860	1 12	1 22	0 37 E	0 54	1 20	0 38 E	0 06 W	1 54	1 32
1870	0 34 E	0 44	0 01 W	0 16 E	1 58	0 00	0 44	1 16	2 10
1880	0 04 W	0 06 E	0 38	0 21 W	2 35	0 38 W	1 21	0 38	2 47
1890	0 39	0 29 W	1 11	0 55	3 08	1 13	1 55	0 02 E	3 20
1900	1 10	1 00	1 38	1 24	3 35	1 44	2 24	0 30 W	3 47
1910	1 33 W	1 23 W	1 58 W	1 46 W	3 55 W	2 07 W	2 46 W	0 55 W	4 07 W

TABLE II.—*Values of the magnetic declination at the county seats from 1750 to 1910*—Continued.

Year.	County and town.								
	Graham, Robbinsville.*	Granville, Oxford.	Greene, Snow Hill.	Guilford, Greensboro.	Halifax, Halifax.	Harnett, Lillington.	Haywood, Waynesville.*	Henderson, Hendersonville.*	Hertford, Winton.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	3 04 E	0 24 E	0 43 W	1 22 E	0 42 E	0 29 E	2 34 E	2 00 E	0 34 W
1760	3 42	1 00	0 08 W	1 59	1 17	1 05	3 12	2 38	0 01 E
1770	4 17	1 32	0 23 E	2 32	1 48	1 37	3 47	3 12	0 32
1780	4 48	1 57	0 46	2 59	2 11	2 02	4 18	3 42	0 55
1790	5 11	2 14	1 01	3 19	2 26	2 19	4 41	4 04	1 10
1800	5 26	2 22	1 07	3 29	2 32	2 27	4 56	4 18	1 16
1810	5 32	2 21	1 03	3 30	2 28	2 26	5 02	4 23	1 12
1820	5 28	2 10	0 50	3 22	2 15	2 15	4 58	4 18	0 59
1830	5 15	1 51	0 28 E	3 04	1 53	1 56	4 45	4 04	0 37
1840	4 53	1 23	0 00	2 39	1 25	1 28	4 23	3 41	0 09 E
1850	4 25	0 50	0 35 W	2 07	0 50	0 55	3 55	3 12	0 26 W
1860	3 50	0 13 E	1 12	1 31	0 13 E	0 18 E	3 20	2 36	1 03
1870	3 13	0 25 W	1 50	0 53	0 25 W	0 20 W	2 43	1 59	1 41
1880	2 35	1 02	2 27	0 15 E	1 02	0 57	2 05	1 21	2 18
1890	1 58	1 36	3 00	0 20 W	1 35	1 31	1 28	0 46	2 51
1900	1 25	2 05	3 27	0 51	2 02	2 00	0 55	0 12 E	3 18
1910	0 58 E	2 27 W	3 47 W	1 14 W	2 22 W	2 22 W	0 28 E	0 14 W	3 38 W

Year.	County and town.								
	Hyde, Swanquarter.	Iredell, Statesville.	Jackson, Webster.	Johnston, Smithfield.	Jones, Trenton.*	Lenoir, Kinston.	Lincoln, Lincolnton.	McDowell, Marion.	Macon, Franklin.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	0 39 W	1 22 E	3 18 E	1 31 E	0 24 E	0 52 E	1 20 E	0 59 E	3 11 E
1760	0 04 W	1 59	3 56	2 07	0 59	1 27	1 57	1 36	3 49
1770	0 27 E	2 32	4 31	2 39	1 30	1 58	2 31	2 10	4 24
1780	0 50	2 59	5 02	3 04	1 53	2 21	3 00	2 39	4 55
1790	1 05	3 19	5 25	3 21	2 08	2 36	3 22	3 01	5 18
1800	1 11	3 29	5 40	3 29	2 14	2 42	3 34	3 13	5 33
1810	1 07	3 30	5 46	3 28	2 10	2 38	3 38	3 17	5 39
1820	0 54	3 22	5 42	3 17	1 57	2 25	3 32	3 11	5 35
1830	0 32	3 04	5 29	2 58	1 35	2 03	3 16	2 55	5 22
1840	0 04 E	2 39	5 09	2 30	1 07	1 35	2 53	2 32	5 00
1850	0 31 W	2 07	4 39	1 57	0 32 E	1 00	2 23	2 02	4 32
1860	1 08	1 31	4 04	1 20	0 05 W	0 23 E	1 47	1 26	3 57
1870	1 46	0 53	3 27	0 42	0 43	0 15 W	1 09	0 48	3 20
1880	2 23	0 15 E	2 49	0 05 E	1 20	0 52	0 31 E	0 10 E	2 42
1890	2 56	0 20 W	2 12	0 29 W	1 53	1 25	0 05 W	0 26 W	2 05
1900	3 23	0 51	1 39	0 58	2 20	1 52	0 37	0 58	1 32
1910	3 43 W	1 14 W	1 12 E	1 20 W	2 40 W	2 12 W	1 02 W	1 23 W	1 05 E

TABLE II.—*Values of the magnetic declination at the county seats from 1750 to 1910*—Continued.

Year.	County and town.								
	Madison, Marshall.	Martin, Williamston.	Mecklenburg, Charlotte.	Mitchell, Bakersville.*	Montgomery, Troy.	Moore, Carthage.	Nash, Nashville.	New Hanover, Wilmington.	Northampton, Jackson.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	1 49 E	0 21 W	1 48 E	1 47 E	0 46 E	1 11 E	1 00 E	0 50 E	0 29 W
1760	2 27	0 14 E	2 25	2 24	1 23	1 47	1 35	1 25	0 06 E
1770	3 02	0 45	2 58	2 58	1 56	2 19	2 06	1 56	0 37
1780	3 33	1 08	3 25	3 27	2 23	2 44	2 29	2 19	1 00
1790	3 56	1 23	3 45	3 49	2 43	3 01	2 44	2 34	1 15
1800	4 11	1 29	3 55	4 01	2 53	3 09	2 50	2 40	1 21
1810	4 17	1 25	3 56	4 05	2 54	3 08	2 46	2 36	1 17
1820	4 13	1 12	3 48	3 59	2 46	2 57	2 33	2 23	1 04
1830	4 00	0 50	3 30	3 43	2 28	2 38	2 11	2 01	0 42
1840	3 38	0 22 E	3 05	3 20	2 03	2 10	1 43	1 33	0 14 E
1850	3 10	0 13 W	2 33	2 50	1 31	1 37	1 08	0 58	0 21 W
1860	2 35	0 50	1 57	2 14	0 55	1 00	0 31 E	0 21 E	0 58
1870	1 58	1 28	1 19	1 36	0 17 E	0 22 E	0 07 W	0 17 W	1 36
1880	1 20	2 05	0 41	0 58	0 21 W	0 15 W	0 44	0 54	2 13
1890	0 43	2 38	0 06 E	0 22 E	0 56	0 49	1 17	1 27	2 46
1900	0 10 E	3 05	0 25 W	0 10 W	1 27	1 18	1 44	1 54	3 13
1910	0 17 W	3 25 W	0 48 W	0 35 W	1 50 W	1 40 W	2 04 W	2 14 W	3 33 W

Year.	County and town.								
	Onslow, Jacksonville.	Orange, Hillsboro.	Orange, Chapel Hill.	Pamlico, Bayboro.	Pasquotank, Elizabeth City.	Pender, Burgaw.	Perquimans, Hertford.	Person, Roxboro.	Pitt, Greenville.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	0 11 E	0 20 E	0 55 E	0 03 W	1 35 W	1 14 E	0 33 W	0 13 E	0 07 E
1760	0 46	0 56	1 31	0 32 E	1 00	1 49	0 02 E	0 49	0 42
1770	1 17	1 28	2 03	1 03	0 29	2 20	0 33	1 21	1 13
1780	1 40	1 53	2 28	1 26	0 06 W	2 43	0 56	1 46	1 36
1790	1 55	2 10	2 45	1 41	0 09 E	2 58	1 11	2 03	1 51
1800	2 01	2 18	2 53	1 47	0 15	3 04	1 17	2 11	1 57
1810	1 57	2 17	2 52	1 43	0 11 E	3 00	1 13	2 10	1 53
1820	1 44	2 06	2 41	1 30	0 02 W	2 47	1 00	1 59	1 40
1830	1 22	1 47	2 22	1 08	0 24	2 25	0 38	1 40	1 18
1840	0 54	1 19	1 54	0 40	0 52	1 57	0 10 E	1 12	0 50
1850	0 19 E	0 46	1 21	0 05 E	1 27	1 22	0 25 W	0 30	0 15 E
1860	0 18 W	0 09 E	0 44	0 32 W	2 04	0 45	1 02	0 02 E	0 22 W
1870	0 56	0 29 W	0 06 E	1 10	2 42	0 07 E	1 40	0 36 W	1 00
1880	1 33	1 06	0 31 W	1 47	3 19	0 30 W	2 17	1 13	1 37
1890	2 06	1 40	1 05	2 20	3 52	1 03	2 50	1 47	2 10
1900	2 33	2 09	1 34	2 47	4 19	1 30	3 17	2 16	2 37
1910	2 53 W	2 31 W	1 56 W	3 07 W	4 39 W	1 50 W	3 37 W	2 38 W	2 57 W

TABLE II.—*Values of the magnetic declination at the county seats from 1750 to 1910*—Continued.

Year.	County and town.								
	Polk, Columbus.*	Randolph, Ashboro.	Richmond, Rockingham.	Robeson, Lumberton.	Rockingham, Wentworth.	Rowan, Salisbury.	Rutherford, Rutherfordton.	Sampson, Clinton.	Scotland, Laurinburg.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	1 55 E	0 14 E	0 48 E	1 17 E	0 15 E	1 30 E	1 40 E	0 54 E	1 08 E
1760	2 32	0 51	1 25	1 53	0 52	2 07	2 17	1 30	1 44
1770	3 06	1 24	1 58	2 25	1 25	2 40	2 51	2 02	2 16
1780	3 35	1 51	2 25	2 50	1 52	3 07	3 20	2 27	2 41
1790	3 57	2 11	2 45	3 07	2 12	3 27	3 42	2 44	2 58
1800	4 09	2 21	2 55	3 15	2 22	3 37	3 54	2 52	3 06
1810	4 13	2 22	2 56	3 14	2 23	3 38	3 58	2 51	3 05
1820	4 07	2 14	2 48	3 03	2 15	3 30	3 52	2 40	2 54
1830	3 51	1 56	2 30	2 44	1 57	3 12	3 36	2 21	2 35
1840	3 28	1 31	2 05	2 16	1 32	2 47	3 13	1 53	2 07
1850	2 58	0 59	1 33	1 43	1 00	2 15	2 43	1 20	1 34
1860	2 22	0 23 E	0 57	1 06	0 24 E	1 39	2 07	0 43	0 57
1870	1 44	0 15 W	0 19 E	0 28 E	0 14 W	1 01	1 29	0 05 E	0 19 E
1880	1 06	0 53	0 19 W	0 09 W	0 52	0 23 E	0 51	0 32 W	0 18 W
1890	0 30 E	1 28	0 54	0 43	1 27	0 12 W	0 15 E	1 06	0 52
1900	0 02 W	1 59	1 25	1 12	1 58	0 43	0 17 W	1 35	1 21
1910	0 27 W	2 22 W	1 48 W	1 34 W	2 21 W	1 06 W	0 42 W	1 57 W	1 43 W

Year.	County and town.								
	Stanly, Albemarle.*	Stokes, Danbury.*	Surry, Mount Airy.†	Swain, Bryson City.	Transylvania, Brevard.	Tyrrell, Columbia.	Union, Monroe.	Vance, Henderson.	Wake, Raleigh.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	1 13 E	0 48 E	0 59 E	2 30 E	2 03 E	1 19 W	1 56 E	0 03 W	0 00
1760	1 50	1 25	1 36	3 08	2 41	0 44	2 33	0 33 E	0 36 E
1770	2 23	1 58	2 09	3 43	3 16	0 13 W	3 06	1 05	1 08
1780	2 50	2 25	2 36	4 14	3 47	0 10 E	3 33	1 30	1 33
1790	3 10	2 45	2 56	4 37	4 10	0 25	3 53	1 47	1 50
1800	3 20	2 55	3 06	4 52	4 25	0 31	4 03	1 55	1 58
1810	3 21	2 56	3 07	4 58	4 31	0 27	4 04	1 54	1 57
1820	3 13	2 48	2 59	4 54	4 27	0 14 E	3 56	1 43	1 46
1830	2 55	2 30	2 41	4 41	4 14	0 08 W	3 38	1 24	1 27
1840	2 30	2 05	2 16	4 19	3 52	0 36	3 13	0 56	0 59
1850	1 58	1 33	1 44	3 51	3 24	1 11	2 41	0 23 E	0 26 E
1860	1 22	0 57	1 08	3 16	2 49	1 48	2 05	0 14 W	0 11 W
1870	0 44	0 19 E	0 30 E	2 39	2 12	2 26	1 27	0 52	0 49
1880	0 06 E	0 19 W	0 08 W	2 01	1 34	3 03	0 49	1 29	1 26
1890	0 29 W	0 54	0 43	1 24	0 57	3 36	0 14 E	2 03	2 00
1900	1 00	1 25	1 14	0 51	0 24 E	4 03	0 17 W	2 32	2 29
1910	1 23 W	1 48 W	1 37 W	0 24 E	0 03 W	4 23 W	0 40 W	2 54 W	2 51 W

† For the county seat, Dobson, it is estimated that the figures in this column will have to be corrected as follows: For east declination (1750–1870) add 7′ to the tabular quantities, and for west declination (1880–1910) subtract 7′ from the tabular quantities.

TABLE II.—*Values of the magnetic declination at the county seats from 1750 to 1910*—Continued.

Year.	County and town.							
	Warren, Warrenton.	Washington, Plymouth.	Watauga, Boone.*	Wayne, Goldsboro.	Wilkes, Wilkesboro.	Wilson, Wilson.	Yadkin, Yadkinville.*	Yancey, Burnsville.*
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	0 01 W	0 47 W	1 27 E	0 52 E	1 26 E	0 43 E	1 09 E	1 52 E
1760	0 35 E	0 12 W	2 04	1 27	2 03	1 18	1 46	2 29
1770	1 07	0 19 E	2 38	1 58	2 37	1 49	2 19	3 03
1780	1 32	0 42	3 07	2 21	3 06	2 12	2 46	3 32
1790	1 49	0 57	3 29	2 36	3 28	2 27	3 06	3 54
1800	1 57	1 03	3 41	2 42	3 40	2 33	3 16	4 06
1810	1 56	0 59	3 45	2 38	3 44	2 29	3 17	4 10
1820	1 45	0 46	3 39	2 25	3 38	2 16	3 09	4 04
1830	1 26	0 24 E	3 23	2 03	3 22	1 54	2 51	3 48
1840	0 58	0 04 W	3 00	1 35	2 59	1 26	2 26	3 25
1850	0 25 E	0 39	2 30	1 00	2 29	0 51	1 54	2 55
1860	0 12 W	1 16	1 54	0 23 E	1 53	0 14 E	1 18	2 19
1870	0 50	1 54	1 16	0 15 W	1 15	0 24 W	0 40	1 41
1880	1 27	2 31	0 38	0 52	0 37	1 01	0 02 E	1 03
1890	2 01	3 04	0 02 E	1 25	0 01 E	1 34	0 33 W	0 27 E
1900	2 30	3 31	0 30 W	1 52	0 31 W	2 01	1 04	0 05 W
1910	2 52 W	3 51 W	0 55 W	2 12 W	0 56 W	2 21 W	1 27 W	0 30 W

DISTRIBUTION OF THE MAGNETIC DECLINATION IN NORTH CAROLINA FOR THE YEAR 1900.

By the term "distribution of the magnetic declination" is meant the geographic distribution, i. e., the relation which the declination at a station bears to its geographic location. It is usually shown by means of a chart on which lines are drawn through all places having the same declination. This is called an "isogonic chart," and the lines "isogonic lines," or "lines of equal magnetic declination." As it seldom happens, however, that there are many stations having exactly the same declination, in practice the lines are drawn to represent declinations differing successively by equal amounts—as, for example, by one degree.

We have seen that the declination varies from year to year, so that such a chart must be constructed from observations referring to the same epoch and applies only to that particular time. In general, the observations of a magnetic survey extend over a period of years, but they may be reduced to the same epoch by means of a knowledge of the secular variation of the declination. In the case of North Carolina the 1st of January, 1900, has been selected as the epoch for the isogonic chart, being the same as the latest isogonic charts for the United States and for other countries. By means of the secular variation tables (No. II) given in the preceding chapter all the available observations in North Carolina and parts of the adjoining States have been reduced to that epoch. These reduced values were then plotted on a map (Pl. I, frontispiece) of the State and the isogonic lines drawn in free hand for whole degrees of declination, conforming as well as possible to the irregularities of distribution, though the stations are not sufficiently numerous to do so except in a general way.

The distribution of the magnetic declination in North Carolina is so irregular that but little dependence can be placed on the isogonic chart as a substitute for actual observations. A comparison of the observed declinations with corresponding values scaled from the isogonic chart shows that a difference of half a degree is not unusual, and that as much as one degree is reached in several cases, while for Concord, Cabarrus County, the observed declination differs about two degrees from what the surrounding stations would lead us to expect. The observations are too widely distributed to enable us to decide whether these differences are due to causes extending over large areas or to purely local disturbances, and it has therefore been deemed inexpedient to attempt more than a representation of the general features of the distribution. It will be noticed that the quantities as actually derived by observation and reduced to January 1, 1900, are given on the isogonic chart.

In the following tables the stations are arranged alphabetically by counties. The first table contains the observations made by Mr. J. B. Baylor, Assistant, United States Coast and Geodetic Survey, in connection with the North Carolina Geological Survey. In the last column is indicated by the letter N. or S. whether observations were made over the north or south meridian monument. The columns headed "*D* observed" and "*D* 1900" contain, respectively, the observed declination and the same reduced to January 1, 1900. The declinations as published in this table are the means of the two extreme positions of the needle during the day. The mean of these two extreme positions corresponds, for all practical purposes, with the average direction of a compass during the day. The remaining tables contain declinations observed and collected from various sources by the United States Coast and Geodetic Survey. The general arrangement is the same, but here the date of observation is given to the nearest tenth of a year and the name of the observer or authority is given in the last column. The letters B. F. refer to observations made at the charge of the "Bache fund" of the National Academy of Sciences.

In regard to the latitudes and longitudes given in the tables, it should be borne in mind that they are only intended for use in computing the azimuth observations and in locating the stations on the map. As the azimuth observations are made in every case at nearly equal times before and after noon, the effect on the azimuth of a small error in latitude is nearly eliminated in the mean. It is thought that none of the latitudes and longitudes are in error by more than two minutes of arc and few by more than one minute. For the stations along the coast they are derived from the charts of the Coast and Geodetic Survey. In the interior a few are scaled from the maps of the United States Geological Survey and the remainder are computed from the Sun observations checked by the State maps of Rand, McNally & Co. and North Carolina Geological Survey.

THE SECULAR MOTION OF THE AGONIC LINE OVER NORTH CAROLINA.

The agonic line, or line of no declination, has always been of special interest to users of the compass, as it indicates those places where the needle points true north. A study of the county tables in the preceding chapter shows that the agonic line passed near Newbern, Greenville, and Warrenton in 1750 and moved steadily eastward until about 1800, when it reached its extreme easterly position, a short distance off Cape Hatteras. Since that time its motion has been westward, until it has now almost reached the western boundary. The following table gives its approximate location at different dates:

Asheville	1903.
Statesville	1884.
Carthage	1876.
Goldsboro	1866.
Newbern	1752 and 1850.
Manteo	1788 and 1814.

By glancing at Plate No. III the surveyor can get an idea of the approximate distributions of the magnetic declination for the three years 1750, 1800, and 1850. Thus in 1750 the magnetic declination was west of north for the extreme northeastern part of the State and east over the remainder. For the year 1800, however, the declination appears to have been east over the entire State, and for 1850 the distribution was about the same as the year 1750. For 1900 the declination is east for only the extreme southwestern portion of the State, being now west over almost the entire State. It is thus seen how comparatively rapid the whole aspect of the distribution of the magnetic declination is changed over North Carolina.

TABLE III.—*Summary of magnetic declinations in North Carolina, determined by J. B. Baylor, Assistant, United States Coast and Geodetic Survey, in connection with the North Carolina Geological Survey.*

County.	Town.	Latitude.	Longitude.	Date.	Declination observed.	Declination Jan. 1, 1900.	Remarks.
		° ′	° ′		° ′	° ′	
Alamance	Graham	36 04	79 24	Dec. 19, 1899	2 02·9 W.	2 03 W.	S.
Beaufort	Washington	35 33	77 03	June 25, 1898	2 44·0 W.	2 48 W.	S.
Bertie	Windsor	35 56	76 59	May 14, 1898	4 29·6 W.	4 34 W.	N.
Bladen	Elizabethtown	34 36	78 32	Nov. 22, 1899	1 37·8 W.	1 38 W.	S.
Brunswick	Southport	33 55	78 01	Aug. 5, 1898	1 50·4 W.	1 54 W.	N.
Buncombe	Asheville	35 35	82 32	Aug. 31, 1898	0 13·4 E.	0 09 E.	S.
Cabarrus	Concord	35 24	80 35	Aug. 26, 1899	2 48·8 W.	2 50 W.	N.
Chatham	Pittsboro	35 43	79 11	July 15, 1899	2 35·0 W.	2 36 W.	S.
Cherokee	Murphy	35 05	84 03	Sept. 21, 1898	2 18·2 E.	2 14 E.	N.
Chowan	Edenton	36 04	76 36	May 19, 1898	3 29·2 W.	3 33 W.	S.
Cleveland	Shelby	35 17	81 33	Aug. 17, 1899	0 05·4 W.	0 07 W.	S.
Columbus	Whiteville	34 19	78 42	Nov. 25, 1899	1 43·8 W.	1 44 W.	N.
Craven	Newbern	35 07	77 03	July 9, 1898	2 46·6 W.	2 51 W.	S.
Cumberland	Fayetteville	35 03	78 52	May 31, 1899	1 41·7 W.	1 43 W.	S.
Currituck	Currituck	36 27	76 01	May 31, 1898	4 46·1 W.	4 50 W.	S.
Dare	Manteo	35 55	75 40	June 8, 1898	4 22·2 W.	4 26 W.	S.
"	Chicamicomico	35 35	75 28	June 11, 1898	3 52·3 W.	3 56 W.	
"	Cape Hatteras L. H.	35 16	75 32	June 13, 1898	3 53·0 W.	3 57 W.	
Duplin	Kenansville	34 58	77 58	July 4, 1899	1 37·0 W.	1 38 W.	S.
Durham	Durham	36 03	78 55	Apr. 7, 1898	1 18·9 W.	1 24 W.	N.
Edgecombe	Tarboro	35 54	77 37	May 4, 1899	3 33·2 W.	3 35 W.	S.
Forsyth	Winston-Salem	36 06	80 15	Sept. 8, 1899	1 42·9 W.	1 44 W.	S.
Franklin	Louisburg	36 03	78 19	Dec. 14, 1899	2 24·1 W.	2 24 W.	N.
Gates	Gatesville	36 23	76 48	Apr. 12, 1899	3 45·2 W.	3 47 W.	S.
Granville	Oxford	36 18	78 38	Apr. 26, 1898	2 00·5 W.	2 05 W.	S.
Greene	Snow Hill	35 28	77 37	June 25, 1899	3 26·0 W.	3 27 W.	N.
Guilford	Greensboro	36 04	79 49	Sept. 22, 1899	0 50·3 W.	0 51 W.	S.
Halifax	Halifax	36 19	77 38	Apr. 29, 1899	2 00·0 W.	2 02 W.	N.
Harnett	Lillington	35 22	78 47	Dec. 1, 1899	1 59·4 W.	2 00 W.	S.
Hertford	Winton	36 24	76 59	Apr. 15, 1899	3 15·8 W.	3 18 W.	S.
Hyde	Swanquarter	35 24	76 19	June 17, 1898	3 18·9 W.	3 23 W.	S.
Iredell	Statesville	35 47	80 53	Sept. 1, 1899	0 50·5 W.	0 51 W.	S.
Jackson	Webster	35 21	83 14	Oct. 6, 1898	1 43·0 E.	1 39 E.	S.
Johnston	Smithfield	35 32	78 21	June 6, 1899	0 56·8 W.	0 58 W.	S.
Lenoir	Kinston	35 16	77 35	May 20, 1899	1 50·9 W.	1 52 W.	N.
Lincoln	Lincolnton	35 28	81 16	Aug. 12, 1899	0 35·8 W.	0 37 W.	N.
McDowell	Marion	35 40	82 01	Aug. 22, 1898	0 53·6 W.	0 58 W.	N.
Macon	Franklin	35 11	83 23	Sept. 27, 1898	1 36·3 E.	1 32 E.	N.
Madison	Marshall	35 47	82 40	Sept. 8, 1898	0 14·6 E.	0 10 E.	N.
Martin	Williamston	35 50	77 02	Dec. 6, 1899	3 05·3 W.	3 05 W.	S.

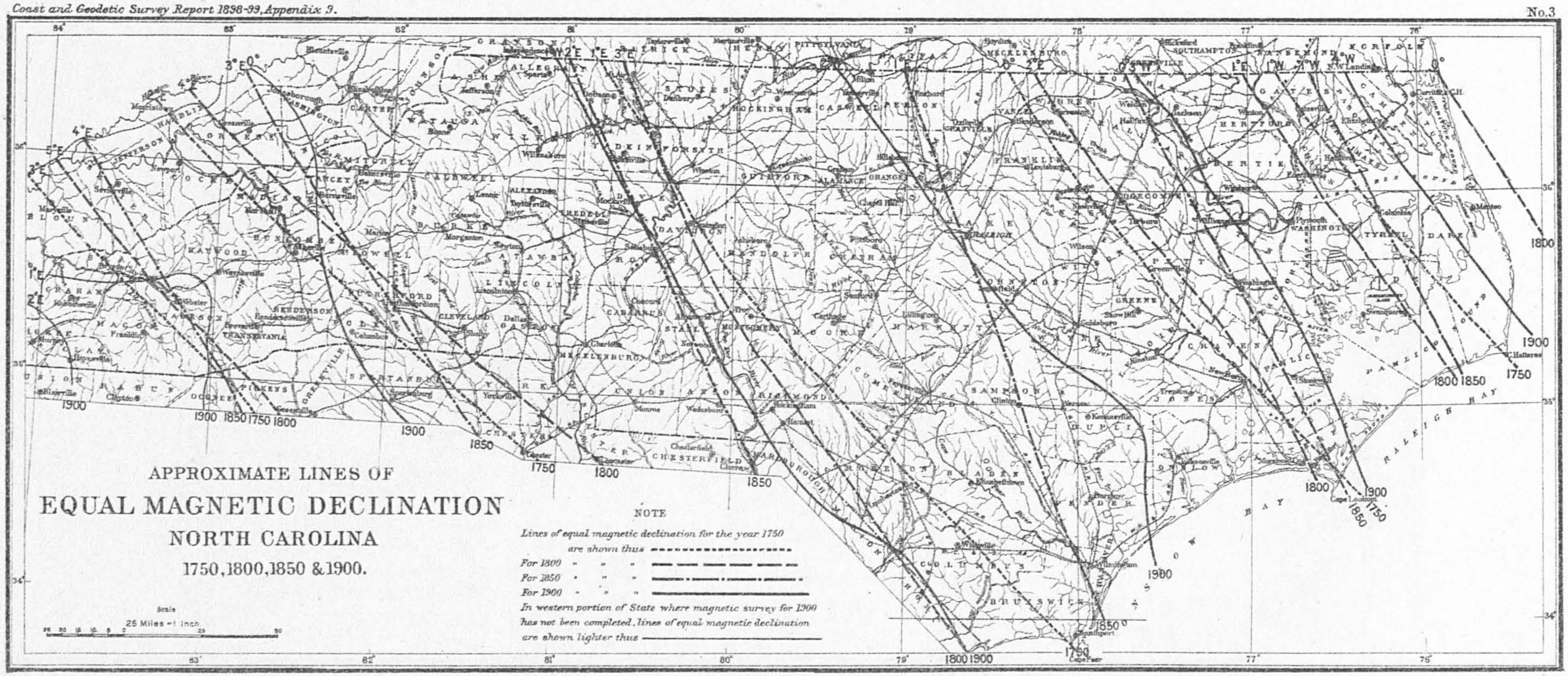

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TABLE III.—*Summary of magnetic declinations in North Carolina, etc.*—Continued.

County.	Town.	Latitude.	Longitude.	Date.	Declination observed.	Declination Jan. 1, 1900.	Remarks.
		° ′	° ′		° ′	° ′	
Mecklenburg	Charlotte	35 13	80 51	Aug. 9, 1899	0 23.5 W.	0 25 W.	S.
Montgomery	Troy	35 22	79 52	Oct. 7, 1899	1 26.3 W.	1 27 W.	N.
Moore	Carthage	35 20	79 25	July 21, 1899	1 16.2 W.	1 18 W.	S.
Nash	Nashville	35 58	77 58	May 10, 1899	1 42.2 W.	1 44 W.	N.
New Hanover	Wilmington	34 14	77 57	July 30, 1898	1 50.2 W.	1 54 W.	S.
Northampton	Jackson	36 23	77 29	Apr. 24, 1899	3 11.1 W.	3 13 W.	N.
Onslow	Jacksonville	34 44	77 22	July 23, 1898	2 28.8 W.	2 33 W.	S.
Orange	Hillsboro	36 04	79 05	Apr. 13, 1898	2 03.9 W.	2 09 W.	S.
Do.	Chapel Hill	35 54	79 03	Mar. 25, 26, 1898	1 28.6 W.	1 34 W.	S.
Pamlico	Bayboro	35 08	76 45	July 14, 1898	2 43.2 W.	2 47 W.	S.
Pasquotank	Elizabeth City	36 18	76 13	May 27, 1898	4 14.4 W.	4 19 W.	N.
Pender	Burgaw	34 32	77 55	July 8, 1899	1 28.8 W.	1 30 W.	S.
Perquimans	Hertford	36 11	76 28	Apr. 2, 1899	3 15.1 W.	3 17 W.	S.
Person	Roxboro	36 23	78 59	Apr. 19, 1898	2 11.4 W.	2 16 W.	S.
Pitt	Greenville	35 36	77 22	June 30, 1898	2 33.5 W.	2 37 W.	S.
Randolph	Ashboro	35 42	79 49	Oct. 2, 1899	1 58.8 W.	1 59 W.	S.
Richmond	Rockingham	34 54	79 46	July 28, 1899	1 24.0 W.	1 25 W.	S.
Robeson	Lumberton	34 36	78 58	Nov. 16, 1899	1 12.0 W.	1 12 W.	N.
Rockingham	Wentworth	36 24	79 47	Sept. 27, 1899	1 57.7 W.	1 58 W.	S.
Rowan	Salisbury	35 39	80 32	Aug. 16, 1898	0 38.5 W.	0 43 W.	N.
Rutherford	Rutherfordton	35 22	81 57	Aug. 22, 1899	0 15.6 W.	0 17 W.	S.
Sampson	Clinton	35 00	78 19	June 30, 1899	1 33.3 W.	1 35 W.	S.
Scotland	Laurinburg	34 47	79 28	Nov. 11, 1899	1 20.6 W.	1 21 W.	N.
Surry	Mount Airy	36 30	80 37	Sept. 13, 1899	1 13.0 W.	1 14 W.	N.
Swain	Bryson City	35 25	83 27	Sept. 15, 1898	0 55.5 E.	0 51 E.	S.
Transylvania	Brevard	35 14	82 44	Oct. 13, 1898	0 27.8 E.	0 24 E.	S.
Tyrrell	Columbia	35 55	76 15	Apr. 6, 1899	4 01.1 W.	4 03 W.	N.
Union	Monroe	34 58	80 34	July 31, 1899	0 15.8 W.	0 17 W.	N.
Vance	Henderson	36 22	78 22	Dec. 9, 1899	2 32.0 W.	2 32 W.	N.
Wake	Raleigh	35 48	78 36	June 10, 1899	2 27.1 W.	2 29 W.	S.
Warren	Warrenton	36 24	78 09	May 3, 1898	2 25.2 W.	2 30 W.	S.
Washington	Plymouth	35 52	76 44	May 10, 1898	3 26.9 W.	3 31 W.	N.
Wayne	Goldsboro	35 23	77 59	May 25, 1899	1 50.3 W.	1 52 W.	S.
Wilkes	Wilkesboro	36 09	81 09	Sept. 16, 1899	0 29.7 W.	0 31 W.	N.
Wilson	Wilson	35 44	77 55	May 15, 1899	1 59.6 W.	2 01 W.	N.

TABLE IV.—*Declinations in North Carolina and vicinity observed and collected by the U. S. Coast and Geodetic Survey.*

NORTH CAROLINA.

County.	Station.	Latitude.	Longitude.	Date.	D. observed.	D. Jan. 1, 1900.	Authority.
		° ′	° ′		° ′	° ′	
Anson	Wadesboro	34 58	80 04	1900.4	0 00.9 E.	0 02 E.	G. R. Putnam, C. and G. S.
Beaufort	Washington	35 33	77 03	1891.4	2 13.5 W.	2 37 W.	J. B. Baylor, C. and G. S.
Brunswick*	Fort Johnson	33 55	78 01	1859.3	0 38.1 E.	1 40 W.	G. W. Dean, C. and G. S.
Do.	do	33 55	78 01	1875.0	0 23.9 W.	1 42 W.	J. B. Baylor, C. and G. S.
Do.	do	33 55	78 01	1887.2	1 07.8 W.	1 44 W.	Do.
Buncombe	Asheville	35 35	82 32	1873.6	1 58.2 E.	0 24 E.	F. E. Hilgard, B. F.
Burke	Morganton	35 44	81 41	1873.6	1 11.0 E.	0 22 W.	Do.
Camden	Dismal Swamp †	36 33	76 23	1886.9	3 15.9 W.	3 53 W.	C. H. Sinclair, C. and G. S.
Carteret	Beaufort	34 43	76 40	1880.0	1 44.1 W.	2 44 W.	J. B. Baylor, C. and G. S.
Do.	do	34 43	76 40	1898.3	2 36.3 W.	2 41 W.	C. C. Yates, C. and G. S.
Do.	Portsmouth Island	35 04	76 03	1871.3	2 22.0 W.	3 53 W.	A. T. Mosman, C. and G. S.
Chowan	Edenton	36 04	76 36	1891.5	2 52.1 W.	3 15 W.	J. B. Baylor, C. and G. S.
Columbus	Fair Bluff	34 19	79 01	1891.4	0 36.5 W.	1 01 W.	Do.
Do.	Lake Waccamaw	34 18	78 32	1891.4	0 41.2 W.	1 06 W.	Do.
Craven	Newbern ‡	...	...	...	...	...	
Currituck	Knott Island †	36 33	75 56	1887.1	3 33.2 W.	4 10 W.	C. H. Sinclair, C. and G. S.
Do.	North West †	36 33	76 12	1887.0	2 54.0 W.	3 31 W.	Do.
Do.	Shellbank	36 04	75 44	1847.2	1 44.8 W.	4 47 W.	C. O. Boutelle, C. and G. S.
Dare	Bodies Island	35 48	75 32	1847.0	1 13.4 W.	4 16 W.	Do.
Do.	Sand Island	35 50	75 40	1876.1	2 58.9 W.	4 13 W.	E. Smith, C. and G. S.
Duplin	Warsaw	34 59	78 05	1891.4	1 34.9 W.	1 58 W.	J. B. Baylor, C. and G. S.
Edgecombe	Tarboro	35 54	77 37	1891.4	2 56.2 W.	3 19 W.	Do.
Forsyth	Winston	36 06	80 15	1891.7	1 20.0 W.	1 46 W.	J. N. Ambler.
Gates	Hines †	36 33	76 34	1887.1	3 04.7 W.	3 41 W.	C. H. Sinclair, C. and G. S.
Guilford	Greensboro	36 04	79 49	1873.6	0 43.0 E.	0 47 W.	F. E. Hilgard, B. F.

* Where more than one result is given for one place, either in this table or this and the preceding one combined, preference should be given to the latest value, since it is least affected by the uncertainty of the secular change. Though the same latitude and longitude are given for the different results, the stations occupied were generally not identical. The stations Goldsboro, Tarboro, and Edenton of 1891 are identical with those of the same name in the preceding table.

† On North Carolina-Virginia boundary.

‡ See secular variation discussion.

TABLE IV.—*Declinations in North Carolina and vicinity observed and collected by the U. S. Coast and Geodetic Survey*—Continued.

NORTH CAROLINA—Continued.

County.	Station.	Latitude.	Longitude.	Date.	D. observed.	D. Jan. 1, 1900.	Authority.
		° ′	° ′		° ′	° ′	
Halifax	Weldon	36 27	77 38	1875·5	1 40·7 W.	2 57 W.	J. M. Poole, B. F.
Do.	...do	36 27	77 38	1887·2	2 30·8 W.	3 07 W.	J. B. Baylor, C. and G. S.
Hertford	Riddicksville	36 32	76 56	1887·2	2 30·1 W.	3 06 W.	C. H. Sinclair, C. and G. S.
Lenoir	Kinston	35 16	77 35	1891·4	1 32·4 W.	1 55 W.	J. B. Baylor, C. and G. S.
Martin	Jamesville	35 48	76 52	1891·5	2 09·2 W.	2 32 W.	Do.
Mecklenburg	Charlotte	35 13	80 51	1873·6	1 03·9 E.	0 26 W.	F. E. Hilgard, B. F.
Mitchell	Roan High Bluff	36 06	82 09	1894·8	0 33·4 E.	0 17 E.	A. H. Buchanan, C. and G. S.
New Hanover	Wilmington	34 14	77 57	1854·4	1 13·5 E.	1 22 W.	G. W. Dean, C. and G. S.
Do.	...do	34 14	77 57	1891·4	1 16·1 W.	1 39 W.	J. B. Baylor, C. and G. S.
Pasquotank	Elizabeth City	36 18	76 13	1891·5	3 42·9 W.	4 06 W.	Do.
Pender	Burgaw	34 32	77 55	1891·4	0 53·2 W.	1 16 W.	Do.
Perquimans	Stevenson Point	36 06	76 11	1847·1	1 39·6 W.	4 42 W.	C. O. Boutelle, C. and G. S.
Rowan	Salisbury	35 39	80 32	1873·6	0 52·1 E.	0 38 W.	F. E. Hilgard, B. F.
Wake	Raleigh	35 47	78 38	1854·0	0 44·5 E.	1 56 W.	G. W. Dean, C. and G. S.
Do.	...do	35 47	78 38	1887·2	1 17·8 W.	1 56 W.	J. B. Baylor, C. and G. S.
Wayne	Goldsboro	35 23	77 59	1875·5	0 15·1 W.	1 32 W.	J. M. Poole, B. F.
Do.	...do	35 23	77 59	1891·4	1 16·7 W.	1 40 W.	J. B. Baylor, C. and G. S.
Wilkes	Poore	36 03	81 09	1895·7	0 25·7 W.	0 40 W.	A. H. Buchanan, C. and G. S.
Wilson	Wilson	35 44	77 55	1891·4	1 42·2 W.	2 05 W.	J. B. Baylor, C. and G. S.

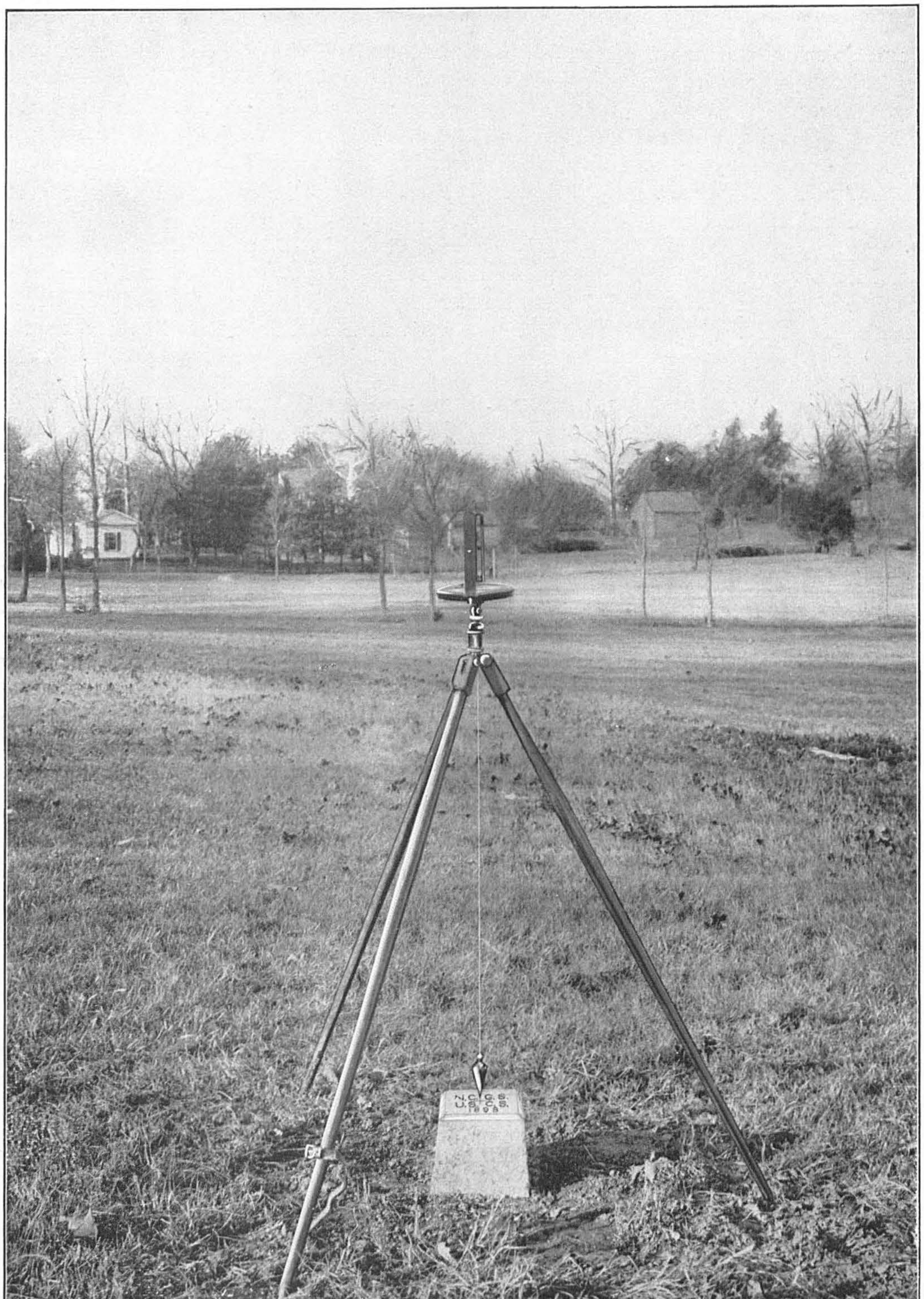
SOUTH CAROLINA.

County.	Station.	Latitude.	Longitude.	Date.	D. observed.	D. 1900.	Authority.
		° ′	° ′		° ′	° ′	
Florence	Florence	34 09	79 43	1875·5	1 12·2 E.	0 11 W.	J. M. Poole, B. F.
Do.	...do	34 09	79 43	1891·4	0 00·9 W.	0 28 W.	J. B. Baylor, C. and G. S.
Marion	Marion	34 09	79 20	1891·4	0 22·2 W.	0 47 W.	Do.
Richland	Columbia	34 00	81 02	1854·1	3 02·2 E.	0 17 E.	G. W. Dean, C. and G. S.
Do.	...do	34 00	81 02	1875·5	1 49·3 E.	0 24 E.	J. M. Poole, B. F.
Do.	...do	34 00	81 02	1900·2	0 12·6 E.	0 13 E.	D. L. Hazard, C. and G. S.
Spartanburg	Pacolet	34 51	81 45	1886·4	1 15·0 E.	0 30 E.	G. E. Ladshaw.
Do.	Block House*	35 12	82 13	1896·9	0 16·8 E.	0 07 E.	W. C. Hodgkins, C. and G. S.
Do.	Talent*	35 09	82 13	1896·9	0 05·4 E.	0 05 W.	Do.
Do.	Gowensville*	35 07	82 13	1896·9	0 33·4 E.	0 23 E.	Do
Do.	Gold Mine*	35 02	82 13	1896·9	0 25·8 E.	0 16 E.	Do.
Do.	Flint Rock*	34 59	82 13	1896·9	0 03·2 E.	0 07 W.	Do.
Do.	Spartanburg	34 58	81 56	1896·9	0 04·3 E.	0 06 W.	Do.
Do.	Greers*	34 57	82 13	1896·9	0 06·5 E.	0 04 W.	Do.
Do.	Pelham*	34 52	82 13	1896·9	0 17·7 E.	0 08 E.	Do.
Do.	Baker*	34 51	82 13	1896·9	0 09·6 E.	0 00	Do.
Do.	Green*	34 49	82 13	1896·9	0 15·9 E.	0 06 E.	Do.

* Station on the boundary line between Spartanburg and Greenville counties.

TENNESSEE.

County.	Station.	Latitude.	Longitude.	Date.	D. observed.	D. 1900.	Authority.
		° ′	° ′		° ′	° ′	
Hawkins	Rogersville	36 25	83 03	1873·6	1 49·0 E.	0 15 E.	F. E. Hilgard, B. F.
Knox	Knoxville	35 58	83 55	1873·6	1 52·6 E.	0 19 E.	Do.
Do.	...do	35 58	83 55	1875·5	1 39·6 E.	0 13 E.	Do.
Do.	...do	35 58	83 55	1890·5	0 35·0 E.	0 04 E.	J. B. Baylor, C. and G. S.
Do.	...do	35 58	83 55	1900·5	0 00·2 W.	0 01 E.	D. L. Hazard, C. and G. S.
McMinn	Athens	35 27	84 37	1881·6	1 44·2 E.	0 41 E.	J. B. Baylor, C. and G. S.
Sullivan	Bristol	36 36	82 11	1873·6	1 19·5 E.	0 14 W.	F. E. Hilgard, B. F.
Do.	...do	36 36	82 11	1881·5	0 38·5 E.	0 24 W.	J. B. Baylor, C. and G. S.
Do.	...do	36 36	82 11	1890·5	0 07·6 E.	0 23 W.	Do.
Do.	...do	36 36	82 11	1898·4	0 21·2 W.	0 26 W.	E. Smith, C. and G. S.
Unicoi	Big Butte △	36 04	82 38	1893·8	0 39·0 E.	0 19 E.	A. H. Buchanan, C. and G. S.



MERIDIAN LINE AT CHAPEL HILL, N. C.

TABLE IV.—*Declinations in North Carolina and vicinity observed and collected by the U. S. Coast and Geodetic Survey*—Continued.

VIRGINIA.

County.	Station.	Latitude.	Longitude.	Date.	D. observed.	D. 1900.	Authority.
		° ′	° ′		° ′	° ′	
Floyd	Buffalo △	36 48	80 29	1895·7	0 08·9 W.	0 22 W.	A. H. Buchanan, C. and G. S.
Grayson	Peach Bottom	36 36	81 00	1824·0	3 50·0 E.	0 14 W.	Boye.
Do.	Rogers △	36 40	81 33	1894·6	0 13·5 E.	0 04 W.	A. H. Buchanan, C. and G. S.
Greenesville	Cor. of Brunswick Co.	36 36	77 48	1824·0	0 55 E.	3 13 W.	Boye.
Do.	Emporia	36 40	77 32	1897·4	3 29·2 W.	3 36 W.	J. B. Baylor, C. and G. S.
Halifax	Mount Airy	36 52	79 06	1873·6	0 55·2 E.	0 32 W.	F. E. Hilgard, B. F.
Do.	Meadville	36 47	78 57	1882·0	1 50 W.	2 46 W.	M. French.
Do.	do	36 47	78 57	1885·5	1 28 W.	2 12 W.	Do.
Do.	do	36 47	78 57	1886·1	1 30 W.	2 12 W.	Do.
Do.	Houston	36 46	78 56	1897·6	2 23·9 W.	2 31 W.	O. B. French, C. and G. S.
Norfolk	N. C. boundary	36 33	75 52	1728·2	3 00 W.	4 22 W.	Colonel Byrd.
Do.	N. end Knott Island	36 34	75 55	1873·3	2 54·8 W.	4 19 W.	A. T. Mosman, C. and G. S.
Pittsylvania	Danville	36 37	79 25	1873·6	1 16·3 W.	2 43 W.	F. E. Hilgard, B. F.
Scott	Big Knob △	36 40	82 30	1893·7	0 19·2 W.	0 40 W.	A. H. Buchanan, C. and G. S.
Smyth	Marion	36 50	81 31	1881·5	0 01·7 W.	1 04 W.	J. B. Baylor, C. and G. S.
Do.	do	36 50	81 31	1898·4	1 02·0 W.	1 07 W.	E. Smith, C. and G. S.
Washington	Emory	36 40	81 46	1855	2 05 E.	0 37 W.	Prof. J. A. Davis.
Do.	do	36 40	81 46	1881·2	1 00 E.	0 04 W.	Do.
Do.	do	36 38	81 47	1892·7	0 08 E.	0 16 W.	F. D. Leffingwell.
Do.	Abingdon	36 42	81 58	1897·6	0 12·9 W.	0 21 W.	O. B. French, C. and G. S.
Wythe	Wytheville	36 57	81 04	1839·3	2 41 E.	0 51 W.	J. M. Gibboney.
Do.	do	36 57	81 04	1881·5	0 01·3 E.	1 01 W.	J. B. Baylor, C. and G. S.
Do.	do	36 57	81 04	1882·3	0 11 E.	0 49 W.	J. M. Gibboney.
Do.	do	36 57	81 04	1898·4	0 49·4 W.	0 54 W.	E. Smith, C. and G. S.

DIRECTIONS TO SURVEYORS CONCERNING THE USE OF THE COUNTY MERIDIAN LINES.

The following directions to surveyors concerning the use of the county meridian lines either for determining the magnetic declination or for ascertaining the index errors of their instruments should be followed.

If the instrument used be mounted on a tripod, it should be carefully centered and leveled over the cross on top of the same monument—the "reference" monument—over which observations were made in the magnetic survey and described in the descriptions of stations as published in this report. The monument to be sighted on is termed the "range" monument.

Should the instrument used be mounted on a simple Jacob's staff, it can be placed in the meridian line as close to the "reference" monument as possible and leveled.

A small rod should then be held in a vertical position over the cross in the top of the other monument—the "range" monument. The compass needle is released and magnetic bearing of the small rod read. This should be done with a small nonmagnetic magnifying glass, and it should be repeated about ten times, disturbing the needle with a bit of iron and letting it come to rest before each reading. The mean of all these bearings should be taken as the magnetic declination west or east, as the case may be.

In order to obtain the mean declination for the day (24 hours) these results should be obtained between 10 and 10·30 a. m. or about 6 p. m. local mean time. (See Table I, page 907.) The local mean time is obtained by subtracting from the railroad time four minutes for every degree of longitude the surveyor is west of the seventy-fifth meridian of longitude. No observations should be made during times of violent changes of the pointing of the magnetic needle, as, e. g., during magnetic storms.

Should the resulting declination differ essentially from the declination as obtained from the published value in this report, it proves conclusively that the surveyor's instrument has an error, which should be gotten rid of as nearly as possible by putting the instrument and needle in good adjustment. Any difference still remaining after the surveyor has satisfied himself that his instrument is in first-class condition and in good adjustment should be duly allowed for and recorded by the surveyor. The correct declination for the next ten years can be obtained by interpolation from Table II.

According to the act of March 7, 1899, a copy of which is given below, all results for declination taken over any of these monuments should be entered in the book kept by the Register of Deeds, giving the year, the day, and the local time the observations were made, and should also be entered on surveys made at that time. (See specimen record for keeping these observations.)

AN ACT REGULATING THE USE OF AND FOR THE PROTECTION OF MERIDIAN MONUMENTS AND STANDARDS OF MEASURE AT THE SEVERAL COUNTY SEATS IN NORTH CAROLINA.—MARCH 7, 1899.

Whereas Meridian monuments for determining the variations of the magnetic needle of the compass from the true north and a standard length for measuring surveyors' chains have already been established in nearly one-half of the counties of the State by the North Carolina Geological Survey and the United States Coast and Geodetic Survey, cooperating with the Commissioners in the several counties, and similar provision has been made for establishing such standards at the remaining county seats of the State during the present year; and whereas it is of great importance in the making of all surveys of boundaries of land, townships, counties, etc., that the chains, compasses, and other instruments used by surveyors should at intervals be properly tested,

The General Assembly of North Carolina do enact--

SECTION 1. That every surveyor operating in any of the counties of this State with magnetic instruments, whether in a public or private capacity, shall, between the first day of January and the thirty-first day of December in each and every year, carefully test his needle upon the official meridian monuments in the county in which he resides, or the nearest county in which such monuments have been erected, by adjusting his instrument over the intersection of the lines cut into the top of one of the meridian monuments so established and sighting to the intersection of the lines cut into the top of the other meridian monument, noting the variation of the magnetic from the true meridian and the direction thereof, and shall test the chain or other instrument of linear measure upon the distance from center to center, as indicated by intersecting lines of the two brass tablets or other official monuments set at or near the county court-house for this purpose, noting the error of such instrument as compared with the standard of the monuments. Such tests and the corrections, if any resulting therefrom, shall be returned by the surveyor in writing and under oath to the Register of Deeds for the county in which such meridian is situate within ten days from the taking of the observations aforesaid, setting forth the name of the surveyor, his residence, the character of the instrument tested, the date of the observations, the declination east or west of the magnetic needle from the true meridian, together with a fee of ten cents for filing and recording the same; and such return shall be filed and recorded by the Register of Deeds in a book properly ruled and lettered, to be furnished by the Board of Commissioners of the county, to be used for such purpose exclusively, and entitled "The Meridian Record:" Provided, That before making surveys in any county other than the one in which the magnetic instruments and instruments for linear measure to be used have already been tested, said surveyor shall procure in writing from the Register of Deeds of the county in which said monuments have been established, nearest to the point where the survey is to be made, a statement giving the declination of the magnetic needle for the year in which it was last determined and the rate and direction of variation of said magnetic needle since that time, and this data shall be recorded as a part of the record of his survey: Provided, further, That no surveyor shall be required to go outside of the county in which he resides for the purpose of testing the instruments herein named.

SEC. 2. That it shall be the duty of the Board of County Commissioners to maintain and protect such meridian monuments and tablets or monuments for the testing of chains or other instruments of linear measure, established by the State or National surveys, cooperating with the county authorities, in good order and condition as the official standards of the county.

SEC. 3. Any person or persons who shall in any manner injure, deface, remove, or destroy such monuments or tablets, or any part thereof, or who shall fail, neglect, or refuse to do and perform any act, matter, or thing by this act required of him or them to be done, shall be guilty of a misdemeanor, and upon conviction thereof shall pay a fine or be imprisoned, or both, at the discretion of the court, for every such offense.

SEC. 4. That this act shall be in force from and after its ratification.

Meridian Record, County *State: North Carolina.*

[Act of March 7, 1899.]

Day (of week).	Date.	Meridian stone. (North or south.)	Time of day. Standard time.	Instrument tested. (Compass or transit.)	Declination of needle. E. or W.	Mark sighted on.	Chain or tape tested.	Error of chain or tape.		Surveyor's name.	Residence.	Date of his report.	Remarks—Kind of weather, etc.
								Long or short.	Feet or links.				

DESCRIPTIONS OF THE MAGNETIC STATIONS.

A.—Stations in North Carolina Occupied by J. B. Baylor, Assistant, U. S. Coast and Geodetic Survey in Connection with the North Carolina Geological Survey in 1898 and 1899.

The arrangement of the stations is by counties, in alphabetical order. The stations are marked with solid granite posts, weighing about 400 pounds each. The top of the monument is dressed about 6 inches square and is lettered

N. C. G. S.
+
U. S. C. S.

The center of the cross marks the precise point. These granite posts are about 4½ feet long. Four feet of the stone is left in the rough, undressed, this part of the stone being sunk into the ground; the rest of the stone is dressed and projects 6 inches out of the ground. These granite monuments are used to mark the north and south ends of the true meridian lines established in connection with the magnetic survey.

Alamance County, Graham, 1899.—Observations made over the monument in the southwest corner of the Court-House square. The other monument is true north of this monument near the northwestern boundary of the Court-House property.

Anson County, Wadesboro, 1900.—See Group B, p. 932.

Beaufort County, Washington, 1898.—Observations made over the monument in the city cemetery near its southern inclosure. The other monument is true north of this monument near the western entrance of the cemetery.

Bertie County, Windsor, 1898.—Observations were made over monument at the "County Home," 2 miles southeast of Windsor, near the superintendent's house. The other monument is true south of this monument and near the fence.

Bladen County, Elizabethtown, 1899.—Observations were made over the monument in the southeast corner of the Court-House square. The other monument is true north of this monument, near the Court-House building.

Brunswick County, Southport, 1898.—Observations made over the monument in the northeast corner of the ground of Fort Johnson. The other monument is true south of this monument, near the river bank.

Buncombe County, Asheville, 1898.—Observations made over the monument in the "Asheville Cemetery," in front of the William Johnston section. The other monument is true north of this monument, near the entrance of the cemetery.

Cabarrus County, Concord, 1899.—Observations made over the monument in the open square in the rear of the Court-House. The other monument is true south of this monument, in the Court-House square.

Carteret County, Beaufort, 1898.—A true north and south line, marked with two monuments, was established in the Court-House square. A surveyor should mount his compass over the south monument.

CHATHAM COUNTY, PITTSBORO, 1899.—Observations made over the monument in the southeast corner of the Court-House square. The other monument is true north of this monument, on the Court-House property.

CHEROKEE COUNTY, MURPHY, 1898.—Observations made over the monument on the open lot east of High School. The other monument is true south of this monument, on the edge of the hill, and also on county property.

CHOWAN COUNTY, EDENTON, 1898.—Observations made over the monument in the southeast corner of the Court-House square. The other monument is also in the Court-House square, true north of this monument.

CLEVELAND COUNTY, SHELBY, 1899.—Observations made over the monument in the Court-House square southeast of the building. The other monument is true north of this monument, in the Court-House square.

COLUMBUS COUNTY, WHITEVILLE, 1899.—Observations made over the monument in the northwest corner of the Court-House lot. The other monument is true south of this monument, near the southern boundary of the Court-House property.

CRAVEN COUNTY, NEWBERN, 1898.—Observations made over the monument in the extreme northern part of Cedar Grove cemetery. The other monument is true north of this monument, in a grove of pines.

CUMBERLAND COUNTY, FAYETTEVILLE, 1899.—Observations made over the monument in the lot owned by the city near the old Court-House square, in front of Mr. Underwood's house. The other monument is true north of this monument, in the old Court-House square.

CURRITUCK COUNTY, CURRITUCK, 1898.—Observations made over the monument in the southeast corner of the Court-House square. The other monument is true north of this monument, and also in the Court-House square.

DARE COUNTY, MANTEO, 1898.—Observations made over the monument in the southwest corner of the Court-House square. The other monument is true north of this monument, near the fence.

DARE COUNTY, CHICAMICOMICO, 1898.—No monuments marking the true north and south line were established here. Station marked by a stub and tack 30 yards from inner beach and east of house owned by Aaron O'Neal.

DARE COUNTY, CAPE HATTERAS, 1898.—No monuments marking the true north and south line were established here. Station marked by a stub and tack 50 yards from inner beach, on a point of land southeast of house owned by Dr. J. J. Davis.

DUPLIN COUNTY, KENANSVILLE, 1899.—Observations made over the monument in the large open square (the property of Duplin County) west of the Court-House. The other monument is true north of this monument, and also in this square.

DURHAM COUNTY, DURHAM, 1898.—At the County Home, 3 miles from the city of Durham, observations made over the monument just in front of superintendent's house. The other monument is true south of this monument, near the public road.

EDGECOMBE COUNTY, TARBORO, 1899.—Observations made over the monument in "The City Common," in front of the High School. The other monument is true north of this monument, in "The Common."

FORSYTH COUNTY, WINSTON-SALEM, 1899.—Observations made over the monument near the southern boundary fence of the Moravian cemetery. The other monument is also in the cemetery, true north of this monument. The monuments at this place are rough granite posts with a small hole marking the center.

FRANKLIN COUNTY, LOUISBURG, 1899.—Observations made over the monument in the county lot in the rear of the jail. The other monument is true south of this monument, in the same county lot, near the river.

GATES COUNTY, GATESVILLE, 1899.—Observations made over the monument in the southwest corner of the Court-House lot. The other monument is true north of this monument, in the Court-House lot.

GRANVILLE COUNTY, OXFORD, 1898.—Observations made over the monument in the grounds of the Orphan Asylum. The other meridian stone is also in the Orphan Asylum grounds and true north of this monument.

GREENE COUNTY, SNOW HILL, 1899.—Observations made over the monument on the bluff on the side of the road which runs in front of the Court-House. The other monument is true south of this monument, near the Court-House building.

GUILFORD COUNTY, GREENSBORO, 1899.—Observations made over the monument in the park in front of the Greensboro Female College. The other monument is true north of this monument, near the street.

HALIFAX COUNTY, HALIFAX, 1899.—Observations made over the monument in the Court-House lot, northeast of the building. The other monument is true south of this monument, near the eastern fence of the Court-House square.

HARNETT COUNTY, LILLINGTON, 1899.—Observations made over the monument in the southeast corner of the Court-House square. The other monument is true north of this monument, in the Court-House square.

HERTFORD COUNTY, WINTON, 1899.—Observations made over the monument near the southern edge of the Court-House lot. The other monument is true north of this monument, in the Court-House lot, near the fence.

HYDE COUNTY, SWANQUARTER, 1898.—Observations made over monument in southwest corner of the Court-House square. The other monument is true north of this monument, near the Court-House building.

IREDELL COUNTY, STATESVILLE, 1899.—Observations made over the monument in the grounds of the Statesville Graded School. The other monument is true north of this monument, near the street. The monuments at this place are of marble instead of granite.

JACKSON COUNTY, WEBSTER, 1898.—Observations made over the monument on the edge of the public road which runs in front of the Court-House. The other monument is true north of this monument, near the Court-House building.

JOHNSTON COUNTY, SMITHFIELD, 1899.—Observations made over the monument in the southeast corner of the Court-House square. The other monument is true north of this monument, near the edge of the street.

LENOIR COUNTY, KINSTON, 1899.—Observations made over the monument in the northeast corner of the Court-House lot. The other monument is true south of this monument, near the street.

LINCOLN COUNTY, LINCOLNTON, 1899.—Observations made over the monument in the open Court-House square. The other monument is true south of this monument, near the Court-House building.

MCDOWELL COUNTY, MARION, 1898.—Observations made over the monument in the northeast corner of the Court-House square. The other monument is true south of this monument, near the edge of the Court-House square.

MACON COUNTY, FRANKLIN, 1898.—Observations made over the monument in the northeast corner of the Court-House square. The other monument is true south of this monument, in the open space near the jail.

MADISON COUNTY, MARSHALL, 1898.—Observations made over the monument on the side of the hill above the Court-House. The other monument is true south of this monument, near the jail fence.

MARTIN COUNTY, WILLIAMSTON, 1899.—Observations made over the monument in the rear of the Court-House. The other monument is true north of this monument, near the boundary fence of the Court-House yard.

MECKLENBURG COUNTY, CHARLOTTE, 1899.—Observations made over the monument in the large open lot in the rear of "The Charlotte Graded School." This lot is the property of the school. The other monument is on this same lot, true north of this monument.

MONTGOMERY COUNTY, TROY, 1899.—Observations made over the monument in the northeast corner of the Court-House lot. The other monument is true south of this monument, near the southern boundary of the Court-House lot.

MOORE COUNTY, CARTHAGE, 1899.—Observations made over the monument southwest of the Court-House building. The other monument is true north of this monument, on the Court-House property.

NASH COUNTY, NASHVILLE, 1899.—Observations made over the monument in the Court-House lot near its northern boundary. The other monument is true south of this monument in the Court-House lot.

NEW HANOVER COUNTY, WILMINGTON, 1898.—Observations made over the monument in the grounds of "The City Hospital." The other monument is true north of this monument, near northern inclosure of the grounds.

NORTHAMPTON COUNTY, JACKSON, 1899.—Observations made over the monument in the Court-House lot northwest of the building. The other monument is true south of this monument in the Court House lot, near the fence.

ONSLOW COUNTY, JACKSONVILLE, 1898.—Observations made over the monument in the southeast corner of the Court-House square. The other monument is near the jail and is true north of this monument.

ORANGE COUNTY, HILLSBORO, 1898.—Observations made over monument on edge of the public road, east of the town. The other monument is also on the edge of the public road and is true north of this monument.

ORANGE COUNTY, CHAPEL HILL, 1898.—On the campus of the University of North Carolina; observations made over the monument just east of the building used by the State Geological Survey. The other monument also on the campus near the Episcopal Church, and true north of this monument.

PAMLICO COUNTY, BAYBORO, 1898.—Observations made over the monument in the northeast corner of the Court-House square. The other monument is true north of this monument, near the northern edge of the Court-House square.

PASQUOTANK COUNTY, ELIZABETH CITY, 1898.—Observations made over the monument at the "County Home," west of the building. The other monument is near the fence and is true south of this monument.

PENDER COUNTY, BURGAW, 1899.—Observations made over the monument southeast of the Court-House building. The other monument is also in the Court-House lot, true north of this monument.

PERQUIMANS COUNTY, HERTFORD, 1899.—Observations made over the monument in the broad avenue of "The City Cemetery." The other monument is true north of this monument, near the gate of the cemetery.

PERSON COUNTY, ROXBORO, 1898.—Observations made over the monument in the city cemetery, 1½ miles from town. The other monument is also in the city cemetery and true north of this monument.

PITT COUNTY, GREENVILLE, 1898.—Observations made over the monument in the open space just north of the Methodist cemetery. The other monument is true north of this monument, in edge of the city cemetery.

RANDOLPH COUNTY, ASHBORO, 1899.—Observations made over the monument in the southwest corner of the Court-House square. The other monument is true north of this monument, near the northern boundary of the Court-House square.

RICHMOND COUNTY, ROCKINGHAM, 1899.—Observations made over the monument in the grounds of "The Graded School." The other monument is true north of this monument in the grounds of the school, and near the street.

ROBESON COUNTY, LUMBERTON, 1899.—Observations made over the monument in the northeast corner of the Court-House square. The other monument is true south of this monument, near the southern boundary of the Court-House square.

ROCKINGHAM COUNTY, WENTWORTH, 1899.—Observations made over the monument in the southeast corner of the Court-House square. The other monument is true north of this monument, near the jail fence.

ROWAN COUNTY, SALISBURY, 1898.—Observations made over the monument near the center of the city cemetery. The other monument is true south of this monument, near the southern gate.

RUTHERFORD COUNTY, RUTHERFORDTON, 1899.—Observations made over the monument in the open lot in the rear of the Court-House near the southern boundary of the Court-House property. The other monument is true north of this monument, on the Court-House property.

SAMPSON COUNTY, CLINTON, 1899.—Observations made over the monument in the open space in front of the city cemetery. The other monument is true north of this monument, on the edge of the road.

SCOTLAND COUNTY, LAURINBURG, 1899.—Observations made over the monument in the northern edge of the ground of the Presbyterian Church. The other monument is true south of this monument near the public road.

SURRY COUNTY, MOUNT AIRY, 1899.—Observations made over the monument in the front yard of the residence of Thomas Woodroffe, of the Mount Airy granite quarry. The other monument is true south of this monument in the same yard.

SWAIN COUNTY, BRYSON CITY, 1898.—Observations made over the monument on top of the hill in the city cemetery, near the Collins section. The other monument is true north of this monument, near crest of the hill.

TRANSYLVANIA COUNTY, BREVARD, 1898.—Observations made over the monument in the southeast corner of the Court-House square. The other monument is true north of this monument, in the Court-House square.

TYRRELL COUNTY, COLUMBIA, 1899.—Observations made over the monument in "The Academy" grounds east of the town. The other monument is true south of this monument, near the southeast corner of the Academy grounds.

UNION COUNTY, MONROE, 1899.—Observations made over the monument in the northeast corner of the Court-House square. The other monument is true south of this monument, also in the Court-House lot.

VANCE COUNTY, HENDERSON, 1899.—Observations made over the monument in the northern corner of the Court-House square. The other monument is true south of this monument, near the boundary fence of the Court-House property.

WAKE COUNTY, RALEIGH, 1899.—Observations made over the monument in the open park in front of the "A. M. College." The other monument is also in this park true north of this monument, near a small summerhouse.

WARREN COUNTY, WARRENTON, 1898.—Observations made over monument in the new city cemetery. The other monument is also in the city cemetery true north of this monument.

WASHINGTON COUNTY, PLYMOUTH, 1898.—Observations made over monument in the paddock adjoining the house of W. H. Stubbs on edge of road. The other monument is also on the edge of road true south of this monument.

WAYNE COUNTY, GOLDSBORO, 1899.—Observations made over the monument in the southeast corner of the Court-House square. The other monument is true north of this monument, near the register's office.

WILKES COUNTY, WILKESBORO, 1899.—Observations made over the monument in the northwest corner of the Court-House property. The other monument is true south of this monument at the corner of the street.

WILSON COUNTY, WILSON, 1899.—Observations made over the monument in the grounds of "The Graded School" in the eastern section of the city. The other monument is true south of this monument in the school lot, near the edge of the street.

B.—STATIONS IN NORTH CAROLINA OCCUPIED CHIEFLY BY THE UNITED STATES COAST AND GEODETIC SURVEY SINCE 1847.

ANSON COUNTY, WADESBORO, 1900.—In the field occupied by the Smithsonian eclipse expedition in May, 1900. A meridian line was established and permanently marked by two marble blocks 9 by 9 inches square and 2 feet long. The magnetic observations were made by G. R. Putnam at a point 91 yards east of the line, the meridian line having been established later.

BEAUFORT COUNTY, WASHINGTON, 1891.—Observations of 1891 made in the open space near the foot of Main street and its intersection with Telfair street. The lot is held in trust by the Episcopal church, and in it is the monument to Augustus Harvey and wife. The station is marked by a copper tack in a yellow-pine post, with a bottle filled with coal dust sunk 2 feet in the ground under this post. It is 27·1 metres distant from a stone post at the center of Main and Telfair streets. It is distant 16·7 metres from the fence east of the magnetic station.

BRUNSWICK COUNTY, FORT JOHNSON, 1859.—Station of 1859 on the parade ground at Fort Johnson, near the river bank. It is 89·2 metres in a westerly direction from the Coast Survey geodetic station. Station of 1875 is also on the parade ground at Fort Johnson near the river bank 150 feet south of the flagstaff. Station of 1887 is identical with the station of 1875.

BUNCOMBE COUNTY, ASHEVILLE, 1873.—Station of 1873 is in the grounds of the old Eagle hotel at Asheville, 5 paces west of the east wall and 3 paces north of the south wall.

BURKE COUNTY, MORGANTON, 1873.—Station of 1873 is in the front lawn of Maj. J. W. Wilson's dwelling, opposite the Episcopal church. It is 10 paces west of the east fence and 15 paces south of the north fence of the yard.

CAMDEN COUNTY, DISMAL SWAMP, 1886.—Station of 1886 is about 100 feet north of the "Dismal Swamp Canal, Virginia and North Carolina boundary stone." This is where the State boundary crosses the Dismal Swamp Canal, 4 miles south of Wallaceton.

CARTERET COUNTY, BEAUFORT, 1880.—Station of 1880 is in the open lot in the rear of Miss Davis's boarding house, 80 yards from the rear of the house and 40 yards from Ann street. Station of 1898 is in the same lot and in about the same spot. Miss Davis's boarding house is near the steamboat dock.

CARTERET COUNTY, PORTSMOUTH ISLAND, 1871.—Station of 1871 is at Northeast Base on Portsmouth Island. Northeast Base is one of the Coast and Geodetic Survey stations used in the survey of the island and is where a base line was measured.

CHOWAN COUNTY, EDENTON, 1891.—Station of 1891 is in the southeast corner of the Court-House square in about the same spot as the station of 1898.

COLUMBUS COUNTY, FAIRBLUFF, 1891.—Station of 1891 is in the open space just one block south of the Atlantic Coast Line Railroad between the properties of Col. T. F. Toms and Mr. J. A. Mearsand, near the center of the street. It is marked with a yellow-pine post and a copper tack. This post has a bottle under it filled with coal dust and sunk 2 feet in the ground.

COLUMBUS COUNTY, LAKE WACCAMAW, 1891.—Station of 1891 is in the yard of Mr. G. S. Gillespie in northern suburbs of village. It is 62·5 feet from the southwest corner of Mr. Gillespie's house and is 12 feet from the west fence and 74·3 feet from the north fence of the yard. The station is marked by a yellow-pine post and copper tack, with a bottle filled with coal dust sunk 2 feet in the ground under the post.

CRAVEN COUNTY, NEWBERN, 1874.—Station of 1874 is located in the solid brick inclosure of the national cemetery, in the open space to the west of the superintendent's house.

CURRITUCK COUNTY, KNOTT ISLAND, 1887.—Station of 1887 is on the Virginia and North Carolina boundary on Knott Island about 1 700 feet from Back Bay, a little north of Mr. Williams's stable and 52 feet east of the latitude station of the Virginia and North Carolina boundary line.

CURRITUCK COUNTY, NORTHWEST, 1887.—Station of 1887 is on the Virginia and North Carolina boundary, 10 miles east of where the State line crosses the Dismal Swamp Canal.

CURRITUCK COUNTY, SHELLBANK, 1847.—Station of 1847 is northeast of the Coast Survey geodetic station at Shellbank, which was used in the survey of the coast.

DARE COUNTY, BODIES ISLAND, 1847.—Station of 1847 is at Station LXXII of base line which was measured on Bodies Island in the survey of the coast. It is 7 223 metres from the south end of this base line and is near the house of Mr. E. B. Midgett.

DARE COUNTY, SAND ISLAND, 1876.—Station of 1876 is 50 yards from the geodetic station at Sand Island which was used in the survey of the coast, and it bears from it 64° 35′ west of south.

DUPLIN COUNTY, WARSAW, 1891.—Station of 1891 is in the open lot adjoining the Methodist church in the southeastern suburbs of the village. It is marked by a copper tack in a yellow-pine post. A bottle filled with coal dust is sunk 2 feet in the ground under this post. The point is distant 30·3 metres from the southwest corner of the Methodist church and is distant 13·15 metres from the southwest corner of the ditch in rear of the church.

EDGECOMBE COUNTY, TARBORO, 1891.—Station of 1891 is in the "Town Common" in front of the high school and within a few feet of the station of 1899.

FORSYTH COUNTY, WINSTON, 1891.—Station of 1891 was occupied by Mr. J. N. Ambler, at Winston, but no description is filed giving the exact locality where observations were made.

GATES COUNTY, HINES, 1887.—Station of 1887 is 54 feet north of the latitude station of the Virginia and North Carolina line. It is located on the land of Dr. Hines and near the Mathias farm.

GUILFORD COUNTY, GREENSBORO, 1873.—Station of 1873 is in the ground of Mr. Colwell, on Gaston street above Green. It is 4 paces from the east side of the carriage road and 9 paces from the front fence, in the northeast corner of the front lawn.

HALIFAX COUNTY, WELDON, 1875 and 1887.—Station of 1875 is in the lot west of the Methodist church. This lot is bounded by property owned by Mr. Smalley, Mrs. Allen, and Mrs. Brown. The station is 15 paces from Mrs. Allen's fence and northwest of it. Station of 1887 is the same as the station of 1875 and is in the Methodist churchyard.

HERTFORD COUNTY, RIDDICKSVILLE, 1887.—Station of 1887 is 1 mile south of the Nottaway River on the lawn in front of the house of Mr. James D. Riddick.

LENOIR COUNTY, KINSTON, 1891.—Station of 1891 is in the open space in the center of King avenue, in the southeastern suburbs of the town. It is distant 14·2 metres from the northern limits of King avenue and 17 metres from the southern limits of King avenue. It is between two elm trees, the sixth and seventh trees counting from East street. The station is marked by a yellow pine post and copper tack. A bottle filled with coal dust is sunk 2 feet in the ground under this post.

MARTIN COUNTY, JAMESVILLE, 1891.—Station of 1891 in the open lot adjoining the "White Methodist church," in the southeastern suburbs of the town. The station is marked with a yellow pine post and copper tack. A bottle filled with coal dust is sunk 2 feet in the ground under this post. The station is distant 28·3 metres from the northeast corner of the Methodist church and 32·5 metres from the southeast corner of this church.

MECKLENBURG COUNTY, CHARLOTTE, 1873.—Station of 1873 is in the front yard of Mr. Reidiger, living on the northeast corner of Church and Sixth streets. It is 3 paces northeast of the fence corner.

MITCHELL COUNTY, ROAN HIGH BLUFF, 1895.—Station of 1895 is at Roan High Bluff triangulation station. It is on a very high bluff three-fourths mile from "Cloudland hotel," near the State line in Mitchell County. It is on a very large rock on the edge of High Bluff. Roan High Knob is the highest point in this vicinity.

NEW HANOVER COUNTY, WILMINGTON, 1854 and 1891.—Station of 1854 is upon the land adjoining Dr. Drune's residence, north side of Market street, near the Episcopal church. It is due north of the astronomical transit station on this lot used by the Coast Survey in 1854.

Station of 1891 is on the grounds of the United States marine-hospital in the eastern suburbs of the city. It is distant 22·1 metres from the southern inclosure of the grounds and 33·5 metres from the eastern inclosure of the hospital grounds. The station is marked with a copper tack in a yellow pine post. A bottle filled with coal dust is sunk 2 feet in the ground under this post.

PASQUOTANK COUNTY, ELIZABETH CITY, 1891.—Station of 1891 is in the Albemarle park fair grounds. This park is just 1 mile east of the center of the town on the bank of Pasquotank River. The station is in the open space just south of the ticket office and 47 metres from it and 21 metres northwest of a walnut tree. It is marked by a cross on a granite bowlder. A bottle filled with coal dust is sunk in the ground 2 feet under this bowlder.

PENDER COUNTY, BURGAW, 1891.—Station of 1891 is in southwest corner of the Court-House grounds. It is 42·2 metres from the southwest corner of the Court-House building and 14·5 metres east and 33·3 metres north of the inner edge of the ditch around the grounds. It is marked with a yellow pine post and copper tack, with a bottle filled with coal dust sunk 2 feet in the ground under it.

PERQUIMANS COUNTY, STEVENSON POINT, 1847.—Station of 1847 is in a line bearing 10° 13′ west of north from the Coast Survey geodetic station at Stevenson Point, which was used in the survey of the coast.

ROWAN COUNTY, SALISBURY, 1873.—Station of 1873 is located in the pasture of Mr. J. K. Burk, on Main street, just out of town going west. It is 20 paces southwest of the sixth fork of the fence running north and south.

WAKE COUNTY, RALEIGH, 1854.—Station of 1854 is 105 feet east and 26·6 feet north of the center of the State capitol dome.

WAKE COUNTY, RALEIGH, 1887.—Station of 1887 is in the Capitol grounds, 23·5 metres due north of the center of the stone occupied by the transit instrument of United States Coast and Geodetic Survey in 1854.

WAYNE COUNTY, GOLDSBORO, 1875.—Station of 1875 is on the lot on the southeast corner of John and Spruce streets. It is 30 paces from the sidewalk on Spruce street and 30 paces from John street.

WAYNE COUNTY, GOLDSBORO, 1891.—Station of 1891 in the southeast corner of the Court-House square and within a few feet of the station of 1899.

WILKES COUNTY, POORE, 1895.—Station of 1895 is at Poore triangulation station, which is on the summit of Poore's Knob, Brushy mountains, near the county line of Alexander county, N. C.

WILSON COUNTY, WILSON, 1891.—Station of 1891 is in the grounds of the Wilson graded school, in the northern suburbs of the town. The station is located in the open space just in front of the center of the school building and distant 23·4 metres from the inner edge of Maplewood avenue and 37·2 metres from the outer edge of the front steps of the graded school building. The station is marked by a tack in a yellow pine post. A bottle filled with coal dust is sunk under this post 2 feet in the ground.

C. MAGNETIC STATIONS IN SOUTH CAROLINA OCCUPIED CHIEFLY BY THE U. S COAST AND GEODETIC SURVEY BETWEEN 1854 AND 1900.

FLORENCE COUNTY, FLORENCE, 1875.—Station of 1875 is on Coit street, about 600 yards from the railroad, and is 25 paces southeast of the old African church, and on a line with the sidewalk of the street.

FLORENCE COUNTY, FLORENCE, 1891.—Station of 1891 is in the northwest corner of the National cemetery. It is marked by a copper tack in a yellow pine post and with a bottle filled with coal dust sunk 2 feet under it.

MARION COUNTY, MARION, 1891.—Station of 1891 is in the northwest suburbs of the town in the open lot just in front of the livery stable of the Planters hotel and just south of and adjoining the property of Mr. W. H. Cross. The station is marked with a yellow pine post and copper tack, with a bottle filled with coal dust sunk 2 feet under this post.

RICHLAND COUNTY, COLUMBIA, 1854, 1875, and 1900.—Station of 1854 is in the Capitol grounds, 164 feet from the southwest corner and 293 feet from the northwest corner of the new Capitol building.

Station of 1875 is in the southwest corner of the Capitol square, as near the location of the old station as could be determined. It is 20 paces from the fence.

Station of 1900 is in southwest corner of Capitol grounds, 40 feet from Senate street and about 225 feet from the southwest corner of the State house.

SPARTANBURG COUNTY, PACOLET, 1886.—Station of 1886 was occupied by Mr. G. E. Ladshaw in the town of Pacolet, in Spartanburg county, S. C., and no description of the locality is filed.

SPARTANBURG COUNTY, BLOCK HOUSE, 1896.—Station of 1896 is 100 feet northeast of the road leading from Landrum, S. C., to Tyron, N. C., and about 700 feet northeast of the Spartanburg and Asheville railroad. It is on the North Carolina and South Carolina boundary line and is marked by a large stone marked N. C. on the north side and S. C. on the south side. This stone also marks the boundary between the counties of Spartanburg and Greenville.

SPARTANBURG COUNTY, TALENT, 1896.—Station of 1896 is on the farm of Mr. B. S. Talent about 1 mile north of Earles' mill on the road from Gowensville to Landrum, S. C. It is west of the road and just south of a clump of woods opposite Mr. Talent's house, and on the county line as marked at the time.

SPARTANBURG COUNTY, GOWENSVILLE, 1896.—Station of 1896 is on the south side of the road leading from the village of Gowensville, S. C., to Campbell and Spartanburg and is about 750 metres east of Gowensville. It is marked by a square stone post placed there to mark the county boundary, and it is 36 metres west of the so-called "old boundary" at the forks of the road where there is an old stone.

SPARTANBURG COUNTY, GOLD MINE, 1896.—Station of 1896 is between Gowensville and Greers and nearly on the line between Spartanburg and Greenville counties, S. C., being 8 metres west of a stake left by the Greenville surveyor in March, 1896. This land belongs to the McBee family, whose agent, Mr. Steele, lives in the house a little east of station. The gold mine from which the name is derived is a short distance south of the station.

SPARTANBURG COUNTY, FLINT ROCK, 1896.—Station of 1896 is on the crest of the ridge immediately south of Gap creek road. It is about 50 yards to the eastward of a small blacksmith shop belonging to Mr. "Bill" Farmer, whose house is west of the shop. This small shop is directly on the line marked as the county boundary in 1896 by the Greenville surveyor. The locality called "Gap Creek Stone" or "Old Flint Rock" is on the north side of the road.

SPARTANBURG COUNTY, SPARTANBURG, 1896.—Station of 1896 is in the ground of Wofford College. It is on the college campus and in front of the main building. It is 67·25 metres nearly south from the Coast and Geodetic Survey primary triangulation station Wofford, which is on roof of college building. The magnetic station is marked by a stone post about 6 inches square, lettered U. S. C. S. and also M. S.

SPARTANBURG COUNTY, GREERS, 1896.—Station of 1896 is in the eastern part of Greers, S. C., and just on the Spartanburg side of the "old county line," which is here marked by a lane, said to have been laid out equally on each side of the boundary. The line marked by the Greenville surveyor in 1896 lies a little farther west. The station is in the yard of Mr. Wyatt, who keeps an inn here. It is west of the house and between it and the lane, near the fence.

SPARTANBURG COUNTY, PELHAM, 1896.—Station of 1896 is on the west side of the road leading from Greers, S. C., to Pelham, S. C., and is on the outskirts of the latter village. It is about a quarter of a mile north of Pelham bridge, on the summit of the ridge overlooking the factory and surroundings. The station is marked by a square stone post, placed there by the Greenville surveyor to mark the boundary line.

SPARTANBURG COUNTY, BAKER, 1896.—Station of 1896 is in Greenville County, S. C., on the land of Mr. Baker, about a mile south of Pelham. It is about 100 metres east of the old Indian boundary line on the top of a small knoll east of the road and about 150 metres southeast of Sam Hitching's old store.

SPARTANBURG COUNTY, GREEN, 1896.—Station of 1896 is in Greenville County, S. C., about 2 miles south of Pelham bridge and near the old Indian boundary line, being a little west of that line and a little east of the road, and on land belonging to Luce Green.

D. MAGNETIC STATIONS IN TENNESSEE OCCUPIED CHIEFLY BY THE U. S. COAST AND GEODETIC SURVEY BETWEEN 1873 AND 1900.

HAWKINS COUNTY, ROGERSVILLE, 1873.—Station of 1873 is in the garden of Capt. F. A. Butler, keeper of the Rogersville house. It is 3 paces from the west fence and 7 from the south fence of the garden.

KNOX COUNTY, KNOXVILLE, 1873, 1875, 1890, and 1900.—Station of 1873 is in the asylum for the Deaf and Dumb, 3 paces southeast of the large tree in front of the house of the director, Professor Imes.

Station of 1875 is probably the same as the station of 1873.

Station of 1890 is on the grounds of the University of Tennessee, in the open space west of Agricultural building and conservatory. It is on the side of the hill, in the triangular strip of grass between the two roads, and is marked with a solid limestone post 4 by 4 inches on top and sunk 2 feet in the ground.

Station of 1900 is identical with that of 1890.

MCMINN COUNTY, ATHENS, 1881.—Station of 1881 is the grounds of the East Tennessee and Wesleyan University, southeast of the main building; it is marked by a post.

SULLIVAN COUNTY, BRISTOL, 1873, 1881, 1890, and 1898.—Station of 1873 is in Mr. Jameson's lot on the spot occupied by the eclipse party, nearly midway between the pillar holes. It is 12 paces from the south fence and is 8 paces from the east fence.

Station of 1881 is the same as the station of 1873 on the Jameson lot, on the summit of the hill on Cumberland street west of the Union railroad station.

Station of 1890 is 112·2 feet almost north of the station of 1881, distant 70·5 feet from the inner edge of Cross street, and 138 feet from the inner edge of Cumberland street. It is marked with a limestone rock.

Station of 1898 is the grounds of the Southwestern Virginia Institute. It is 107 feet from the front line of the grounds of the institute, and is 60 feet to the right of the center of the walk leading to the main building. The station is marked by a solid limestone, lettered:

U. S. C. & G. S.
⊙
1898

A similar stone (excepting as to lettering) was set 120½ feet true south of this stone.

UNICOI COUNTY, BIG BUTTE TRIANGULATION STATION, 1893.—Station of 1893 is at Big Butte Triangulation Station, on the North Carolina and Tennessee boundary line, between the counties of Unicoi, Tenn., and Madison, N. C. It is 15 miles south of Fullens.

E. STATIONS IN VIRGINIA OCCUPIED BETWEEN 1839 AND 1898.

FLOYD COUNTY, BUFFALO TRIANGULATION STATION, 1895.—Station of 1895 at Buffalo Triangulation Station, is on the summit of Buffalo Mountain, Floyd County, Va. This is a well-known mountain.

GRAYSON COUNTY, PEACH BOTTOM, 1824.—Station of 1824 was probably in suburbs of the little town of Peach Bottom, Grayson County, Va.

GRAYSON COUNTY, ROGERS, 1894.—Station of 1894 is at Rogers Triangulation Station; Grayson County, Va., 20 miles southeast of Chilhowee, Va. This is a well-known point in this section.

GREENVILLE COUNTY, CORNER OF BRUNSWICK COUNTY, 1824.—Station of 1824 is probably at the corner of Brunswick and Greenville counties, Va.

GREENVILLE COUNTY, EMPORIA, 1897.—Station of 1897 is in the open lot (owned by the county) in front of the graded school. It is marked by a solid granite post, lettered:

U. S.
C. S.

with a bolt marking the point.

True north of this post, and in the same lot, a similar post was sunk marking the true north and south line. These granite posts are dressed about 4 inches square on top and the center of the bolt marks the point.

HALIFAX COUNTY, MOUNT AIRY, 1873.—Station of 1873 is in the front yard of Mr. Buck's residence. It is 13 paces from the west fence and 9 paces from the north fence.

HALIFAX COUNTY, MEADVILLE, 1882, 1885, and 1886.—Station of 1882 was occupied by Mr. M. French, in the small town of Meadville, on the Banister River, west of Halifax County Court-House.

Station of 1885 was occupied by Mr. M. French, and probably over the same point occupied by him in 1882.

Station of 1886 was also occupied by Mr. M. French, and probably over the same point occupied in 1886 and 1882 by Mr. French.

HALIFAX COUNTY, HOUSTON, 1897.—Station of 1897 is on the vacant lot southwest of the county Court-House. This lot is owned by Mrs. Bolden, whose residence is just opposite. The station is marked by solid granite post set 3½ feet in the ground. Its top is dressed 6 inches square and is lettered:

U. S.
C. S.

The other meridian stone was to have been set by the county surveyor of Halifax, Va.

NORFOLK COUNTY, NORTH CAROLINA BOUNDARY, 1728.—No description of this station is filed. The observations were made along the southern boundary of Norfolk County, Va., and the northern boundary of North Carolina.

NORFOLK COUNTY, NORTH END OF KNOTT ISLAND, 1873.—Station of 1873 is on the north end of Knott Island, about 1 foot above water in the marsh overlaid by a stratum of sand 1 foot in thickness.

PITTSYLVANIA COUNTY, DANVILLE, 1873.—Station of 1873 is on Clayburn's hill, on the north side of Dan River. It is on top of the small hill, part of Clayburn's hill, nearly in a straight line with the end of the toll bridge.

SCOTT COUNTY, BIG KNOB TRIANGULATION STATION, 1893.—Station of 1893 is at Big Knob triangulation station, Scott County, Va. Big Knob is a well-known mountain summit in this county.

SMYTH COUNTY, MARION, 1881.—Station of 1881 is in the grounds of the Marion Female College, in the lot just west of the main building. It is marked by a locust post sunk even with the ground.

WASHINGTON COUNTY, EMORY, 1855, 1881, and 1892.—Station of 1855 was occupied by Prof. J. A. Davis, at Emory and Henry College. No description of the exact locality is filed.

Station of 1881 was occupied by Prof. J. A. Davis, at Emory and Henry College. No description of the exact locality is filed.

Station of 1892, observations were made by Mr. Leffingwell, about 2 miles south and 1 mile west of Emory and Henry College.

WASHINGTON COUNTY, ABINGDON, 1897.—Station of 1897 is on the property belonging to Gen. Arthur C. Cummings, on the west side of the Norfolk and Western Railroad, a little east of the station at Abingdon. A solid granite post 4 feet long and dressed 6 inches square on the top, lettered:

U. S.
·
C. S.

marks the station.

A south meridian stone, similar to the north meridian stone (excepting it is not lettered), was set just below the summit 150 or 200 metres from the north meridian stone.

WYTHE COUNTY, WYTHEVILLE, 1839, 1881, 1882, and 1898.—Station of 1839, no description filed. The observations were probably made in the suburbs of the town of Wytheville by Mr. J. M. Gibboney.

Station of 1881 is in the open grass field about 100 yards southeast of Boyd's hotel, and south of the railroad. It is marked by a post sunk even with the ground.

Station of 1882 was occupied by Mr. J. M. Gibboney, and probably in the same locality where he observed in 1839.

Station of 1898 is on the hill back of Boyd's hotel, and is marked with limestone rock, lettered:

U. S. C. & G. S.
⊙
1898

A similar limestone rock, with the center marked (but with no lettering), was set near the railroad, opposite the Mountain View hotel. The centers of these two stones mark the true north and south line.

APPENDIX No. 10.

REPORT 1898-1899.

THE MAGNETIC WORK OF THE UNITED STATES COAST AND GEODETIC SURVEY.

By L. A. BAUER,

Inspector of Magnetic Work and Chief of Division of Terrestrial Magnetism.

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APPENDIX No. 10. 1898-99.

THE MAGNETIC WORK OF THE UNITED STATES COAST AND GEODETIC SURVEY.

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A.—PAST WORK.

In the "Plan for the Reorganization of the Survey of the Coast, as adopted by a Board convened on the 30th of March, 1843, by direction of the President of the United States," explicit provision is made for the making of "all such magnetic observations as circumstances and the state of the annual appropriations may allow." Since then Congress, by more or less generous appropriations, has distinctly recognized the importance of this feature of the work of the Survey.

Under the first Superintendent, Prof. F. R. Hassler, the magnetic declination ("variation") was supplied on the Coast Survey Charts, as determined with the aid of the ordinary nautical instrumental means then in vogue. In the Transactions of the American Philosophical Society, Philadelphia, 1825, Professor Hassler proposed to measure relative magnetic intensity by means of oscillations of a needle, no method for absolute measurement being then known.

The real magnetic work of the Survey, however, may be said to have commenced with Professor Hassler's successor, Prof. Alexander Dallas Bache. Professor Bache had previously made a magnetic survey of Pennsylvania, which was not followed until in quite recent years by the magnetic surveys of Missouri, New Jersey, Maryland, and North Carolina. He had likewise established the first magnetic observatory in this country—that at Girard College, Philadelphia—and, while on a trip abroad, had made a series of magnetic observations at various places.

Improved magnetic instruments were now imported, and the expert aid of Dr. John Locke, of Cincinnati, and Professor Renwick, of Columbia College, was temporarily employed. The three magnetic elements—declination, dip, and intensity—were determined at various places, chiefly along the seacoast.

The work of magnetic observation, thus fairly started, has since been prosecuted without interruption over the entire country, including Alaska and Hawaiian Islands, as well as in some foreign countries, by various members of the Survey.

The following notes are taken almost verbatim from Mr. Schott's various reports

1. ISOGONIC CHARTS PUBLISHED BY THE SURVEY.

The first table of declination results accompanied by an isogonic chart* was published by A. D. Bache, Superintendent, and J. E. Hilgard, Assistant, in the Annual Report for 1855, Appendix No. 47, and plate No. 56. The declinations were reduced to a common epoch—1850—by means of assumed values of the annual change, and for convenience of discussion the declinations were arranged in geographical groups which could be separately treated by application of Lloyd's interpolation formula. The table comprises 153 stations, and the isogonic curves, computed for each degree of declination, cover but a narrow strip along the coast line. In the following year the same authors produced a new chart, as the result of a more extended discussion, inclusive of all recent observations, but retained the epoch 1850. (See Annual Report of 1856, Appendix No. 28.) On plate No. 61 of the Report, the isogonic curves fairly cover the area of the eastern part of the United States, as well as the area bordering on the Pacific coast, and a connection is shown over the Gulf of Mexico and along the Mexican boundary.

The Annual Report for 1861, Appendices No. 23 and No. 24, contains two small isogonic charts (plate No. 30) designed for a special purpose and in aid of navigation along the southern coast; epoch 1860.

The Annual Report for 1862, Appendix No. 19, gives an account of a magnetic survey of the State of Pennsylvania, and on plate No. 47 shows isomagnetic lines laid down for the two epochs 1842 and 1862.

The next isogonic chart, constructed by Assistant C. A. Schott, accompanies Appendix No. 19 of the Annual Report for 1865, plate No. 27. It is on a larger scale, but covers about the same area as the chart of 1856. It embodies, however, the results accumulated, and uses the latest information respecting the secular change. The epoch is 1870.

The next chart issued, Report for 1876, Appendix No. 21, plate No. 24, is due to Assistant J. E. Hilgard. It is referred to the epoch 1875, and includes the results of the Survey up to 1877, and in part to 1879, as well as about 200 observations made from 1871 to 1876, under the auspices of the National Academy of Sciences and at the expense of the Bache fund. In this chart the isogonic curves cover the whole of the United States, excepting Alaska, and distinct notice is taken of certain large irregularities in the distribution of magnetism which made themselves manifest in certain regions in the eastern and central parts of the country. The curves over the western part remain smooth and regular, the observations there not yet being sufficiently numerous for the safe delineation of irregularities.

"Distribution of the Magnetic Declination for 1885." This publication, brought out in the Annual Report for 1885, Appendix No. 13, by Assistant C. A. Schott, is designated by him as the "first edition," on account of its completeness, a special chart for Alaska and adjacent regions being included. The arrangement of the table of results is alphabetic by States, with two subdivisions in each, one for Coast and Geodetic Survey results, the other containing the results from all remaining available sources, as

*The first detail chart extending some distance into the interior of the country was constructed by Prof. E. Loomis for the epoch 1840, and published in Silliman's Journal Science and Arts, Vol. XL.

compiled by the author; the table contains in all 2 359 stations. The results were reduced to the epoch 1885, with the aid of Mr. Schott's extensive secular variation discussions. The curves for the United States were determined by the graphical process, and were published on a chart of scale $\frac{1}{1\,100\,000}$, while those for Alaska and adjacent waters, on account of the scarity of data, were made to depend upon an interpolation formula established by the application of the method of least squares; these last curves were published on a chart, to the scale of $\frac{1}{13\,700\,000}$. As far as the accumulated material would permit, special notice was taken of all locally disturbed regions, and the extent and the amount of the local deflections were shown on the chart.

"Distribution of the Magnetic Declination for 1890." This is Mr. Schott's "second edition," and is contained in the Report for 1889, Appendix 11. The table of declinations comprises 3 237 stations; in all cases where a station has been repeatedly occupied, only that observation nearest to the epoch 1890 is given. The curves for the United States are again obtained by the graphical method, and those for Alaska by a newly established interpolation formula. The writer had the privilege of assisting Mr. Schott in the construction of these charts.

"Distribution of the Magnetic Declination for 1900." (Third edition.) The charts for the epoch 1900 are based on 3 591 tabulated declinations. They are a great improvement upon the former charts, the reductions to the epoch 1900 being based on a new and very exhaustive discussion of the secular variation of the magnetic declination at 118 stations, embracing 1 435 annual observations.

The steady improvement in the isogonic charts is made readily apparent by a comparison of the earlier ones with those of recent date. In the latter the curves are no longer beautifully curved lines, but exhibit many sinuosities, showing that the magnetic distribution, as it actually occurs in nature, is being more and more truly represented. For Alaska, on account of the paucity of the data, the distribution, as shown by the charts, must still be more or less conventional.

"Magnetic Declination Tables for the year 1900; embracing the United States and Countries under its Jurisdiction, prefaced by an Historical Sketch of the Fundamental Phenomena of the Earth's Magnetism." This publication is now under way and will appear in the next Annual Report. It is being prepared primarily for the use of surveyors and mariners, and will embody all of the results for magnetic declination and of its secular variation obtained thus far, and will be accompanied by the revised isogonic charts for 1900. Those interested can obtain a copy by addressing the Superintendent.

2. ISOCLINIC AND ISODYNAMIC CHARTS.

The first complete discussion of the dip and the intensity observations was made by Mr. Schott for the epoch 1885. (See the Annual Report for 1885, Appendix No. 6.) In the general collection of data, Mr. Schott makes an attempt to bring together, in systematic form, all observed dips and intensities within the boundaries of the country, from the earliest to the present time. The observations made at sea, being in general less accurate, are excluded from the present collection, with the exception of a few results obtained on the frozen sea ice off the coast of Alaska. The table contains 1 999 results for dip and 1 523 for horizontal intensity; only the most recent values, however, were used in the construction of the magnetic charts. In the table all intensities are expressed in absolute measure and in terms of the English units—the foot, the grain, and the second of mean time. On the two accompanying maps, showing the distribution of the horizontal and total intensities, the C. G. S. units are also introduced.

The discussion of the secular variation of the dip resulted in the delineation, on the isoclinic map, of a belt of "no change" for epoch 1885, with increasing dip on the one side and decreasing dip on the other. A similar feature was recognized in the discussion of the secular variation of the horizontal intensity. We have also pointed out to us the occurrence in about the year 1860, for the eastern part of the country, of a secondary maximum in the variation of the dip, as well as a minimum in the variation of the horizontal component of the intensity. Upon the whole, the representation of the dip for the epoch 1885 was far more satisfactory than the representation of the horizontal intensity for the same epoch, the cause of this being ascribed to defective determination of the instrumental constants in the intensity observations. This discussion has been in part superseded by the more recent one for the epoch 1900.

The secular variation of the dip and intensity is now discussed conjointly with that of the declination. (See Report for 1895, Appendix 1.) For the 118 secular variation stations there are tabulated and discussed 1 435 declination observations (annual values), 577 dip results, and 479 horizontal intensity observations. The intensities are all expressed in C. G. S. units. The curves described by the north end of a freely suspended magnetic needle in the lapse of time are drawn for a number of stations, and reversals in the more generally prevailing clockwise direction of motion are pointed out for certain stations along the Pacific coast.

In Appendix 1, Report for 1897, the distribution of the magnetic inclination and intensity is represented on three charts for the epoch January 1, 1900, each to the scale of $\frac{1}{7000000}$. The first chart gives the lines of equal dip, the second those of equal horizontal force, and the third the lines of equal total force. In the table entitled "Collection of the Most Recent Magnetic Dips and Intensities Observed in the United States and Referred to the Epoch 1900.0," results for dip and intensity are given for 1 641 stations, of which 1 271 are within the United States; the stations are as yet very irregularly distributed. These charts are decided improvements upon the earlier ones.

3. MAGNETIC OBSERVATORIES.

While the Girard College Observatory at Philadelphia, which was in operation from 1840 to 1845, did not belong distinctly to the Survey, it is not improper to include here a mention of it, since Professor Bache continued to direct its work after he assumed charge of the Survey. Mr. Schott, also, was later on employed in the discussion of the observations.

The first survey observatory was established under Professor Bache at Key West, Fla., and was carried on from 1860 to 1866. The variations of the declination and of the horizontal and vertical intensities were recorded continuously by means of photography, one of the Brooke magnetographs having been imported. After a lapse of half a sun-spot cycle, the instrument was transported to Madison, Wis., and put in operation from 1876 to 1880. The same instrument was then adapted for direct or eye observations, and transported to Point Barrow, Alaska, where, under the charge of Lieutenant Ray, magnetic records were obtained for one year—1882–83.

A superior self-recording magnetic apparatus, the Adie magnetograph, patterned after the Kew model, recorded the magnetic variations, photographically, at Los Angeles, from 1882 to 1887. This instrument was then set up at San Antonio, Tex., in 1890, and in September, 1892, it had to be removed on account of electric car disturbances, to Hillside Ranch, near San Antonio. The observatory, unfortunately, had to be abandoned in March, 1895, on account of the smallness of the appropriations for magnetic work in that year.

The computations of the records from these observatories have not as yet been completed, because of insufficient computing force in the past. Only for Los Angeles has a complete discussion been attempted.

4. MAGNETIC WORK IN THE POLAR REGIONS.

The magnetic records brought home by the polar expeditions in command of Lieutenants Ray and Greely were placed in the care of the Coast and Geodetic Survey. This material was subjected to computation and discussion and arranged for the press. The Point Barrow work (1881–1883) forms Part VI of the official publication of Lieutenant Ray's expedition (published in 1885), and the work done at Fort Conger (1881–1883), under Lieutenant, now General, Greely, forms Appendix No. 139 of Vol. II of General Greely's official publication (1888).

B.—PRESENT AND FUTURE WORK.

For many years Mr. Schott has emphasized in his various reports the pressing need of an expansion of the Survey work in the line of terrestrial magnetism, if the Survey was to fulfill to the best advantage all the purposes for which it was created. He recognized, in the first place, that the magnetic work should form a division of its own. Hitherto, all magnetic records have been turned over to the Computing Division of the Survey, which, owing to the great variety of its work and the insufficiency of the computing force, has been utterly unable to give the attention to the magnetic work which the subject demanded.

That, notwithstanding these adverse circumstances, Mr. Schott has been able to accomplish so much in this special field is due to his untiring zeal and enthusiasm. In recognition of his contributions to terrestrial magnetism, the Paris Academy awarded him last year the Wilde Prize of 4 000 francs. This honor, coming at the time it did, was especially *apropos*, as Mr. Schott had just rounded out a full half century of usefulness in the Survey.

The present superintendent, perceiving the need of expansion in magnetic work, created, as a first step, on July 1, 1899, a separate division for magnetic work, known as the Division of Terrestrial Magnetism of the United States Coast and Geodetic Survey. The chief of this division, being also Inspector of Magnetic Work, has full control of all magnetic work, both in the field and in the office.

The following preliminary outline will serve to give some indication of the character and scope of the work being carried out with the enlarged opportunities.

1. SECULAR VARIATION INVESTIGATIONS.

The best evidence of the great demand for secular variation data is the fact that, thus far, eight editions of Schott's secular variation papers have been successively issued by the Survey.

In all matters relating to the relocation of land boundaries, where it is frequently necessary to know the precise amount of angular change in the direction of the magnetic meridian since the first or original survey, the Coast and Geodetic Survey is recognized throughout the country as the ultimate authority. The amount of money saved to land-owners by such authoritative determinations as the Survey is able to furnish can scarcely be estimated. It certainly exceeds many times the total amount to be spent for magnetic work.

Every effort will be made in the future to multiply and verify the secular variation data, and requests for information on the part of surveyors are being encouraged in every possible manner, and true meridian lines are being established for them in various parts of the country.

2. MAGNETIC SURVEY OF THE COUNTRY.

This involves the determination of the magnetic elements, declination, dip, and intensity, at various points throughout the land. Just how close the stations should be to each other depends upon the special purpose to be accomplished with the means at hand, and the magnetic character of the regions involved.

A magnetic survey has peculiar difficulties to contend with; for the quantities to be experimentally determined are forever undergoing changes—some periodic, others not periodic. A magnetic survey must, therefore, be made to refer to some particular moment of time, and such means must be taken as to enable one to reduce all the measurements, not only to the selected epoch of the survey, but also, as occasion may demand, to some other epoch in the near past or in the near future. Means must also be taken for the proper elimination of all such errors as are to be referred entirely to the particular magnetic instrument used—i. e., instrumental errors.

These requirements call for—

Elimination of all variations of short period or of brief duration, such as the diurnal variation, seasonal variation, disturbance variation, by means of the continuous observations at magnetic observatories, suitably situated, and in sufficient number for the area covered by the magnetic survey. This requires, in addition to the permanent magnetic observatories, of which mention is made in another connection, the establishment at certain base stations of temporary magnetic observatories, more or less completely equipped. In many cases simply self-registering or eye-reading declinometers will suffice for the equipment of the temporary or secondary observatories.

Elimination of the secular variation.—For this purpose a certain number of well-selected stations distributed over the area with some degree of uniformity—so-called "secular variation" or "repeat stations"—are being established, where observations will be made with special care and repeated at certain intervals of time.

Mr. Schott's list of "secular variation stations," embracing thus far 118 stations, serves as an excellent basis in the selection of the "repeat stations." The number, however, is being greatly extended, especially in the western part of the country, as only about one-sixth of the stations included in his list lie west of the Mississippi.

Were we to select one "repeat station" to every 10 000 square miles—i. e., one station for a land area such as is included in the State of Maryland, for example, or that of Vermont—we should require 300 "repeat stations" for the United States alone. Whether this number will be sufficient must be the subject of a special investigation. The number will probably have to be increased, as provision must also be made against some unavoidable loss in the number of the "repeat stations" originally established, on account of the encroachments of civilization.

Elimination of instrumental errors.—Various European investigators have found that the instrumental errors are frequently larger than the purely observational errors. In order, therefore, to make possible the strict intercomparison of all our magnetic work, a "reduction correction to the selected Coast and Geodetic Survey Magnetic Observatory Standard" is being determined at proper intervals of time for each survey instrument used. The Coast and Geodetic Survey magnetometer No. 18 and dip circle No. $\frac{66}{4440}$ were compared by the writer in the fall of 1899 with the standard instruments at the following European magnetic observatories: Kew (England), Parc St. Maur (France), Potsdam (Germany), and Pawlowsk (Russia). The results of these comparisons and of others conducted during the year 1899–1900 will be published in the next report.

At how many stations will it be necessary to determine the magnetic elements?—The areas of the countries at present belonging to or under the jurisdiction of the United States are, approximately, as follows:

	Square miles.
United States	3 025 600
Alaska	577 390
Philippine Islands	119 000
Hawaiian Islands	6 250
Porto Rico	3 530
Guam Island, Tutuila Island, and Midway Islands	220
Total	3 731 990

Hence we control an area equal to that of entire Europe, or about one-fifteenth of the entire land area of the globe. As magnetic surveys have been especially prosecuted in Europe, it will be of interest to note the density of distribution of the magnetic stations in two recent fruitful magnetic surveys, viz, that of Great Britain, where there was one station to every 139 square miles, and that of Holland, embracing one station to every 40 square miles.

Suppose we were to decide upon one station, on the average, to every 100 square miles—an end that we must hope to attain some day—then we would require the determination of the magnetic elements at 30 000 stations within the United States. At the rate of 400 stations a year, the magnetic survey, as detailed as this, would require for its completion at least seventy-five years. It is not well, however, to have a magnetic survey extend over such a long interval of years. The errors incurred in reducing the observations to a common epoch would greatly exceed the errors of observation.

It is evident, then, that we must either have a very large number of observers and instruments at our disposal, so as to complete the survey within a short interval, say ten years at the most, or we must content ourselves for the present with making a less detailed survey.

Our present means will enable us to complete 450 stations per annum, of which 400 will be within the United States. It is hoped that at the end of the year 1910 we shall have occupied 4 000 stations in the United States and have made the necessary "repeat observations," and that the stations will have been to some degree uniformly distributed, so that we shall have on the average one new station to every 756 square miles. Selecting as the epoch to which the observations are to be reduced January 1, 1905, we shall then have, with the addition of about 1 000 former stations, which we could utilize, a magnetic survey the stations of which will be distributed at the average rate of one to every 600 square miles, or, approximately, one station to an area 25 miles (40 kilometres) square.

This will give a very satisfactory representation of the distribution of the earth's magnetism within our confines, and will suffice for the accomplishment of many of the practical purposes of magnetic surveys.

We will call this our "first survey," and, as stated, its epoch will be 1905. We shall now be able to tell in what portion of the country more stations are needed—that is, the density of the ultimate distribution of stations will not be a uniform one. In regions where the distribution of magnetism is fairly regular, comparatively few stations will suffice, while in magnetically disturbed areas the number of stations must be increased in conformity with the character and extent of the disturbance. The subsequent work will consist then in filling in stations where most needed and repeating observations at the "repeat stations."

In short, the plan of conducting a magnetic survey of this country which appears to be best suited to the present conditions, and one that it is possible to carry out within a reasonably short time, is as follows: To make first a general magnetic survey of the country, with stations about thirty to forty miles apart, then, as opportunities present themselves, to add stations in the magnetically disturbed areas. The observations at the "repeat stations" made from time to time will furnish the proper secular variation corrections.

The great advantages of this plan over that of attempting a greatly detailed magnetic survey at once, the steady progress of which over the entire country, on account of its extent, would necessarily be very slow, will be readily perceived. It will be of interest, however, to point out that the plan as briefly outlined, and as followed at present, will make it possible within a reasonable time to construct two sets of magnetic maps for the same epoch, each set based upon a different distribution of the stations. An opportunity will thus be afforded, as in the case of the recent magnetic survey of Great Britain, to obtain some idea of the accuracy with which the isomagnetic lines can be determined. The satisfactory solution of this question will serve as a valuable guide in future magnetic work.

3. STATE MAGNETIC SURVEYS.

Various State geologists either have already made plans or are making plans for detailed magnetic surveys of their respective States, in cooperation with the Coast and Geodetic Survey. The detailed magnetic surveys of Maryland and North Carolina, conducted in cooperation with the State geological surveys, are nearing completion.

4. MAGNETIC SURVEY OF OCEAN AREAS.

Provisions for the determination of the magnetic elements at sea are likewise being made. With the many vessels at the service of the Coast and Geodetic Survey, exceptional facilities for this purpose will be afforded. In fact, one of the chief duties of the Survey is the supplying of magnetic data to the mariner. From an economic standpoint, this feature of magnetic work is the one really of the greatest practical importance. In recognition of this fact, the Survey vessels will hereafter take advantage of every opportunity to obtain the magnetic elements on sea and on shore, with magnetic instruments specially adapted for such work.

5. MAGNETIC OBSERVATORIES.

The rapid, successful, and economical execution of the plans as above briefly outlined requires the establishment, at certain points (primary stations), of magnetic observatories, where the countless variations in the earth's magnetic force are continuously and automatically recorded, thus enabling the proper corrections to be applied to observations made at stations at any hour of the day.

The present plans contemplate the establishment of a magnetic observatory on the Atlantic coast, to be situated in Maryland, 16 miles southeast of Washington city—this will be the central or standard observatory; another in the western part of the United States; one in the Hawaiian Islands, and one in Alaska. With the cooperation of the observatories at Toronto, Mexico, and Habana, and with the aid of secondary observatories (secondary base stations) established as occasion may demand, the areas to be surveyed will be fairly well covered.

It is very much to be hoped, however, that our universities and colleges will seriously consider the establishment of magnetic observatories. Many an institution which utterly lacks the means of making a reputation in astronomical work could still afford to inauguarate work of great importance in terrestrial magnetism.

The United States stands at the bottom of the list of civilized countries possessing magnetic observatories. Almost every European power of note maintains not only one, but several magnetic observatories. France has four already established, and four additional ones in process of erection; and progressive Japan, with its small strip of territory, has six continuously operating magnetic observatories.

The recent International Magnetic Conference recommended the establishment of a magnetic observatory at the Lick Observatory. It is earnestly to be hoped that this suggestion will be carried out. It is unfortunate that the San Antonio observatory in Texas had to abandoned. A permanent observatory should be reestablished in this locality.

The scheme of work for the Coast and Geodetic Survey observatories will embrace, in addition to the regular magnetic work, observations in atmospheric electricity and of the electric currents within the earth. Such observations can be carried on with practically no additional cost, and yet add greatly to the value of the observatory work. Arrangements will likewise be entered into with foreign magnetic observatories for the making of strictly simultaneous observations of a special character.

The United States Government, through the Coast and Geodetic Survey, has already promised to cooperate with the magnetic parties of the antarctic expeditions in making, simultaneously with them, observations of the variations of the earth's magnetism at the base stations of the magnetic survey.

The plan of referring the initiation and prosecution of magnetic work in this country to the Coast and Geodetic Survey will readily be seen to have decided advantages. In the first place, the machinery for carrying on the work is already to a great extent in existence. The observer engaged in geodetic or astronomical work can frequently include to advantage magnetic observations, and thus can often be saved the chief cost of magnetic work—the occupation of stations. Thus, for example, the parties at present engaged in surveying work in Alaska are also provided with magnetic outfits. Again, the care and refinement with which the geodetic and astronomical work of this Bureau must be carried out will ever be an incentive to keep the magnetic work of the same high order.

ALPHABETICAL INDEX.

(Exclusive of Appendices 3 to 10.)

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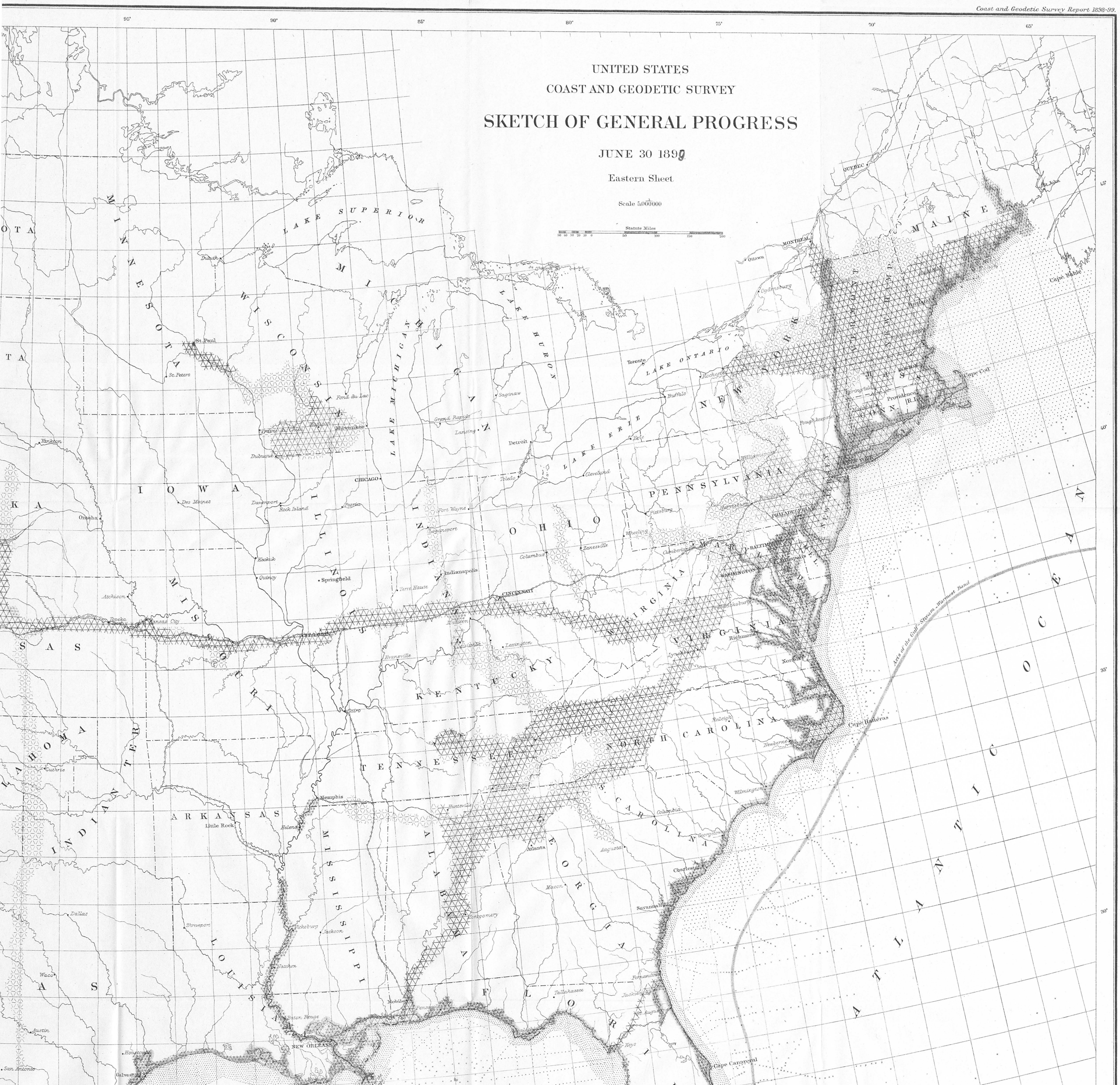
UNITED STATES
COAST AND GEODETIC SURVEY
SKETCH OF GENERAL PROGRESS
JUNE 30 1899
Eastern Sheet
Statute Miles
EXPLANATION OF SYMBOLS
Primary Triangulation
Secondary Tertiary Triangulation
Reconnaissance
Surveyed Topography
do. In-shore Hydrography
do. Off-shore do.
Lines of Deep Sea Soundings
do. Geodetic Levelling
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ATLANTIC OCEAN
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YUCATAN
MAINE
NEW YORK
PENNSYLVANIA
OHIO
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ILLINOIS
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LAKE SUPERIOR
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Cape Catoche
C. San Antonio
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CINCINNATI
Memphis
Springfield
Indianapolis
Detroit
St. Paul
Little Rock
Mobile
Savannah
Charleston
Norfolk
Richmond
Nassau
Vera Cruz
Campeche
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No. 1

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Statute Miles
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Secondary / Tertiary Triangulation
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do. In-shore Hydrography
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WASHINGTON
OREGON
IDAHO
MONTANA
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PACIFIC OCEAN
Cape Flattery
Portland
Salem
Lewiston
Walla Walla
Helena
Virginia City
Boise City
Bismarck
Deadwood
Pierre
Yankton
Cape Mendocino
Ogden City
Salt Lake City
Cheyenne
Denver
Pueblo
Pt. Concepcion
Santa Barbara
Prescott
Santa Fe
Albuquerque
Tucson
El Paso del Norte
Guadalupe I.
Cerros I.
Chihuahua
Eagle Pass
Laredo
San Antonio
Austin
Corpus Christi
Matamoros
Monterey
Guaymas
Cape San Lazaro
La Paz
Cape San Lucas
Mazatlan
San Blas
Cape Corrientes
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