DEPARTMENT OF COMMERCE AND LABOR

REPORT OF THE SUPERINTENDENT

OF THE

COAST AND GEODETIC SURVEY

SHOWING

THE PROGRESS OF THE WORK

FROM

JULY 1, 1904, TO JUNE 30, 1905

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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DEPARTMENT OF COMMERCE AND LABOR

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COAST AND GEODETIC SURVEY.

LETTER OF TRANSMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
OFFICE OF THE SECRETARY,
Washington, September 1, 1905.

In compliance with the requirements of section 4690, Revised Statutes, I have the honor to transmit herewith, for the information of Congress, a report transmitted to this Department by Mr. O. H. Tittmann, Superintendent of the Coast and Geodetic Survey, showing the progress made in that work during the fiscal year ended June 30, 1905. It is accompanied by maps illustrating the general advance in the operations of the Survey up to that date.

V. H. METCALF,
Secretary.

The SENATE and HOUSE OF REPRESENTATIVES.

LETTER OF SUBMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
COAST AND GEODETIC SURVEY,
Washington, D. C., September 1, 1905.

SIR: In conformity with law and with the regulations of the Department of Commerce and Labor, I have the honor to submit herewith, for transmission to Congress, the Annual Report of progress in the Coast and Geodetic Survey for the fiscal year ended June 30, 1905. It is accompanied by maps illustrating the general advance in the field work of the Survey up to that date.

Respectfully,

O. H. TITTMANN,
Superintendent.

The SECRETARY OF COMMERCE AND LABOR.

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REPORT OF THE SUPERINTENDENT.

O. H. TITTMANN, *Superintendent.*

FRANK WALLEY PERKINS, *Assistant Superintendent.*

THE WORK OF THE YEAR.

The most notable feature of the work of the year is the completion of the line of precise levels connecting the Atlantic Ocean and Gulf of Mexico with the Pacific Ocean. The three principal connections with sea level are at Sandy Hook, New Jersey, at Biloxi, Miss., and at Seattle, Wash. The distance between Sandy Hook and Seattle along the shortest line of leveling of the highest degree of accuracy is 7 400 kilometers, and the similar distance between Biloxi and Seattle is 5 700 kilometers. This leveling is a portion of the precise leveling operations which will eventually furnish standard elevations in the United States, upon which the extensive operations of the Reclamation Service can be based and for the use of geographers, civil engineers, and surveyors, and for physical investigations relating to the planet on which we live. The leveling operations have been thoroughly checked by closed circuits as far west as Norfolk, Nebr., and the closure of the line westward on mean sea level at Seattle, a distance of 3 300 kilometers, with a small discrepancy which is within the allowable limits of error in levels extending over this distance, is most satisfactory.

Work on the opening and re-monumenting of the International Boundary between the United States and Canada west of the Rocky Mountains is making satisfactory progress under my direction and that of the Director of the United States Geological Survey, as Commissioners on the part of the United States, with officers of these Surveys detailed to the immediate charge of operations in the field. The condition of this work on December 1, 1904, may be stated as follows, and represents the joint work of the parties representing the United States and Canada since the inauguration of the work in 1903, viz: The line was located and the vista cut through the woods from the Rocky Mountains to Skagit River; the triangulation was completed between the same points, except for a distance of 30 miles east of Laurier; the topography was completed between these points, except for a distance of 20 miles west of Okinakine River; about 17 per cent of the whole distance from the Rocky Mountains to the Pacific Coast was monumented with the new aluminum-bronze monuments.

An examination of the international boundary between the State of Vermont and the Dominion of Canada with a view of establishing additional boundary marks to supplement the original monuments still in existence, is in progress as the result of a request from the State Department, made in order to satisfy the requirements of the Treasury Department in the enforcement of the revenue laws.

Under my direction, as Commissioner on the part of the United States, the demarcation of the Alaska-Canada Boundary made such progess as the unfavorable weather conditions permitted and the work of locating the line, opening the vista along the line and of erecting monuments, was in active operation at the date of closing this report.

The demands of the Navy for assurance that no undiscovered dangers to navigation existed in certain waters was met by the construction of a wire drag 1 000 feet long and a method was devised by which this drag, set to any desired depth, can be pulled through the water over all portions of any bay or harbor with resulting knowledge that no danger to navigation exists above the prescribed depth or the certain discovery of any such danger. This drag was successfully used in Frenchmans Bay on the Coast of Maine.

In response to a request from the Isthmian Canal Commission, a survey was made of the Bay of Limon and approaches to Colon, in the Canal Zone.

A survey of the Government Reservation at Fort Stanton, N. Mex., used as a sanitarium by the Public Health and Marine-Hospital Service, is in progress as the result of a request from the Treasury Department.

Work at the Latitude Observatories at Gaithersburg, Md., and at Ukiah, Cal., maintained by the International Geodetic Association under my direction, made the usual progress during the year.

The Convention under which the International Geodetic Association exists expires on January 1, 1907. I am a member of the Permanent Commission of the Association and have been informed that steps were taken during the year to insure the renewal of the Convention for another period of ten years.

At the request of the Navy Department the Speed Trial Course off Santa Barbara, Cal., and in Puget Sound were put in order for use.

The Coast and Geodetic Survey maintained an exhibit, with an officer in charge, at the Louisiana Purchase Exposition, St. Louis, Mo., as a part of the Department Exhibit from July 1 to November 30, 1904 and has a similar exhibit at the Lewis and Clark Centennial Exposition, Portland, Oreg.

An officer of the Survey continued on duty as a member of the Mississippi River Commission, as required by law, devoting as much of his time as necessary to the work of the Commission and aiding in the regular work of the Survey, whenever his duties as a member of the Commission permitted.

The geographic positions of Aids to Navigation were determined along the coasts of Maine, Massachusetts, Connecticut, New York, Georgia, and Florida.

Hydrographic examinations were made off the entrance to Frenchmans Bay, Maine; in the vicinity of Gloucester, in New Bedford Harbor, and in Nantucket Sound, Massachusetts; off the entrance to New London Harbor, Connecticut; in the vicinity of a shoal off Dyers Island, Rhode Island; in the vicinity of Execution Rocks, western end of Long Island, and in the entrance to Charleston Harbor, South Carolina.

Coast Pilot work was done in the Delaware River and along the Atlantic Coast from Chesapeake Bay entrance to Florida.

Steady progress was made in the resurvey of the Potomac River from Washington to the mouth, and the work was almost completed at the close of the year.

Hydrographic work was done in the vicinity of Atlantic City, N. J.; at Key West, Fla.; and from Cubits Gap to Pass a Loutre, Louisiana.

The triangulation was extended from Mount Shasta in California to Eugene, Oreg.; in Minnesota, from the North Dakota Line to Aitkin; in Texas, from Floresville to Alice; and was in progress in Minnesota and in Washington, north of the Columbia River, at the close of the year. The progress along the ninety-eighth meridian was more rapid and at less cost than during any previous year.

The leveling work was extended from St. Cloud, Minn., to Watertown, S. Dak., via Fairmont, N. Dak.; from Durkee, Oreg., to Clealum, Wash., and was in progress in Iowa and South Dakota at the close of the year.

A continuous record of the variations in Terrestrial Magnetism was obtained during the year by photographic means at the Magnetic Observatories at Cheltenham, Md., at Baldwin, Kans., at Vieques, P. R., at Sitka, Alaska, and at Honolulu, Hawaii. Incidentally meteorological and seismological observations were made at these observatories.

The year was made notable by the large number of magnetic storms, which sensibly affected the compass direction, this being the period of maximum sun-spot activity. On the average there have occurred two such storms monthly, which deflected the compass by one-quarter of a degree and more. A comparatively large number of earthquake records were also obtained during the year, the most notable one being the Indian earthquake of last April.

The magnetic survey of the country was extended by making observations at numerous stations (286) with portable instruments in 41 States and Territories. Some magnetic observations were also obtained in the West Indies during the voyages of the Coast and Geodetic steamers *Bache* and *Explorer* to the Canal Zone and Porto Rico.

Valuable results for the improvement and correction of the magnetic charts of the Atlantic Ocean were obtained on the cruises of the Coast and Geodetic Survey steamers *Blake* and *Bache* from Baltimore to the Maine coast last summer, also by the *Explorer* on her cruise to Porto Rico and back, and by the *Bache* on her trip to the Canal Zone.

Similar results for the Pacific Ocean were obtained by the Coast and Geodetic Survey steamers *Patterson* and *Gedney* on their respective cruises. In all, magnetic data were obtained at about 50 different points in the Atlantic and Pacific oceans.

In this connection mention should also be made of the effective cooperation entered into between the Survey and the Carnegie Institution at Washington, and it is expected that most valuable data will be obtained in the Pacific Ocean. This Institution has taken up the systematic magnetic survey of the Pacific Ocean. It has chartered a vessel for this purpose and placed it under the command of one of the most experienced officers of the Survey.

ALASKA.

In Alaska the survey of Iphegenia Bay, Davidson Inlet, and Sea Otter Sound was continued. The work on the international boundary and at the Magnetic Observatory at Sitka is mentioned under appropriate headings in this report. A survey was made of Kiska Harbor at the request of the Navy Department. Surveys were also made in Resurrection Bay and in Prince William Sound. A hydrographic examination was made of the waters between Prince William Sound and Resurrection Bay at the request of the War Department, to facilitate the laying of a cable by the Signal Corps. The longitude of Sitka was determined from Seattle by the telegraphic method, and the work of determining the longitude of other points by the same method was in progress at the close of the year.

HAWAII.

In Hawaii a survey was made of Kahoolawe Island and vicinity, including hydrography, topography, and triangulation.

PHILIPPINE ISLANDS.

In the Philippine Islands the following field work was done:

West coast of Luzon.—The triangulation and topography was extended south from Bontolan Point to Capones Light-house and the topography in the vicinity of Point Bolinao was completed, connecting with the previous work in Lingayen Gulf.

Vigan to San Fernando.—The hydrographic survey of this coast between the points named was completed, including large scale surveys of Vigan Anchorage, Solbec Cove, Port San Esteban, and Port Santiago. Ship work was carried offshore for about 10 miles and the coast line and reefs developed by boat work. The shore line of Port Santiago and Port San Esteban was resurveyed on a scale of 1:5 000 to provide for detailed hydrography.

Vicinity of Iba.—A hydrographic survey was made from Palauig Reefs to Iba and a large scale survey of Palauig Bay. This survey has cleared previous doubts concerning one of the most important menaces to navigation on the west coast of Luzon.

Central Valley of Luzon-Manila to Dagupan.—The triangulation in this valley is in progress and is the most important work of this character undertaken in the Philippines. It will connect the triangulation of Manila Bay with that of Lingayen Gulf, and materially strengthen the smaller coast triangulation. It will also furnish data for the extensive improvements projected for the Pappanga and Tarlac rivers, besides improving the topography of one of the most important commercial regions of the islands. The main scheme consists of a series of quadrilaterals with sides averaging about 15 miles in length. The reconnaissance and signal building have been completed, and the observations of horizontal and vertical angles finished up to the borders of Pangasinan Province. The field work was almost completed on June 30.

Manila Bay.—An inshore hydrographic survey was made of the eastern shore of Manila Bay, extending from the mouth of the Vitas River northward to a point abreast of the Binuangan River. This survey extended from 1 to 4 miles offshore and included both entrances to Malabon. Another inshore hydrographic survey was made of the area around San Nicolas Banks and extending to the south shore of Manila Bay from Salinas to Naig.

Vicinity of Nasugbu.—A plane table survey of the coast between Talin Point and Limbones Cove was executed, together with hydrography for the same region, including Port Jamelo and offshore ship work extending 15 miles to the west of Fortun Island to examine the Simo Bank. A few soundings were also taken near Caballo Island and off Vigia Point for the examination of shoals.

Verde Island Passage.—Complete surveys, including triangulation, topography, and hydrography, were made in Balayan and Batangas bays and the vicinity of Maricaban Island. These surveys proved the nonexistence of two shoals previously indicated as obstructions in the track of shipping.

North coast of Panay.—The survey of the north coast of Panay was continued by the addition of the triangulation, topography, and hydrography of Sapian Bay, thus filling the gap between Capiz and Port Batan which was left unfinished during the previous year. The survey was also extended from Port Batan westward to include the mouth of the Aclan River.

East coast of Luzon.—A complete survey, including triangulation, topography, and hydrography, is now in progress, extending the survey of the east coast of Luzon from Lagonoy Gulf northward through the Maqueda Channel, including the topography of the west coast of Catanduanes. This party also has instructions to examine the shoals off the south coast of Catanduanes and also to make a reconnaissance of the east coast of the same island.

Guimaras Strait.—A complete survey is now in progress in Guimaras Strait, extending the former work from Inampulugan Island northward. The hydrography was completed to Nalunga Island, and a few lines have been run across the strait farther north. The triangulation is being carried on in advance.

Iligan Bay, Mindanao.—A complete survey was executed in the southern portion of Iligan Bay in the vicinity of Iligan military post at Camp Overton. Triangulation and topography were carried from Quinalang Cove to Point Binuni. The inshore hydrography for the same stretch of coast was closely developed and additional lines run offshore into the bay, which deepens rapidly.

East coast of Samar.—Two parties completely equipped for all classes of surveying are operating on the north and east coasts of Samar. One is established with headquarters at Laguan, surveying the channels and islands in this vicinity. The triangulation and secondary astronomic observations for positions have been completed, and the topography and hydrography are now under way. The second party is now in the vicinity of Oras and Hilaban Island, endeavoring to carry on the survey in the face of a hostile population and active military operations. A base line has been measured, signals erected, and the triangulation and topography are in progress.

PORTO RICO.

In Porto Rico the hydrographic survey off the south coast was continued, and information necessary for the preparation of a Coast Pilot of the islands was collected by an officer sent to the field for that purpose.

TIDE OBSERVATIONS.

Self-registering tide gauges have been successfully maintained during the year at the following stations: Fort Hamilton, N. Y.; Philadelphia, Pa.; Baltimore, Md.; Fernandina, Fla.; Weeks, La. (March 1 to June 30, 1905); Galveston, Tex.; Presidio, Cal.; Seattle, Wash.; Honolulu, Hawaii; Manila and Iloilo, P. I.

The tide indicators at Fort Hamilton, N. Y., Reedy Island, Delaware, and Alcatraz Island, San Francisco Bay, California, have continued in successful operation. The electric tide indicators in the rooms of the Maritime Association of New York and in the Bourse building, Philadelphia, Pa., have given satisfaction.

CHANGES IN SURVEYING FLEET.

Two new ships were added to the surveying fleet, one, the *Explorer*, being built by the Government, and the other, the *Fathomer*, by the Philippine government for the use of the Survey in charting the waters of the Philippine Archipelago.

One vessel, the historic steamer *Blake*, with an international reputation in the work of deep-sea sounding and Gulf Stream investigations, having become so old that the amount required for repairs was excessive, was sold at auction.

OFFICE WORK.

In the Office, the current work was kept up to date and satisfactory progress was made in various branches of its work, including computation, reduction, plotting and discussion of results of field work, and the preparation of the data for publication by chart or otherwise.

The demand for data from the archives of the Survey increases year by year as a result of the extension of its operations and the growth of the country. The geographic positions of the triangulation stations and the descriptions of these stations are published as rapidly as they can be prepared, in order to avoid the necessity of having copies made as often as requests for them are received.

The computation of the transcontinental line of levels was completed and the reduction of the triangulation in California, north of Monterey Bay to the United States Standard Datum, made excellent progress. The computation of the triangulation along the ninety-eighth meridian follows closely the completion of the work in the field, and good progress has been made.

The results of the magnetic observations made on land and sea during the year have been revised and prepared for publication in my Annual Report. A preliminary chart of the lines of equal magnetic declination for the Philippines has been prepared. The necessary material is now being collected for the preparation of a new set of magnetic charts for the United States and Alaska for the year 1905. The discussion of the secular variation affecting the direction of the magnetic needle has progressed sufficiently far to indicate that the reversal of the secular motion during the past decade has apparently extended over all but the extreme eastern part of the country. Progress has been made with the reduction of the magnetic observatory work, and a compilation of the magnetic storms and earthquakes recorded at the various observatories has been undertaken and nearly completed.

The Tide Tables containing the predictions for the year 1906 were prepared for publication and sent to the printer. Copies of the predicted tides for Astoria, Oreg., and Sitka, Alaska, have been furnished to the Canadian government in response to a request from the authorities, and similar data for Wellington and Auckland, New Zealand, have been furnished to the New Zealand authorities upon their request.

The drawings for the series of charts on the Mercator projection, on an approximate scale of 1:400 000, covering the Philippine Islands, have been completed. During the year a large number of new charts of localities in the Philippine Islands were completed. The charts covering Chesapeake Bay and the Potomac River were thoroughly revised. The series of large scale charts for San Francisco Bay was completed.

The work of engraving has been principally confined to making necessary corrections on existing plates to bring them up to date, though several new plates were completed.

The work of printing shows a material increase during the year. The lithographing establishment of the Survey printed two-thirds of the charts published by this process, leaving only one-third to be printed by contract. The work is good and a chart can be issued on a very limited notice.

The issue of charts during the year has been greater by more than 10 per cent than during the previous year.

The Annual Report for 1904 was prepared for printing and sent to the printer on September 1, 1904, and it was available for issue on January 3, 1905, earlier than ever before. Several valuable papers accompanied the Report as Appendices. One gives the results of the determination of longitude across the Pacific Ocean, completing the circuit of the earth. In another the Cotidal Lines for the world are shown on numerous charts. Numerous tests of a transit micrometer are described in one appendix, and another contains complete data, in convenient form for the use of engineers, in regard to more than 1 300 points, fixed in position by triangulation in California, south of Monterey Bay.

The amount appropriated for the Coast and Geodetic Survey for the fiscal year 1905 was $863 569.79,* of which $210 245 was for manning and equipping the vessels of the Survey, $43 544.79 for repairs and maintenance of vessels, and $50 500 for Office expenses. The remainder of the appropriation was about equally divided between expenses of parties in the field and salaries of the field and Office force.

In addition to the above sums, the appropriations of $50 000 for marking the boundary between the United States and Canada west of the Rocky Mountains and of $65 000 for locating and marking the Alaska boundary, made to be expended under the direction of the Secretary of State, are disbursed, under my direction as Commissioner, by the disbursing agent of the Coast and Geodetic Survey as special disbursing officer for the State Department.

OFFICE OF ASSISTANT IN CHARGE.

ANDREW BRAID, *Assistant in Charge.*

The Assistant in Charge has direct supervision of the work of the divisions of the Office as follows:

Computing Division.
Division of Terrestrial Magnetism.
Tidal Division.
Drawing and Engraving Division.
Chart Division.
Instrument Division.
Library and Archives Division.

He also has charge of the purchase of supplies and of all other expenditures for Office expenses, the care of the public property at the Office, the distribution of the publications of the Survey issued free, and of the sale of the Charts, Coast Pilots, and Tide Tables published by the Survey.

* Exclusive of appropriation for printing.

OFFICE OF INSPECTOR OF HYDROGRAPHY AND TOPOGRAPHY.

H. G. OGDEN, *Inspector.*

The work of the parties in the field was inspected whenever necessary, and numerous short trips were made in connection with the repair and maintenance of the surveying vessels.

A new vessel, the *Explorer*, begun during the previous fiscal year, was completed under contract and turned over to the Survey on November 30, 1904.

THE VESSELS AND THEIR HYDROGRAPHIC WORK.

THE STEAMER BACHE.

At the beginning of the year this vessel was at Baltimore undergoing repairs and fitting out for a cruise on the coast of Maine. She sailed from Baltimore August 6, arriving at Frenchmans Bay August 15. Magnetic observations were made en route. The work of the season included an examination of the region northeast from Mount Desert Rock, where a 9½-fathom spot had been reported. The work of sweeping Frenchmans Bay was then taken up, in conjunction with the steamer *Blake*, and completed on October 28. Two uncharted rocks were located in the vicinity of Gloucester, Mass., on which the U. S. S. *Prairie* had struck, and one off Ten Pound Island, near the light-house of the same name.

The *Bache* reached New York on December 12, having been storm bound en route and having stopped at Boston to prepare estimates for repairs. On February 10 the *Bache* sailed for Colon, Isthmus of Panama, stopping at Norfolk to make magnetic observations. She arrived at Colon on March 13, and made a hydrographic survey of the Bay of Limon and the approaches to Colon. Magnetic observations were made in the harbor of Kingston, Jamaica, en route to Colon, and at sea between Jamaica and Key West. On May 11 the *Bache* arrived at Key West, where an examination was made of Southwest and Southeast channels. Magnetic observations were also made at Key West. On June 15 the *Bache* arrived at Baltimore and remained there until June 30.

THE STEAMER BLAKE.

At the beginning of the year this ship was at Baltimore undergoing repairs. On July 22 the *Blake* sailed for Frenchmans Bay, arriving there on the 29th. Magnetic observations were made en route. The work of sweeping the bay with a long wire drag was commenced and continued until the close of the season. Magnetic observations were made at Frenchmans Bay. The *Blake* arrived at Baltimore on November 6. On December 22 she was laid up, and on January 25, 1905, was placed out of commission. Competitive bids were advertised for and received, and the vessel was sold.

THE STEAMER ENDEAVOR.

At the beginning of the year the *Endeavor* was at Norfolk, Va., undergoing repairs and fitting out for work off the coast of Massachusetts. She arrived at New Bedford, Mass., on August 15, and an examination was made of several shoal spots in New Bedford Harbor. She also located, by the use of the harbor sweep, the rock on which the

U. S. S. *Prairie* had struck. On September 9 she arrived at Edgartown and examined 11 old wrecks in that vicinity to determine their condition as dangers to navigation. The work in this vicinity was completed and the vessel sailed for Norfolk, Va., and reached there on October 16. On November 21 she went to St. Marys City, Md., for hydrographic work in that vicinity, having stopped at Baltimore en route for repairs. On December 15 she returned to Norfolk, Va., for repairs, remaining there until May 15, when she commenced a hydrographic survey of the area at the mouth of the Potomac River between Smith Creek–Coan River to Point Lookout–Smith Point. On June 7 and 8 experiments were made with a quick sounding machine. On June 20 an examination of the new channel through the Kettle Bottom Shoals was begun, and at the close of the year the vessel was still engaged upon this work.

THE STEAMER EXPLORER.

The *Explorer* was built under contract by the Pusey & Jones Company, Wilmington, Del., and delivered to the Survey on November 30, 1904. She was placed in commission on December 29, 1904, and from that date until March 9, 1905, remained at Wilmington weather-bound most of the time. She sailed for Porto Rico on March 9, and made magnetic observations at Norfolk, Va., and at sea on the trip between Norfolk and Porto Rico. The work of the season included Coast Pilot work in Porto Rico and hydrography off the south coast of the island. On her return voyage magnetic observations were made on two days, and she arrived in Baltimore on June 21. At the close of the year she was undergoing repairs at Baltimore.

THE STEAMER GEDNEY.

At the begining of the year the *Gedney* was engaged in the survey of the approaches to Davidson Inlet, including triangulation, topography, and hydrography. She continued upon this work until October 5, when, after storing the *Cosmos* and launch *No. 117* at Sitka, she sailed for Seattle, Wash., arriving there on October 25. On November 8 she was put out of commission at Seattle and laid up for the winter.

On the 6th of May, 1905, she was put in commission, and after being repaired and outfitted she sailed for Davidson Inlet to continue the work of the previous season, and was engaged on this work at the close of the year. The *Cosmos* and launch *No. 117* were used by the party.

THE STEAMER HYDROGRAPHER.

At the close of the year the *Hydrographer* was en route from Key West, Fla., to Charleston, S. C., arriving at the latter place on July 2. A hydrographic examination of the northern portion of the entrance to Charleston Harbor was made, and on July 8 she sailed for Baltimore, Md., arriving there on the 13th. The command of the vessel was transferred to Nautical Expert Ross, and, after making necessary repairs, the vessel sailed on August 10 to make hydrographic examinations along the coasts of Virginia, Delaware, New York, Rhode Island, and Connecticut. This work was completed and the vessel returned to Washington, D. C., on September 30, and Assistant Parker was again placed in command. After obtaining supplies the hydrography of the Potomac River in the vicinity of Colonial Beach was taken up on October 8, and was continued until December 18, when the vessel sailed for Norfolk, Va., for repairs

The repairs were completed on March 21, and on March 23 Nautical Expert Ross, in command of the vessel, took up the fieldwork required for a new edition of United States Coast Pilot, Atlantic Coast, Part VII, Chesapeake Bay entrance to Key West. This work was completed and the *Hydrographer* arrived in Baltimore on June 25, where she was at the close of the year.

THE SCHOONER MATCHLESS.

At the beginning of the year the *Matchless* was engaged in hydrographic work in the Potomac River. This work was continued throughout the year, with exception of the period from December 16 to April 21, during which time work was interrupted by ice and necessary repairs.

THE STEAMER M'ARTHUR.

At the beginning of the year the *McArthur* was at Kiska Harbor, Alaska, engaged in a survey of that harbor in cooperation with the party on the steamer *Patterson*. She continued upon this work until September 8, when she sailed for Seattle, Wash., arriving there on October 9. On October 24 she was placed out of commission and laid up at Seattle, Wash.

On May 4, 1905, she was placed in commission, with Assistant H. C. Denson in command, and on May 13 sailed for Seward, Alaska. She arrived there on May 29, and from that date until the close of the year was engaged in hydrographic work in that vicinity.

THE STEAMER PATTERSON.

At the beginning of the year the *Patterson* was en route to Kiska Harbor, Alaska, arriving there on July 6. The survey of Kiska Harbor, including topography, hydrography, triangulation, astronomic, and magnetic observations was taken up. The work was completed and the *Patterson* sailed for Honolulu, Hawaii, via Dutch Harbor, on September 24, and arrived there on October 13. A survey of Kahoolawe Island, and vicinity was made, and on March 15 the vessel sailed for Seattle, Wash., and arrived on the 27th. She remained at Seattle until May 19, during which time she was repaired and outfitted for the coming season. From May 19 to June 3 she was engaged in making the passage from Seattle to Seward, Alaska, magnetic observations being made en route and at Seward. From June 9 until the close of the year she was engaged in reconnaissance, triangulation, topography, and hydrography in Prince William Sound.

THE STEAMER TAKU.

The steamer *Taku* was laid up at Orca during most of the year. On May 6 the vessel was placed in commission and began hydrographic work in Resurrection Bay. This work was in progress at the close of the year.

THE SCHOONER TRANSIT.

At the beginning of the year the *Transit* was laid up at Madisonville, La., minor repairs were made, and she arrived at Cubits Gap, La., on December 7, where she was engaged in hydrographic and topographic work until April 1, when she was laid up at Madisonville, La.

The schooners *Spy* and *Quick* were laid up during the entire year at Madisonville, La., in charge of a ship keeper.

The steamer *Yukon* and the launches *Alpha* and *Delta* were laid up during the year at Dutch Harbor, Alaska.

The launch *Cosmos* and *No. 117* were assigned as tenders to the *Gedney* and during the interval between seasons were laid up at Japonski Island, Alaska.

The launch *Inspector* was assigned to the parties of Assistants J. B. Boutelle and D. B. Wainwright at Atlantic City, N. J., and afterwards to the party of Assistant Wainwright on the Potomac River. At the close of the year she was laid up at Washington, D. C.

The steamers *Pathfinder*, *Fathomer*, and *Research* were engaged during the year in making surveys in the Philippine Islands.

COAST PILOT PARTY.

The work in the Office included the following, viz: the correction of Coast Pilots to date of issue; the reading of the proof of Coast Pilot, Part IV; the compilation of data to assist in the establishment of lines within which the inland rules of the road should apply on the Pacific coast of the United States; the preparation of material for a revised edition of Coast Pilot, Part VII, and the compilation of Supplements to Coast Pilot volumes.

OFFICE OF INSPECTOR OF GEODETIC WORK.

J. F. HAYFORD, *Inspector*.

The duties of the Inspector of Geodetic Work were performed at the Office in Washington except for the periods September 26 to October 2 and April 26 to 28. He went to New York on September 26 and inspected the triangulation work in progress by the city authorities under the direction of an officer of the Survey detailed for the purpose.

Three evenings were spent upon the Ocean Parkway base line observing the work of the base party. On these evenings the four New York tapes were standardized by comparing with three base tapes belonging to the Coast and Geodetic Survey, and 6 600 feet, or slightly more than one-half, of the base was measured.

The four tapes owned by New York City are similar in cross section to the Survey base tapes, namely, about one-fourth inch wide and about one-fiftieth inch thick. They are each 150 feet long. The city also owns the necessary tape stretchers and thermometers for use in connection with these tapes. It is expected that these tapes, which will have been thoroughly standardized in connection with the base measurements in New York City, will be given to the separate boroughs at the close of the triangulation, to be retained as their standards of length.

The observations of angles in the New York triangulation were commenced in August, 1903, and have, therefore, been in progress slightly more than one year.

There will be from 35 to 40 primary stations in the triangulation covering Greater New York; of these, 19 have been occupied to date.

There will probably be from 150 to 200 other stations, secondary stations, and some determined by intersections, in the triangulation. Of these only 8 have been completely determined to date. There are many others upon which some of the observations have been taken.

According to the charter of Greater New York the triangulation must be completed in 1907. The present indications are that it will be finished within the limit.

The computations made to date indicate that to secure the desired degree of accuracy in the length a second base will be necessary, and must be located somewhere in the Borough of the Bronx.

On April 26, 27, and 28 the Inspector was again in New York inspecting this work and the triangulation along the Hudson River.

During the remainder of the year the necessary supervision was exercised by a careful examination of the correspondence with the field parties and of the records of observations sent to the Office and by an inspection of the computations and results.

OFFICE OF INSPECTOR OF MAGNETIC WORK.

L. A. BAUER, *Inspector.*

The duties of this Office comprise the preparation of the necessary instructions and information required by the various parties engaged in magnetic work, the inspection of the field parties and observatories, the examination of the records of observations, the controlling of the constants of the various instruments employed, and the testing and standardization of new instruments.

The Inspector inspected the work of the field parties operating in New Jersey, New York and Rhode Island in August, and the party working in Ohio in September. He also inspected the Baldwin and Cheltenham magnetic observatories, and visited the new steamer *Explorer* to select the proper location of the ship dip-circle stand.

The activity of the Survey in magnetic work may be summarized as follows:

MAGNETIC OBSERVATORIES.

Cheltenham observatory.—Both the Eschenhagen and Adie magnetographs were kept in operation throughout the year. In November a Bosch seismograph was installed and continuous record secured for the rest of the year. Numerous instruments, new and old, were standardized, including three dip circles and two magnetometers for the Naval Observatory.

The *Baldwin observatory* was in operation throughout the year. In December a new magnetograph, including a vertical intensity variometer, was installed, and beginning with January, a record was secured of the variations of vertical intensity as well as of declination and horizontal intensity.

The *Honolulu observatory* was in operation throughout the year. A vertical intensity variometer was installed in December, and beginning with January a record was secured of the variations of vertical intensity as well as of declination and horizontal intensity. The Milne seismograph was also in continuous operation throughout the year.

Sitka observatory.—The magnetograph and seismograph were in operation throughout the year. In December a vertical intensity variometer was installed at this observatory.

Porto Rico observatory.—The old Brooke magnetograph No. 2 was in operation from the beginning of the year to the end of May. A new Eschenhagen magnetograph comprising declination, horizontal intensity and vertical intensity variometers was installed in January and a satisfactory record secured from the 1st of March to the end of the year. The Bosch seismograph was in continuous operation throughout the year.

MAGNETIC SURVEY WORK ON LAND.

The magnetic declination, dip, and intensity were determined at 288 stations distributed over 41 States and Territories and 2 foreign countries, as summarized in the following table:

Summary of results on land.

	Number of localities.	Number of stations.	Old localities reoccupied.	Declinations observed.	Dips observed.	Intensities observed.
Alabama	12	13	2	13	13	13
Alaska	5	7	2	7	5	5
Arizona	1	1	1	1	1	1
Arkansas	3	3	0	3	3	3
California	14	14	4	14	14	14
Connecticut	8	8	3	8	8	8
Delaware	1	2	1	2	2	2
District of Columbia	1	2	1	7	12	8
Florida	1	1	1	2	2	2
Georgia	32	32	7	39	39	39
Hawaii	2	2	1	3	2	3
Idaho	8	8	0	8	8	8
Illinois	6	6	1	6	6	6
Indian Territory	6	6	1	6	6	6
Iowa	1	1	1	1	1	1
Kansas	42	42	7	50	50	50
Kentucky	5	5	2	5	5	5
Maine	3	4	0	5	5	5
Maryland	5	5	5	11	16	11
Massachusetts	1	1	1	1	1	1
Mississippi	18	18	2	18	18	18
Missouri	3	3	0	3	3	3
Nevada	5	5	2	5	5	5
New Jersey	3	3	0	3	3	3
New Mexico	1	1	1	1	1	1
New York	16	18	7	19	19	19
North Carolina	2	2	2	2	2	2
North Dakota	1	1	0	1	1	1
Ohio	23	23	3	23	23	23
Oklahoma	12	12	1	12	12	12
Philippine Islands *	5	5	0	5	3	3
Porto Rico	4	4	3	5	5	5
Rhode Island	5	5	2	5	5	5
South Carolina	7	7	1	7	7	7
Texas	3	3	2	3	3	3
Utah	1	1	1	1	1	1
Virginia	1	1	1	4	4	4
Washington	1	1	1	3	2	2
West Virginia	3	3	2	3	3	3
Wisconsin	4	5	1	5	5	5
Wyoming	2	2	1	2	2	2
Foreign countries	2	2	0	5	6	5
Total	279	288	74	327	332	323

* Estimated.

In consequence of the reversal in the secular change of declination which was indicated by the observations of 1903–4, a large proportion of "repeat" stations were selected in laying out the field work for 1904–5. From the observations made at repeat stations during the past two years, it appears that on the North Atlantic coast west declination is increasing somewhat more rapidly than had been predicted. The annual change becomes less as the agonic line is approached, and on the other side of that line east declination is increasing about 2′ a year on the Gulf coast and more than 3′ a year on the Pacific coast.

In the course of the field work extensive tests were made of the accuracy of Lloyd's Method of determining the total intensity with dip circle, and of the declinations obtained with the compass attachment of a dip circle, from which it appears that with a good instrument the results are not much inferior to those obtained with a magnetometer.

MAGNETIC WORK AT SEA.

The observations made on shipboard are summarized in the following table:

Summary of magnetic work executed at sea July 1, 1904, to June 30, 1905.

Vessel.	General region.	Observations from swings.			Observations on and near course.		
		Declination.	Dip.	Intensity.	Declination.	Dip.	Intensity.
Bache	Atlantic Ocean	14	15	15	2		
Blake	do	6	6	6	4	4	4
Explorer	do	11	10	10	6	6	6
Patterson	Pacific Ocean	6	6	6			
Gedney	do	4					
McArthur	do	2			27		
Total		43	37	37	39	10	10

Results were obtained by the *Bache* on the trips to Maine in the summer and to Colon in the winter; by the *Blake* on the trip to Maine; by the *Explorer* on the trip to Porto Rico; by the *Patterson* on the trip from Kiska to Honolulu and thence to Seattle.

Each of these vessels is fitted with a stand for a Lloyd-Creak dip circle, so that determinations of the three elements were secured.

The experience of the *Patterson* on her trip to Honolulu and of the *Bache* on her trip to Colon has shown that Lloyd's Method can not be employed for determining the total intensity on shipboard within a considerable distance of the magnetic equator, at least with the deflecting needle and mounting usually provided. The earth's magnetic force is entirely overcome by the force of the deflecting needle, and the suspended needle will not take a position of equilibrium at right angles to the deflector.

To overcome this difficulty, an arrangement has been devised by the Inspector of Magnetic Work which contemplates the determination of relative horizontal intensity by means of deflections of a standard liquid compass, the deflections being produced by a dip needle or small magnet mounted at a fixed distance above the compass. Observations on land indicated that the angle of deflection could be read with a sufficient degree of accuracy, and the device is now being tried on board the brig *Galilee* on the preliminary trip of the Magnetic Survey of the North Pacific Ocean, which has been undertaken by the Department of Terrestrial Magnetism of the Carnegie Institution.

OFFICE OF DISBURSING AGENT.

SCOTT NESBIT, *Disbursing Agent.*

The disbursement of the funds of the Coast and Geodetic Survey is made not only by payments directly from the Disbursing Agent, but also largely through the medium of the Assistants and other officers when acting as chiefs of parties. These officers, on approval of the Superintendent, receive advances of public funds from the Disbursing Agent in lump sums, under authority of an Executive order, dated March 26, 1886.

In conformity to this order there are now 74 officers of this Service bonded in the sum of $2 000 to $5 000 each. When acting as chiefs of parties, these officers receive from time to time such advances of public funds from the Disbursing Agent as are required to meet the necessary current expenses of the work in hand.

A ledger account is kept in the office of the Disbursing Agent with each chief of party receiving an advance, each one being charged with all advances made to him, and, on the other hand, receiving credit for all proper expenditures made by him when presented on regularly supported vouchers after such accounts have been audited in the office of the Disbursing Agent and found to be correct. All of these accounts, with their supporting vouchers, are then sent to the Auditor for the State and other Departments for examination and audit by him.

This system has met the needs of this Service, and results in the main in economy and good order in its expenditures.

In addition to the regular appropriations of the Coast and Geodetic Survey, the Disbursing Agent also disburses the appropriations for the survey and marking of the boundary between the United States and Canada and the boundary between Alaska and Canada. During the year additional appropriations were made under these items of $50 000 and $65 000, respectively.

An itemized statement of receipts and expenditures is submitted to Congress each year, in accordance with law, and is printed as a Congressional document.

OFFICE OF THE EDITOR OF PUBLICATIONS.

The Annual Report (pp. 1–774), covering the progress of the work of the Survey during the fiscal year 1904, was completed, made ready for printing, and sent to the Public Printer through the Secretary of Commerce and Labor on September 1, 1904. The first proof of this Report was received on September 20, and the last proof was read and returned to the printer on December 13. Copies of the Report were received for distribution on January 3, and it was ready to transmit to Congress in print in December for the first time in the history of the Survey.

An abstract covering the work of the year was prepared for the Annual Report of the Secretary, and as much progress as possible was made in the preparation of the Annual Report for 1905.

Numerous assignments to temporary duty were completed, and all possible aid was extended to officers engaged in the preparation of material to form part of the Annual Report.

The publications of the Coast and Geodetic Survey during the fiscal year are given in the following list:

Report of the Superintendent, showing the progress of the work July 1, 1903, to June 30, 1904, 774 pages, with the following appendices published as separates.

No. 3. Results of magnetic observations made by the Coast and Geodetic Survey between July 1, 1903, and June 30, 1904. 73 pages.

No. 4. Telegraphic longitudes. The Pacific Arcs from San Francisco to Manila, 1903–1904. 56 pages.

No. 5. The cotidal lines for the world. 88 pages.

No. 6. Precise leveling from Red Desert, Wyoming, to Owyhee, Idaho. 30 pages.

No. 7. Precise leveling from Holland to New Braunfels, Tex. 20 pages.

No. 8. A test of a transit micrometer. 38 pages.

No. 9. Triangulation in California. 274 pages.

United States Coast Pilot, Atlantic Coast, Part IV, from Point Judith to New York (4th edition). 208 pages.

United States Coast Pilot, Atlantic Coast, Part V, New York to Chesapeake Bay entrance (3d edition). 150 pages.

Bulletin No. 40. Coast Pilot Notes on the Fox Island Passes, Unalaska Bay, Bering Sea, and Arctic Ocean as far as Point Barrow (5th edition). 77 pages.

Tide Tables for the year 1905. 516 pages.

Tide Tables, Atlantic Coast (reprint), 1905. 162 pages.

Tide Tables, Pacific Coast (reprint), 1905. 151 pages.

Notice to Mariners, Nos. 313–325.

The Work of the Coast and Geodetic Survey. Reprint of leaflets describing the operations of the Survey. 160 pages.

Notice to Mariners and volumes of sailing directions were prepared and published in Manila, P. I., and issued from the suboffice at that place as follows, viz:

Philippine Island Notices to Mariners, Nos. 6 to 12, of 1904, and Nos. 1 to 6, of 1905.

Sailing Directions, Philippine Islands, Section III (2d edition). 91 pages.

Sailing Directions, Philippine Islands, Section IV (2d edition). 87 pages.

APPENDIX 1

REPORT 1905

DETAILS OF FIELD OPERATIONS

CONTENTS.

DETAILS OF FIELD OPERATIONS.

EASTERN DIVISION.

EASTERN DIVISION—EAST OF THE MISSISSIPPI RIVER.

Alabama.	Maine.	Ohio.
Connecticut.	Maryland.	Pennsylvania.
Delaware.	Massachusetts.	Rhode Island.
District of Columbia.	Michigan.	South Carolina.
Florida.	Mississippi.	Tennessee.
Georgia.	New Hampshire	Vermont.
Illinois.	New Jersey.	Virginia.
Indiana.	New York.	West Virginia.
Kentucky.	North Carolina.	Wisconsin.

TRIANGULATION. — CONNECTICUT. MAINE. MASSACHUSETTS. NEW YORK. RHODE ISLAND. — J. B. Baylor.

SUMMARY OF RESULTS.

33 triangulations stations recovered.
72 triangulation stations occupied.
105 geographic positions determined.
2 000 square miles area covered by triangulation.

The determination of the geographic positions of certain aids to navigation was assigned to Assistant Baylor. He proceeded to Vineyard Haven, Mass., on July 5 and organized a party. Field work began on the next day and continued until November 8, when the work closed for the season.

Thirty-three old triangulation stations were recovered, and these were re-marked in cases where the existing marks were insufficient.

Gasoline launches were hired from time to time and used with great advantage to the work. They can be hired in all the principal towns along the coast.

The geographic positions of numerous aids to navigation were determined in the vicinity of Rockport and Camden, Me., in West Penobscot Bay; of Cox's Head and Perkins Island, Maine, in Kennebec River; of Portland, Me., in Casco Bay; of Boston, Mass., in Boston Harbor; of New Bedford, Mass., in Buzzards Bay and Vineyard

Sound; of Fall River, Mass.; of Watch Hill, R. I., and Stonington, Conn., in Fishers Island Sound; of New Haven, Conn., in Long Island Sound; of Willets Point and Harts Island, N. Y. Assistant Baylor calls attention to the extensive changes along the coast due to the construction of hotels and cottages, with the resulting destruction of old triangulation stations, and states that many others have been rendered useless by the building operations. The accurate determination of the position of all lighthouses and other permanent structures makes them doubly useful as aids to navigation and as triangulation stations upon which all work required in future can be based.

VERMONT-CANADA BOUNDARY. J. B. Baylor.

A request for an examination and better definition of the international boundary between the United States and Canada north of the State of Vermont was made by the Treasury Department through the State Department, and the work was assigned to Assistant Baylor. He left Washington on June 10 and proceeded to Albany Springs, Vt., where he met a representative of the Canadian government. After consultation, these officers began a joint examination of the boundary in question and were actively engaged in the work at the close of the fiscal year.

HYDROGRAPHY.	MARYLAND.	J. B. Boutelle.
RECONNAISSANCE.	NEW JERSEY.	
TOPOGRAPHY.	NEW YORK.	
TRIANGULATION.	VIRGINIA.	

SUMMARY OF RESULTS.

Hydrography:
- 26 square miles area covered.
- 645 miles lines sounded.
- 32 491 soundings made.
- 2 tide stations occupied.
- 3 hydrographic sheets completed.

Reconnaissance:
- 21 square miles area covered.
- 45 triangulation stations selected.

Triangulation:
- 21 square miles area covered.
- 13 old stations recovered.
- 38 stations occupied.
- 65 geographic positions determined.

The revision of the topographic details in the vicinity of Hempstead Harbor, Long Island, N. Y., was assigned to Assistant Boutelle. He proceeded to the locality on July 5 and on July 8 had completed the observations necessary to locate the new wharves at the place.

He then went to Atlantic City, N. J., where he had repairs made to the steam launch *Inspector* and organized a party to revise the topography and hydrography from

Brigantine Inlet to Absecon Inlet. The necessary signals were erected and their positions determined. Sounding began on August 15 and was continued until the 30th, when the work was turned over to Assistant Wainwright. The statistics of work accomplished and other details in regard to it are stated in the abstract of Assistant Wainwright's report.

Hydrographic work in the resurvey of the Potomac River was then assigned to Assistant Boutelle, and his party reached Chicomuxen Creek on September 14. The necessary signals were erected and their positions determined. The work of sounding was begun on September 23 and continued, whenever the weather conditions and the necessity of building signals permitted, until December 17, when the ice on the river stopped the work for the season.

The work covered the river from Cockpit Point to Aquia Creek and a portion of the work was done between Aquia Creek and Maryland Point. During the latter part of the season the work was much delayed by freezing weather.

On April 1 Mr. Boutelle began work on the triangulation of Hudson River from a point in the vicinity of Anthonys Nose to Milton. Below Cold Spring 12 old triangulation stations were recovered and 6 new ones were established. Above Cold Spring new triangulation stations were established all the way to Milton, where 1 old station was recovered. No old stations were found between these two places.

The work was completed on June 7.

MAGNETIC OBSERVATIONS. CONNECTICUT. RHODE ISLAND. J. E. Burbank.

Stations occupied.

CONNECTICUT.

Brooklyn.	Litchfield.	New London.
Danbury.	Middletown.	Tolland.
Hartford.	New Haven.	

RHODE ISLAND.

Bristol.	Kingston.	Providence.
East Greenwich.	Newport.	

Magnetic work in Connecticut and Rhode Island was assigned to Magnetic Observer Burbank. He occupied four of the stations in Connecticut and then made observations at the other stations named above.

Meridian lines were established in cooperation with the local authorities at Hartford, Danbury, and New London, in Connecticut, and at Providence and Kingston, in Rhode Island.

The old stations at New Haven, Conn., and at Newport, R. I., were recovered and occupied.

MAGNETIC OBSERVATIONS. NORTH CAROLINA. SOUTH CAROLINA. W. H. Burger.

Stations occupied.

NORTH CAROLINA.

Salisbury.

SOUTH CAROLINA.

Anderson.	Pickins.	Union.
Greenwood.	Spartanburg.	Walhalla.

The extension of the magnetic survey of North Carolina and in South Carolina was assigned to Assistant Burger. Observations were made at all the stations to determine the three elements of terrestrial magnetism. The work closed at Salisbury on April 22.

HYDROGRAPHY. TOPOGRAPHY. LOUISIANA. H. C. Denson.

SUMMARY OF RESULTS.

Hydrography:
- 54 square miles area covered.
- 226 miles lines sounded.
- 9 252 soundings made.
- 5 tide stations occupied.
- 2 hydrographic sheets completed.

Topography:
- 51 square miles area covered.
- 103 miles general coast line surveved.
- 50 miles shore line of creeks surveyed.
- 26 miles shore line of ponds surveyed.
- 2 topographic sheets completed.

The resurvey of the coast of Louisiana in the vicinity of Cubits Gap from Pass á Loutre to Bird Island Sound was assigned to Assistant Denson. The necessary preparations were made at Madisonville and New Orleans, and he left West End on the *Transit* on December 3.

Field work began on the 7th and continued until April 1, 1905. Numerous signal poles were erected along the shores of the various passes, and their positions were determined from the old triangulation stations by using the plane table. The shores of the passes were then defined by sketching between the positions thus determined. These shores are all covered with a growth of willows or cane, ranging from 10 to 18 feet in height, growing in the mud, and a survey with the plane table was impracticable. All the bayous leading from the different passes were surveyed by carrying a ladder, sufficiently high to overlook the growth along the streams, from place to place in a boat, so that an observer mounted upon it could determine the position of any point selected on shore by using a sextant and the signals already fixed in position. The shore line of the bayous was fixed in this way.

The hydrographic survey was made by sounding between the points established as stated above. Six signals were erected on the water 2 to 3 miles offshore for use in the hydrographic work offshore. A gasoline launch was used and the sounding lines were extended out to sea as far as it was practicable to see the signals. A plane of reference for reducing the soundings was obtained by establishing a tide staff which was referred to a bench mark of the Mississippi River Commission. Extensive changes in the hydrography and shore line were noted. At one point the shore line is 4½ miles to the eastward of its former position.

TOPOGRAPHY. MARYLAND. VIRGINIA. J. W. Donn.

SUMMARY OF RESULTS.

28 square miles area covered.
4 miles shore line surveyed.
41 miles shore-line creeks surveyed.
44 miles roads surveyed.

The revision of the shore line of the Potomac River was in progress on July 1, under the direction of Extra Observer J. W. Donn. He completed this work from Blackistone Island to the mouth of the river and also completed a resurvey of St. George Island by September 21. He then closed work on the river and proceeded to Chesapeake Bay to resume work in that locality. His work covered portions of Sassafras Neck, Town Point Neck, and Bohemia Neck and was continued until December 21.

The statistics of the work in Maryland are given above.

HYDROGRAPHY. MAGNETIC OBSERVATIONS. MAINE. R. L. Faris, Commanding, Steamer *Blake*.

The steamer *Blake*, with Assistant D. B. Wainwright temporarily in command, left Baltimore on July 23 for Frenchmans Bay, Maine, and reached that place on the 29th. Details of the work of the party from July 24 to August 24 are given under Assistant Wainwright's name. On August 24 Assistant Faris reported on board and resumed command on the 25th, relieving Assistant Wainwright. He immediately reported to Assistant Welker, commanding the *Bache*, and under his orders proceeded to examine Frenchmans Bay by using the 1 000 foot wire drag recently constructed.

This work continued until October 31, when it was closed for the season. Details of the work are given under Assistant Welker's name.

Magnetic observations were made on land at three stations in the vicinity of Frenchmans Bay and in the bay by swinging the ship in August and in October. Magnetic observations were also made at sea on the return trip to Baltimore between November 1 and 5.

MAGNETIC OBSERVATIONS. GEORGIA. MARYLAND. NEW YORK. OHIO. WEST VIRGINIA. J. A. Fleming.

Stations occupied.

GEORGIA.

Augusta.	Sandersville.	Sylvania.
Gibson.	Swainsboro.	Waynesboro.
Louisville.		

MARYLAND.

Oakland.

NEW YORK.

Delhi.	Elmira.	Oxford.

OHIO.

Athens.	Lisbon.	New Lexington.
Caldwell.	Logan.	New Philadelphia.
Cambridge.	Marietta.	St. Clairville.
Canton.	McArthur.	Winfield.
Carrollton.	McConnellsville.	Woodsfield.
Coshocton.	Millersburg.	Wooster.
Gallipolis.	Newark.	Zanesville.
Ironton.		

WEST VIRGINIA.

Mason City.	West Union.	Winfield.

The extension of the magnetic work in Maryland, Ohio, and West Virginia was assigned to Magnetic Observer Fleming, and magnetic observers were assigned to work under his direction.

The stations were marked by stone posts with suitable lettering. A second stone post was placed in position to mark a meridian line at several of the stations at the request of the local authorities and at their expense. Complete sets of observations were made at these stations.

The work was in progress on June 30.

TOPOGRAPHY. MARYLAND. VIRGINIA. S. Forney.

SUMMARY OF RESULTS.

62 square miles area covered.
35 miles shore line of rivers surveyed.
14 miles shore line of creeks surveyed.
120 miles of roads surveyed.
15 miles of railroads surveyed.
5 topographic sheets completed.

Topographic work along the Potomac River was in progress under the direction of Assistant Forney on July 1. The work continued until December 20, when it was suspended until March 20. It was resumed on this date and continued without interruption until the close of the year.

The topographic survey was extended along the south bank of the river from Smiths Point to Gunston Cove, and on the north bank from Chickomuxen Creek to Indian Head.

The party was then transferred to Rock Point, Md., and the topographic survey of the north bank was extended from that place to Lower Cedar Point.

The work was in progress on June 30.

HYDROGRAPHY. TOPOGRAPHY. TRIANGULATION.	MASSACHUSETTS. VIRGINIA.	J. J. Gilbert.

Work under the above headings was assigned to Assistant Gilbert. In response to a request from the commanding officer at Fort Hunt, Va., Assistant Gilbert was instructed to determine the relative positions of certain objects in that vicinity. He visited Fort Hunt on April 26, May 19, 20, 22, and 23, and measured all the angles required for the work. The work was based on the distance between the old triangulation stations, Fort Washington and Bryant Point. It was impracticable to use the latter station and the line was prolonged a certain distance to a point called Bryant Point 2, from which the desired observations could be made.

On June 3 Assistant Gilbert proceeded to Woods Hole, Mass., and made a hydrographic examination of a portion of the Middle Ground in Vineyard Sound where shoal water had been reported, and returned to the Office on June 8.

On June 12 Assistant Gilbert proceeded to Virginia Beach, Va., to determine the position of a number of prominent objects which could be used in making a hydrographic examination off Cape Henry.

He measured the distance from Cape Henry Light-house to Life-Saving Station No. 4, which is located south of Virginia Beach. From this measured line the position of all prominent objects along the shore were determined by using a plane table. A check was obtained on the work by using the old triangulation line from Cape Henry Light-house to Cape Charles Light to determine the position of the Princess Anne Hotel at Virginia Beach, one of the objects determined with the plane table from the measured line.

The work was completed June 21.

MAGNETIC OBSERVATIONS. ALABAMA. ILLINOIS. MISSISSIPPI. J. W. Green.

Stations occupied.

ALABAMA.

Centerville.	Daphne.	Mobile.
Citronelle.	Fayette.	Russelville.
Columbiana.	Grove Hill.	Talladega.
Dadeville.	Jasper.	Tuscaloosa.

ILLINOIS.

Bloomington.	Havana.	Hillsboro.

MISSISSIPPI.

Ackerman.	Hazlehurst.	Meadville.
Brookhaven.	Indianola.	Rolling Fork.
Canton.	Kosciusko.	Rosedale.
Clarksdale.	Liberty.	Tunica.
Fayette.	Macon.	Waynesboro.
Greenville.	Magnolia.	Woodville.

The extension of the magnetic work in Alabama and Mississippi was assigned to Magnetic Observer Green. He began work at Tunica, Miss., on January 4 and closed work on March 28.

At Greenville, Miss., and at Citronelle, Ala., the old stations had been destroyed by buildings and could not be occupied. At Brookhaven, Miss., the old station was occupied. At Mobile, Ala., observations were made at the old station and also at a new one, as an electric car line was in operation within 300 feet of the old station.

Mr. Green began work at Bloomington, Ill., on June 5 and completed the observations at the three stations named above on June 10, and closed work in this section on June 11. The old station at Bloomington was recovered and occupied.

MAGNETIC OBSERVATIONS. GEORGIA. J. S. Hill.

Stations occupied.

Athens.	Dublin.	Macon.
Atlanta.	Dupont.	Madison.
Bainbridge.	Elberton.	Mount Vernon.
Baxley.	Gainesville.	Reidsville.
Blue Ridge.	Hawkinsville.	Thomaston.
Buena Vista.	Jackson.	Valdosta.
Carrollton.	Jesup.	Washington.
Clarkesville.	La Grange.	Waycross.
Douglas.		

Magnetic observations in Georgia were assigned to Assistant Hill.

He began work at Atlanta on January 9 and closed work at Blue Ridge on March 4. Observations to determine the three elements of terrestrial magnetism were made at the stations named above.

Considerable delay in the work was caused by unfavorable weather.

Only one old station was recovered and occupied (Valdosta).

MAGNETIC OBSERVATIONS. ILLINOIS. WISCONSIN. W. B. Keeling.

Stations occupied.

ILLINOIS.

Freeport.	Knoxville.	Princeton.

WISCONSIN.

Madison.	Montello.	Richland Center.
Marston.		

Magnetic work in Illinois and Wisconsin was assigned to Magnetic Observer Keeling.

He began work on June 10 at Knoxville, Ill., and continued it during the remainder of the month.

Observations were made to determine the elements of terrestrial magnetism at the stations named above. These stations were marked with stone posts lettered in a suitable manner.

The work was in progress at the end of the fiscal year.

TOPOGRAPHY. TRIANGULATION. VIRGINIA. E. B. Latham.

SUMMARY OF RESULTS.

Topography:
- 180 square miles area covered.
- 60 miles general coast line surveyed.
- 210 miles shore line of rivers surveyed.
- 30 miles of shore line of creeks surveyed.
- 330 miles roads surveyed.
- 6 topographic sheets completed.

The continuation of the resurvey of certain portions of the shores of Chesapeake Bay and tributaries was assigned to Assistant Latham.

At the beginning of the fiscal year he was at work in the vicinity of Pungoteague Creek and the survey was continued to the southward from that point, the topographic work extending inland to the Bayside road.

On April 8 the work was completed to Cape Charles and includes Long Island and that portion of Smiths Island south of the light-house and life-saving station. The party then moved to Bloomtown and completed the unfinished work in the vicinity of the mouth of Pocomoke River. A sailboat was then hired and a survey was made of Watts Island and the small islands near it.

The party went ashore on Tangier Island and completed the survey of this island on May 20.

On June 1 the triangulation of Mobjack Bay and vicinity was begun and was in progress at the close of the fiscal year, being nearly completed.

MAGNETIC OBSERVATIONS. KENTUCKY. F. M. Little.

Stations occupied.

Elizabethtown.	Hopkinsville.	Louisville.
Greensburg.	Leitchfield.	

Magnetic work in Kentucky was assigned to Assistant Little.

He proceeded to Greensburg and began observations on October 27. Work was continued until November 24.

Observations to determine the elements of terrestrial magnetism were made at the stations named above.

LEVELING. MARYLAND. OHIO. E. H. Pagenhart.

SUMMARY OF RESULTS.

125 kilometers of line completed.
61 bench marks established.

Leveling work in Maryland and Ohio was assigned to Aid Pagenhart. He began work at Baltimore on April 14 and on the 19th completed the connection between the tidal bench marks at Fort McHenry and the bench marks on the Baltimore and Ohio Railroad from which the railroad leveling started to the westward to reach Chicago Junction, Ohio. In order to use this line in connection with other lines of levels of similar accuracy this connection with tide water was made at Baltimore and a line was run from Chicago Junction to Deshler, Ohio, to connect with the Coast and Geodetic Survey bench marks at Deshler. The route followed the main line of the Baltimore and Ohio Railroad between these places, and the work was completed between April 21 and June 7.

In this line the elevations of a number of bench marks established by the United States Geological Survey and by the Baltimore and Ohio Railroad were determined.

HYDROGRAPHY. MARYLAND. SOUTH CAROLINA. VIRGINIA. W. E. Parker, Commanding, Steamer *Hydrographer*.

SUMMARY OF RESULTS.

40 square miles area covered.
778 miles of line sounded.
49 501 soundings made.
2 tide stations occupied.
4 hydrographic sheets completed.

A hydrographic examination of the northern portion of the entrance to Charleston Harbor was assigned to Assistant Parker. He arrived at Charleston with the steamer *Hydrographer* on his way north from Key West, Fla., on July 2. The necessary data reached him on July 5 and the work began immediately. The work was completed in three days and on the 8th the vessel proceeded north. An area of 5 square miles extending from the north side of the north jetty to the shore and to a point 1 mile east of the end of the jetty was examined by sounding. Tidal data and a tracing of the record on the self-registering tide gauge covering the time occupied by the work was kindly furnished to the party by Capt. G. P. Howell, Corps of Engineers, U. S. Army.

Hydrographic work in Potomac River was assigned to Assistant Parker in October and he reached Colonial Beach, Va., on the 8th.

Forty square miles of area in the river between Lower Cedar Point and Blakistone Island were covered with soundings. In the "Kettle Bottoms" 146 shoal spots were examined and developed. Most of the work about the shoals was done with the ship, while a party in the whaleboat made soundings close inshore extending the work to the shore line.

The shoal off Lower Cedar Point and the channel between the point of land and the shoal was covered by sounding and the work was extended to the northeast as far as necessary to define the limits of the shoal.

In Rosier and Mattox creeks the channels were sounded to the limit of steamboat navigation. A detailed survey was made in Monroe Creek. In the entrance to Wicomico River the hydrography was extended from the limit of the recent survey as far on the flats at Cob Point and St. Catharine Island as the draft of the ship would permit. Nearly all the old signals were found standing and only a few additional ones were erected. Tide staffs at Colonial Beach and at Cob Point Bar Light-house were used at different times during the season and referred to each other by simultaneous observations. Simultaneous observations were also made in cooperation with the other parties engaged in work in this vicinity.

HYDROGRAPHY. | CONNECTICUT. DELAWARE. NEW YORK. RHODE ISLAND. VIRGINIA. | John Ross, Commanding, Steamer *Hydrographer*.

SUMMARY OF RESULTS.

116 miles of lines sounded.
6 998 soundings made.

Hydrographic examinations along the coast north of Virginia were assigned to Nautical Expert Ross.

He left Baltimore on August 10 and made an examination of the region covered by two shoal spots shown on the chart of Assateague Anchorage. The vessel proceeded to Lewes, Del., and made a practical test of the compass deviation ranges established on the Delaware Breakwater.

On August 19 the vessel reached Newport, R. I. A tide gauge was erected in Point Judith Breakwater Harbor, and an examination was made of the harbor to determine its capacity as a harbor of refuge. This work was completed on September 4.

On the 6th and 7th a hydrographic examination was made of the locality where a shoal had been reported, north of Dyers Island, in Narragansett Bay. On the 8th an examination was made of the shoal southeast of Black Ledge off the entrance to New London Harbor. On the 16th a search was made by using the channel drag for a rock reported 1 200 feet south of Execution Rocks Light-house. An area 1 mile long and one-third of a mile wide was covered with the drag set to a depth of 30 feet.

Beginning on September 28 an examination was made of the ranges on the Delaware River, and after completing this work the vessel returned to Washington on September 30.

COAST PILOT WORK. — FLORIDA. GEORGIA. NORTH CAROLINA. SOUTH CAROLINA. — John Ross, Commanding, Steamer *Hydrographer*.

The field work required for the revision of the United States Coast Pilot, Atlantic Coast, Part VII, Chesapeake Bay entrance to Key West was assigned to Nautical Expert Ross, commanding the steamer *Hydrographer*.

The *Hydrographer* sailed from Norfolk, Va., on March 23 and returned to that port on June 24. During this period work was done as stated below.

The principal places visited during the season were: Elizabeth City, Edenton, Belhaven, Newbern, Portsmouth, Ocracoke, Morehead City, Lookout Bight, Southport, and Wilmington, N. C.; Georgetown, Charleston, Beaufort, and Port Royal, S. C.; Savannah, Darien, and Brunswick, Ga.; and Fernandina, Mayport, Jacksonville, Miami, and Key West, Fla.

Sailing lines were checked along the coast from Ocracoke Inlet to Fowey Rocks, through Albemarle and Pamlico sounds, the sounds and harbors to Key West, the inland passage between Charleston and Fernandina, and through the Hawk Channel.

In the course of the work a spar (danger to navigation), a buoy in Frederica Creek, a cluster of rocks in the Hawk Channel, and a shoal off Winyah Bay were located and reported to the Office.

Great courtesy was shown by the United States engineers in charge of improvements, the local authorities, and the pilots and steamboat and towboat captains, who invariably put themselves to some inconvenience to furnish information for the Coast Pilot.

In the collection of data, special attention was given to the sailing lines with reference to the aids (buoys, etc.), also any landmarks which can be used when making a landfall or in approaching the entrances to the sounds. Time would not permit of making systematic current observations, but the best local steamboat men, fishermen, and pilots were consulted, and their information corroborates the general information obtained on the subject.

The navigation on this section of the coast calls for more local information than is generally required on other parts of our coast. The frequent changes in the depths over the bars and the nature of the improvements under the supervision of the United States engineers require that vessels of deep draft (over 21 feet) inquire beforehand what depth they can take in and out of the port to which they are bound; this is the general practice at present. The presence, however, of Government dredges on the bars of the principal harbors will in the near future insure more permanent depths than has been the case in previous years.

In connection with the inland waterways, the need is felt for a greater depth over the swashes to Ocracoke Inlet. At present the best draft taken through Wallace Channel is 6½ feet, and through Teaches Hole Channel, 7 feet; these drafts require the top high water and what is known locally as a good tide. The only vessels which can now use Ocracoke Inlet to avoid Cape Hatteras are of 7 feet or less draft, and as vessels of 8 to 9 feet draft navigate Albemarle and Pamlico sounds and the canals, it would seem that a depth of 9 feet over one of the swashes would benefit many vessels.

MAGNETIC OBSERVATIONS. OHIO. L. B. Smith.

Stations occupied.

Cadiz. Steubenville.

Magnetic observations were made at the two stations named above in October (1–6) under the direction of Magnetic Observer Smith.

TIDE OBSERVATIONS. FLORIDA. MARYLAND. NEW YORK. PENNSYLVANIA.

Self-registering tide gauges were kept in operation throughout the year at the following places:

Fort Hamilton, N. Y.	Baltimore, Md.	Fernandina, Fla
Philadelphia, Pa.		

HYDROGRAPHY. MARYLAND. VIRGINIA. W. I. Vinal, Commanding, Schooner *Matchless*.

SUMMARY OF RESULTS.

165 square miles area covered.
1 419 miles lines sounded.
62 249 soundings made.
6 tide stations occupied.
7 hydrographic sheets completed.

Hydrographic work in the Potomac River was in progress on July 1 under the direction of Assistant Vinal, commanding the *Matchless*.

He completed the work from the vicinity of Fort Hunt to Cockpit Point, joining the work already completed in that vicinity.

He then completed the work from Upper Cedar Point to Lower Cedar Point and afterwards returned to Glymont, Md., to make a survey of Belmont Bay and Occoquan

Creek. This work was nearly completed on December 16, when the ice in the river made it necessary to close work.

The hydrographic work on the Potomac River was resumed on April 21 in the vicinity of Coles Point, Va.

Tide gauges were erected at several points and connected by simultaneous observations, and as many as possible of the old triangulation stations were recovered.

The hydrography was completed from Blakistone Island to Coan River. Some additional shoals were found off the entrance to Nomini Bay and these were developed and their limits defined.

At the close of the year the hydrographic survey of the entrances to the bays, rivers, and creeks along the lower Potomac River was in progress.

HYDROGRAPHY. TOPOGRAPHY.	MAINE. MARYLAND. NEW JERSEY. VIRGINIA.	D. B. Wainwright.

SUMMARY OF RESULTS.

New Jersey.

Hydrography (includes Assistant Boutelle's work):
- 25 square miles area covered.
- 383 miles lines sounded.
- 12 558 soundings made.
- 2 tide stations occupied.
- 3 hydrographic sheets completed.

Topography:
- 21 miles general coast line surveyed.
- 3 topographic sheets completed.

Potomac River.

Hydrography:
- 12 square miles area covered.
- 221 miles lines sounded.
- 11 390 soundings made.
- 1 tide station occupied.
- 1 hydrographic sheet completed.

Topography:
- 16 miles shore line surveyed.
- 2 topographic sheets completed.

The construction of a wire drag 1 000 feet long was assigned to Assistant Wainwright. He left Baltimore on July 23 in temporary command of the steamer *Blake*, and proceeded to Frenchmans Bay, Maine. Magnetic observations were made at sea on the voyage to Maine.

The work of constructing the drag, involving the necessary experimental work, was completed as soon as possible, and it was pulled over a few lines before August 24, when the work was turned over to Assistant P. A. Welker, commanding the steamer *Bache*. This vessel reached Frenchmans Bay on August 15 and took part in the work under the direction of Assistant Wainwright until August 24.

On August 26 the continuation of the resurvey in the vicinity of Atlantic City was taken up by Assistant Wainwright. The work was in progress under the direction of Assistant Boutelle, and he proceeded to other duty as soon as relieved.

The resurvey of Absecon Inlet was completed on September 25 and of Great Egg Harbor Inlet on October 15.

The work included the survey of the shore line at the entrance to Brigantine, Absecon, and Great Egg Harbor inlets, and a sufficient number of soundings to show the characteristic features of the approaches, bars, and mouths of the inlets.

The party then proceeded to Chesapeake Bay on the launch *Inspector* and took up the resurvey of the shore line from Halls Creek to Cockrells Creek.

Excellent weather made it possible to complete this work before the end of October, and the party reached Riverside, Md., on the 29th.

The resurvey of Nanjemoy Reach (from Maryland Point to Upper Cedar Point on the Potomac River) began on October 31, and was completed on December 11. A close survey was made of the deep water in the reach, but the launch in use drew 4½ feet, and consequently no work was done in water less than 6 feet deep.

On December 12 the party went to Clifton Beach to aid in finishing the work in that locality, but little was accomplished. The weather had become quite cold, and the river soon filled with ice floes, which made it necessary to close work on the 18th.

Between April 26 and May 4 Assistant Wainwright went to Jamestown Island, Virginia, and revised the old topographic work on the western portion of the island, in order to show its present condition, so that the chart of the island can be brought up to date.

On June 17 Assistant Wainwright went to Rockland, Me., to verify the length of a speed-trial course which had been established off that place. This work was done at the request of the Navy Department. Unfavorable weather delayed the work, and it was in progress on June 30.

HYDROGRAPHY. MARYLAND. VIRGINIA. D. B. Wainwright, Commanding, Steamer *Endeavor*.

SUMMARY OF RESULTS.

129 miles lines sounded.
4 498 soundings made.
2 tide stations occupied.

Hydrographic work at the mouth of the Potomac River and experimental work with a quick-sounding machine were assigned to Assistant Wainwright. He assumed command of the steamer *Endeavor* on May 14, and made a hydrographic survey of the area at the mouth of the Potomac River between Smith Creek–Coan River to Point Lookout–Smith Point.

The hydrographic work was suspended on June 7, and on the 8th experiments were made with a quick-sounding machine.

On June 9 the vessel left the working ground and proceeded to Washington.

MAGNETIC OBSERVATIONS. MARYLAND. NEW JERSEY. NEW YORK. W. T. Wallis.

Stations occupied.

NEW JERSEY.

Belvidere.	Morristown.	Newton.
Hackensack		

NEW YORK.

Carmel.	Kingston.	Poughkeepsie.
Setauket.	Monticello.	West Hampton.
Fire Island.	New City.	White Plains.
Greenport.	Oyster Bay.	

The magnetic work at the magnetic observatory at Cheltenham, Md., was assigned to Magnetic Observer Wallis, and he was also placed in charge of the observations in certain localities in New Jersey and New York.

The variations in the force of terrestrial magnetism at Cheltenham, Md., were automatically recorded on two sets of self-registering instruments at the observatory during the year.

Observations to determine the absolute value of the magnetic elements were made on two days each week, and special records were obtained on the 1st and 15th of each month.

The observatory is a voluntary station of the Weather Bureau, and daily meteorological observations were made as required of voluntary observers.

In the latter part of November a seismograph was mounted at the observatory and a record has been obtained since that time.

Magnetic observations at 4 stations in New Jersey and at 11 stations in New York were made under the direction of Mr. Wallis.

HYDROGRAPHY. MAGNETIC OBSERVATIONS. TRIANGULATION. FLORIDA. MAINE. MASSACHUSETTS. P. A. Welker, Commanding, Steamer *Bache*.

SUMMARY OF RESULTS.

Hydrography:
- 112 square miles area covered.
- 266 miles of line sounded.
- 12·023 soundings made.
- 4 tide stations occupied.
- 5 hydrographic sheets completed.

Magnetic observations:
- 2 stations occupied on land.
- 7 stations occupied at sea.

Triangulation:
- 503 square miles area covered.
- 4 stations occupied.
- 5 geographical positions determined.

The steamer *Bache* left Baltimore on August 6 for Frenchmans Bay, Maine, under command of Assistant P. A. Welker, to take part in the hydrographic examination of that bay with the long wire drag recently constructed. Magnetic observations were made at sea on the voyage to Maine and the vessel reached Frenchmans Bay on August 15. Assistant Welker reported immediately to Assistant Wainwright, commanding the steamer *Blake*, and was engaged in work under his direction until August 25. On August 26 Assistant Welker assumed direction of the work of his own vessel and that of the steamer *Blake*, under command of Assistant Faris.

The *Blake* and three launches were used to operate the long wire drag while the *Bache* made an examination of the region northeast from Mount Desert Rock, where a 9½-fathom spot had been reported.

A description of the long wire drag, constructed for use in the work, is published as an appendix to this report.

The work of sweeping Frenchmans Bay was completed on October 28. The drag was carried over a distance of 331 miles, and the area covered was 43 square miles.

An area of 66 square miles, covering the vicinity of the reported 9½-fathom bank, was carefully examined with the submarine sentry set to depths from 15 to 20 fathoms.

On October 1 the *Bache* went to the assistance of the sloop *Island Belle*, reported ashore on Long Porcupine Island. The sloop had been abandoned. A crew in charge of Mr. Sanger was placed on board, and the sloop was towed into Bar Harbor. The master and two men were afterwards taken off the island and placed on board the sloop.

The work in this vicinity closed October 31.

Between November 11 and 15 two uncharted rocks were located, one in the vicinity of Gloucester, Mass., on which the U. S. S. *Prairie* had struck, and one off Tenpound Island, near the light-house of the same name.

The *Bache* reached Key West, Fla., on May 11, and preparations were made immediately to examine South West and South East channels.

The necessary signals were erected and their positions were determined. Drags set at various depths, as required, were used on the ship and on one of the launches. Lines were run, with the drags in position, approximately parallel to the axes of the channel, at distances of 10 to 70 meters apart. Whenever an obstruction was struck the locality was thoroughly developed by sounding, and the shoalest water was obtained by setting the drag at various depths until one was found which would just clear the obstruction.

Magnetic observations were made in the harbor of Kingston, Jamaica, en route from Colon to Key West, and at sea between Jamaica and Key West. Observations were made on land at Key West and at sea en route to Chesapeake Bay, also off Fort Monroe after entering the bay.

TRIANGULATION. FLORIDA. GEORGIA. Isaac Winston.

SUMMARY OF RESULTS.

23 old stations recovered.
14 new stations established.
31 stations occupied.
59 geographic positions determined.

The recovery of old triangulation stations along the coast south of Brunswick, Ga., and the determination of certain aids to navigation was assigned to Assistant Winston.

He reached Brunswick on January 17 and began work immediately. Five stations were recovered in the vicinity of Brunswick and one new one was established, and from the bases furnished by these stations the positions of five beacons and two other objects were determined.

The location of all old stations between Brunswick and Fernandina were visited and a search was made for the station marks. The frequent burning of the woods, the growth of the trees and the extension of wooded areas, the erosion of banks by floods and high tides, and the destructive action of curious persons during the many years which had elapsed since the stations were established and used, all contributed to make the work of recovery difficult.

Three stations were recovered south of St. Andrews Sound, and the triangulation was extended to cover the entrance to the sound by establishing 5 new stations. Four wharves on Cumberland Island and one on the Mainland were fixed in position by angles measured from the wharves.

In the vicinity of Fernandina 3 old stations were recovered and 3 new ones were established. From the bases thus furnished the positions of fourteen aids to navigation and other objects were determined.

In the vicinity of Nassau Sound 5 old stations were recovered.

In the vicinity of the mouth of St. Johns River 4 old stations were recovered and 6 new ones were established. From these bases 12 aids to navigation and other objects were determined. Three of the new stations were stations used by the Corps of Engineers in their triangulation of the river and they were used to connect the two systems of triangulation.

In the vicinity of St. Augustine 3 old stations were recovered and the positions of 7 prominent objects in the town were determined. The marks at the old stations recovered were renewed or supplemented in a manner to make them more permanent.

All new stations were marked in a substantial manner. The buildings in Brunswick, Fernandina, and St. Augustine were located on the plans of the town, so that the charts can be corrected to show the existing conditions.

The self-registering tide gauge at Fernandina was inspected and certain necessary repairs were made. Fieldwork closed May 4.

HYDROGRAPHY. MARYLAND. MASSACHUSETTS. VIRGINIA. F. A. Young, Commanding, Steamer *Endeavor*.

SUMMARY OF RESULTS.

195 miles line sounded.
11 196 soundings made.

The determination of certain dangers to navigation off the coast of Massachusetts was assigned to Assistant Young, commanding the steamer *Endeavor*.

The vessel reached New Bedford, Mass., on August 15 and an examination was made of several shoal spots in New Bedford Harbor.

A rock on which the U. S. S. *Dixie* struck was located by using the harbor sweep after the lead line had failed to show its presence, which indicates that it is small and has a rounded top.

On September 9 the vessel went to Edgartown and the regions in the vicinity of eleven old wrecks were examined by dragging a long wire over the location of the wrecks, as formerly determined. Some of them have disappeared and no trace of them could be found. The present condition of the others as dangers to navigation was determined.

This work was completed and the vessel sailed from New Bedford to Norfolk, Va., on October 14.

On June 20 Assistant Young, on the *Endeavor*, reached Colonial Beach, Va., and made an examination of the new channel through the Kettle Bottom Shoals on the north side of the Potomac River by using a channel sweep.

Lines were run through this channel with the sweep in position and the greatest depth possible to be carried through at low water was determined.

Hydrographic work was in progress on the lower Potomac River at the close of the fiscal year.

MIDDLE DIVISION.

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

Arkansas.	Louisiana.	North Dakota.
Indian Territory.	Minnesota.	Oklahoma.
Iowa.	Missouri.	South Dakota.
Kansas.	Nebraska.	Texas.

ASTRONOMIC OBSERVATIONS.	MINNESOTA.	W. H. Burger.
RECONNAISSANCE.	TEXAS.	
TRIANGULATION.		

SUMMARY OF RESULTS.

Astronomic observations:
- 7 azimuths established.

Reconnaissance:
- 2 240 square miles area covered.
- 52 stations selected.

Triangulation:
- 4 580 square miles area covered.
- 63 stations occupied.
- 95 geographic positions determined.

The extension of the trangulation along the ninety-eighth meridian was in progress on July 1 under the direction of Assistant Burger, and he was engaged in completing the observations at Oscarson triangulation station in Minnesota. Stations Foss, Wahpeton, and Western were occupied, and after completing the observations at these stations a branch triangulation was extended to Royalton and thence along the Mississippi to Brainerd, where the work closed for the season on October 22.

Observations were made at the following stations in addition to those named above, viz, Bullis, Dalton, Elbow, Leaf, Alexandria, Holmes, Parkers, Long, Osakis, Maple, Leslie, Eagle, Lone, Birch, Brockway, Royalton South Base, Royalton North Base, Alberta, Johnson, Falls, Rail, Daggett, Gull, and Jones. Dalton astronomic station was connected with the triangulation. Azimuth observations were made at stations Osakis, Royalton South Base, and Gull.

The positions of the following stations of the triangulation along the Mississippi River, made under the direction of the Mississippi River Commission, were determined, viz, Back-Base, Skounter-Hill, Gottwalt, Royalton, Swan Creek, Big Mound, and Oleson. In addition to these, station Brockway is identical with Mississippi River Commission station Suintax.

The elevation of Back-Base had been determined by precise leveling and it was also connected with the triangulation by vertical angles. During the latter part of the season fog, mist, and rain caused considerable delay in the progress of the work. Signalman J. S. Bilby extended the reconnaissance from Aitkin to Duluth, Minn., by September 1 and took charge of the signal building personally on that date. Foremen W. C. Nohl and Floyd Bilby had been in charge of the building party previous to that date under the supervision of Signalman Bilby, who directed their movements by letter. The building party closed work in Minnesota on September 12 and went to Texas to continue the work in that State.

Signalman Bilby completed the reconnaissance between Floresville and Alice on November 4, when he again took personal charge of the signal building party which had been at work under his direction in charge of Foreman Floyd Bilby. On December 22 the work of building signals was completed for the season, and the party was disbanded. The observing party began work in Texas at Serita station on November 10 and continued work until January 29, when the observations were completed for the season.

Observations were made at the following stations, viz: Serita, Stockdale, Ruckman, Karnes, Bryde, Choate, Pettus, Borroum, Wiess, Beeville, Fleming, Miller, O'Neill, Welder, Skelly, Mathis, Nolan, Elliff, Reynolds, Alice, Wood, Alice East Base, and Alice West Base.

Observations to determine azimuths were made at stations Karnes, Miller, and Alice.

The reconnaissance was extended from the vicinity of Barquette to the Gulf of Mexico off Corpus Christi. The work in connection with the closing operations for the season was completed on February 11.

Advantage was taken of Assistant Burger's presence in Texas and he was directed to inspect the tide gauge at Galveston. He proceeded to that place on the 12th and performed the duty assigned him. He also verified the position of the tide staff by leveling to the bench marks.

Assistant Burger resumed work on the triangulation in Minnesota on April 24, when Signalman Bilby reached Aitkin with the party outfit, which was brought from Texas under Assistant Burger's direction. He organized a signal building party and began the erection of signals on May 4. At the close of the fiscal year signals had been erected at 13 stations and the work was in progress.

Assistants Burger and King reached Aitkin on May 31 and immediately organized an observing party.

Observations began on June 8 and the following stations were occupied before June 30, viz: Gull, Jones, Rabbit, Brook, and Bethlehem. While at Aitkin a short base line was selected and angles were measured to determine the elevation of certain prominent objects in the town above a bench mark established on the court-house by the Mississippi River Commission. These objects were connected with the triangulation as a check on the elevations. The chief of the party did all in his power to aid Assistant King in becoming familiar with the details of the work in anticipation of transferring the charge of the work to him in July.

Observations were in progress at Bethlehem station on June 30.

MAGNETIC OBSERVATIONS. NORTH DAKOTA. J. A. Fleming.

Stations occupied.

Fargo.

On June 26 Mr. Fisk began work in North Dakota under the direction of Magnetic Observer Fleming and made observations at the station named above. The work was in progress on June 30.

MAGNETIC OBSERVATIONS. ARKANSAS. MISSOURI. J. W. Green.

Stations occupied.

ARKANSAS.

Bentonville.	Russellville.	Van Buren.

MISSOURI.

Greenville.	Houston.	Mount Vernon.

The work of making magnetic observations at certain places in Arkansas and Missouri was assigned to Magnetic Observer Green. He began work at Russellville, Ark., on May 19 and closed on June 3. During this period he made observations to determine the elements of terrestrial magnetism at the stations named above.

MAGNETIC OBSERVATIONS. IOWA. W. B. Keeling.

Stations occupied.

Keokuk.

Magnetic work in Iowa was assigned to Magnetic Observer Keeling, and he made observations to determine the elements of terrestrial magnetism at Keokuk on June 14. The station was marked by a stone post suitably lettered.

LEVELING. IOWA. MINNESOTA. NORTH DAKOTA. SOUTH DAKOTA. J. B. Miller.

SUMMARY OF RESULTS.

831 kilometers of line completed.
304 bench marks established.

The extension of the standard levels west from St. Cloud, Minn., was assigned to Aid Miller.

The work began on July 6, and started from a bench mark established by the Mississippi River Commission near St. Cloud. The route follows the Great Northern Railway to Fairmount, N. Dak., thence over the Chicago, Milwaukee and St. Paul Railway to Twinbrooks, S. Dak.; thence across the country to Stockholm, and thence along the Great Northern Railway to Watertown, S. Dak., where the work closed for the season on November 5.

At Fairmount, N. Dak., the line was connected with bench marks established by the United States Geological Survey, and at Ortonville, Minn., it was connected with bench marks established by the Corps of Engineers, U. S. Army. The elevations of the station marks at triangulation stations Osakis, Alexandria, Elbow, Foss, Oscarson, and Mound were determined.

Mr. Miller resumed work on the extension of the levels in South Dakota in April. He began work at Watertown on the 17th, and extended the line along the Great Northern Railway to Vienna, S. Dak., and thence along the Chicago, Milwaukee and St. Paul Railway to Sioux City, Iowa, via Madison and Sioux Falls Junction. From Madison a branch line was run across the country 7 miles to triangulation station Crane, and triangulation station Hansen was reached by a branch line 2½ miles long.

Nine bench marks established by the United States Geological Survey near Harrisburg were used in the work and three bench marks established by the Corps of Engineers, U. S. Army, near Elk Point, S. Dak. In leveling along the railroads the rails were used as turning points. Velocipede cars were used as the means of transportation and the thanks of the Survey are due the officials of the railway companies for their kindness in granting this privilege and for the courtesies extended to the party.

The work was completed on June 30.

LEVELING. MINNESOTA. E. H. Pagenhart.

SUMMARY OF RESULTS.

42 kilometers of line completed.
9 bench marks established.

The extension of the standard levels northward from Evansville, Minn., was assigned to Aid Pagenhart and he began work on June 17. The route followed the Great Northern Railway to Dalton, where the work was in progress on June 30.

MAGNETIC OBSERVATIONS. INDIAN TERRITORY. L. B. Smith.
KANSAS.
OKLAHOMA.
TEXAS.

Stations occupied.

INDIAN TERRITORY.

Claremore.	Sapulpa.	Vinita.
Okmulgee.	Tahlequah.	Wagoner.

KANSAS.

Abilene.	Hutchinson.	Pratt.
Cimarron.	Jetmore.	Russell.
Clay Center.	Junction City.	Salina.
Concordia.	Kingman.	Scott.
Dighton.	Kinsley.	Seneca.
Dodge City.	Lakin.	St. John.
Eldorado.	Larned.	Tribune.
Ellis.	Leoti.	Wakeeney.
Ellsworth.	Lincoln Center.	Wallace.
Garden City.	Lyons.	Washington.
Gove.	McPherson.	Westmoreland.
Great Bend.	Ness City.	Wichita.
Greensburg.	Newton.	Winfield.
Hays.	Parsons.	

OKLAHOMA.

Alva.	Enid.	Newkirk.
Anadarko.	Guthrie.	Oklahoma.
Chandler.	Lawton.	Pawhuska.
Cordell.	Mangum.	

TEXAS.

El Paso.	Odessa.	Sierra Blanca.

The magnetic work at the Baldwin Magnetic Observatory and the extension of the magnetic survey in certain localities was assigned to Magnetic Observer Smith.

The variations in the force of terrestrial magnetism at Baldwin, Kans., were automatically recorded at the observatory during the year on self-registering instruments. Observations were made at this station on Monday of each week to determine the absolute value of the magnetic forces, and special records were made with the magnetograph on the 1st and 15th of each month.

During the month of December the old magnetograph was removed and a set of new Schulze instruments were installed.

During the year magnetic observers were assigned to duty under the direction of Mr. Smith, and they made observations to determine the value of the elements of terrestrial magnetism at the places named above.

TIDE OBSERVATIONS. LOUISIANA.

TEXAS.

A self-registering tide gauge was kept in operation throughout the year at Galveston, Tex.

Another self-registering gauge was established at Weeks, La., on March 1, and maintained during the rest of the fiscal year.

WESTERN DIVISION.

WESTERN DIVISION—WEST OF THE ROCKY MOUNTAINS.

Arizona.	Montana.	Utah.
California.	Nevada.	Washington.
Colorado.	New Mexico.	Wyoming.
Idaho.	Oregon.	

LEVELING. WASHINGTON. G. C. Baldwin.

SUMMARY OF RESULTS.

277 kilometers of line completed.
86 bench marks established.

The extension of the standard levels was in progress on July 1 by a party under the direction of Aid Baldwin, and he was at work in the vicinity of Clealum, Wash. The levels were extended over the main line of the Northern Pacific Railway to Pasco, and thence over a branch line to Hunts Junction, Wash. From this place the levels were carried along the Washington and Columbia River Railway to a point 5 miles distant, when a connection was made with the levels from the eastward, completing the line from the Atlantic to the Pacific oceans. The officials of the railways were unwilling to grant the privilege of using velocipede cars on their tracks, but they generously placed a freight car at the disposal of the party, to be used as quarters, and hauled this car from place to place, as requested. No charge was made for this service which greatly facilitated the progress of the work in the sparsely settled region over which the route passed.

In his report Mr. Baldwin expresses his appreciation of the favors shown the party by the officials of the two railways, and the thanks of the Survey are due the companies for the above and other courtesies extended to the party.

On the portion of the line between Pasco and a point 4 miles south of Hunts Junction the country is desolate and sandy, and the drifting sand in windy weather made it impossible to use the wind break and stopped the work when the wind was very strong. The work was completed on October 1 and the party was immediately disbanded.

ASTRONOMIC OBSERVATIONS. CALIFORNIA. O. B. French.
RECONNAISSANCE. OREGON.
TRIANGULATION. WASHINGTON.

SUMMARY OF RESULTS.

Astronomic observations:
5 azimuths determined.

Reconnaissance:
- 3 150 square miles area covered.
- 37 triangulation stations selected.
- 2 base lines selected.

Triangulation:
- 10 700 square miles area covered.
- 30 stations occupied.
- 74 geographic positions determined.

The triangulation along the coast of California, north of San Francisco, was in progress on July 1 under the direction of Assistant French, with Assistant Hill as a member of his party, and observations were being made at Spur station.

On July 9 the observing party proceeded to Boliver station in charge of Mr. J. S. Hill, and Mr. French went to Washington to extend the reconnaissance from the Columbia River to Puget Sound. After considerable delay on account of the smoky condition of the atmosphere several stations were approximately located and a base line was selected. Mr. French returned to the observing party on August 10. The following stations in the main scheme were occupied in the order named: Spur, Boliver, Central Point, Sterling, Soda, Rust, Black, Onion, White, Scott, Yellow, and Fairview.

In October the astronomic station at Roseburg, Oreg., was occupied. In order to connect with a Geological Survey bench mark at this place, a short base line was measured and two points were occupied for the measurement of the necessary angles. Later in the month 2 stations, Rose and Burg, in this vicinity, were occupied. Observations were made to determine an azimuth at the astronomic station on Skinners Butte and horizontal angles were measured at that station and at Seavies to connect the astronomic station with the main scheme. On November 12 Mr. French returned to Tacoma and spent a week on reconnaissance, but the weather was unfavorable and very little was accomplished. Work for the season closed on November 20.

Mr. French resumed work on the reconnaissance on April 14 and selected several stations before starting a signal building party to work. He then completed the reconnaissance to Tacoma and returned to Eugene, Oreg., May 31. Mr. Hill had reached Eugene a few days before and had the outfit nearly ready for use. Observations began at Ridge station on June 6, and the work at North Base, Twin, and Peterson was completed. On June 15 the outfit was shipped to Tacoma and the observing party proceeded to that place. Some time was spent in completing the work of the signal building in the vicinity, as that party was sent at once to the mountains. Stations Wash, Smelt, Tacoma, Astronomic, Robinson II, Dash, and Piner were occupied before June 30.

ASTRONOMIC OBSERVATIONS. NEW MEXICO. E. D. Preston.
BASE MEASUREMENT.
RECONNAISSANCE.
TRIANGULATION.

SUMMARY OF RESULTS.

Astronomic observations:
- 1 azimuth determined.
- 1 latitude determined.
- 1 longitude determined.

Base measurement:
- 1 base line measured.

Reconnaissance:
- 45 square miles area covered.
- 53 triangulation station selected.

Triangulation:
- 45 square miles area covered.
- 29 stations occupied.
- 85 geographic positions determined.

The survey of the United States Public Health and Marine-Hospital Service Reservation at Fort Stanton, N. Mex., requested by the Treasury Department, was assigned to Assistant Preston. He reached Fort Stanton on September 17 and found Mr. Fitzgerald at work, and various preparations had been made. The reconnaissance was extended over the reservation, and numerous triangulation stations were selected. A base line was measured with a steel tape, and the latitude and longitude of a point and the azimuth of a line were determined from observations of the sun. The triangulation stations in the main scheme were occupied, and their geographic positions were determined. The elevations of these stations were also determined trigonometrically. The reservation covers 38 square miles and has a general rectangular shape, but the boundary is irregular and is composed of 62 separate lines, which involves an equal number of corners to be recovered and marked.

HYDROGRAPHY.	CALIFORNIA.	A. F. Rodgers.
SPEED TRIAL COURSE.	WASHINGTON.	
TIDE OBSERVATIONS.		
TRIANGULATION.		

Work as indicated was assigned to Assistant Rodgers. On July 9 he proceeded to Santa Barbara and put the speed trial course in that vicinity in order, as the result of a request from the Navy Department. The range marks were repaired and two detached line fences were constructed to strengthen the definition of the western range. Two of the old triangulation stations were recovered, and, from the line between them as a base, the position of a windmill in the rear of Santa Barbara Light-house was determined to strengthen the eastern range. The field work was completed on July 20.

On September 8 Mr. Rodgers proceeded to Seattle, Wash., to prepare the Alki speed trial course for use. Two of the targets had been destroyed and had to be replaced. This work was done at the request of the Navy Department. It was completed on September 18.

In June Aid P. C. Whitney reported to Assistant Rodgers for the purpose of establishing a self-registering tide gauge in Santa Monica Bay, California, under his direction. Mr. Whitney reached Santa Monica on June 13, and, after examining the available localities, selected Redondo as the most suitable place for the erection of the gauge. The work of installing the gauge began immediately and was in progress at the close of the year.

Tide observations were continued during the year at the Presidio Station, San Francisco, Cal., under Mr. Rodgers's direction.

CHARGE OF SUBOFFICE. CALIFORNIA. A. F. Rodgers.

The suboffice of the Survey in San Francisco was continued under the charge of Assistant Rodgers, who attended to numerous duties, many of them matters of routine, as the representative of the Superintendent on the Pacific coast.

Various officers were temporarily attached to the suboffice during the year, engaged in completing the records of their work in the field.

LEVELING. OREGON. WASHINGTON. F. H. Sewall.

SUMMARY OF RESULTS.

323 kilometers of line completed.
105 bench marks established.

The work of extending the standard levels westward from Durkee, Oreg., was in progress July 1 by a party under the direction of Aid Sewall. The route followed the Oregon Short Line Railroad to Huntington, Oreg., and thence along the road of the Oregon Railroad and Navigation Company to a point 5 miles south of Hunts Junction, Wash., where a junction was made with a line from the west, thus completing the line between the Atlantic and Pacific oceans on October 14, 1904.

Velocipede cars were used as the means of transportation, and the thanks of the Survey are due the officials of the railway companies mentioned for their generosity in granting this privilege without charge.

MAGNETIC OBSERVATIONS. ARIZONA. CALIFORNIA. IDAHO. NEVADA. NEW MEXICO. UTAH. WYOMING. L. B. Smith.

Stations occupied.

ARIZONA.

Yuma.

CALIFORNIA.

Bakersville.	Imperial.	San Bernardino.
Banning.	Indio.	San Diego.
Calexico.	Ransburg.	Stedman.
Escondido.	Redlands.	Temecula.
Holtville.	Sacramento.	

IDAHO.

Arco.	Malad City.	Shoshone.
Blackfoot.	Minidoka.	Soda Springs.
Dubois.	Pocatello.	

NEVADA.

Carson City.	Hawthorne.	Yerington.
Elko.	Sodaville.	

NEW MEXICO.

Deming.

UTAH.

Ogden.

WYOMING.

Cokeville.	Green River.

Magnetic work in the States named above was assigned to Magnetic Observer Smith and a magnetic observer was detailed to make the observations. He began work at Deming, N. Mex., on February 4. After completing the observations at that place, he occupied 1 station in Arizona, 14 stations in California, 8 stations in Idaho, 5 in Nevada, 1 in Utah, and 2 in Wyoming. The work was in progress at Shoshone, Idaho, on June 30.

TIDE OBSERVATIONS.

WASHINGTON.

A self-registering tide gage was maintained throughout the year at Seattle, Wash.

DIVISION OF ALASKA.

HYDROGRAPHY. ALASKA. H. C. Denson, Commanding, Steamer *McArthur*.

SUMMARY OF RESULTS.

160 square miles area covered.
388 miles of lines sounded.
783 soundings made.
1 tide station occupied.

Hydrographic work in Resurrection Bay, Alaska, was assigned to Assistant Denson. He left Seattle, Wash., in the *McArthur* on May 12, and reached Seward, Alaska, on the 29th. Signals were erected and the work of sounding began as soon as the necessary preparations were completed. The work in Resurrection Bay was suspended on June 6 and the vessel proceeded to Prince William Sound and began hydrographic work in the vicinity of Naked, Smith, and Seal islands. This work was in progress on June 30.

HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.
ALASKA. E. F. Dickins, Commanding, Steamer *Gedney*.

SUMMARY OF RESULTS.

Hydrography:
216 square miles area covered.
1 331 miles of lines sounded.
18 307 soundings made.
9 tide stations occupied.
Topography:
123 square miles area covered.
280 miles shore line surveyed.
112 miles shore line sketched.
2 topographic sheets completed.
Triangulation:
65 square miles area covered.
26 stations occupied.
60 geographic positions determined.

On July 1 the party on the steamer *Gedney*, under command of Assistant Dickins, was at work in Port Alice, Davidson Inlet, Alaska.

The work was continued in this locality until July 27, when the ship was moved to Holbrook, at the head of the inlet, and work was done in the vicinity until August 24, when the ship went to Cyrus Cove and remained there until the close of the season.

During the season a hydrographic survey was made of Iphegenia Bay, of a portion of Warren Channel, of Davidson Inlet, and of Sea Otter Sound. A survey was made of the shore line on Warren Island in Iphegenia Bay and Warren Channel, along the shore of Davidson Inlet and Sea Otter Sound, and a portion of Tuxekan Passage, and of several islands in these waters. The shore line at Shakan was surveyed. A reconnaissance was made through El Capitan Passage, and the shore line of the main islands and of numerous small islands was sketched. Interior topography was surveyed along the shores of Davidson Inlet, of Sea Otter Sound, and of Tuxekan Passage, and a survey was made of numerous small islands in these waters. Triangulation was done in Iphegenia Bay and Sea Otter Sound.

Field work closed on October 5 and the vessel proceeded to Sitka via Wrangell for coal. At Sitka the *Cosmos* and launch *117*, which had been used during the season, were hauled out and housed. On October 15 the vessel left Sitka and reached Seattle on October 23.

On May 17 Assistant Dickins left Seattle on the *Gedney* to resume work on the coast of Alaska. On May 23 the survey of the north arm of Moira Sound began and was completed on the 27th. A hydrographic survey, based on a plane table triangulation, was made of Dolomi Bay and Port Johnson. Work in Cordova Bay was begun on June 5 and signals were erected around the bay and in Hetta Inlet. A tide staff was established at Coppermount and at Sulzer. A base line was measured by means of a stadia on Jumbo Island and a plane table triangulation was extended as far as Lime Point at the head of Cordova Bay. The hydrographic work began near Jumbo Island and was extended to the head of the inlet. The shore line was determined by plane table intersections and sextant angles and was sketched between these stations. An examination was made of the portage between the head of Hetta Inlet and Cholmondeley Sound.

On June 17 the vessel went to Coppermount and continued the work to the southward until June 20, when the anchorage was changed to Hassiah Inlet, where another tide staff was established. The work was continued to the southward until the 29th, when the vessel moved to Kassa Inlet, where a tide staff was erected, and the work was in progress in this inlet on June 30. The weather was unusually favorable during the whole season.

MAGNETIC OBSERVATIONS. ALASKA. H. M. W. Edmonds.

The work at the magnetic observatory at Sitka, Alaska, was assigned to Magnetic Observer Edmonds. The variations of the forces of terrestrial magnetism were automatically recorded by self-registering instruments at the observatory during the year. Observations to determine the absolute value of the magnetic forces were made at least once every week. A record was obtained on the seismograph and meteorological observations were made every day. Time observations were made when the weather permitted, as the time signals sent over the cable could not be depended upon.

An astronomical clock, received toward the close of the fiscal year at the marine barracks, was set up, and it is hoped that it will eventually prove to be of value in the work of the observatory.

A special record was made by the magnetograph on the 1st and 15th of each month.

HYDROGRAPHY. ALASKA. W. C. Hodgkins, Commanding, Steamer *Patterson*.

Hydrographic work in southeastern Alaska was assigned to Assistant Hodgkins. He left Seattle, Wash., on May 19 and began sounding on June 2 on the line selected for the military cable between Valdez and Seward, Alaska, and reached Seward on the 3d. The *McArthur*, with Assistant H. C. Denson in command, and the *Taku*, with Aid Sasnett in command, were found at work in Resurrection Bay. The *McArthur* was sent to make additional soundings in Montague Strait in the vicinity of Seal Island, near the northern end of the strait.

Magnetic observations were made at Seward and the ship was swung for magnetic observations at sea. A running reconnaissance was made through Montague Strait, and on June 10 a reconnaissance in this strait began for the purpose of selecting triangulation stations. Two old triangulation stations were recovered and several new stations were selected. Some topographic work was done on two small islands (Smith Island and a small island off the southwest end of Smith Island called provisionally Giacomini Island). A hydrographic examination was made of the space between Resurrection Bay and Montague Strait and some soundings were made in Prince William Sound. An examination was made of the entrance to Landlocked Bay and a reported rock was located. A search was made for a shoal reported as having been seen 3 miles off Bligh Island at very low tide, but no such shoal was found.

The work was in progress at the end of the fiscal year.

ASTRONOMIC OBSERVATIONS. ALASKA. J. E. McGrath.

SUMMARY OF RESULTS.

1 longitude station occupied.

The determination of the longitude by the telegraphic method of certain places in Alaska was assigned to Assistants J. E. McGrath and Edwin Smith, in charge of cooperating parties.

Mr. McGrath reached Sitka, Alaska, on April 17 and mounted the instruments in a small building belonging to the Magnetic Observatory. Owing to the unfavorable weather and a break in the cable no observations were obtained until May 24. The observations were completed, and on May 29 Mr. McGrath started to Seattle, from which place the longitude of Sitka was being determined, to exchange stations with Assistant Smith, and reached there on June 3.

At the request of the Canadian government, observations were made in cooperation with a Canadian observer at Vancouver, British Columbia, on eight nights. Observations were also made to determine the relative personal equation of Assistants McGrath and Baird.

Owing to unfavorable weather at Sitka it was only possible to make observations on two nights at both ends of the line previous to June 26, when it was necessary for Mr. McGrath to suspend operations and sail for Valdez, Alaska, in order to complete the determination of that place and St. Michael before the close of the season. On June 30 he was en route to Valdez.

ASTRONOMIC OBSERVATIONS.
HYDROGRAPHY.
MAGNETIC OBSERVATIONS.
TOPOGRAPHY.
TRIANGULATION.

ALASKA.

J. F. Pratt, Commanding,
Steamer *Patterson*.

SUMMARY OF RESULTS.

Astronomic observations:
- 1 latitude determined.
- 1 longitude determined (chronometric).
- 1 azimuth determined.

Hydrography:
- 72 square miles area covered.
- 479 miles of line sounded.
- 11 779 soundings made.
- 1 tide station occupied.
- 3 hydrographic sheets completed.

Magnetic observations:
- 2 stations occupied on land.
- 2 stations occupied at sea.

Topography:
- 7 square miles area covered.
- 80 miles of general coast line surveyed.
- 5 miles shore line of ponds surveyed.
- 2 topographic sheets completed.

Triangulation:
- 30 square miles area covered.
- 13 stations occupied.
- 57 geographic positions determined.

The direction of the survey of Kiska Harbor, Alaska, was assigned to Assistant Pratt. He reached Kiska on the steamer *Patterson* on July 6 and found Assistant Ritter, commanding the *McArthur*, already at work.

In accordance with instructions, Assistant Ritter reported to Assistant Pratt upon his arrival and he immediately assumed supervision of the work, though the work of the *McArthur* is given under the name of her commander. Work began immediately and was continued whenever the weather conditions permitted until September 24, when the field work closed for the season.

Astronomic observations were made on three nights, the only nights during the season when it was clear enough for this work.

The triangulation was extended from the base line at the head of Kiska Harbor, over the harbor, Little Kiska Island, and to the northward as far as the northeast corner of Kiska Island.

The topography covered the shores of Kiska Harbor, including North and South passes, all of Little Kiska Island, and a portion of Kiska Island north of the harbor.

The hydrographic survey of the harbor was made on a large scale in order to show minor details, and includes the North and South passes. South Pass was also covered with the channel sweep in position. A survey on a smaller scale was made of the approach to Kiska Harbor, including Tanadak Pass.

Magnetic observations were made at two stations on shore and at sea in Dutch Harbor.

BASE MEASUREMENT.
HYDROGRAPHY.
MAGNETIC OBSERVATIONS.
TOPOGRAPHY.
TRIANGULATION.

ALASKA.

H. P. Ritter, Commanding,
Steamer *McArthur*.

SUMMARY OF RESULTS.

Base measurement:
- 1 base measured.

Hydrography:
- 50 square miles area covered.
- 127 miles of line sounded.
- 387 soundings made.
- 1 hydrographic sheet completed.

Magnetic observations:
- 5 stations occupied on land.
- 4 stations occupied at sea.

Topography:
- 2 square miles area covered.
- 1 mile general coast line surveyed.
- 5 miles shore line of creeks surveyed.
- 2 miles shore line of ponds surveyed.
- 2 topographic sheets completed.

Triangulation:
- 3 square miles area covered.
- 5 stations occupied.

The work of assisting in the survey of Kiska Harbor, under the direction of Assistant J. F. Pratt, was assigned to Assistant H. P. Ritter, commanding the steamer *McArthur*.

He was at Kiska on July 1 and began work immediately. A base line was measured with a steel tape and signals were erected until the limited supply of lumber on board was exhausted. The stormy condition of the weather prevented work outside of the harbor and the topographic survey of the upper end of the harbor was begun by Assistant Denson. During July and August the weather was very unfavorable, and storms and gales followed each other in rapid succession.

On August 20 the topographic survey of the coaling depot was completed, and the hydrographic survey of the northeastern approach to the harbor began on the 23d and was continued until August 30. While engaged on this work a dangerous reef was discovered and located.

Some magnetic observations were made on shore, and the ship was swung in the harbor to determine the compass deviation.

Unfavorable weather prevented any other work, and on September 6 the vessel stated to Seattle. A northeast gale forced the ship to return to the harbor, and a final departure was made on September 8. Stormy weather prevented magnetic observations at sea on the return voyage.

BASE MEASUREMENT. HYDROGRAPHY. TOPOGRAPHY. TRIANGULATION. — ALASKA. — E. C. Sasnett, Commanding, Steamer *Taku*.

SUMMARY OF RESULTS.

Base measurement:
- 1 base line measured.

Hydrography:
- 132 square miles area covered.
- 504 miles lines sounded.
- 2 109 soundings made.
- 1 tide station occupied.
- 1 hydrographic sheet completed.

Topography:
- 9 miles coast line surveyed.

Triangulation:
- 24 square miles area covered.
- 12 stations occupied.

An extension of the work in Prince William Sound was assigned to Aid Sasnett. He reached Orca on May 4 and on the 14th began a hydrographic examination in Prince William Sound from Smith Island to Cape Clear for the purpose of facilitating the laying of the military cable between Valdez and Seward by the Signal Corps, U. S. Army. The sounding lines to the westward of Green Island between Montague and Latouche islands.

The adjacent shore line was sketched by using tangents and intersections on prominent points.

This work was completed on May 19, and party proceeded to Resurrection Bay and began work there on the 22d. A base line was measured at the head of the bay and a triangulation was extended from it to Fox Island.

A hydrographic survey was made to a point opposite Resurrection Point and the work was in progress on June 30.

SUMMARY OF RESULTS.

1 longitude station occupied.

The determination of the longitude, by the telegraphic method, of certain places in Alaska was assigned to Assistants Edwin Smith, J. E. McGrath, in charge of cooperating parties.

Mr. Smith reached Seattle on April 3 and Mr. Baird reported to him for instruction on the following day.

Excavations were in progress in the university grounds, where the astronomic station was located, and it was not possible to occupy the station. A new station was selected and referred to the old station. This new station was prepared for the work, and two sets of instruments were mounted on piers—one for the regular work and the other for the use of Mr. Baird in making himself familiar with all the operations connected with the work.

Mr. Smith was ready for work on April 15 and Mr. McGrath, at Sitka, on April 23, but bad weather prevented observations until May 24, when exchanges of signals were made, and also on the four succeeding nights. After completing the observations the observers immediately exchanged stations, but both ends of the line were not ready for work until June 8. After that date the bad weather again prevented work, except on the 13th and 18th, until June 22, when it was necessary for Mr. Smith to leave Sitka and proceed to Fort Egbert in order to complete that station before the winter season.

He had not reached his destination on June 30, being compelled to wait at Dawson for a steamer.

OUTLYING TERRITORY.

ASTRONOMIC OBSERVATIONS.
BASE MEASUREMENT.
HYDROGRAPHY.
MAGNETIC OBSERVATIONS.
TOPOGRAPHY.
TRIANGULATION.

CANAL ZONE.

P. A. Welker, Commanding,
Steamer *Bache*.

SUMMARY OF RESULTS.

Astronomic observations:
1 azimuth established.
Base measurement:
1 base line measured.
Hydrography:
24 square miles area sounded.
727 miles lines sounded.
30 458 soundings made.
1 tide station occupied.
2 hydrographic sheets completed
Magnetic obvservations:
3 stations occupied on land.
5 stations occupied at sea.
Topography:
28 miles of general coast line surveyed.
2 topographic sheet completed.
Triangulation:
13 square miles area covered.
6 stations occupied.
16 geographic positions determined.

The survey of Limon Bay, Canal Zone, was assigned to Assistant Welker, commanding the steamer *Bache*.

Magnetic observations were made off Norfolk and in Hampton Roads, Virginia, and on February 28 the vessel sailed for Colon, Panama, via Kingston, Jamaica.

Magnetic observations at sea were made on the voyage north of Cape Hatteras, but the sea was too rough for observations during the remainder of the voyage, except in Kingston Harbor and off Colon.

The vessel reached Colon on March 11 and Assistant Welker called upon Mr. Charles List, the resident engineer of the Panama Canal, and later visited Chief Engineer John F. Wallace, at Panama, for consultation.

A base line was measured on Mangrove Beach, at the entrance to the canal, to serve the purpose of the survey of Limon Bay and to be used in extending a triangulation along the canal. The ends of this base line were marked in a permanent manner, so that it will be available after the canal is completed.

A triangulation was extended from this base line to cover the bay and furnish lines upon which the topographic and hydrographic work could be based. The weather was generally favorable, but in certain portions of the bay there was a strong swell and heavy breakers almost constantly. Extra precautions were taken to prevent sickness and the health of the crew was good throughout the season.

The survey was completed on April 28 and on May 2 the vessel sailed for Key West.

From February 12 to May 15 Mr. J. P. Ault, magnetic observer of the Carnegie Institution, was attached to the vessel for the purpose of obtaining magnetic observations. He rendered valuable assistance in the duty assigned to him and also in other work of the Survey, in which he took an active part.

MAGNETIC OBSERVATIONS. HAWAII. S. A. Deel.

The work at the Magnetic Observatory near Honolulu, Hawaii, was assigned to Magnetic Observer Deel. Mr. Nyswander reported for duty at the observatory on September 3 and assisted in the work after that date.

The variations in the forces of terrestrial magnetism were automatically recorded by self-registering instruments at the observatory during the year.

Observations to determine the absolute value of the magnetic forces were made on Monday of each week, and a special record was made with the magnetograph on the 1st and 15th of each month.

A record was obtained with a seismograph at the observatory and the ordinary meteorological observations were made

HYDROGRAPHY.
MAGNETIC OBSERVATIONS.
TOPOGRAPHY.
TRIANGULATION.

HAWAII.

J. F. Pratt, Commanding,
Steamer *Patterson*.

SUMMARY OF RESULTS.

Hydrography:
- 770 square miles area covered.
- 572 miles lines sounded.
- 5 051 number of soundings made.
- 2 tide stations occupied.
- 6 hydrographic sheets completed.

Magnetic observations:
- 2 stations occupied on land.
- 2 stations occupied at sea.

Topography:
- 61 square miles area covered.
- 55 miles shore line surveyed.
- 13 miles roads surveyed.
- 4 topographic sheets completed.

Triangulation:
- 23 stations occupied.
- 44 geographic positions determined.

The survey of certain portions of Hawaii was assigned to Assistant Pratt. He sailed from Dutch Harbor, Alaska, on October 1 and reached Honolulu, Hawaii, on the 13th. On November 4 the vessel reached her working ground off Kahoolawe Island.

A triangulation was extended over the island and over a portion of Maui. A topographic survey was made of Kahoolawe and of Molokini islands and of the southwesterly portion of Maui. Some supplementary topography was done in Hilo Bay.

Hydrographic surveys were made around the coast of Kahoolawe, along the southwest coast of Maui, and in Alalakeiki and Kealaikahiki channels. The vessel sailed from Honolulu on March 15 and reached Seattle March 27.

COMBINED OPERATIONS. PHILIPPINE ISLANDS. G. R. Putnam.

The important work of surveying the coast of the Philippine Islands was continued under the direction of Assistant Putnam, who represented the Superintendent in all matters requiring immediate decision.

In performing this duty he adopted plans for field operations, issued instructions for field work, compiled all data secured, and prepared charts of the waters surveyed. Notices to Mariners and Sailing Directions were prepared and published. He was aided in this work by such advice and instructions issued from Washington as became necessary.

During the year the work was prosecuted under the same general plan of division of expense as previously. The United States paid the salaries and subsistence of its technical corps detailed for this duty, including several experts in the office; furnished nearly all the instrumental equipment, paid all the expense of operation of one large surveying vessel, of chart publication, traveling expenses to and from the United States, and a part of the expense of coal and launch hire. The Philippine government paid the other office and field expenses in the islands, including the salaries of the employees in the office in Manila, expense of operating two survey vessels, the building of a new survey vessel, and furnished office accommodations and printing. Money and property accounts were rendered to each government for the resources furnished, respectively, and complete duplicate reports of all work accomplished were rendered to the secretary of the department of commerce and police of the Philippine government, and to the Superintendent of the Coast and Geodetic Survey at Washington.

Mr. Putnam went to the United States in March and returned to Manila in August, 1904. While in Washington many matters affecting the Philippine work were considered and useful information was obtained, particularly in regard to the construction of charts in Manila and their prompt publication in Washington. Under authority from the Secretary of Commerce and Labor he returned to Manila by way of London and Madrid for the purpose of making inquiries regarding British and Spanish surveys in the Philippine Islands. In London he was courteously permitted to examine the original sheets of the surveys made in former years by British vessels within the limits of the islands. In Madrid he was furnished information at the various Government offices regarding the work done by the Spanish in the Philippine Islands, and learned that in general the results of the Government surveys have all been published. He was fortunate in meeting, in Madrid, Mr. Enrique d'Almonte, the leading Spanish geographer of the Philippines, and secured from him the remainder of his collection of Philippine maps, partly in manuscript. From his inquiries in Madrid he concluded that there is no further unpublished information of geographic value available, except perhaps of an historical nature.

FIELD WORK.

The following is a brief summary of the field work done during the fiscal year:

West coast of Luzon.—Triangulation and topography, shore party, July, 1904, W. B. Fairfield, chief of party; January and February, 1905, R. B. Derickson, chief of party. Mr. Fairfield's work along the coast of Zambales Province was terminated in July, 1904, near Botolan Point, south of Iba, on account of the rainy season. This work was extended to the southward in January and February, 1905, by Mr. Derickson, the topography being carried to Cabingan and the triangulation to Capones Light-house; there remains only a small stretch to complete the topography of the coast of Zambales Province.

Guimaras Strait and coast of Guimaras Island.—General survey, hydrography, triangulation, and topography, steamer *Research*, July, 1904, R. B. Derickson, commanding; December, 1904, to June, 1905, W. C. Dibrell, commanding. The surveys of the previous season south of Iloilo were extended, and at the end of the fiscal year the coast of Guimaras Island and of Negros Island, between Bacolod and Binalbagan, and the intervening water area had been practically completed. The former charts of Guimaras Strait were dangerously misleading, channels having been shown where shoals exist and shoals where there are good channels. Because of the many islands much intricate work was required around the southern coast of Guimaras.

Batangas and Balayan bays and Verde Island Passage, southwest coast of Luzon.—General survey, hydrography, triangulation, and topography, shore party, with chartered launch *Amelia*, August, 1904, to February, 1905, William Bowie, chief of party. This survey includes Batangas Bay, Balayan Bay, Port Maricaban, the anchorages off the towns of Batangas, Balayan, and Taal, and the waters surrounding Maricaban Island, including the northern side of Verde Island Passage from Cape Santiago to Matocot Point; Minerva rock, a danger marked as doubtful on the charts, in the entrance to Balayan Bay, does not exist.

Southeastern part of Iligan Bay, north coast of Mindanao.—General survey, hydrography, triangulation, and topography, shore party, September, 1904, to January, 1905, O. W. Ferguson, chief of party. This survey includes the anchorages at Camp Overton, Iligan town, and at Quinalang Cove, the offlying hydrography, and the coast topography from Binuni Point on the westward to the point north of Quinalang Cove. The work was done because of the importance of this vicinity as the entrance to the Lake Lanao country, and the incompleteness and the inaccuracy of existing charts. The military authorities courteously granted the use of the station steam launch for the offshore hydrography, the balance of the work being done with small boats.

Northwest coast of Luzon, Point Dile to San Fernando.—Hydrography steamer *Pathfinder*, November, 1904, to February, 1905, Ferdinand Westdahl, commanding. This survey consisted of filling in the hydrography along the coast and for a few miles offshore, from Vigan to San Fernando, thus completing the survey of the northwest coast of Luzon from Lingayen Gulf to Laoag. Special development was made of Vigan

Anchorage, Solbec Cove, Port San Esteban, and Santiago Cove. Also, when leaving this field of work, a line of deep-sea soundings was made by the *Pathfinder* from off San Fernando to Iba.

North coast of Panay, Sapian Bay, and Aclan River mouth.—General survey, hydrography, triangulation, and topography, steamer *Research*, August to November, 1904, R. B. Derickson, commanding. This survey was for the purpose of filling in the unfinished portions of the important stretch of coast between Capiz and Calivo, the other portions, including Port Batan and Capiz Bay, having been finished the previous season.

Manila Bay to Lingayen Gulf, triangulation through the central valley of Luzon.—November, 1904, to June, 1905, W. B. Fairfield, chief of party. This triangulation is for the purpose of connecting in position the coast surveys on the northwest coast of Luzon with those of Manila Bay and to the southward. Incidentally it determines the position of many intermediate points in this important valley, which may be used as reference points for other surveys. At the close of the fiscal year the field work had been nearly completed.

Manila Bay, hydrography of vicinity of Malabon, and of San Nicolas Banks.—Shore party with chartered launch *Filipinas*, November, 1904, to January, 1905, H. M. Trueblood, chief of party. This survey was made for the purpose of filling in and correcting the work of important areas on the Manila and Cavite chart, and on the Manila Bay chart. San Nicolas Beacon was known to be incorrectly located, and this survey developed the fact that San Nicolas Banks were very different from what had been shown.

The work off Malabon was for the purpose of filling in a blank area on the local chart and showing the entrance to Malabon.

Northeast coast of Samar, vicinity of Laoang (Laguan).—General survey, hydrography, triangulation, and topography, shore party with chartered launch *Comillas*, February to June, 1905, O. W. Ferguson, chief of party. The work of this party includes Laguan Bay, Port Palapag, and the neighboring islands and channels. The work was in progress at the close of the fiscal year. A launch was chartered a part of the time to facilitate the work.

West coast of Luzon, coast south of Manila Bay, and dangers near the entrance to Manila Bay.—General survey, hydrography, triangulation, and topography, steamer *Fathomer*, March and April, 1905, C. C. Yates, commanding. This work included the investigation of a shoal marked doubtful, extending from Caballo Island, the investigation of a reported danger off Vigia Point, and the survey of the coast south of Manila Bay to San Diego Point, south of Nasugbu. The rock off Nasugbu was definitely located, and the reported dangers near Caballo Island and Vigia Point were proven not to exist.

The results of this survey will materially improve the chart of the vicinity of Manila.

West coast of Luzon, reefs off Iba and Palauig Bay.—Hydrography, steamer *Pathfinder*, February to March, 1905, Ferdinand Westdahl, commanding. This work included the location and sounding out of the group of reefs lying to the westward of Iba, off the coast of Luzon, and the hydrography of the anchorage at Iba and of Palauig Bay, a few miles to the northward of Iba.

Investigation of dangers near San Bernardino Straits.—Hydrography, steamer *Pathfinder*, April, 1905, Ferdinand Westdahl, commanding. Because of conflicting reports regarding the position in which the steamer *Pharsalia* was wrecked, a reconnaissance was made of the vicinity; the wreck was found to be lying on the southeastern part of Calantas Bank, the chart being fairly correct as to the southern extent of this shoal. Soundings were made in Biri Channel, north of Samar, and it was proven that the two doubtful shoals shown as lying near the center of the channel do not exist, thus clearing this useful channel. A good anchorage for safety in a typhoon, east of Biri Island, was developed.

East coast of Samar.—General survey, hydrography, topography, and triangulation, steamer *Pathfinder*, April to June, 1905, Ferdinand Westdahl, commanding. Because of the present number of Government vessels going to this coast this work was taken up as early as the monsoon season would permit. Work was commenced in the vicinity of Oras, and at the end of the fiscal year had been extended to Apiton and Hilaban islands, and was in progress. This coast was found to be very crudely represented on existing charts, there being serious errors in distances and relative positions. A small harbor that may be valuable as a refuge was found between Oras and Dolores.

East coast of Luzon.—General survey, hydrography, topography, and triangulation, steamer *Fathomer*, May and June, 1905, C. C. Yates, commanding. The east coast of Luzon is the most poorly charted of the commercially important parts of the islands. In previous seasons surveys were made to include Lagonoy Gulf and the south coast of Catanduanes Islands. The present season's work was commenced at Maqueda Channel, between Catanduanes and Luzon, and the surveys were extended to the north and northwest, and the work was in progress at the close of the fiscal year. Preliminary reports received show that points on the northwest coast of Catanduanes Island and on the islands to the westward of Catanduanes are in error from 3 to 4 miles, as shown on the present charts.

Tidal and magnetic observations.—In addition to the field work above outlined, observations of tides and currents and of the magnetic declination have been made in connection with the other work, and in addition automatic self-registering tide gauges have been maintained throughout the year at Manila and Iloilo.

Survey steamers.—The Coast and Geodetic Survey steamer *Pathfinder*, after a thorough overhauling at Hongkong, returned to the Philippines November 4, 1904, and has since been continuously at work, except for short intervals when outfitting at Manila.

The steamer *Research* has been continuously engaged on field work throughout the year, except for short intervals when outfitting or having repairs made.

The steamer *Fathomer* was under construction at Hongkong at the beginning of the fiscal year, under the inspection of C. C. Yates on behalf of the Survey, and also of Lloyd's surveyor at Hongkong, as required by the contract. The trial trip took place at Hongkong on December 10, with the following board acting for the Coast and Geodetic Survey: C. C. Yates, Assistant; J. C. Dow, Nautical Expert; H. C. Liebenow, Inspector of Boilers, city of Manila; E. S. Daniels, Watch Officer, and D. Macdonald, Surveyor to the British Corporation. The vessel made a speed of 10.5 knots, being 0.5 knot more than contract requirements. The board recommended the acceptance of the vessel on the completion of certain changes and additions to be made by the contractor, and with certain guaranties for a limited time. The *Fathomer* was delivered by the contractor in Manila Bay on January 19, 1905, and was immediately taken over and placed in commission. The steamer was hauled out on the marine railway at Canacao on April 3 and examination made under the guaranties of the builders, and the vessel was finally accepted, all requirements having been fulfilled. The vessel was completed within the amount of the appropriation. In the arrangements for survey work and living quarters the *Fathomer's* design differs materially from existing surveying vessels, and those who have served aboard report that the steamer is conveniently adapted for the purpose intended, and is comfortable for work in the Tropics.

OFFICE WORK.

The office work is done in the following divisions: Computing, Nautical Information, Chart Construction, Hydrographic Verification, and Correspondence and Property. The whole is under the supervision of the Director, who draws up the schemes for field work and for charts, examines the drawings for charts and nautical information prepared for publication, and makes such further inspection of the work in each line as time permits.

Computing Division.—This work continued under the supervision of Mr. E. R. Frisby, Chief Computer, who has been assisted by one computer for the past three months, by two junior computers throughout the year, and by occasional aid from members of the field force temporarily on duty in Manila. The work of this division includes the receipt and register of all survey records (not drawings), and the completion of all computations necessary to put the field records in shape for chart construction or other purpose. The computations made in the field are verified. The principal classes of computations are the reduction of tidal observations and planes of reference, reduction of astronomic observations for latitude, longitude and azimuth, reduction of all soundings to mean lower low water, computation of distances, positions and elevations from triangulation, and computation of magnetic declination. Data must constantly be prepared for the use of the field parties in extending surveys, and for the use of the office in plotting hydrographic sheets and in the preparation of charts.

Nautical Information Division.—This work was in charge of J. C. Dow, Nautical Expert, until March, 1905, when H. L. Ford, Nautical Expert, took up this duty. The following publications were prepared, verified, and issued:

Notices to Mariners, Nos. 6 to 12 of 1904.
Notices to Mariners, Nos. 1 to 7 of 1905.
Sailing Directions, Section III, Coasts of Panay, Negros, Cebu and adjacent islands, edition of 1904.
Sailing Directions, Section IV, Coasts of Samar and Leyte and the East Coast of Luzon, edition of 1904.
Sailing Directions, Section V, Coasts of Mindanao and adjacent islands, edition of 1905.
Catalogue of Charts, Sailing Directions, and Tide Tables of the Philippine Islands, 1905.

Manila being the shipping center of the Philippines, one important duty of the Nautical Expert is to furnish information in response to inquiries regarding charts, sailing directions, or other nautical matters. Files of corrected charts and other publications are kept in the office for the benefit of those interested.

During the latter part of the year the correction of charts was under the supervision of the Nautical Expert, and a systematic register of these corrections has been established. One or two junior draftsmen are constantly engaged in placing important corrections on the charts from new information, and all charts are thus corrected by hand before being issued.

Chart Construction Division.—This work was in charge of J. P. Keleher, Chief Draftsman, except during his absence from October 15 to December 2, 1904, when John Bach, Observer, had charge. Twelve junior draftsmen and three apprentice draftsmen were engaged on this work. The work of the division includes the preparation of drawings for new charts and new editions of charts, the completion of unfinished field sheets, as the inking of topographic sheets and the plotting of hydrographic sheets, the preparation of projections for field parties, and of the various miscellaneous drawings.

The following drawings for charts were completed during the fiscal year and forwarded to Washington to be printed.

No. 4511. Basilan Strait.
No. 4619. Eastern part of Illana Bay (with two plans).
No. 4265. Harbors on east coast of Luzon (nine plans).
No. 4417 Northeast coast of Panay.
No. 4646. Pujada Bay.
No. 4345. Anchorages Verde Island Passage to Cuyo (nine plans).
No. 4238. Bolinao Harbor.
No. 4456. Harbors of Samar and Leyte (eight plans).
No. 4458. Harbors in Cebu and Negros (eight plans).
No. 4237. Tabaco Bay to Legaspi.
No. 4423. Southern part of Samar.
No. 4222. Lagonoy Gulf to Sisiran Bay.
No. 4221. Albay Gulf and Lagonoy Gulf (new edition).
No. 4457. Guiuan and approaches.
No. 4644. Harbors on north coast of Mindanao (sixteen plans).
No. 4710. Batan Islands (one plan).
No. 4348. Cagayan Sulu and Sandakan (four plans).
No. 4209. Lingayen Gulf (one plan).
No. 4618. Dumanquilas Bay and part of Illana Bay.
No. 4346. Harbors of Palawan Island (six plans).
No. 4316. Northwest coast of Palawan.
No. 4514. Tawitawi Islands (three plans).
No. 4541. Jolo Anchorages (three plans; new edition).
No. 4231. Manila Harbor (new edition).
No. 4207. Laoag to Vigan (two plans).

At the close of the fiscal year there were in preparation at Manila drawings for seventeen charts or new editions of charts, of which seven were well advanced.

Hydrographic Verification Division.—John Bach, Cartographer, was detailed to this duty in December, 1904. The work consists of the examination and verification of hydrographic sheets, the examination of all survey sheets, and assistance in the verification of drawings for charts, which is indispensable in maintaining a proper standard of accuracy.

Correspondence and Property Division.—W. H. MacDonald has continued to act as Chief Clerk, in charge of routine business of the Office, including property returns, the first checking of vouchers, time records, distribution of publications, requisitions, forwarding instruments and supplies to field parties, stationery, etc.

William Auerbach was appointed as clerk in September, 1904, and he has since acted as stenographer and assisted in the clerical work, and one junior clerk was employed part of the year to assist in copying.

The Office force consists of the following: Chiefs of Divisions and Chief Clerk, 5; Computers, 3; Clerks, 2; Draftsmen, 16; Messenger, 1; total, 27.

Distribution of publications.—During the fiscal year about 6 000 charts were sent out from the Manila office, either for official use or for sale. Of this number about 1 500 charts were furnished to the Navy and about 2 200 charts to various departments of the Philippine government.

About 9 000 copies of Notices to Mariners and about 2 200 copies of Sailing Directions were distributed during the year to nautical men, shipping companies, and others interested.

Valuable information has been received from the civil, military, and naval officials, and from commercial and private sources, among which may be mentioned especially reports from Coast Guard vessels, the Light-House Service, Army Transport Service, Customs Service, Bureau of Engineering, Office of Port Works, etc. Verbal and manuscript information, sketches and blueprints were furnished by this Office in response to various inquiries and requests.

Additional vessels for survey work.—At the close of the fiscal year, under authorization of the United States Department of Commerce and Labor and of a resolution of the Philippine Commission, arrangement was made for the transfer of two Coast Guard vessels for survey work, to be operated under an extension of the joint arrangement.

BASE MEASUREMENT. PHILIPPINE ISLANDS. William Bowie.
HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

SUMMARY OF RESULTS.

Base measurement:
1 base line measured.
Hydrography:
1 155 miles lines sounded.
15 190 soundings made.
2 tide stations occupied.
5 current stations occupied.
10 hydrographic sheets completed.
Topography:
258 square miles area covered.
129 miles general coast line surveyed.
50 miles shore line of rivers surveyed.
64 miles shore line of creeks surveyed.
60 miles roads surveyed.
11 topographic sheets completed.

The survey of Batangas and Balayan bays was assigned to Assistant Bowie. He left Manila on August 23 and reached Batangas on the following day. Field work began immediately. A base line was measured and the necessary signals were erected. The triangulation was completed on September 20 and the hydrographic work began on the 26th.

On November 19 the survey of Batangas Bay and approaches, including the eastern half of Maricaban Island, was completed and the party moved to a camp on the eastern shore of Balayan Bay. The work was continued and on February 25 the survey of Balayan Bay and the western half of Maricaban Island was completed.

The positions and elevations of all peaks and hills near the coast were determined by triangulation or with the plane table. The triangulation has lines from which it can be extended in any direction. A large steam launch was used with great success by the party.

During the six months spent on this work, the party lived in camp on Batangas and Balayan bays. The inhabitants were friendly and nothing was molested by them during the season. In several instances they put up signal poles which had fallen down. The natives of this section are industrious if given fair compensation.

PHILIPPINE ISLANDS.

HYDROGRAPHY.
RECONNAISSANCE.
TOPOGRAPHY.
TRIANGULATION.

R. B. Derickson, Commanding,
Steamer *Research*.

SUMMARY OF RESULTS.

Hydrography:
16 square miles area covered.
292 miles lines sounded.
7 334 soundings made.
Reconnaissance:
20 square miles area covered.
6 stations selected.
Topography:
53 square miles area covered.
23 miles general coast line surveyed.
22 miles shore line of rivers surveyed.
22 miles roads surveyed.
3 topographic sheets completed.
Triangulation:
342 square miles area covered.
19 stations occupied.
42 geographic positions determined.

The survey along the north coast of Panay was in progress on July 1 under the direction of Assistant Derickson, commanding the steamer *Research*.

The hydrographic survey of Sapian Bay was completed, and also the hydrographic and topographic survey of Sapian River as far as Sapian Barrio. This survey completed the work between Capiz and Port Batan, and the survey is now continuous between Nipa Point in the vicinity of Capiz to New Washington, formerly called Lugatic.

The only serious interruption to the work was during the period July 23 to August 21, when necessary repairs were being made to the ship.

On October 31 the work on the north coast of Panay was suspended on account of the change in the monsoon, and the vessel proceeded to Iloilo.

On November 12 the survey of the southern end of Guimaras Straits was resumed. The old triangulation points were recovered and the necessary signals were erected and the positions of the stations needed in the work below Luceran Light were determined. The work was continued until December 8, when the command of the ship was turned over to Assistant W. C. Dibrell. The account of the work after this date is given under his name.

In January the extension of the coast triangulation and topography south from Iba, Luzon, was assigned to Assistant Derickson. He proceeded to Iba on January 4 and recovered triangulation points in the vicinity. The triangulation was extended south to Capones Light-house and a reconnaissance was begun up the San Marcelino Valley to extend the triangulation to Subic, but not completed.

The topographic survey of the shore line, main road, and adjacent mountains was extended from a point near the mouth of Bucao River to Cabangan. The work closed on February 28.

BASE MEASUREMENT.
HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

PHILIPPINE ISLANDS.

W. C. Dibrell, Commanding,
Steamer *Research*.

SUMMARY OF RESULTS.

Base measurement:
- 1 base line measured.

Hydrography:
- 625 square miles area covered.
- 3 063 miles lines sounded.
- 73 688 soundings made.
- 2 tide stations occupied.
- 4 current stations occupied.
- 4 hydrographic sheets completed.

Typography:
- 41 square miles area covered.
- 62 miles coast line surveyed.
- 26 miles shore line of rivers surveyed.
- 14 miles roads surveyed.
- 4 topographic sheets completed.

Triangulation:
- 500 square miles area covered.
- 28 stations occupied.
- 62 geographic positions determined.

The continuation of the survey of Guimaras Strait was assigned to Assistant Dibrell, and he took command of the steamer *Research* at Iloilo. The triangulation was extended from the work already done along the southern and southwestern shore of the Strait. It was also extended to southeast across the Strait to the west coast of Negros and northward of Inampulugan Island across the Strait to Negros.

A base line was measured to check the work on the west coast of Negros on the beach near Pulupandan. The position of the mountain peaks visible from the stations were determined whenever the clouds permitted.

A topographic survey was made from Lusaran Point to Dolores Point, joining work already completed at both ends. The topographic work was completed from Binalbagan northward to a junction with the survey south of Vallodolid.

The survey of the east coast of Guimaras Strait was then extended by completing about 8 miles of coast and joining the work already done in this region.

The survey of the west coast of Negros, north of Pandan, was in progress on June 30.

The hydrographic work was completed in Guimaras Strait from Binalbagan to Bacolod, and the area west of Binalbagan and south of Guimaras Island was also surveyed.

A self-registering tide gauge was in operation on the southeast coast of Guimaras Island, but the record was not continuous until May 1, as no regular keeper could be engaged until that time. On June 26 this gauge was moved to the village of Nobatas, on the north coast of Guimaras Island. A record was also obtained on a self-registering gauge at Iloilo.

Strong northeast winds prevailed in December, usually blowing day and night. Changing light winds in January. Strong northeast wind again prevailed in February until the middle of the month, when the weather became favorable for work and continued so until the end of April. In May the wind blew strong from the north until the monsoon changed at the end of the month, when the weather was again favorable.

There was no rain until June, and the unusually dry season caused delay in making it necessary for the ship to visit Iloilo every ten days for water, which could not be obtained near the working ground.

TRIANGULATION. PHILIPPINE ISLANDS. W. B. Fairfield.

SUMMARY OF RESULTS.

13 stations occupied.
140 geographic positions determined.

The extension of the triangulation along the central valley of Luzon from Manila to Lingayen Gulf was assigned to Assistant Fairfield.

In January a reconnaissance was made and the positions of stations were selected.

Observations of horizontal angles were begun on February 20, and were continued during the remainder of the fiscal year whenever the conditions permitted. Haze and smoke caused serious delay early in the season and later more delay was caused by storms and rain.

It was very difficult to obtain transportation, as the natives decline to work except when they need money, and it was necessary to use them to carry the instrument and outfit. The entire outfit had to be packed by men from 8 to 10 miles to reach the stations at the west end of the valley, and in some places there were no trails. The Observer remained at the stations with a very light outfit while making the observations and suffered a good deal in bad weather. All water used had to be packed from 1½ to 3 miles.

Rainy weather prevailed in June and made the rice fields almost impassable to the men carrying the outfit.

A base line 5 miles long was selected near Lingayen and permanently marked. The positions of all bell towers to churches and other prominent objects and mountain peaks visible from the stations were determined. Most of the churches are large stone buildings and many of the bell towers can be occupied as stations.

The Negritos in the mountains were very timid and hard to catch, but proved to be good workmen as packers.

The Observer expresses his appreciation of the aid extended to him by the treasurers and supervisors in the several provinces, who did all in their power to advance the work.

The work was in progress on June 30.

ASTRONOMIC OBSERVATIONS. PHILIPPINE ISLANDS. O. W. Ferguson.
BASE MEASUREMENT.
HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

SUMMARY OF RESULTS.

Astronomic observations:
- 2 azimuths determined.

Base measurement:
- 2 base lines measured.

Hydrography:
- 236 square miles area covered.
- 605 miles lines sounded.
- 24 855 soundings made.
- 2 current stations occupied.
- 2 tide stations occupied.
- 2 hydrographic sheets completed.
- 54 miles lines of deep-sea soundings.
- 209 deep-sea soundings made.

Topography:
- 65 square miles area covered.
- 48 miles shore line surveyed.
- 25 miles shore line rivers surveyed.
- 2 miles shore line creeks surveyed.
- 9 miles roads surveyed.
- 6 topographic sheets completed.

Triangulation:
- 265 square miles area covered.
- 36 stations occupied.
- 59 geographic positions determined.

The survey of the southeastern portion of Iligan Bay, Mindanao, was assigned to Assistant Ferguson.

He reached Camp Overton, Mindanao, on September 23, and began work immediately. A hydrographic survey was made of the anchorages at Camp Overton and Iligan and of Quinalang Cove. The topographic survey covered the coast from Binui Point on the westward to the point north of Quinalang Cove. The work was completed on January 17.

The military authorities courteously granted the use of the station steam launch for the offshore hydrography, and the remainder of the hydrographic work was done by using small boats.

On March 2 Mr. Ferguson and the party under his direction began the survey of the northeast coast of Samar in the vicinity of Laoang. A base line was measured and an azimuth was determined. The triangulation was extended to cover the harbor and the neighboring islands. A hydrographic survey was made of the harbor and off the entrance to the harbor. There are numerous islands in this vicinity with many wide bays and channels between them, and numerous rivers flowing into the sea.

The shores are covered with a dense growth, which delayed the progress of the triangulation and forced the topographic party to work in the water a good deal of the time.

A dangerous shoal was located west of the northern portion of Cahayagan Island 4 miles offshore.

A self-registering tide gauge was maintained at Laoang.

The work was in progress on June 30.

HYDROGRAPHY. PHILIPPINE ISLANDS. H. M. Trueblood.

SUMMARY OF RESULTS.

531 miles lines sounded.
22 913 soundings made.

The extension of the hydrographic work in Manila Bay was assigned to Aid Trueblood.

He chartered a launch and began work on November 8 in the vicinity of Malabon. Signals were erected and additional positions were determined. The work of signal building was unusually laborious on account of the extensive mud flats which extend offshore in this region. The work of sounding began on the 12th, and was continued until December 2, when the work was completed. The tide observations made at Manila were used to deduce the plane of reference for the soundings. No statistics for this work were given in Mr. Trueblood's report.

On December 7 the hydrographic survey of San Nicolas Banks, in Manila Bay, was begun. A tide staff was erected at the entrance of Naic River, and levels were run to a bench mark established in the vicinity. The work was completed on January 21. The work was delayed by wind and rain during December. The statistics given above refer to the work on San Nicolas Banks. The shape of these banks was developed and proved to be very different from that shown on the published chart. The position of San Nicolas Beacon was determined.

ASTRONOMIC OBSERVATIONS. PHILIPPINE ISLANDS. F. Westdahl, Commanding,
HYDROGRAPHY. Steamer *Pathfinder*.
TOPOGRAPHY.
TRIANGULATION.

SUMMARY OF RESULTS.

Astronomic observations:
1 azimuth determined.
1 latitude determined.
1 longitude determined (chronometric).
Hydrography:
640 square miles area covered.
1 927 miles line sounded.
43 816 soundings made.
4 tide stations occupied.
2 current stations occupied.
14 hydrographic sheets completed.
Topography:
25 square miles area covered.
56 miles general coast line surveyed.
2 miles rivers surveyed.
4 topographic sheets completed.
Triangulation:
80 square miles area covered.
16 stations occupied.
79 geographic positions determined.

Surveys in various portions of the Philippine Islands were assigned to Assistant Westdahl.

He reached Solvec Cove on the west coast of Luzon on November 5 and began work immediately. A hydrographic survey was made along the coast, which consisted of completing the unfinished work alongshore and for a few miles offshore, from Vigan to San Fernando, thus completing the survey of the northwestern coast of Luzon from Lingayen Gulf to Laoag. A special development was made of Vigan Anchorage, Solbec Cove, Port San Esteban, and Santiago Cove, and a line of deep-sea soundings was made from San Fernando to Iba. A group of reefs lying to the westward of Iba was located and developed by sounding, and the hydrography of the anchorage at Iba and of Palauig Bay.

The work referred to above was completed on March 9. It was continued, whenever the weather permitted, from November 5 to the date stated, except for the periods December 8 to 9 and January 28 to February, when the vessel was absent to procure coal and stores.

On April 13 work in San Bernardino Strait and on the east coast of Samar was taken up and was continued during the remainder of the fiscal year.

The position of the wreck of the steamer *Pharsalia* in San Bernardino Strait was determined, and a reconnaissance was made of the vicinity. Soundings were made in Biri Channel, north of Samar, and it was proven that the two doubtful shoals shown on the charts as lying near the center of the channel do not exist. East of Biri Island a good anchorage for safety in a typhoon was developed.

A general survey was made along the east coast of Samar from the vicinity of Oras to Apiton and Hilaban islands. A small harbor, valuable as a harbor of refuge, was found between Oras and Dolores. The work along the coast of Samar was delayed and rendered more difficult by the hostility of the natives, who were fighting the authorities.

A good deal of the time the parties sent to work on shore were accompanied by a military escort, which was regarded as necessary by the commanding officer of the Philippine Scouts, who was conducting military operations in this region. This officer kindly issued the instructions necessary to secure these escorts.

On May 20 and 21 the vessel was engaged in transporting troops, in response to a request from the commanding officer at Oras, from Oras to Borongan and return, as no other steamer was available.

In response to a request from the commanding officer, on June 7 assistance was rendered to the U. S. gunboat *Paragua*, which had gone ashore on a reef between Apiton Island and Binugayen Point.

MAGNETIC OBSERVATIONS. PORTO RICO. P. H. Dike.

The work at the Magnetic Observatory at Vieques, Porto Rico, was continued.

The variations in the force of terrestrial magnetism were recorded automatically on self-registering instruments at the observatory.

Observations to determine the absolute value of the magnetic forces were made once each week, and after February an additional determination of the magnetic dip was made each week.

A record was obtained with a seismograph at the observatory, and meteorological observations were made every day.

A special record was made by the magnetograph on the 1st and 15th of each month.

COAST PILOT WORK. PORTO RICO. R. L. Faris, Commanding,
HYDROGRAPHY. Steamer *Explorer*.
MAGNETIC OBSERVATIONS.

SUMMARY OF RESULTS.

Hydrography:
554 miles of line sounded.
9 566 soundings made.
Magnetic observations:
5 stations occupied on shore.
13 stations occupied at sea.

Coast Pilot work in Porto Rico and hydrographic work off the south coast was assigned to Assistant Faris.

All necessary preparations were made, including magnetic observations off Norfolk, and the *Explorer* sailed from Norfolk for Porto Rico on March 18 and reached San Juan on March 24.

During the voyage magnetic observations were made every day, the series beginning and ending with observations on shore at Norfolk, Va., and Fajardo, P. R.

H. C. Graves, Nautical Expert, was attached to the ship for the purpose of obtaining data for a Coast Pilot of Porto Rico, and from March 28 to May 10 the ship was engaged in transporting Mr. Graves from place to place and in making various hydrographic examinations required by him to complete a verification of the range and sailing lines. Details of this work are given in the abstract of Mr. Graves's report. He left the ship on March 11, and on the 16th the *Explorer* proceeded to Ponce.

Hydrographic work was done off the south coast of the island until May 31, when the work closed for the season and the ship returned to San Juan and sailed for Washington on June 3.

During the voyage magnetic work was done on two days, the only days on which the weather conditions permitted observations to be made.

The magnetic work was completed by making observations off Norfolk, Va., and the vessel reached Washington on June 10.

COAST PILOT WORK. PORTO RICO. H. C. Graves.

The collection of the data necessary for the publication of a Coast Pilot of Porto Rico was assigned to Nautical Expert Graves.

He proceeded to Porto Rico on the steamer *Explorer* and was afforded all necessary assistance by the commanding officer, Assistant R. L. Faris.

During the period March 25 to May 15 the *Explorer* was engaged in Coast Pilot work in the vicinity of Porto Rico, Culebra, Vieques, Desecheo, and Mona islands.

The *Explorer* was taken into every harbor and anchorage around these islands that a vessel of her draft could enter, and the sailing lines into them were checked and notes on ranges, prominent features, and shoals were made for the Coast Pilot. Masters of vessels, pilots, and other local authorities were consulted for information as to anchorages, channels, usual sailing tracks of vessels, supplies, winds, currents, and other general information. The captains of the ports were consulted for information as to harbor regulations and pilotage. The officers of the United States Public Health and Marine-Hospital Service gave information as to local quarantine practices and anchorages, and the local United States Weather Bureau officials supplied data in regard to winds and weather.

At all the principal ports a special inquiry was made of the best local authorities available for information as to geographical names and their proper spelling. The deputy collectors of customs, captains of ports, pilots, and in one case (Vieques) the alcalde, supplied information of this character.

Current observations were made in Vieques Passage, in Guanajibo Channel on the west coast of Porto Rico, and in Mona Passage, near the edge of the bank off the west coast of Porto Rico. At each station observations were made on selected days, both when the moon was near zero and maximum declination. Current observations were also made in the sound between Culebra and Culebrita islands while a hydrographic party was examining Windward Passage.

Photographs were made of the prominent features of the islands for views for the Coast Pilot.

On May 15 Mr. Graves left the *Explorer* and made the passage around Porto Rico on the coasting steamer *Porto Rico*, which stopped at Fajardo, Port Mulas, Humacao, Arroyo, Ponce, Mayaguez, Agüadilla, and Arecibo, arriving at San Juan on May 22. On May 23 and 24 he went by rail and stage from San Juan to Ponce, stopping over a day en route at Arecibo.

Great courtesy was shown by local authorities in supplying information for the Coast Pilot. Mr. Graves makes special mention of the assistance afforded him by Mr. James H. Causten, collector of customs for Porto Rico, both at San Juan and by letters to his deputies and others around the islands. The masters of the New York and Porto Rico steamers also supplied information for the Coast Pilot.

SPECIAL DUTY.

LOUISIANA PURCHASE EXPOSITION. J. J. Gilbert.

The Coast and Geodetic Survey exhibit was maintained as a portion of the exhibit of the Department of Commerce and Labor at the Louisiana Purchase Exposition, St. Louis, Mo., from July 1 to the close of the exposition on November 30.

LEWIS AND CLARK CENTENNIAL EXPOSITION. William Eimbeck.

The Coast and Geodetic Survey maintained an exhibit, with Assistant Eimbeck in charge, at the Lewis and Clark Centennial Exposition at Portland, Oreg., from June 1 to 30, as a part of the exhibit of the Department of Commerce and Labor.

TRIANGULATION OF THE CITY OF NEW YORK. A. T. Mosman.

SUMMARY OF RESULTS.

The triangulation of the city of New York by the city authorities was continued during the year, under the direction of Assistant Mosman.

The primary triangulation from the line Highbridge–Jackson to the line Bogart–Sandy Hook Light-house was completed.

The Ocean Parkway base line was measured and connected with the triangulation.

The triangulation was extended northward from the line Jackson–Highbridge and was completed in the Borough of the Bronx.

The work was in progress at the close of the year.

MISSISSIPPI RIVER COMMISSION. H. P. Ritter.

Assistant Ritter continued on duty as a member of the Mississippi River Commission during the year.

Between November 10 and 22 he attended a meeting of the Commission in St. Louis and went on a low-water inspection trip to New Orleans. April 1 to 17 he performed similar duty on the high-water inspection trip, and he attended a business meeting of the Commission June 18 to 21.

During the remainder of the year he performed all the duties required of a member of the Commission.

NORTHWEST BOUNDARY. O. H. Tittmann.

On July 1 the work of remarking the boundary line between the United States and Canada was in progress, under the direction of the Department of State, with Messrs. O. H. Tittmann, Superintendent of the Coast and Geodetic Survey, and C. D. Walcott, Director of the United States Geological Survey, as Commissioners representing the United States, and with W. F. King, Chief Astronomer of the Canadian Department, as Commissioner representing the British Government.

Messrs. C. H. Sinclair and E. C. Barnard were assigned to the immediate charge of the work in the field, representing the United States Commissioners, and the following statement covers the work done by the parties under them during the season of 1904:

Parties were organized at Gateway, Mont., Porthill, Idaho, and Laurier, Wash., during the early part of May, 1904, and were all disbanded before the middle of November.

The vista along the boundary was cleared for a distance of 84 miles, 10 miles between Mooyie River and Porthill, 61 miles between the Samilkameen and Skagit rivers, and 13 miles between Cascade and Midway, British Columbia.

Twenty-five preliminary sites for boundary monuments were located. Twenty-five aluminum bronze monuments were set in concrete between Frozen Lake and the high ridge between the forks of Yaak River and twenty-five between Laurier, Wash., and Midway, British Columbia.

The topographic work was completed from the Samilkameen River to Skagit River, a distance of 61 miles, and from Laurier to Danville, a distance of 13 miles. It extends 2 miles on both sides of the boundary line.

The triangulation was completed from the vicinity of Cascade to Skagit River, a distance of 141 miles, and a reconnaissance was made to extend the triangulation to Monument No. 1, on the summit of the Rocky Mountains.

Leveling was done between Barron, Wash., and the boundary at Pasayten River, a distance of 35 miles, and the elevation of the base line near Danville, Wash., was determined by a line of levels 5 miles long.

SUMMARY OF RESULTS.

61 miles of boundary located.
84 miles of vista cleared.
25 monument sites selected.
50 monuments erected.
70 miles of boundary marked by monuments.
141 miles of triangulation completed.
288 square miles of topography completed.
40 miles of leveling completed.
10 bench marks established.
150 miles of trail built.
50 miles of trail opened.

In May, 1905, boundary parties were again organized, and work was in progress the close of the fiscal year.

ALASKA BOUNDARY. O. H. Tittmann.

The work of tracing and marking the boundary line between Alaska and Canada as laid down in the award of the Alaska Boundary Tribunal at London in 1904 was continued, with O. H. Tittmann, Superintendent Coast and Geodetic Survey, and W. F. King, Chief Astronomer of the Canadian Department of Interior, as members of the Delimitation Commission, representing the United States and Great Britain, respectively.

Messrs. Fremont Morse and J. A. Flemer were in charge of parties at work on July 1, and on July 29 another party was organized at Skagway, under charge of Mr. O. M. Leland, for work in the vicinity of White Pass.

Mr. Morse cleared a portion of the line north from the Stikine River. He established four permanent monuments on the boundary line, one on the north bank of the Stikine River, one five-eighths of a mile back from the river, on high ground, one on the summit of Elbow Mountain (Peak 4235 of the award), and one on the summit of Peak 4300 (Peak 4200 of the award).

A topographic sketch was made of the vicinity of the cleared portion of the line, and several peaks in the neighborhood of the work were connected by triangulation.

Numerous photographs were made of the boundary line, showing the monuments in position and the mountain peaks on the line or in its vicinity.

Mr. Morse reports his appreciation of the courtesies extended to him by Mr. White-Fraser, chief of the Canadian party at work in the vicinity, and by Mr. F. E. Bronson, deputy collector of customs at Wrangell. The work closed for the season on September 30.

On May 17 Mr. Morse resumed work on the Alaska—Canada boundary in the vicinity of Unuk River with Messrs. Netland and Mosheim as his assistants. Mr. J. D. Craig accompanied the party as the representative of the British Government.

The work was in progress on June 30.

Mr. Flemer was at work on the boundary on July 1, with Messrs. D. W. Eaton, J. M. Donn, and Edmund Polk as assistants.

The triangulation of the lower Chilkat River was connected with the boundary peaks near Pleasant Camp in the Tlehini Valley. A vista was cut along the boundary line across Glave Creek Valley and five monuments were erected on the line, three on the south side and two on the north side of the stream. Eleven triangulation stations and five camera stations were occupied in this vicinity. The geographic positions of boundary peaks Nos. 49, 50, 51, 52, 53, and 55 were determined and they were connected with the triangulation of the upper Chilkat River. The point designated as No. 54 is in the Tlehini Valley just below Pleasant Camp. Numerous photographs of the line and peaks in its vicinity were made.

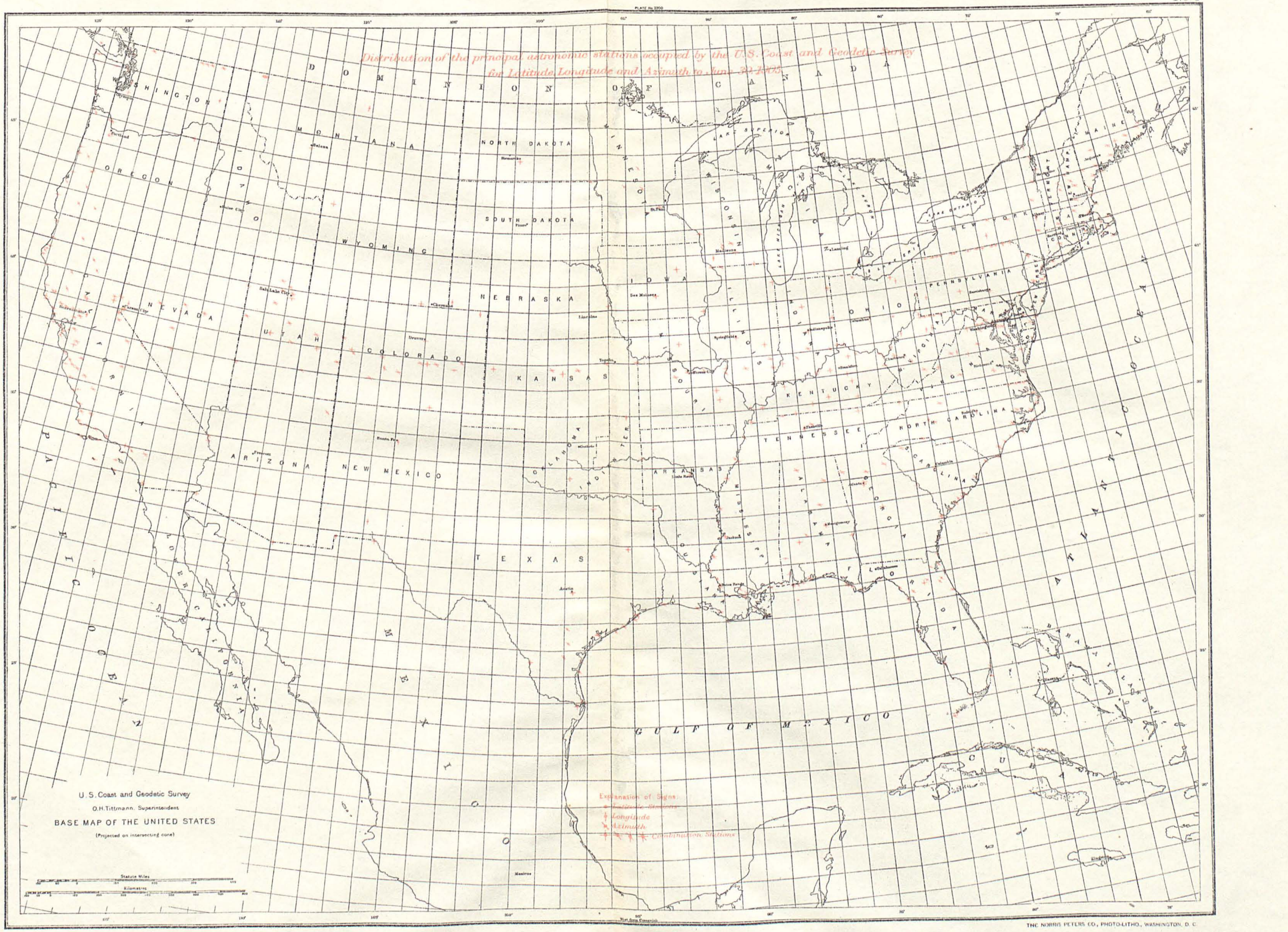
Work was suspended for the season on October 19, when the party started to Seattle, Wash., and reached that place on October 24.

Mr. Flemer resumed work on the boundary on May 17, with D. W. Eaton as assistant, and continued it until the close of the fiscal year. The weather was unfavorable and slow progress was made.

Mr. O. M. Leland reached Skagway on July 29 and immediately organized a party for work on the Alaska boundary in the vicinity of White Pass. The work of the party consisted of the identification of Boundary Peak 5550; the location of a "Turning Point" or angle in the boundary line to be considered as the summit of White Pass; the identification of Boundary Peak 6750 and its connection by triangulation with the Turning Point; observations for azimuth, time, and latitude; and photographic views of the line and peaks in the vicinity.

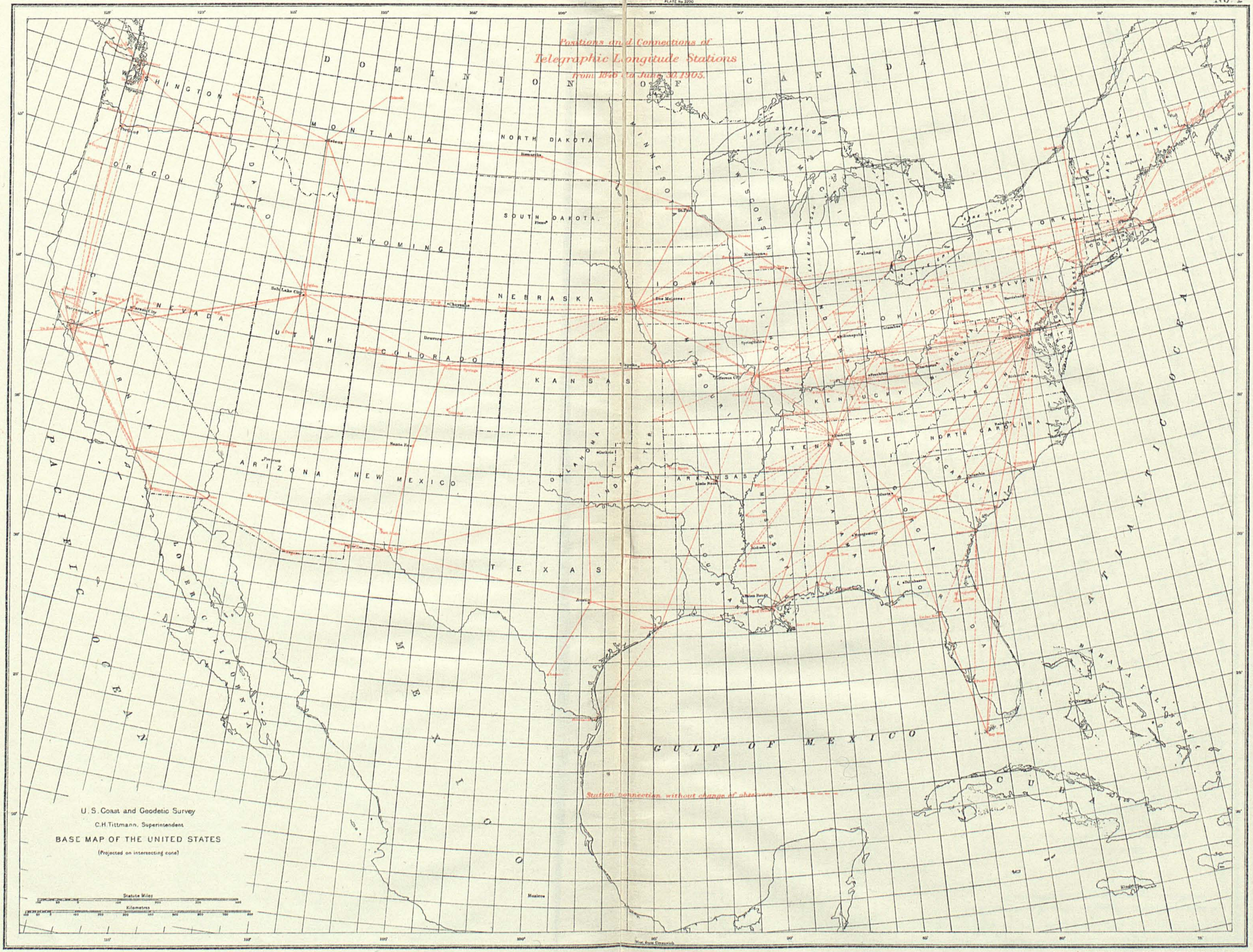
The work closed for the season on September 18 and the party reached Seattle the 21st.

No. 1



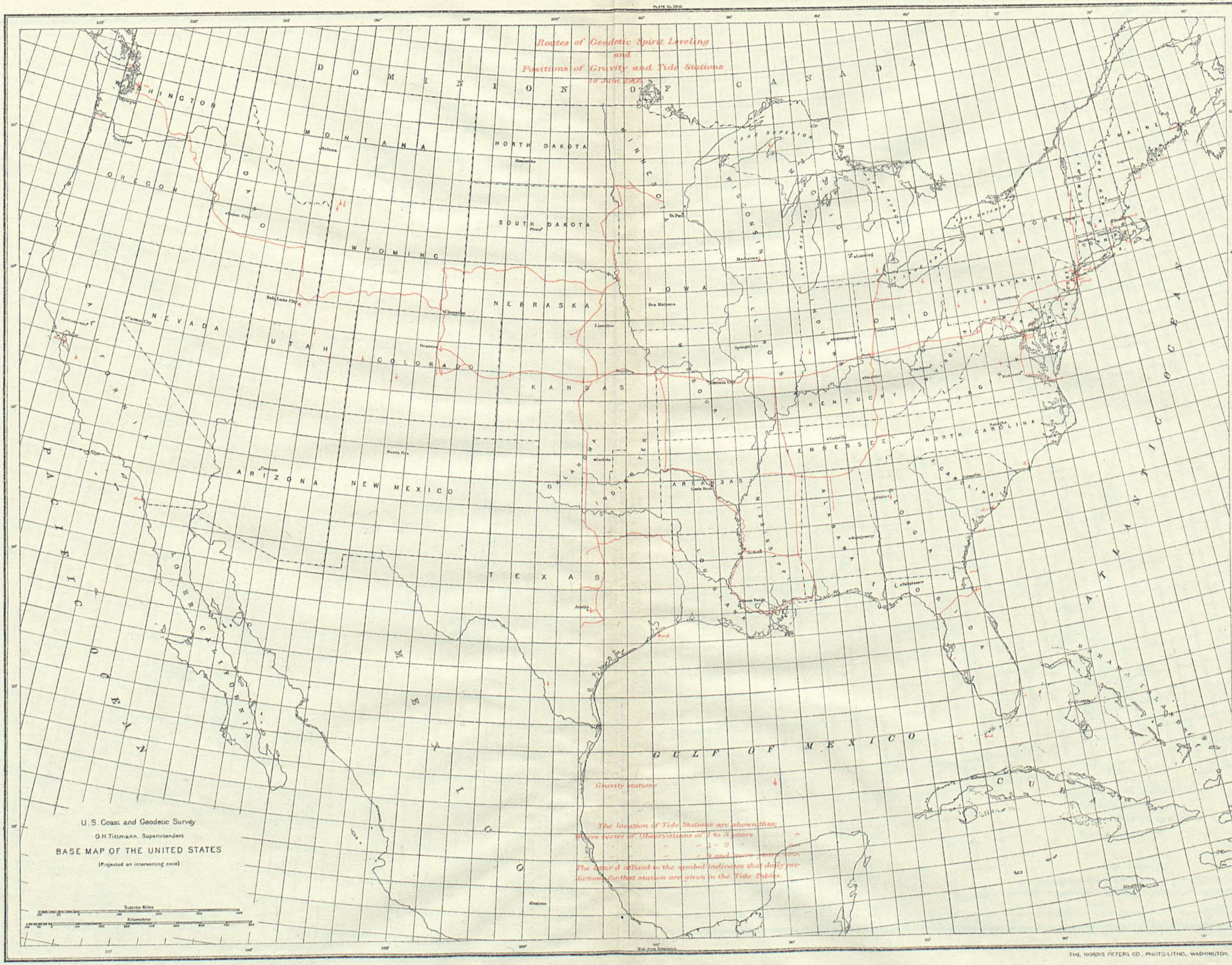
THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D.C.

No. 2



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

No. 3



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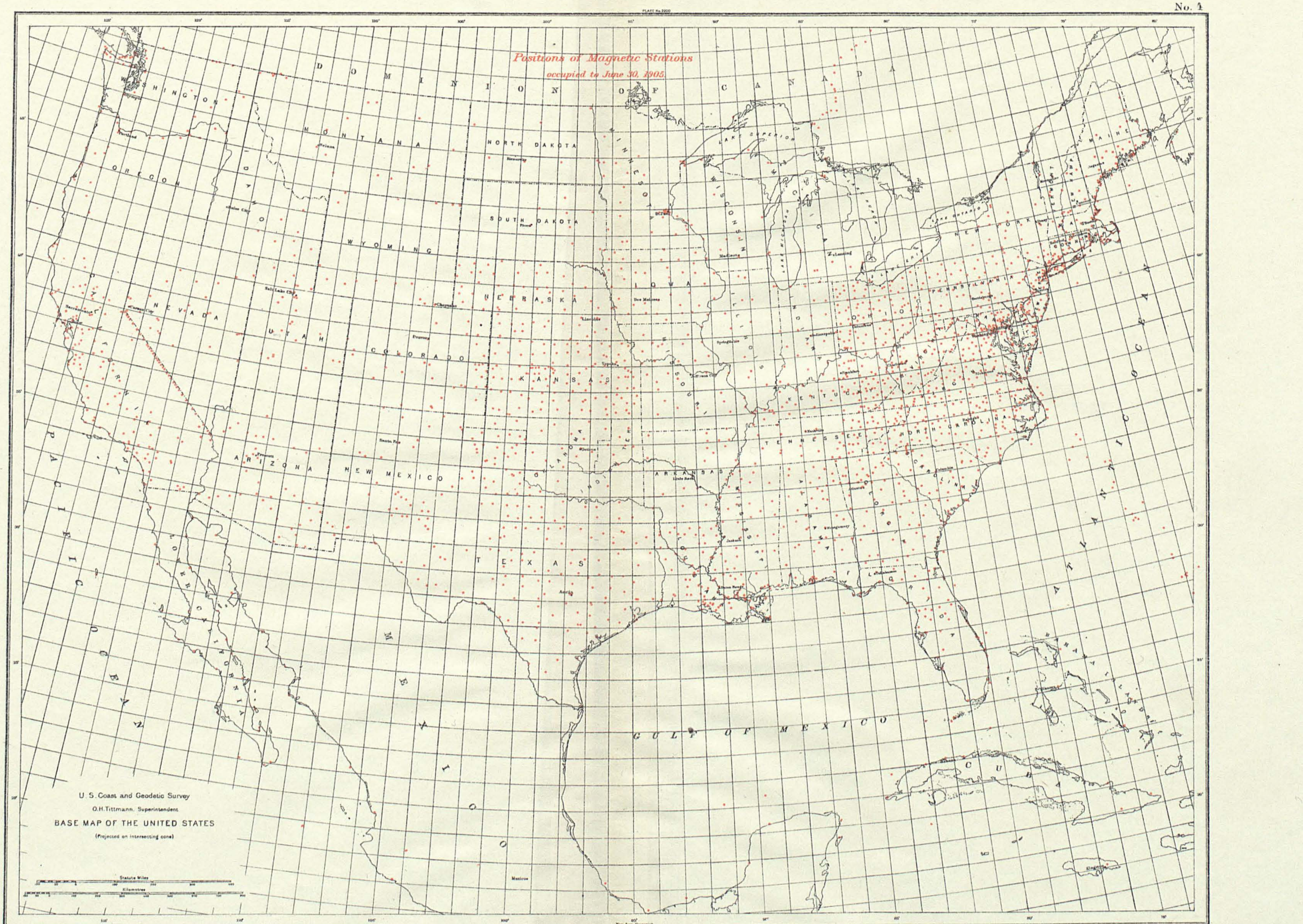
No. 4



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

APPENDIX 2

REPORT 1905

DETAILS OF OFFICE OPERATIONS

CONTENTS.

DETAILS OF OFFICE OPERATIONS.

OFFICE OF THE ASSISTANT IN CHARGE.

ANDREW BRAID, *Assistant in Charge.*

The Assistant in Charge of the Office has direct supervision of the work of the different divisions of the Office.

The Miscellaneous Section is a part of the immediate Office of the Assistant in Charge.

COMPUTING DIVISION.

The work of furnishing information to the field parties of the Survey and to persons outside the Survey in reply to requests occupied a considerable portion of the time of the Chief of the Division, nearly all the time of the Writer, and 13 per cent of the time of the other members of the Division. The time required for this work is greater than ever before and is increasing rapidly.

The manuscript of the following appendices to the Report for 1904 was completed and the proof was read:

No. 6. Precise Leveling from Red Desert, Wyoming, to Owyhee, Idaho, 1903 (30 pages).
No. 7. Precise Leveling, Holland to New Braunfels, Tex., 1903 (20 pages).
No. 8. A test of a transit micrometer (38 pages).
No. 9. Triangulation in California, Part I (274 pages).

Aside from the routine computations the progress made in the more important computations during the year may be stated as follows:

1. The computation of precise leveling has kept pace with the field work, being kept nearly up to date continuously.

2. The recomputation and reduction to the United States Standard Datum of the triangulation in the southern part of California was completed and considerable progress made in similar computations for the portion of California north of Monterey Bay. The computations of the main scheme of triangulation in northern California are complete, but there are several hundred points not in the main scheme yet to be computed.

3. The computations connected with a new investigation of the form of the geoid in the United States have made considerable progress. The computation of the topographic corrections to observed deflections of the vertical to take account of the topography for a radius of more than 4 000 kilometers around each station has been completed during the year for about 230 astronomic stations. This leaves only 70 more stations immediately available for such treatment. The general plan in studying the form of the geoid by measures within the United States is to divide the whole mass of data available into four groups corresponding to four separate areas, to investigate each

group separately, and then combine the four groups in one large group in deriving the final results. The investigation has been carried nearly to completion in three of the four groups.

Records are kept in the Division from which the cost of the different classes of work done in the Division can be ascertained.

The average effective force of the Division during the year amounted to eleven persons, in addition to the Chief, which is somewhat smaller than during the previous year.

The number of pages of correspondence prepared in the Division was somewhat less than during the preceding year, but the number of geographic positions furnished in response to requests was 23 per cent greater and the number of descriptions of stations was 15 per cent greater than during any previous year.

DIVISION OF TERRESTRIAL MAGNETISM.

Though 15 men have been detailed for temporary duty in the Division, their aggregate time amounted to not much over a year, and as some of them required instruction in computing and observing, the effective time was certainly less than that of one man continuously employed.

The revision of the computation of the magnetic observations made by the various field parties was kept nearly up to date. The results of the field observations made during the preceding fiscal year were submitted for publication as Appendix 3 of the Superintendent's Report for 1904, and the proof of that appendix was read.

The discussion of the magnetic observatory records was begun. The tabulation of hourly values of declination and horizontal intensity for Baldwin for the three years 1902–1904 were nearly completed. On account of the makeshift character of the observatory building at Baldwin, and the consequent large range of temperature and comparatively frequent readjustment of instruments, it seemed desirable to verify the general character of the variations by comparison with Cheltenham before making the final reductions of horizontal intensity. The Cheltenham records were therefore taken in hand and considerable progress made.

The tabulation of results at all stations occupied more than once up to June 30, 1904, was completed. This showed that the reversal of secular motion of declination during the past ten years apparently extended over all but the extreme eastern part of the country.

A preliminary isogonic chart of the Philippines was prepared, based on the observations of the Coast Survey and of the Jesuits.

A preliminary investigation was made of the change in the earth's magnetism between the years 1885 and 1895, treating the subject analytically.

The necessary explanatory data were prepared to accompany reproductions of the magnetograms of the Cheltenham Observatory for the days on which magnetic storms occurred, for transmission to foreign observatories. Lists were prepared of the "quiet" days at all the magnetic observatories of the Coast and Geodetic Survey, and transmitted to Dr. Mauritz Snellen, in accordance with the resolution of the International Committee on Terrestrial Magnetism.

The data for the earthquakes recorded by the seismographs of the Coast Survey up to the end of 1904 were read and tabulated.

A preliminary discussion was made of the results of atmospheric electricity observations at Cheltenham.

TIDAL DIVISION.

Harmonic analyses were computed for 11 stations, with an aggregate length of 4½ years. Nonharmonic reductions were made for 103 stations, with an aggregate length of 33 years. The plane of reference for reduction of soundings was determined for 61 stations. Tide notes were prepared for 407 stations upon 102 charts and 43 original hydrographic sheets. Tidal information was furnished to the field parties and in response to requests from individuals not connected with the Survey in 288 instances, involving the preparation of 476 descriptions of bench marks, tidal data for 31 stations, and current data for 31 stations. About 13 years of self-registering tide-gauge records from 18 stations were tabulated as high and low waters and also as hourly heights of the sea. There were received, examined, and registered in this Division an aggregate of about 30 years of record from self-registering gauges at 28 stations, together with about 4 years of record from box and staff gauges. Tidal records and data from outside sources were received as follows:

Foreign countries.

Argentina: Tides for 1 month at 1 station and tide readings for 6 years at 2 stations.

Australia: Staff readings for 1½ years at 2 stations and harmonic constants for 1 station.

Bermuda: Hourly readings for 1 year at 1 station.

China: Staff readings for 4 years at 2 stations.

Egypt: 1 month of high and low waters at 1 station.

France: Harmonic constants for 7 stations.

Germany: Record from self-registering gauge for 2 months at 2 stations, staff readings for 2 years at 4 stations, and harmonic constants for 1 station.

Great Britain: Staff readings for 6 years at 3 stations.

Italy: Staff readings for 5½ years at 7 stations.

Japan: Hourly heights for 3 months at 1 station and harmonic constants for 1 station.

Liberia: Staff readings for 1 month at 1 station.

Mexico: Staff readings for 5 years at 27 stations.

New Zealand: Staff readings for 1 year at 1 station and harmonic constants for 1 station.

Spain: Staff readings for 12 years at 11 stations.

The Corps of Engineers, U. S. Army, loaned the Survey the record for 16 years with self-registering gauges at 4 stations and high and low water readings for 2½ years at 1 station.

One year's record of a self-registering gauge was procured at Nassau, Bahama Islands.

One year's record of a self-registering gauge was received from Honolulu, Hawaii.

At the request of the Canadian government the predicted tides at Astoria, Oreg., and Sitka, Alaska, for 1906 were furnished.

At the request of the Secretary of the Marine Department of New Zealand the predicted tides at Wellington and Auckland for 1906, and the tidal differences for the principal ports of the country, were furnished.

Appendix No. 5 to the Annual Report for 1904, "Cotidal lines for the world," 88 pages with 41 charts, was completed for printing and the proof was read.

Nearly all the proof of the tide tables for 1905 (516 pages) was read. The manuscript for the tide tables for 1906 was prepared for printing and the proof of 173 pages was read before the close of the fiscal year.

DRAWING AND ENGRAVING DIVISION.

The Division is divided into five sections—the Drawing, the Engraving, the Printing, the Photographing, and the Electrotyping sections. Each section executes the work indicated by its title, and the combined result is shown on the charts published and issued by the Survey.

During the year 350 requests for information were received and answered in the Division. These involved the measurement of areas and shore line and distances between various points, the preparation of tracings from original topographic and hydrographic sheets, copies of old and canceled charts, and the construction of special maps.

Drawing Section.

During the year the following drawings were completed for photolithographing or engraving:

Chart No.	Title.	Scale.
112	Vineyard Sound and Buzzards Bay	1-80 000
136	Sandy Point to Head of Bay	1-80 000
196	Barataria Bay and approaches	1-80 000
329	Portsmouth Harbor	1-20 000
366	Hempstead Harbor	1-20 000
932	Boqueron Bay	1-10 000
4107	Pearl Harbor, Hawaii	1-15 000
4722	Jolo Archipelago	Mercator.
4723	Western Mindanao	Mercator.
6446	Lake Washington, Washington	1-40 000
8160	Zarembo Island and approaches	1-80 000
8170	Wrangell Strait	1-20 000

In addition to the foregoing, 570 charts were revised (including second and third editions of the same chart), corrected, and verified for new editions or new prints; 23 projections for topographic sheets and 54 hydrographic sheets were constructed for the use of field parties or the Office; 381 topographic and hydrographic sheets were inked, plotted, revised, or made ready for the approval of the Office. The illustrations required for the Annual Report of the Superintendent for the year 1904 were completed. Information was compiled in response to numerous requests for information from persons outside the Survey. The publication of the charts in the Philippine

Islands required the time of two draftsmen continuously. Most of the drawings for these charts were prepared at the Manila suboffice. They were carefully examined and verified, and were completed by adding titles, notes, compasses, etc., in this section.

Two young Filipino students were sent to Washington for instruction by the Philippine government and have been attached to this section since February. They have made rapid progress in acquiring knowledge of the work of the section.

All the charts covering Chesapeake Bay and the Potomac River were carefully revised and improved, using all the old hydrographic sheets in this region in connection with the results of the recent resurveys.

Engraving Section.

The following original plates were completed:

Chart No.	Title.	Scale.
413	Pensacola Bay Entrance	1–10 000
518	Calcasieu Pass	1–20 000
549	Baltimore Harbor	1–40 000
902	Guanica Light to Point Tuna Light	1–100 000
931	Mayaguez Bay and approaches	1–15 000
4103	Hilo Bay, Hawaii	1–10 000
6146	Columbia River, Vancouver to Reed Island	1–40 000
6443	Port Orchard, Washington	1–20 000

The following plates were corrected for new editions of charts:

Chart No.	Title.	Scale.
S	San Francisco to Bering Sea	1–3 600 000
131	Chesapeake Bay Entrance, etc	1–80 000
132	Chesapeake Bay, York River to Pocomoke Sound	1–80 000
133	Chesapeake Bay, Pocomoke Sound to Potomac River	1–80 000
134	Chesapeake Bay, Potomac River to Choptank River	1–80 000
170	Key West to Rebecca Shoals	1–80 000
177	Tampa Bay	1–80 000
204	Galveston Bay	1–80 000
205	Galveston Bay to Oyster Bay	1–80 000
244	Salem Harbor and approaches	1–20 000
252	New Bedford Harbor and approaches	1–20 000
300	Passamaquoddy Bay and St. Croix River	1–40 000
313	Damariscotta and Medomak rivers	1–40 000
357	Wickford Harbor	1–20 000
379	Cape Henlopen and Delaware Breakwater	1–20 000
391	Potomac River, Indian Head to Georgetown	1–40 000
443	St. Catherines Sound	1–40 000
444	Sapelo Sound	1–30 000
908	San Juan Harbor	1–10 000
5143	Wilmington and San Pedro harbors	1–40 000
5525	Mare Island Strait	1–30 000
6140	Columbia River, Entrance to Upper Astoria	1–40 000
6450	Admiralty Inlet and Puget Sound to Seattle	1–80 000
6460	Puget Sound, Seattle to Olympia	1–80 000
8240	Sitka Sound, Alaska	1–80 000
8800	Dixon Entrance to Cape St. Elias	1–1 200 000

The following new bassos were completed:

Chart No.	Title.	Scale.
104	Penobscot Bay	1-80 000
115	Plum Island to Stratford Shoal	1-80 000
124	Delaware Entrance	1-80 000
150	Masonboro Inlet to Shallotte Inlet	1-80 000
194	Mississippi River, Passes to Grand Prairie	1-80 000

RECAPITULATION.

	Number.
New plates commenced	3
New plates completed	8
New plates unfinished	15
New editions commenced	24
New editions completed	26
New editions unfinished	15
New bassos commenced	8
New bassos completed	5
New bassos unfinished	3
New catalogue plates completed	22
Plates corrected	766

Printing Section.

	Number.
Impressions for Chart Section, from plates	64 390
Impressions for proofs, from plates	4 096
Impressions for standards, from plates	129
Impressions for transfers (lithograph), from plates	127
Impressions on bond, from plates	379
Total impressions from plates	69 121
Impressions for Chart Section, from stones	29 660
Impressions for proofs, from stones	5 129
Impressions for transfers (Drawing Section), from stones	121
Impressions on bond, from stones	621
Total impressions from stones	35 531
Total impressions	104 652

Of the charts printed from plates for the Chart Section, 1 001, namely, Nos. 369, 380, and 381, required two impressions, leaving 63 389 charts delivered to the Chart Section.

Of the lithograph charts, 11 811 impressions were pulled from stones for charts which had two or more colors, requiring two or more impressions per chart, leaving 17 849 charts which were delivered to the Chart Section.

In addition to the number of charts printed from plates in the Printing Section, the following have been published by photolithography and sent to the Chart Section for distribution:

NEW CHARTS.

Chart No.	Title.	Scale.
932	Boqueron Bay	1-10 000
4107	Pearl Harbor, Hawaii	1-15 000
4219	Passages between Luzon and Masbate*	1-100 000
4222	Lagonoy Gulf to Sisiran Bay	1-100 000
4237	Tabaco Bay to Legaspi	1-40 000
4238	Bolinao Harbor*	1-20 000
4239	Port Sual to Comas Island*	1-15 000
4265	Harbors on the East Coast of Luzon*	Varying.
4311	Southern Part of Mindoro*	1-100 000
4345	Anchorages, Verde Island Passage to Cuyo*	Varying.
4348	Cagayan Sulu	1-75 000
4417	Northeast Coast of Panay*	1-100 000
4423	San Pedro Bay and part of Leyte	1-100 000
4452	Danao River and approaches*	1-10 000
4453	Harbors in Marinduque and Tablas Islands*	Varying.
4455	Harbors off Coast of Masbate*	Varying.
4456	Harbors of Samar and Leyte*	1-50 000
4457	Guiuan and approaches	1-50 000
4458	Harbors of Cebu and Negros	Varying.
4511	Basilan Strait*	1-100 000
4613	Iligan Bay*	1-100 000
4619	Eastern Part of Illana Bay*	1-100 000
4644	Harbors on North Coast of Mindanao	Varying.
4646	Pujada Bay*	1-60 000
4653	Harbors on South Coast of Mindanao*	Varying.
4710	Batan Islands, etc	Mercator.
4715	Southern Part of Luzon*	Mercator.
4719	Surigao Strait and Leyte*	Mercator.
4722	Jolo Archipelago	Mercator.
8513	Controller Bay, Alaska*	1-100 000

NEW EDITIONS.

Chart No.	Title.	Scale.
136	Sandy Point to Head of Bay	1-80 000
244	Salem Harbor and approaches	1-20 000
249	Buzzards Bay	1-40 000
366	Hempstead Harbor	1-20 000
389	Potomac River, Piney Point to Lower Cedar Point	1-60 000
390	Potomac River, Lower Cedar Point to Indian Head	1-60 000
902	South Coast of Porto Rico	1-100 000
4221	Albay Gulf and part of Lagonoy Gulf	1-100 000
4712	West Coast of Luzon*	Mercator.
4713	East Coast of Luzon*	Mercator.
4715	Southeastern Luzon, Masbate, and Northern Samar*	Mercator.
6195	Grays Harbor, Washington	1-40 000
8000	Dixon Entrance to Cape St. Elias*	1-1 200 000
8050	Dixon Entrance to Head of Lynn Canal	1-800 000
8075	Revillagigedo Channel	1-80 000
8170	Wrangell Strait	1-20 000
8303	Lynn Canal, Point Sherman to Head	1-80 000
8521	Port Valdez, Prince William Sound	1-40 000
9302	Bering Sea, eastern part	Mercator.
9380	Norton Sound, Alaska	1-400 000

* Printed by contractor.

NEW PRINTS.

Chart No.	Title.	Scale.
109	Boston Bay and approaches*	1-80 000
260	Guilford to Blackstone Rocks	1-10 000
261	Blackstone Rocks to South End	1-10 000
269	Stamford Harbor to Little Captain Island	1-10 000
270	Little Captain Island to Rye Neck	1-10 000
274	Harlem River	1-10 000
356	Block Island*	1-10 000
376	Delaware and Chesapeake bays *	1-400 000
411	Appomattox River, City Point to Petersburg	1-20 000
463	St. Johns River	1-80 000
512	Lower Barataria Bay	1-40 000
525	Brazos River Entrance	1-10 000
571	Port Royal Sound	1-40 000
577	Fernandina to Jacksonville	1-40 000
1000	Cape Sable to Cape Hatteras*	Mercator.
1007	Gulf of Mexico	Mercator.
4343	East Coast of Paragua*	1-40 000
5002	San Diego to Point St. George	Mercator.
5052	San Francisco to Cape Flattery*	Mercator.
5531	San Francisco Bay, Southern part	1-50 000
5532	San Francisco Entrance	1-40 000
5819	Entrance to Eel River	1-20 000
5832	Humboldt Bay	1-30 000
6400	Seacoast and Interior Waters of Washington	1-30 000
8244	Sitka Harbor, Alaska	1-10 000
8282	Salisbury Sound to Hooniah Sound	1-40 000
8302	Lynn Canal, Entrance to Point Sherman	1-80 000
8455	Yakutat Bay*	1-80 000
8500	Icy Cape to Semidi Islands*	1-1 200 000
8881	Islands and Harbors off Alaska Peninsula*	Varying.

* Printed by contractor.

SUMMARY.

	Number.
New charts printed by contract	19
New editions printed by contract	3
New prints printed by contract	10
Total printed by contract	32
New charts printed in Printing Section	11
New editions printed in Printing Section	17
New prints printed in Printing Section	22
Miscellaneous printed in Printing Section	7
Total printed in Printing Section	57
Total number of lithographs	89

Photographic Section.

	Number.
Glass negatives made	948
Paper negatives made	98
Velox prints made	1 452
Bromide prints made	267
Vandyke prints made	451
Solio prints made	249
Blueprints made	788
Lantern slides made	22
Negatives developed	325
Prints mounted	380

Electrotyping Section.

	Number.
Kilograms of copper deposited	725
Square decimeters on which deposited	5 443
Alto plates made	29
Basso plates made	21

CHART DIVISION.

The Chief of Division supervised the work of the two sections in which this Division is divided, and gave personal attention to the inspection of the work on new charts and on new editions of charts in its various stages of progress. A new edition of the Chart Catalogue was completed.

Chart section.

In this section all letters relating to the sale of charts, tide tables, and coast pilots were prepared; the accounts with the sales agents were kept; the buoys on the charts were colored, and other routine work was done. Editions of 29 new charts printed by photolithography were issued during the year. Forty-four new editions, 24 printed from copper plates and 20 by photolithography, were also issued. Charts were received as follows:

	Number.
From Drawing and Engraving Division, prints from plates	63 389
From Drawing and Engraving Division, prints from stone	17 849
From lithographers	15 427
From Manila suboffice	40
	96705

Charts were issued as follows:

	Number.
Sales agents	34 870
Sales at the Office	2 083
Congressional account	3 149
Hydrographic Office, United States Navy	29 154
Light-House Board	2 330
Coast and Geodetic Survey Office	6 280
Coast and Geodetic Survey suboffice, Manila, P. I	9 610
Executive Departments	6 287
Foreign governments	608
Miscellaneous	939
Total	95 310

A comparison of the total issue of charts for the fiscal year with the issue in previous years shows the total to be 30 per cent larger than the average and 9 per cent larger than during the previous fiscal year.

Hydrographic Section.

The work of indicating the chart corrections and of preparing the Monthly Notice to Mariners was performed and the following work was done.

13 charts reviewed for publication.
186 charts, corrections on Office Standards verified.
86 charts, corrections on proofs verified.
33 hydrographic sheets verified and examined, 107 821 angles; 330 689 soundings; 8 120 square miles of area covered.

INSTRUMENT DIVISION.

In this Division an account was kept of all instruments and general property owned by the Survey or purchased during the year; 1 825 instruments of various classes were put in order, adjusted, and sent to the field. Minor repairs were made to the Office buildings and furniture, and progress was made in constructing a new tide predicting machine.

For the purpose of providing the Director of Coast Surveys in the Philippine Islands with a standard for the comparison of base tapes, one of the tapes which had been used in the base measurement of nine bases on the ninety-eighth meridian, and the length of which is therefore very accurately known, was fitted with appliances for suspension under standard tension, side by side with the one to be compared. These appliances were designed and made in the Instrument Division and forwarded to Manila with the tape.

The theodolites of magnetometers Nos. 10, 11, 17, and 19 having become much worn from use, and being for other reasons inadequate for the convenient and accurate determination of azimuth, new ones were purchased and fitted to these instruments.

A new magnetometer, known as Coast and Geodetic Survey No. 29, was constructed. The wooden magnet box of the old "Bache Fund" magnetometer and a magnet, formerly belonging to magnetometer No. 19, were utilized in the construction of this instrument.

During the year an automatic printing recorder for a Quick Sounding Machine was designed and made. A hotel time stamp was purchased and utilized in the making of this apparatus, which furnishes a record upon a continuous band of paper of the month, day, hour, minute, a. m. or p. m., fathoms, feet, and tenths of feet of each sounding made.

Transits Nos. 4, 18, and 19 were provided with transit micrometers and other appliances incident to this improvement.

Electrical illumination of field instruments, which heretofore only found limited application, owing to the difficulties accompanying the use of liquid batteries, was this year applied in the case of transits Nos. 18 and 19, meridian telescopes Nos. 1 and 3, and zenith telescopes Nos. 2 and 6. This was possible on account of the improvements which have been made in the quality of certain dry cells sold in the market.

There were completed in the early part of this fiscal year two additional plane tables of the same design and material as those of No. 91, described in the last report. One of these has been thoroughly tested in the field and found so superior to the older form, by reason of its reduced weight and added rigidity, that the aluminum alloy known as Ennis's No. 1 can be said to mark a distinct step ahead in the art of making surveying instruments.

The unusually severe winter of 1904–5 afforded an opportunity to prove the efficiency of the float tube of the electric tide indicator of the New York Maritime Exchange, which was designed specially with the view of preventing interruption of the working of the apparatus by ice impeding the free motion of the float. Though other float tubes required attention during the severe freezing spells of that winter, this one never failed to operate, though left entirely to itself.

A plan permitting the application of the same principle even in such localities where there is not sufficient depth of water to afford the requisite vertical space for a column of petroleum equal in height to the distance between extreme high and low waters was devised. This plan is based upon the idea of sinking the tube, the lower end of which is closed, into the bottom to the necessary depth, and to establish communication between the interior of the tube and the outside by means of a small pipe, entering at the side somewhere below the lowest low water and reaching down to within an inch or two from the bottom of the tube, thus preventing the loss of oil even at the lowest low water.

Mr. Fischer made several visits to Pittsburg to inspect different lots of monuments when they were ready for shipment to the United States and Canada boundary, west of the Rocky Mountains, and to the Alaska and Canada boundary. He also supervised the construction, by a private firm, of transit micrometers for two transits belonging to the Canadian government, and repairs to the same instruments.

He served on the jury of awards at the Louisiana Purchase Exposition in the group including scientific and measuring instruments.

LIBRARY AND ARCHIVES.

The routine work in the library was kept up to date. The records of the observations made in the field were indexed as they were received. Assistant Eimbeck was assigned to the Division as Acting Librarian and continued in this position from July 1 to August 31. Mr. Guittard, the Librarian, reported for duty on September 1.

Accessions.

	Purchased.	Donated.	Exchanged.	Total.
Books	178	47	399	624
Pamphlets	7	139	264	410
Serials	76	11	472	559
Maps and charts	47	429	2 837	3 313

Issued for temporary use.

	Number.
Books and pamphlets	1 739
Serials	668
Records	2 438
Original sheets	3 072
Maps and charts	1 595

The following list shows the original records received:

Object.	Volumes.	Cahiers.	Sheets or rolls.
Astronomy	60	52	1
Geodesy	167	132	....
Hydrography	378	85	60
Hypsometry	147	23	....
Magnetism	....	439	....
Tides	91	18	959
Topography	....	....	51
Totals	843	749	1 071
Photographic prints	....	....	737
Photographic negatives	....	....	1 023

MISCELLANEOUS SECTION.

The work in this Section shows an increase during the year.

The publications received were issued without delay and all current work was kept up to date. All purchases under the appropriation for Office expenses were made through this Section, and this involved a great deal of correspondence. All requisitions for stationery received from the parties in the field were filled promptly.

The following publications were received from the Public Printer:

	Number.
Report of the Superintendent of the Coast and Geodetic Survey for 1904	1 986
Appendices to Report for 1904, published as separates	3 504
Bulletin No. 40, Coast Pilot notes in Alaska (fifth edition)	1 025
Catalogue of Charts, 1903	501
United States Coast Pilots, Atlantic Coast Pilots, 1 to 8	4 305
Leaflets for distribution at Louisiana Purchase Exposition, at St. Louis, Mo.	118 500
Tide Tables, complete	1 300
Tide Tables, Atlantic Coast	1 034
Tide Tables, Pacific Coast	8 121
Notices to Mariners	62 633
The work of the Coast and Geodetic Survey	5 000

The following publications were received from the Manila Suboffice:

	Number.
Catalogue of Charts, Philippine Islands (second edition)	25
Sailing Directions, Philippine Islands, Sections 1 to 7	400
Notices to Mariners	1 182

The following publications were issued by the Office:

	Number.
Annual Reports covering the years 1851 to 1904	2 721
Appendices to Annual Reports	2 780
Bulletins, Nos. 1 to 41	1 081
Catalogue of Charts, 1903	1 050
Catalogue of Charts, Philippine Islands (second edition)	21
Atlantic Coast Pilots, Parts 1 to 8	2 542
Pacific Coast Pilots, Part 1	84
Pacific Coast Pilot, California, Oregon, and Washington	422

	Number.
Supplements to Coast Pilots	1 210
Louisiana Purchase Exposition Leaflets	145 315
Pan-American Leaflets, English edition	80
Pan-American Leaflets, Spanish edition	794
United States Magnetic Declination Tables, 1902	260
Sailing Directions, Philippine Islands, Sections 1 to 7	318
Special Publications:	
No. 1	27
No. 2	4
No. 3	33
No. 4	56
No. 5	76
No. 6	126
No. 7	39
Tide Tables, complete	1 270
Tide Tables, Atlantic Coast	1 164
Tide Tables, Pacific Coast	8 474
General Statement of Administration and Work	6
On the Air contained in Sea Water	1
Coast Pilot Notes on Warren Channel	30
Conversion Tables	18
Deep-Sea Sounding and Dredging	5
Field Catalogue of 983 Transit Stars	1
General Instructions to Hydrographic Parties	7
General Instructions for Hydrographic Work	4
Report on Geodetic Operations in the United States	24
Instructions and Memoranda for Descriptive Report	8
Laws and Regulations, 1887	16
Laws of General Application	6
List and Catalogue of Publications	192
Report on Nicaragua Route	2
Star-Factors, A, B, C	1
Tidal Researches	3
Treatise on Projections	22
Notice to Mariners	60 879
Notice to Mariners, Philippine Islands	621
Standard Places of Fundamental Stars	1
Work of Coast and Geodetic Survey	1 025

APPENDIX 3

REPORT 1906

RESULTS OF MAGNETIC OBSERVATIONS MADE BY THE COAST AND GEODETIC SURVEY BETWEEN JULY 1, 1904, AND JUNE 30, 1905

By L. A. BAUER
Inspector of Magnetic Work and Chief of Division of Terrestrial Magnetism
Assistant, Coast and Geodetic Survey

CONTENTS.

RESULTS OF MAGNETIC OBSERVATIONS MADE BY THE COAST AND GEODETIC SURVEY BETWEEN JULY 1, 1904, AND JUNE 30, 1905.

By L. A. BAUER,
Inspector of Magnetic Work and Chief of Division Terrestrial Magnetism, Assistant, Coast and Geodetic Survey.

INTRODUCTION.

The present publication contains the results of the magnetic observations made on land and at sea by members of the Coast and Geodetic Survey in the prosecution of the magnetic survey of the United States and outlying territories during the period July 1, 1904, to June 30, 1905.* There are also included the results of some observations made by magnetic observers of the Department of Terrestrial Magnetism of the Carnegie Institution, who were temporarily attached to parties of the Coast and Geodetic Survey for purposes of instruction, and some made in Louisiana by Prof. G. D. Harris of the Louisiana Geological Survey, with an instrument loaned to him by this Bureau.

Five magnetic observatories† have been in continuous operation throughout the year: At Cheltenham, Md.; Baldwin, Kans.; Sitka, Alaska; near Honolulu, Hawaii; on Vieques Island, Porto Rico.

OBSERVATIONS ON LAND AND THEIR DISTRIBUTION.

The distribution of the stations on land is shown in the following table, from which it will be seen that the work of the year was principally in Alabama, California, Connecticut, Georgia, Idaho, Kansas, Mississippi, New York, Ohio, and Oklahoma, with a few stations in each of 31 other States and Territories.

* For previous results see United States Magnetic Declination Tables and Isogonic Charts for 1902, and Principal Facts Relating to the Earth's Magnetism, by L. A. Bauer. Washington, Government Printing Office, 1902. A second edition of this special publication of the Coast and Geodetic Survey was issued in 1903.

Magnetic Dip and Intensity Observations, January, 1897, to June 30, 1902, by D. L. Hazard, with preface by L. A. Bauer. Appendix 6, Report for 1902. Washington, Government Printing Office, 1903.

Results of Magnetic Observations made by the Coast and Geodetic Survey between July 1, 1902, and June 30, 1903. Appendix 5, Report for 1903. Washington, Government Printing Office, 1904.

Results of Magnetic Observations made by the Coast and Geodetic Survey between July 1, 1903, and June 30, 1904. Appendix 3, Report for 1904. Washington, Government Printing Office, 1904.

† For description of observatories, see Appendix 5, Report for 1902.

Summary of results on land.

State	Number of localities	Number of stations	Old localities reoccupied	Declinations observed	Dips observed	Intensities observed
Alabama	12	13	2	13	13	13
Alaska	5	7	2	7	4	3
Arizona	1	1	1	1	1	1
Arkansas	3	3	0	3	3	3
California	14	14	4	14	14	14
Connecticut	8	8	3	8	8	8
Delaware	1	2	1	2	1	1
District of Columbia	1	2	1	9	13	10
Florida	2	2	2	3	3	3
Georgia	32	32	7	40	40	40
Hawaii	2	2	1	3	2	3
Idaho	8	8	0	8	8	8
Illinois	6	6	1	6	6	6
Indian Territory	6	6	1	6	6	6
Iowa	1	1	1	1	1	1
Kansas	42	42	7	50	50	50
Kentucky	5	5	2	5	5	5
Louisiana	6	8	3	8	3	3
Maine	3	4	0	5	5	5
Maryland	5	5	5	13	18	12
Massachusetts	1	1	1	1	1	1
Mississippi	18	18	2	18	18	18
Missouri	3	3	0	3	3	3
Nevada	5	5	2	5	5	5
New Jersey	3	3	0	3	3	3
New York	16	18	7	19	19	19
North Carolina	2	2	2	2	2	2
North Dakota	1	1	0	1	1	1
Ohio	23	23	3	23	23	23
Oklahoma	12	12	1	12	12	12
Philippine Islands	3	3	0	3	0	0
Porto Rico	4	4	3	5	5	5
Rhode Island	5	5	2	5	5	5
South Carolina	7	7	1	7	7	7
Texas	3	3	2	3	3	3
Utah	1	1	1	1	1	1
Virginia	1	1	1	4	4	4
Washington	1	1	1	1	0	0
West Virginia	3	3	2	3	3	3
Wisconsin	4	5	1	5	5	5
Wyoming	2	2	1	2	2	2
Foreign countries	2	2	0	5	6	5
Total	283	294	77	336	332	322

There have now been obtained precise magnetic data for determining both the distribution of the magnetic elements and their secular change in every State and Territory of the United States at a sufficient number of stations to warrant the early publication of a new set of magnetic charts, viz, for the year 1905. The construction of these charts necessarily involves a rediscussion of all available secular variation data and the preparation of a new set of tables. This work is now in progress. Some results of a preliminary discussion of the declination data are considered of sufficient importance to be published herewith, in advance of the full report.

SECULAR CHANGE OF MAGNETIC DECLINATION.

The magnetic survey of Louisiana, which was completed in 1904, developed the fact that, contrary to expectation, the declination had reached a minimum in that State about the year 1898, and has since been increasing, and there were indications of a similar reversal of the secular motion at other places in the interior of the country. On the Pacific coast it was supposed that east declination had reached a maximum about ten years ago, but the reoccupation of several old stations in the spring of 1904 showed that east declination had been increasing quite rapidly since 1897.

In view of these facts, more than the usual number of old stations were selected for reoccupation in planning the field work for the fiscal year 1904–5, and although on account of changed local conditions many of the old stations were no longer available, a sufficient number were reoccupied exactly or approximately to give a general idea of the secular change of the magnetic declination during the past 5 or 10 years. The results are presented in the following table. The letters after the names of stations indicate: (*a*) that the old station was reoccupied exactly, (*b*) that it was reoccupied approximately, and (*c*) that the new station was some distance (half a mile or more) from the old one.

Comparison of declination results at repeat stations.

State	Station		Former occupation		Last occupation		Average annual change
			Date	Declination	Date	Declination	
				° ′		° ′	′
Me.	Portland	a	1895 Jy	14 16.2 W	1903 No	14 32.5 W	−2.0
Mass.	Boston	b	1896 Je	12 20.7 W	1905 My	12 52.2 W	−3.5
R. I.	Newport	b	1896 Je	11 27.9 W	1904 Au	12 07.2 W	−4.8
	Providence	c	1895 Au	11 35.2 W	1904 Au	12 06.5 W	−3.5
Conn.	New Haven	a	1895 Au	9 36.3 W	1904 Jy	10 05.9 W	−3.3
N. Y.	Oxford	a	1885 Se	7 43.3 W	1905 Je	8 49.2 W	−3.3
	Buffalo	b	1885 Se	5 04.3 W	1905 My	6 12.2 W	−3.6
N. J.	Sandy Hook	b	1895 Je	8 24.8 W	1903 Se	8 52.9 W	−3.4
	Cape May	b	1891 My	5 40.7 W	1903 Jy	6 27.6 W	−3.8
	New Brunswick	b	1895 Se	7 47.0 W	1903 Se	8 17.5 W	−3.8
Pa.	Harrisburg	b	1895 Se	6 06.3 W	1901 Oc	6 25.0 W	−3.1
Md.	Baltimore	b	1895 Se	5 20.3 W	1903 My	5 48.2 W	−3.8
	Cheltenham	a	1900 De	5 00.7 W	1905 Ap	5 16.5 W	−3.6
	Upper Marlboro	a	1896 Se	4 59.0 W	1903 Ap	5 27.6 W	−4.3
	Linden	a	1900 Jy	3 41.5 W	1905 Ap	3 56.3 W	−3.1
	La Plata	a	1896 Se	4 36.8 W	1905 Je	5 04.8 W	−3.2
	Oakland	a	1897 Jy	3 23.0 W	1904 Jy	3 30.7 W	−1.1
Va.	Norfolk	a	1897 My	4 17.8 W	1905 Fe	4 38.3 W	−2.6
W. Va.	Winfield	a	1900 My	1 39.8 W	1904 Au	1 44.0 W	−1.0
	West Union	a	1900 My	0 43.0 W	1904 Jy	0 48.0 W	−1.2
N. C.	Salisbury	b	1898 Au	0 38.5 W	1905 Ap	0 34.0 W	+0.7
S. C.	Charleston	b	1895 Je	0 19.3 W	1902 My	0 32.9 W	−2.0
	Spartanburg	a	1896 No	0 04.3 E	1905 Ap	0 13.5 W	−2.1
Ga.	Savannah	b	1895 My	0 57.2 E	1903 Mh	0 40.7 E	−2.1
	Macon	b	1900 Ap	1 58.0 E	1905 Fe	2 01.8 E	+0.8
	Augusta	a	1900 Mh	0 44.4 E	1905 Ja	0 44.3 E	0.0
	Atlanta	a	1896 Ap	1 51.1 E	1905 Ja	1 39.9 E	−1.3
	Valdosta	a	1903 Fe	2 01.6 E	1905 Ja	2 01.0 E	−0.3
Fla.	Key West	a	1903 Mh	2 33.8 E	1905 My	2 32.8 E	−0.5
	Miami	a	1903 Ap	1 39.7 E	1905 Je	1 37.2 E	−1.2
	Lake City	a	1900 Ap	1 33.0 E	1903 Mh	1 32.0 E	−0.3
Ala.	Mobile	b	1896 Mh	4 31.2 E	1905 Mh	4 28.8 E	−0.3
	Selma	c	1896 Mh	3 09.5 E	1903 Fe	2 57.8 E	−1.7
	Eufaula	c	1896 Mh	2 55.5 E	1903 Fe	2 39.3 E	−2.3
	Birmingham	c	1900 Je	2 46.4 E	1903 De	2 52.0 E	+1.6

Comparison of declination results at repeat stations—Continued.

State	Station		Former occupation		Last occupation		Average annual change
			Date	Declination	Date	Declination	
				° ′		° ′	′
Miss.	Mississippi City	a	1896 Fe	4 57.0 E	1902 De	4 54.4 E	−0.4
	Greenville	c	1890 My	6 18.0 E	1905 Ja	6 01.0 E	−1.2
	Brookhaven	a	1901 Mh	5 32.5 E	1905 Fe	5 40.8 E	+2.1
La.	Alexandria	a	1901 Ap	6 34.9 E	1904 Fe	6 38.0 E	+1.1
	Amite	b	1896 Fe	5 46.3 E	1903 Ja	5 43.4 E	−0.4
	Donaldsonville	b	1896 Ja	5 48.8 E	1903 Fe	5 46.5 E	−0.3
	Baton Rouge	c	1896 Fe	5 59.3 E	1903 Ja	5 51.5 E	−1.1
	Shreveport	c	1888 De	7 24.0 E	1904 Ja	6 59.1 E	−1.7
	Lafayette	c	1890 Ap	6 45.3 E	1905 Ja	6 31.1 E	−1.0
	Cheneyville	c	1896 Ja	6 33.1 E	1904 Fe	6 38.2 E	+0.6
	Franklin	a	1903 Fe	6 02.4 E	1905 Mh	6 06.5 E	+2.0
Ky.	Williamsburg	a	1900 Je	0 51.9 E	1903 Jy	1 05.9 E	+4.6
	Jackson	a	1900 Je	1 14.4 E	1903 Au	1 15.5 E	+0.3
	Louisville	b	1896 Ap	1 36.6 E	1904 No	1 20.1 E	−1.9
Ohio	Cincinnati	a	1899 Au	1 06.2 E	1903 My	1 09.0 E	+0.7
	Marietta	a	1898 Je	2 01.4 W	1904 Jy	2 08.6 W	−1.2
	Athens	a	1898 Je	0 22.2 W	1904 Au	0 30.8 W	−1.4
Ill.	Bloomington	a	1891 Se	4 00.4 E	1905 Je	3 30.6 E	−2.2
Wis.	Madison	a	1900 No	4 53.0 E	1905 Je	4 54.6 E	+0.3
Iowa	Keokuk	a	1900 Jy	5 54.8 E	1905 Je	5 58.4 E	+0.7
Mo.	Chillicothe	a	1900 Oc	7 01.9 E	1903 Jy	7 11.4 E	+3.4
Tex.	Austin	c	1895 My	8 07.0 E	1901 Oc	8 12.3 E	+0.8
	San Antonio	b	1895 Fe	8 37.5 E	1902 Oc	8 48.2 E	+1.4
	El Paso	c	1895 Ap	11 46.0 E	1905 Ja	12 03.2 E	+1.7
	Amarillo	b	1899 De	11 31.6 E	1902 De	11 40.2 E	+2.9
	Memphis	a	1900 Ja	9 49.4 E	1902 De	9 59.7 E	+3.5
	Lindenau	a	1901 Se	8 13.0 E	1902 Se	8 15.0 E	+2.0
Okla.	Mangum	a	1900 De	10 14.6 E	1904 De	10 26.1 E	+2.9
Kans.	Baldwin	a	1900 No	8 21.6 E	1905*	8 26.9 E	+1.3
	Emporia	a	1902 Au	9 52.4 E	1904 Je	9 57.0 E	+2.6
	Winfield	a	1902 Au	9 21.0 E	1904 Jy	9 26.5 E	+2.9
	Abilene	a	1902 Au	10 13.0 E	1904 Au	10 14.5 E	+0.7
Nebr.	Lincoln	a	1900 Au	10 07.6 E	1902 Oc	10 10.0 E	+1.1
	Ogallala	a	1900 Oc	13 36.4 E	1902 No	13 38.0 E	+0.8
Utah	Ogden	a	1886 Se	17 24.6 E	1905 My	17 39.7 E	+0.8
Ariz.	Yuma	c	1903 Ja	14 00.6 E	1905 Fe	14 07.2 E	+3.2
Cal.	San Diego	a	1897 Fe	13 30.9 E	1905 Ap	14 00.8 E	+3.7
	San Bernardino	a	1897 Ja	14 35.3 E	1905 Mh	15 03.6 E	+3.5
	Indio	c	1897 Mh	14 15.7 E	1905 Mh	14 45.0 E	+3.7
	Sacramento	c	1897 Oc	16 05.6 E	1905 Ap	16 44.1 E	+5.1
	San Jose	a	1896 No	17 48.5 E	1904 My	18 13.2 E	+3.3
	Santa Cruz	a	1896 De	16 31.3 E	1904 Ap	16 53.0 E	+3.0
Nev.	Carson City	c	1895 No	16 36.9 E	1905 My	17 01.7 E	+2.6
	Elko	a	1881 Ap	17 30.8 E	1905 My	18 05.4 E	+1.4
Alaska	Sitka	a	1900 Oc	29 47.4 E	1905*	29 57.6 E	+2.1

A tabulated value of annual change refers approximately to the middle of the period from which it is deduced. A plus sign indicates increasing east declination or decreasing west declination, and a minus sign the reverse.

It appears that the line of no annual change does not differ much from the agonic line, and that in general both east and west declination are increasing. On the Atlantic coast the annual increase of west declination is probably not more than 1′ in Maine, but rises to more than 3′ from Rhode Island to New Jersey, and then decreases to zero in

* Mean of observations in December, 1904, and January, 1905.

Georgia and Florida. At the Porto Rico Magnetic Observatory, on Vieques Island, west declination is increasing at the rate of about 7′ per year. In Mississippi and Alabama east declination is increasing about 2′ per year, and along the whole Pacific coast the increase appears to be as much as 3′ per year.

OBSERVATIONS AT SEA AND THEIR DISTRIBUTION.

The policy of making magnetic observations at sea as often as the regular surveying duties of the ships of the Bureau would permit has been continued. Observations were made on the *Bache* during her cruises from Norfolk, Va., to Maine and return, and from Norfolk to Colon, Canal Zone, and return; on the *Blake* on the cruise between Norfolk and Maine and return; on the *Explorer* on the cruise to Porto Rico and return; on the *Patterson* on the way from Kiska, Alaska, to Honolulu, and from Honolulu to Seattle, Wash. Some observations were secured also by the *McArthur* and *Gedney* in connection with the work in Alaska. The Carnegie Institution of Washington, through its Department of Terrestrial Magnetism, has undertaken a systematic magnetic survey of the oceanic areas.

The *Bache*, *Patterson*, and *Explorer* are each provided with a Lloyd-Creak dip circle and accompanying gimbal stand, by means of which dip and relative intensity can be determined on board ship, and the *Blake* was similarly equipped until she went out of commission in the fall of 1904. The other vessels of the Survey are not well adapted for magnetic work, on account either of small size or steel construction. They have not been supplied with Lloyd-Creak dip circles, therefore, nor have many declination results been obtained by them. Observations for declination are made with the usual standard liquid compass and an azimuth circle of the Ritchie or Negus pattern. Each value of declination, dip, or intensity usually depends upon the mean of observations made on 8 or 16 equi-distant headings while steaming in a circle, once with port and once with starboard helm. In some cases, however, observations were made on three headings, namely, on the course, one or two points to starboard of the course, and then a like amount to port.

Summary of results at sea.

Vessel	General region	Observations from swings			Observations on and near course		
		Declination	Dip	Intensity	Declination	Dip	Intensity
Bache	Atlantic Ocean	15	14	13	2		
Blake	do	6	5	5	4	4	2
Explorer	do	11	10	10	6	6	6
Patterson	Pacific Ocean	4	4	4			
Gedney	do	4					
McArthur	do	2					
Total		42	33	32	12	10	8

GENERAL METHODS OF OBSERVING.

LAND WORK.

The methods of observing have been the same as those described in previous publications. Observers engaged exclusively in magnetic work are supplied with a complete magnetic outfit, consisting of theodolite-magnetometer, dip circle, half-second pocket chronometer, an observing tent, and small accessories, while those who are expected to get magnetic results incidental to other work are supplied with more or less complete outfits, according to circumstances. Where only declination results can be secured under the conditions involved, a compass declinometer is supplied; but to those who can attempt more, a dip circle with compass attachment is furnished, with which compact outfit, knowing the azimuth of some reference mark from triangulation or other source, the declination, dip, and total intensity (Lloyd's method) can be obtained with a very fair degree of accuracy.

During the year several extended series of observations have been made to test the accuracy of Lloyd's method of determining the relative total intensity with a dip circle. Observations were made at a large number of stations to determine the total intensity by that method in addition to the usual determination of horizontal intensity with the magnetometer. The following table shows what may be expected of a first-class instrument, carefully handled. For purposes of comparison, the horizontal intensity has been computed from the dip and total intensity determined with the dip circle.

Station in California	Date	Horizontal intensity (C. G. S. units)	
		Magnetometer No 11	Dip circle No. 23
	1905		
San Diego	April 4	.27687	.27687
Escondido	April 7, 8	.27358	.27338
Stedman	April 13, 14	.26569	.26577
Randsberg	April 19	.26384	.26394
Bakersfield	April 22, 24	.26390	.26412
Sacramento	April 27	.24375	.24401

Dip circle No. 23, using needles 3 and 4, was adopted as a provisional standard for dip circles before an earth inductor had been secured and, though not new, is a very reliable instrument. Needles 3 and 4 were reserved for relative intensity work during the past year and the "intensity constant" was determined by observations at the Baldwin Magnetic Observatory in October, 1904. From that time to the dates given above it was in continuous use under rather trying conditions of weather and transportation, but an inspection of the table shows not only that the error of observation is small, but also that the "intensity constant" has remained constant for six months. An equally satisfactory showing was made by a new Dover dip circle (No. 169) of Lloyd-Creak pattern belonging to the Carnegie Institution, as will be seen by referring to the tabulation of results in Georgia.

Dip circle No. 56 did not show up so satisfactorily, nor was it expected to do so, for the instrument and intensity needles were known to be of inferior quality. Even with this dip circle, however, the difference between the results by magnetometer and dip circle seldom amounted to 1 part in 200 and averaged about 1 part in 500.

SEA WORK.

The experience of the *Patterson* on her trip to Honolulu, and of the *Bache* on her trip to Colon during the past year has shown that Lloyd's method can not be employed for determining the total intensity on shipboard within a considerable distance of the magnetic equator, at least with the deflecting needle and mounting at present provided. The earth's total force is entirely overcome by the force of the deflecting needle, and the suspended needle will not take a position of equilibrium at right angles to the deflector. Either the deflecting distance must be increased or the relation of the magnetic moments of the two intensity needles altered.

To overcome this difficulty an arrangement has been devised by the Inspector of Magnetic Work, which contemplates the determination of relative horizontal intensity by means of deflections of a standard liquid compass, the deflections being produced by a dip needle or small magnet mounted at a fixed distance above the compass. Observations on land indicated that the angle of deflection could be read with a sufficient degree of accuracy, and the device is in successful use on board the brig *Galilee* on the preliminary trip of the magnetic survey of the North Pacific Ocean which has been undertaken by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

ACCURACY OF RESULTS.

The endeavor in general is to secure on land declination and dip observations whose absolute error (including everything involved—error of observation and reduction) shall not exceed 2′, and that the horizontal intensity be determined within 1 part in 1 000. The experience of the Coast and Geodetic Survey has been that, under all of the conditions involved in a campaign of field work covering a large area, including the standardization of instruments and the determination of reduction errors, this accuracy can not be much reduced. In observatory work with special instruments, or when special investigations are made under the best conditions by special observers, there is no difficulty in reducing these limits of error. But in a large organization, where results must be secured from all kinds of observers, under all conditions, and at times under great physical difficulties, and when all the errors are considered before the results can be utilized, the degree of accuracy stated must be regarded as satisfactory and sufficient. It happens, of course, that these limits, for one reason or another, are occasionally exceeded, and there may be a few isolated cases in which the errors are two or three times the amounts given.

An extended series of observations was made with the compass attached to dip circle No. 56 to test the accuracy of declinations determined with it. From observations at more than 50 stations it was found there were very few cases where the declination results by compass and magnetometer differed by more than 3′, and the difference exceeded 2′ in less than one-third the total number. This bears out the statement made last year (Appendix 3, Report for 1904), that with proper care the declination can be secured with this simple arrangement correct within 2′.

COMPARISON OF INSTRUMENTS.

The absolute instruments at the Cheltenham Observatory, comprising declinometer, magnetometer, earth inductor, and theodolite, have been adopted as the standard instruments to which all instruments are referred. During the year special observations were made at Cheltenham to standardize the Lloyd–Creak dip circles Nos. 28, 33, and 35, new Kew–Dover dip circles Nos. 30 and 31, and new magnetometers Nos. 29, 36, and 37, and various other instruments. Numerous comparisons were also made at the Baldwin Magnetic Observatory and at the station in Washington near the Zoological Park, and individual comparisons were secured at other places where the same station was occupied with different instruments by different observers in the course of their regular field work. These comparisons show that few changes are required in the instrumental constants adopted last year. The various dip circles used and the corrections which have been applied to the results by each are given in the following table. The figures after the decimal in the fourth column indicate, as in the past, the particular needles to which the correction applies—thus 24.12 means dip circle No. 24, needles 1 and 2:

Corrections to dip circles.

Dip circle	Pattern	Needles	Designation	Correction
				′
15	Kew-Casella	2 and 4	15.24	+0.5
18	Kew-Casella	1 and 4	18.14	+2.1
20	Kew-Casella	1 and 2	20.12	+3.8
21	Kew-Casella	1 and 2	21.12	+6.0
22	Wilde-Edelmann	Earth inductor	22 EI	−0.2
23	Kew-Casella *	2, 2 and 3	23 III	−0.4
24	French Magnetic Survey	1 and 2	24.12	+6.6
25	Tesdorpf	IV and VIII	25.48	−3.6
27	Tesdorpf	21 and 24	27.14	+0.7
28	L. C.-Casella	1 and 2	28.12	−5.4
30	Kew-Dover	1 and 2	30.12	−0.4
31	Kew-Dover	1 and 2	31.12	−0.2
31	do.	1, 2, 3 and 4	31 IV	0.0
32	L. C.-Dover	1 and 2	32.12	−0.3
33	L. C.-Dover	1 and 2	33.12	−2.0
34	L. C.-Dover	1 and 2	34.12	−1.9
35	L. C.-Dover	1 and 2	35.12	−2.9
4655	Kew-Casella	1 and 2	55.12	+0.6
56	Kew-Casella	3 and 4	56.34	+0.5
56	do.	3	56.3	+0.5
5678	Kew-Casella	1 and 2	78.12	0.0
CI 169 †	L. C.-Dover	1 and 2	169	−2.7
CI 171 †	Kew-Dover	1 and 2	171	+0.4

* The regular dip needles are 2 Casella and 2 Dover. The needle suspended during deflections, 3 Dover, gave such uniformly good results, even though its polarity was not reversed, that observations with it were given equal weight with those with the regular dip needles.

† Property of Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

Magnetometers Nos. 20 and 21 continue to give results for horizontal intensity less than the standard. The same was found to be true of the two new magnetometers Nos. 36 and 37. The results with these instruments have therefore been corrected as follows:

No. 20	+.002 *H*
No. 21	+.006 *H*
No. 36	+.002 *H*
No. 37	+.003 *H*

Index corrections have been applied to declination results obtained with compass declinometer or compass needle. Declinations determined with magnetometer No. 19 have been corrected by the same amount as last year, namely 1′.5, decreasing west declinations and increasing east declinations,

REDUCTION OF THE OBSERVATIONS.

A first computation is made by the observer in the field, and he must carry it far enough before he leaves a station to assure himself that the desired degree of accuracy has been attained. This computation is carefully revised in the Office in the Division of Terrestrial Magnetism and the necessary corrections are applied to reduce the results to the standard instruments, as indicated in the foregoing section.

Each value of magnetic declination is then corrected to reduce it to the mean of the particular month in which the observation was made, with the aid of the continuous observations at the nearest magnetic observatory, allowance being made for the change in diurnal variation with change in magnetic latitude. No attempt has been made to correct the dip and horizontal intensity for diurnal variation, for the reasons stated last year.

The office work involved in the reduction and revision of results and preparation for publication was intrusted to Mr. D. L. Hazard, computer.

ARRANGEMENT OF THE TABLES.

LAND OBSERVATIONS.

The values of declination, dip, and horizontal intensity presented in Table I are arranged by States alphabetically, the results for each State being given in the order of increasing latitudes. The latitudes and longitudes are in most cases the result of solar observations made with the small theodolite which forms a part of the magnetometer. In default of observations the geographic coordinates were scaled from the best available map, either the United States Geological Survey topographic sheets, a Post Route map, or a Rand & McNally State map. In such cases only the nearest whole minute of latitude and longitude is given. *The horizontal intensity is expressed, as heretofore, in terms of the one hundred thousandth part of a C. G. S. unit of intensity of magnetic force.*

In order to include the desired amount of information in the available space the following abbreviations were adopted. Only the month and day of the date are given, since the observations were all made between July 1, 1904, and June 30, 1905. The names of the months have been abbreviated as follows:

January	Ja	May	My	September	Se
February	Fe	June	Je	October	Oc
March	Mh	July	Jy	November	No
April	Ap	August	Au	December	De

In the column headed "Instruments," M stands for "magnetometer," and D. C. for "dip circle." Italicized numbers in the magnetometer column indicate that the declination was determined with a compass declinometer of the number given. When the declination was determined with the compass attachment of the dip circle, the letter *C* is placed in the magnetometer column. The dip circles have been given the designations indicated on page 116, the figures after the decimal point denoting the needles used. Values of horizontal intensity printed in italics were obtained by combining the observed dip with the total intensity determined by Lloyd's method. The letters *B F* refer to a small magnetometer called the "Bache Fund," which was used in connection with dip circle No. 27 to determine the horizontal intensity. The magnet used to deflect the dip needles Nos. *22* and *23* is suspended for oscillations in the Bache Fund magnetometer and was also used to determine the declination.

The observer is indicated by the initials of his name. The names of the observers are as follows:

J. P. Ault.	J. H. Egbert.	W. B. Keeling.
L. A. Bauer.	R. L. Faris.	F. T. Lawton.
H. L. Beck.	H. W. Fisk.	F. M. Little.
J. E. Burbank.	J. A. Fleming.	F. B. Loren.
W. H. Burger.	J. W. Green.	E. Mueller.
W. G. Cady.	G. D. Harris.	R. E. Nyswander.
S. A. Deel.	D. L. Hazard.	G. B. Pegram.
H. C. Denson.	N. H. Heck.	L. B. Smith.
R. B. Derickson.	J. S. Hill.	D. C. Sowers.
P. H. Dike.	W. M. Hill.	W. M. Wallis.
H. M. W. Edmonds.	C. J. Houston.	

SEA OBSERVATIONS.

The results obtained at sea are presented in Table II. The general arrangement is indicated by the headings. Unless otherwise indicated, the ship was swung with both port and starboard helms. In the columns headed "Sea," Sm means smooth; Sw, swell; Hvy, heavy; Mod, moderate. The names of the ships taking part in the work and their commanding officers are as follows:

Bache	P. A. Welker.
Blake	R. L. Faris and D. B. Wainwright.
Explorer	R. L. Faris.
Gedney	E. F. Dickins.
McArthur	H. P. Ritter.
Patterson	J. F. Pratt.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905.*

ALABAMA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
				East					
	° ′	° ′		° ′	° ′	γ			
Daphne	30 36.1	87 53.8	Mh 8	4 32.5	61 08.3	26891	10	56.3	J. W. G.
Mobile, old station	30 41.0	88 04.6	Mh 6	4 28.8	61 11.8	26866	10	56.3	Do.
Mobile, new station	30 41.0	88 09.2	Mh 4	4 30.5	61 14.2	26854	10	56.3	Do.
Citronelle	31 06.2	88 14.4	Mh 2	4 33.3	61 43.4	26550	10	56.3	Do.
Grove Hill	31 42.2	87 46.2	Mh 13	4 06.4	62 02.6	26553	10	56.3	Do.
Dadeville	32 49.4	85 45.3	Mh 25	3 02.2	63 48.1	25316	10	56.3	Do.
Centerville	32 56.4	87 08.5	Mh 15	3 08.6	64 01.5	25211	10	56.3	Do.
Columbiana	33 10.6	86 36.0	Mh 23, 24	3 03.4	64 08.1	25078	10	56.3	Do.
Tuscaloosa	33 12.7	87 32.6	Mh 16	4 26.4	64 17.3	25024	10	56.3	Do.
Talladega	33 26.4	86 05.8	Mh 27, 28	2 52.4	64 17.9	24834	10	56.3	Do.
Fayette	33 41.3	87 50.2	Mh 18	4 21.5	64 31.9	24986	10	56.3	Do.
Jasper	33 50.4	87 17.1	Mh 20	4 06.7	64 36.2	24964	10	56.3	Do.
Russellville	34 30.8	87 44.2	Mh 22	4 13.0	65 27.8	24085	10	56.3	Do.

ALASKA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
		East		*East*					
	° ′	° ′		° ′	° ′	γ			
Kiska, Post	51 58.6	177 32.0	Au 10	8 14.3	64 01.3	22087	20	32.12	H. L. B.
Kiska, Astro.	51 59.1	177 32.4	Jy 25, 26	8 18.2	64 16.3	21906	20	15.24	Do.
Do.	51 59.1	177 32.4	Au 9	.. ....	64 21.8	.....	..	32.12	Do.
Kiska, Barrel	51 59.5	177 32.8	Se 5	8 04.5	.. ....	.....	*737*	.....	H. C. D.
		West							
Dutch Harbor	53 53.4	166 32.1	Se 12	17 55.6	.. ....	.....	*737*	.....	Do.
Nut, Cordova Bay	55 01.6	132 35	Je 23	28 58	.. ....	.....	*744*	.....	H. L. B.
Clarno, Moira Sd.	55 08.5	132 08.5	My 26, 27	28 35	.. ....	.....	*744*	.....	H. L. B.
Sitka Magnetic-Obs'y	57 02.9	135 20.2	De-Ja	29 57.6	74 44.6	15474	25	25.48	H. M. W. E.

ARIZONA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
				East					
	° ′	° ′		° ′	° ′	γ			
Yuma	32 44.0	114 36.7	Fe 13, 14	14 07.2	58 51.7	27529	11	23.111	W. M. H.

ARKANSAS.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
				East					
	° ′	° ′		° ′	° ′	γ			
Russellville	35 16.1	93 07.6	My 20	7 26.4	65 29.4	24287	10	30.12	J. W. G.
Vanburen	35 26.7	94 21.5	My 23	7 39.2	65 34.6	24312	10	30.12	Do.
Bentonville	36 21.9	94 12.3	My 25	7 16.6	66 20.0	23778	10	30.12	Do.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

CALIFORNIA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*East* ° ′	° ′	γ			
Calexico	32 39.9	115 31.1	Mh 3, 4	14 04.9	58 37.9	27526	11	23. III	W. M. H.
San Diego	32 42.2	117 14.5	Ap 4, 5	14 00.8	58 06.3	27687	11	23. III	Do.
Holtville	32 48.1	115 24.4	Fe 20, 21	14 13.4	58 37.6	27574	11	23. III	Do.
Imperial	32 50.8	115 37.0	Fe 23, 26	14 14.4	58 41.2	27495	11	23. III	Do.
Escondido	33 07.5	117 04.9	Ap 7	15 26.0	59 18.8	27358	11	23. III	Do.
Temecula	33 29.9	117 09.0	Mh 29	14 30.4	59 08.9	27006	11	23. III	Do.
Indio	33 43.6	116 13.8	Mh 7, 8	14 45.0	59 19.8	27218	11	23. III	Do.
Banning	33 55.6	116 54.6	Mh 10–13	14 45.5	59 25.5	27148	11	23. III	Do.
Redlands	34 03.4	117 08.4	Mh 22–27	15 02.6	59 39.6	26927	11	23. III	Do.
San Bernardino	34 06.4	117 16.4	Mh 15–17	15 03.6	59 38.3	26945	11	23. III	Do.
Stedman	34 37.4	116 10.8	Ap 14	15 21.2	60 19.4	26569	11	23. III	Do.
Randsburg	35 22.1	117 40.1	Ap 18, 19	15 32.0	60 41.4	26384	11	23. III	Do.
Bakersfield	35 23.3	119 02.3	Ap 22, 23	15 49.4	60 42.5	26390	11	23. III	Do.
Sacramento	38 33.3	121 27.4	Ap 27, 28	16 44.1	63 35.4	24375	11	23. III	Do.

CONNECTICUT.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*West* ° ′	° ′	γ			
New Haven	41 19.4	72 55.1	Jy 23–25	10 05.9	72 21.0	18024	8	21.12	W. G. C.
New London	41 21.0	72 06.7	Au 9	10 56.0	72 33.8	18047	8	21.12	J. E. B.
Danbury	41 24.0	73 25.0	Au 3	10 35.5	72 23.3	18140	8	21.12	Do.
Middletown	41 33.4	72 36.4	Jy 21, 22	10 11.8	72 41.0	17837	8	21.12	W. G. C.
Litchfield	41 42.0	73 13.6	Au 5, 6	11 04.0	72 45.5	17807	8	21.12	J. E. B.
Hartford	41 44.8	72 39.5	Jy 26–28	10 39.4	72 48.9	17709	8	21.12	W. G. C.
Brooklyn	41 47.4	71 57.8	Au 13–14	11 08.0	73 01.6	17492	8	21.12	J. E. B.
Tolland	41 52.8	72 22.1	Au 12	10 27.9	72 58.7	17463	8	21.12	Do.

DELAWARE.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*West.* ° ′	° ′	γ			
Wilmington 1	39 45.2	75 33.0	Ja, Fe	5 15.4	71 41.6	*18901**	C	34.12	N. H. H.
Wilmington 2	39 45.2	75 32.7	Fe 6, 21	10 54.6	.. ....	.....	C	.....	Do.

* For the value in italics the total intensity determined by Lloyd's method was combined with the observed dip.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

DISTRICT OF COLUMBIA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
				West.					
	° ′	° ′		° ′	° ′	γ			
Washington *	38 53.2	77 00.5	Jy 11–21	5 14.6	69 55.8	20342	10	78.12	D. L. H.
Do.	38 53.2	77 00.5	Au 2–4	.....	69 52.3	.....	..	169	J. P. A.
Do.	38 53.2	77 00.5	Au 9–10	.....	69 54.3	.....	..	35.12	Do.
Do.	38 53.2	77 00.5	Au 9–10	.....	69 51.9	.....	..	34.12	Do.
Do.	38 53.2	77 00.5	Au 2–15	5 11.6	69 52.2	20353	11	23.22	Do.
Do.	38 53.2	77 00.5	Au 12, 13	.....	69 56.1	.....	..	23.22	Do.
Do.	38 53.2	77 00.5	Oc 1–4	5 13.8	69 51.1	20333	19	21.12	W. M. H.
Do.	38 53.2	77 00.5	De 21	.....	69 50.8	.....	..	55.12	J. A. F.
Do.	38 53.2	77 00.5	Fe 9	5 18.3	.....	20266	17	.....	D. C. S.
Washington, near Zoo Park	38 55.2	77 02.5	Jy 22–26	4 24.7	70 25.1	20076	10	56.34	J. A. F.
Do.	38 55.2	77 02.5	Ja 27	4 28.2	70 26.9	20078	19	20.12	J. P. A.
Do.	38 55.2	77 02.5	Ja 28	.....	70 27.9	*20098*†	..	169	D. C. S.
Do.	38 55.2	77 02.5	Fe 17–21	4 26.9	.....	20041	17	.....	Do.
Do.	38 55.2	77 02.5	Je 21, 22	4 29.6	70 31.9	20072	37	21.12	G. B. P.
Do.	38 55.2	77 02.5	Je 24–27	4 28.9	70 29.0	20091	21	24.12	C. J. H.

FLORIDA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
				East.					
	° ′	° ′		° ′	° ′	γ			
Keywest	24 33.5	81 47.6	My 12, 13	2 32.8	54 56.9	29416	19	171	J. P. A.
Do.	24 33.5	81 47.6	My 12, 13	2 28.0	54 59.8	*29396**	C	33.12	E. M.
Miami	25 47.3	80 11.7	Je 14	1 37.2	56 33.7	28730	19	171	J. P. A.

GEORGIA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
				East					
	° ′	° ′		° ′	° ′	γ			
Valdosta	30 50.3	83 16.8	Ja 30	2 01.0	61 54.8	26311	21	24.12	J. S. H.
Bainbridge	30 54.7	84 35.5	Ja 28	2 15.4	61 44.7	26413	21	24.12	Do.
Dupont	31 00.1	82 53.8	Ja 31	1 13.9	62 06.5	26164	21	24.12	Do.
Waycross	31 14.0	82 21.8	Fe 2	1 12.2	62 20.9	26045	21	24.12	Do.
Waycross	31 14.0	82 21.8	Je 16, 17	1 11.8	62 19.7	26018	19	171	J. P. A.
Douglas	31 31.0	82 51.6	Fe 3, 4	1 35.5	63 11.9	25648	21	24.12	J. S. H.
Jesup	31 36.7	81 53.9	Fe 11	0 54.6	62 53.3	25540	21	24.12	Do.
Baxley	31 47.2	82 20.5	Fe 13, 14	1 13.0	63 03.1	25447	21	24.12	Do.
Reidsville	32 05.6	82 06.7	Fe 16, 17	1 07.1	63 10.0	25374	21	24.12	Do.
Mount Vernon	32 11.4	82 34.8	Fe 15	1 34.0	63 18.8	25332	21	24.12	Do.
Hawkinsville	32 17.0	83 28.4	Fe 23	1 48.4	63 20.8	25343	21	24.12	Do.
Buenavista	32 20.0	84 31.7	Ja 26	1 56.2	63 19.1	25561	21	24.12	Do.
Dublin	32 33.1	82 59.4	Fe 18, 19	1 28.8	63 34.4	25278	21	24.12	Do.
Swainsboro	32 36.5	82 19.9	Ja 17	1 07.5	63 56.2	25117	19	20.12	J. A. F.
Swainsboro A	32 36.5	82 19.9	Ja 17	1 07.0	63 51.7	*25117*†	C	169	J. P. A.
Sylvania	32 45.2	81 42.0	Ja 16	0 34.9	64 04.3	25060	19	20.12	J. A. F.
Sylvania A	32 45.2	81 42.0	Ja 16	0 37.7	64 03.1	*25058*†	C	169	J. P. A.
Macon	32 50.6	83 36.6	Fe 24	2 01.8	64 07.8	24879	21	24.12	J. S. H.

* The dip results at this station indicate the presence of local disturbance, different results being obtained with the same instrument when tripods of different heights were used.

† For the values in italics the total intensity determined by Lloyd's method was combined with the observed dip.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

GEORGIA—Continued.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*East* ° ′	° ′	γ			
Thomaston	32 53.5	84 20.2	Ja 23	1 58.8	63 49.0	25100	21	24.12	J. S. H.
Sandersville	32 58.8	82 47.2	Ja 21	1 31.4	64 29.6	24649	19	20.12	J. A. F.
Do.	32 58.8	82 47.2	Ja 21	1 32.2	64 28.8	*24652**	C	169	D. C. S.
Louisville	33 01.0	82 24.6	Ja 19	1 46.8	64 38.3	24537	19	20.12	J. A. F.
Louisville A	33 01.0	82 24.6	Ja 19	1 45.0	64 36.0	*24547**	C	169	J. P. A.
Lagrange	33 04.0	85 02.1	Ja 24	2 08.2	64 00.4	25097	21	24.12	J. S. H.
Waynesboro	33 06.5	82 01.3	Ja 13	0 49.3	64 39.5	24634	19	20.12	J. A. F.
Do.	33 06.5	82 01.3	Ja 14	0 35.6	64 36.4	*24694**	C	169	D. C. S.
Gibson	33 15.3	82 35.4	Ja 23	1 27.3	64 45.1	24482	19	20.12	J. A. F.
Gibson	33 15.3	82 35.4	Ja 23	1 26.8	64 42.7	*24453**	C	169	D. C. S.
Jackson	33 18.4	83 58.2	Ja 19	1 41.1	64 26.4	24793	21	24.12	J. S. H.
Augusta	33 27.9	81 57.3	Ja 11, 12	0 44.3	64 58.4	24287	19	20.12	J. A. F.
Do.	33 27.9	81 57.3	Ja 11, 12	0 38.9	64 58.3	*24286**	C	169	D. C. S.
Carrollton	33 35.3	85 03.4	Ja 16, 17	2 36.2	64 41.5	24578	21	24.12	J. S. H.
Madison	33 36.8	83 29.9	Fe 28	1 19.2	64 34.6	24629	21	24.12	J. S. H.
Atlanta	33 43.9	84 22.3	Ja 9–11	1 39.9	64 50.3	24537	21	24.12	W. F. W.
Washington	33 45.0	82 44.4	Fe 26, 27	1 11.1	64 50.6	24345	21	24.12	J. S. H.
Athens	33 57.6	83 22.5	Mh 2	1 18.4	65 13.2	24190	21	24.12	Do.
Elberton	34 07.5	82 47.2	Mh 3, 4	0 49.1	65 19.8	24114	21	24.12	Do.
Gainesville	34 18.2	83 51.6	Mh 9	1 05.3	65 16.4	24207	21	24.12	Do.
Clarkesville	34 37.4	83 29.1	Mh 7	1 13.8	65 50.8	23885	21	24.12	Do.
Blueridge	34 52.1	84 21.1	Mh 13, 14	1 50.4	66 05.4	23641	21	24.12	Do.

HAWAII.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*East* ° ′	° ′	γ			
Puu Olai, Maui	20 38.1	156 26.9	De 16	10 22.6	.. ....	29308	20	.....	J. H. E.
Honolulu Magnetic Obs'y	21 19.2	158 03.8	De–Ja	9 20.8	40 07.7	29182	22	22 EI	S. A. D.
Do.	21 19.2	158 03.8	Oc 20–22	9 21.8	40 07.8	29243	20	32.2	H. L. B.

IDAHO.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*East* ° ′	° ′	γ			
Malad City	42 11.4	112 14.8	Je 12, 13	18 08.7	68 22.0	21761	11	23. III	W. M. H.
Soda Springs	42 38.8	111 35.9	Je 2, 4	19 27.2	68 54.5	21314	11	23. III	Do.
Minidoka	42 44.8	113 25.7	Je 27, 28	18 16.6	68 20.8	21882	11	23. III	Do.
Pocatello	42 51.4	112 26.2	Je 6, 7	18 08.5	68 56.1	21310	11	23. III	Do.
Shoshone	42 55.9	114 24.8	Je 30	19 22.0	69 21.0	20560	11	23. III	Do.
Blackfoot	43 11.0	112 19.3	Je 16–18	19 56.1	69 03.7	21134	11	23. III	Do.
Arco	43 36.8	113 18.2	Je 20, 21	19 34.8	69 28.4	20746	11	23. III	Do.
Dubois	44 09.9	112 11.2	Je 23, 24	18 12.0	70 15.4	20460	11	23. III	Do.

* For the values in italics the total intensity determined by Lloyd's method was combined with the observed dip.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

ILLINOIS.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′	° ′	γ			
Hillsboro	39 09.8	89 30.3	Je 5	4 33.9	69 55.8	20799	10	30.12	J. W. G.
Havana	40 18.1	90 02.5	Je 9	4 58.9	70 48.3	20122	10	30.12	Do.
Bloomington	40 30.6	88 59.0	Je 7	3 30.6	70 53.6	19977	10	30.12	Do.
Knoxville	40 54	90 18.5	Je 12	5 24.8	71 22.5	19723	10	30.12	W. B. K.
Princeton	41 23.2	89 26.9	Je 16, 17	4 26.7	71 49.2	19243	10	30.12	Do.
Freeport	42 18.8	89 36.0	Je 20	4 29.6	72 47.6	18336	10	30.12	Do.

INDIAN TERRITORY.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′	° ′	γ			
Okmulgee	35 37.6	95 55.8	No 15, 16	8 42.6	65 30.9	24240	11	23. III	W. M. H.
Tahlequah	35 55.3	94 59.6	No 8, 9	8 26.4	65 52.5	23966	11	23. III	Do.
Wagoner	35 58.0	95 22.6	No 4–6	8 12.3	65 53.5	24038	11	23. III	Do.
Sapulpa	35 59.9	96 06.8	No 19	9 11.0	65 47.6	24156	11	23. III	Do.
Claremore	36 19.2	95 37.8	No 1, 2	8 34.8	66 09.3	23812	11	23. III	Do.
Vinita	36 39.4	95 09.2	Oc 28, 29	8 21.7	66 38.3	23557	11	23. III	Do.

IOWA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′	° ′	γ			
Keokuk	40 23.0	91 23.0	Je 14	5 58.4	70 38.2	20212	10	30.12	W. B. K.

KANSAS.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′	° ′	γ			
Winfield	37 14.8	96 59.0	Jy 20–22	9 26.5	67 06.0	23187	BF	27.14	R. E. N.
Parsons	37 20.4	95 15.5	Oc 26, 27	8 31.6	67 18.2	23043	11	23. III	W. M. H.
Greensburg	37 36.8	99 17.4	De 2	11 00.5	66 55.1	23206	10	56.3	J. W. G.
Kingman	37 37.9	98 06.0	Jy 26, 27	9 53.6	67 15.5	22950	BF	27.14	H. W. F.
Pratt	37 40.7	98 46.1	Au 1	10 21.2	67 01.2	23143	BF	27.14	Do.
Wichita	37 43.1	97 17.0	Jy 15–18	10 12.2	67 31.4	22553	BF	27.14	R. E. N.
Dodge City	37 46.0	100 01.6	No 25	11 38.5	66 40.8	23410	10	56.3	J. W. G.
Eldorado	37 49.0	96 50.1	Jy 11, 12	9 41.8	67 19.0	22754	BF	27.14	R. E. N.
Cimarron	37 49.3	100 21.0	No 26	10 32.0	66 39.3	23434	10	56.3	J. W. G.
Kinsley	37 56.0	99 24.3	No 23, 24	10 43.4	67 02.3	23106	10	56.3	Do.
Lakin	37 57.6	101 16.7	No 29	12 14.3	66 40.5	23371	10	56.3	Do.
Garden City	37 58.2	100 53.4	No 28	11 46.6	66 49.5	23290	10	56.3	Do.
St. John	37 58.9	98 44.8	Au 6, 8	10 30.7	67 16.8	23051	BF	27.14	H. W. F.
Hutchinson	38 03.3	97 56.8	Au 3, 4	9 52.7	67 29.9	22764	BF	27.14	Do.
Jetmore	38 05.0	99 53.4	No 21	11 22.2	67 21.0	22906	10	56.3	J. W. G.
Newton	38 05.6	97 18.6	Jy 1–9	9 32.1	67 12.5	23118	BF	27.14	R. E. N.
Larned	38 11.2	99 07.3	No 18	10 44.2	67 26.9	22878	10	56.3	J. W. G.
Great Bend	38 22.2	98 46.7	No 16, 17	10 17.5	67 43.6	22471	10	56.3	Do.
Lyons	38 22.5	98 11.2	Au 10, 11	10 16.0	67 53.1	22430	BF	27.14	H. W. F.
McPherson	38 22.7	97 37.0	Au 13	10 18.9	67 46.3	22683	BF	27.14	Do.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

KANSAS—Continued.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′	° ′	γ			
Ness City	38 27.9	99 53.9	No 15	11 15.4	67 40.7	22667	10	56.3	J. W. G.
Leoti	38 29.5	101 20.7	No 7	12 22.6	67 26.7	22746	10	56.3	Do.
Tribune	38 29.6	101 45.6	No 4, 5	12 14.0	67 08.1	22978	10	56.3	Do.
Scott	38 29.7	100 54.4	No 11	12 04.5	67 16.0	22996	10	56.3	Do.
Dighton	38 30.5	100 27.6	No 12	11 17.0	67 33.8	22774	10	56.3	Do.
Ellsworth	38 44.1	98 13.6	Au 19	10 06.4	68 04.3	22402	BF	27.14	H. W. F.
Baldwin Magnetic Obs'y	38 47.0	95 10.0	De–Ja.	8 26.9	68 41.8	21858	30	1 EI	L. B. S.
Do.	38 47.0	95 10.0	Se 8, 9	8 27.0	68 42.5	21865	BF	27.14	H. W. F.
Do.	38 47.0	95 10.0	Se 21	8 31.5	68 42.2	21855	BF	27.14	L. B. S.
Do.	38 47.0	95 10.0	Oc 8–11	8 30.5	68 41.9	21842	10	56.3	J. W. G.
Do.	38 47.0	95 10.0	Oc 19–22	8 27.5	68 41.7	21861	11	23.III	W. M. H.
Do.	38 47.0	95 10.0	No 11	8 27.6	68 42.0	21843	BF	27.14	L. B. S.
Do.	38 47.0	95 10.0	De 5, 6	8 30.0	68 42.0	21827	10	56.3	J. W. G.
Do.	38 47.0	95 10.0	De 22–24	8 27.5	68 40.8	21868	21	24.12	W. F. W.
Salina	38 49.4	97 35.3	Au 22, 23	11 06.6	68 11.7	22342	BF	27.14	H. W. F.
Do.	38 49.4	97 35.3	Oc 22–24	11 09.1	68 12.0	22286	10	56.3	J. W. G.
Russell	38 54.1	98 53.5	Oc 25	10 05.2	68 06.8	22251	10	56.3	Do.
Hays	38 55.3	99 16.3	Oc 27	11 33.4	67 59.1	22430	10	56.3	Do.
Wallace	38 55.4	101 36.2	No 3	12 25.2	67 41.4	22525	10	56.3	Do.
Ellis	38 56.2	99 34.5	Oc 28, 29	11 18.0	68 02.4	22303	10	56.3	Do.
Abilene	38 56.5	97 12.9	Au 29, 30	10 14.5	68 28.5	22197	BF	27.14	H. W. F.
Gove	38 57.9	100 30.2	No 1, 2	11 26.4	68 07.7	22513	10	56.3	J. W. G.
Lincoln Center	39 02.0	98 08.9	Au 24–26	10 07.4	68 09.9	22310	BF	27.14	H. W. F.
Wakeeney	39 02.1	99 53.6	Oc 31	11 32.8	67 59.7	22392	10	56.3	J. W. G.
Junction	39 04.2	96 47.5	Se 6	9 54.1	68 38.7	22018	BF	27.14	H. W. F.
Westmoreland	39 24.4	96 24.6	Oc 13, 14	9 24.0	69 06.4	21689	10	56.3	J. W. G.
Clay Center	39 25.2	97 07.8	Se 3	9 40.0	68 59.1	21856	BF	27.14	H. W. F.
Concordia	39 34.8	97 40.6	Se 1	9 40.7	69 01.2	21726	BF	27.14	Do.
Seneca	39 49.7	96 04.6	Oc 17	9 05.4	69 50.5	20962	10	56.3	J. W. G.
Washington	39 50.7	97 03.9	Oc 20	10 57.6	69 21.6	21380	10	56.3	Do.

KENTUCKY.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′	° ′	γ		′	
Hopkinsville	36 52.1	87 29.2	No 22, 23	4 08.3	67 30.9	22670	19	55.12	F. M. L.
Greensburg	37 16.6	85 30.2	Oc 28	2 22.2	69 00.8	21554	19	55.12	Do.
Leitchfield	37 28.5	86 17.2	No 11, 14	2 19.2	68 33.2	22106	19	55.12	Do.
Elizabethtown	37 41.6	85 52.0	No 7	1 46.1	68 27.4	21909	19	55.12	Do.
Louisville	38 14.5	85 41.6	No 3, 4	1 20.1	69 33.1	21129	19	55.12	Do.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

LOUISIANA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
				East					
	° ′	° ′		° ′	° ′	γ			
Belle Isle	29 31.8	91 28.8	Mh 17	6 08.6	59 29.9	*27811**	C	35.12	G. D. H.
Berwick Bay	29 42	91 13	Mh 20	6 02.2	59 38.7	*27842**	C	35.2	Do.
Shell Point	29 42.9	91 52.8	Fe 26	6 19.4	.. ....	.....	C†	.. .	Do.
Shark Bayou	29 46.6	91 50.5	Fe 16	6 17.8	.. ....	.....	C†	.. .	Do.
Weeks Island	29 48.3	91 48.5	Ja 15, 16	6 16.5	.. ....	.....	C†	.. .	Do.
Franklin	29 48.5	91 30.0	Mh 16	6 06.5	.. ....	.....	C†	.. .	Do.
Grande Côte	29 50.2	91 47	Ja 17, 29	6 16.6	.. ....	.....	C†	.. .	Do.
Lafayette	30 13	92 00	Ja 6, 7	6 31.1	60 13.2	*27575**	C	35.12	Do.

MAINE.

				West					
	° ′	° ′		° ′	° ′	γ			
Bar Island 2	44 23.8	68 12.2	Oc 28	16 51.6	74 48.7	*15733**	C	28 12	R. L. F.
Bar Island 1	44 24.0	68 12.5	Oc 26	16 46.2	74 51.6	*15596**	C	33.12	E. M.
Jordans Island	44 25.1	68 08.2	Oc 22	14 49.1	75 10.3	*15469**	C	28.12	R. L. F.
Beans Island	44 28.5	68 12.6	Au 11	16 43.9	74 30.6	*16019**	C	28.12	F. T. L.
Do.	44 28.5	68 12.6	Au 22	16 49.2	74 32.7	*15976**	C	33.12	E. M.

MARYLAND.

				West					
	° ′	° ′		° ′	° ′	γ			
La Plata	38 31.2	76 58.0	Je 26, 27	5 04.8	70 02.3	20399	29	56.13	W. F. W.
Cheltenham Magnetic Obsy.	38 44.0	76 50.5	De–Ja	5 15.7	70 25.3	20090	26	26 EI	Do.
Do.	38 44.0	76 50.5	Jy 28, 29	5 12.4	....	20146	11	.....	Do.
Do.	38 44.0	76 50.5	De 6–8	......	70 25.0	.....	..	35.12	J. P. A.
Do.	38 44.0	76 50.5	De 6–8	......	70 25.3	.....	..	169	D. C. S.
Do.	38 44.0	76 50.5	De 9, 10	......	70 25.2	.....	..	20.12	Do.
Do.	38 44.0	76 50.5	De 9, 10	.....	70 24.8	.....	..	21.12	Do.
Do.	38 44.0	76 50.5	De 22–27	......	70 25.1	.....	..	33.12	J. E. B.
Do.	38 44.0	76 50.5	Ja, Fe	5 15.1	....	20086	36	.....	W. F. W.
Do.	38 44.0	76 50.5	Ja, Fe	5 16.1	....	20094	37	.....	Do.
Do.	38 44.0	76 50.5	Ap 11–27	5 16.1	70 26.4	20068	150‡	157‡	J. W. G.
Do.	38 44.0	76 50.5	Ap 15–19	5 16.6	70 26.8	20072	151‡	156‡	Do.
Do.	38 44.0	76 50.5	Ap 20	......	70 26.6	.....	..	158‡	Do.
Do.	38 44.0	76 50.5	My 3, 4	5 18.7	70 25.1	.....	37	31.12	Do.
Do.	38 44.0	76 50.5	My 5, 10	5 16.0	70 25.0	.....	36	30.12	Do.
Do.	38 44.0	76 50.5	Je 14, 25	5 17.4	70 24.9	20088	29	56.13	W. F. W.
Linden	39 00.5	77 03.1	Ap 1–4	3 56.3	70 50.6	19581	21	24.12	L. A. B.
Do.	39 00.5	77 03.1	Ap 4, 21	......	70 47.5	*19700**	C	169	Do.
Do.	39 00.5	77 03.1	My 17	......	70 46.3	.....	..	31 IV	Do.
Baltimore	39 17.5	76 34.7	Je 26, 27	5 51.0	70 45.2	*19658**	C	34.12	N. H. H.
Oakland	39 24.8	79 25.3	Jy 27	3 30.7	70 41.1	19970	10	56.34	J. A. F.

* For the values in italics the total intensity determined by Lloyd's method was combined with the observed dip.
† Declination determined with compass of a surveyor's transit.
‡ Instruments standardized for the Naval Observatory. No corrections applied.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

MASSACHUSETTS.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		West ° ′	° ′	γ			
Boston	42 20.2	71 00.7	My 6, 7	12 52.2	73 00.5	17442	21	24.12	L. A. B.

MISSISSIPPI.

	° ′	° ′		East ° ′	° ′	γ			
Woodville	31 06.6	91 18.5	Ja 28	6 07.8	61 19.0	26820	10	56.3	J. W. G.
Magnolia	31 09.5	90 29.3	Fe 10	5 43.4	61 25.4	26782	10	56.3	Do.
Liberty	31 09.6	90 50.3	Fe 1, 2	5 54.4	61 22.3	26788	10	56.3	Do.
Meadville	31 28.6	90 54.2	Ja 24	5 59.7	61 44.4	26674	10	56.3	Do.
Brookhaven	31 35.4	90 26.8	Fe 13, 14	5 40.8	61 56.8	26454	10	56.3	Do.
Waynesboro	31 40.5	88 38.5	Mh 1	4 48.6	62 11.0	26357	10	56.3	Do.
Fayette	31 43.1	91 03.6	Ja 21	6 11.4	62 04.3	26404	10	56.3	Do.
Hazlehurst	31 53.2	90 22.9	Fe 15	5 40.4	62 18.8	26215	10	56.3	Do.
Canton	32 36.4	90 01.1	Fe 17	5 34.4	62 56.7	25825	10	56.3	Do.
Rolling Fork	32 53.9	90 52.8	Ja 18	6 06.2	63 16.1	25730	10	56.3	Do.
Kosciusko	33 04.1	89 35.0	Fe 23	5 21.6	63 37.1	25528	10	56.3	Do.
Macon	33 06.6	88 33.0	Fe 27	4 39.9	64 02.3	25232	10	56.3	Do.
Ackerman	33 18.7	89 10.4	Fe 24	5 15.8	64 00.1	25217	10	56.3	Do.
Greenville	33 24	91 04.6	Ja 13, 14	6 01.0	63 39.1	25436	10	56.3	Do.
Indianola	33 26.3	90 39.8	Ja 16	6 01.5	63 42.9	25445	10	56.3	Do.
Rosedale	33 51.2	91 01.6	Ja 11, 12	5 56.4	64 11.5	25261	10	56.3	Do.
Clarksdale	34 12.2	90 34.4	Ja 7	6 08.2	64 48.7	24758	10	56.3	Do.
Tunica	34 42.1	90 23.8	Ja 6	5 11.4	65 13.6	24450	10	56.3	Do.

MISSOURI.

	° ′	° ′		East ° ′	° ′	γ			
Mount Vernon	37 06.6	93 48.6	My 27	7 10.0	67 32.3	22799	10	30.12	J. W. G.
Greenville	37 06.7	90 26.3	Je 3	5 44.8	67 17.5	23037	10	30.12	Do.
Houston	37 19.6	91 57.5	My 31	6 23.8	67 15.2	22983	10	30.12	Do.

NEVADA.

	° ′	° ′		East ° ′	° ′	γ			
Sodaville	38 20.0	118 05.7	My 15–17	17 21.7	63 42.9	24631	11	23. III	W. M. H.
Hawthorne	38 32.0	118 37.8	My 12, 13	17 33.9	63 42.1	24489	11	23. III	Do.
Yerington	38 59.4	119 09.6	My 8, 9	17 21.4	64 05.1	24410	11	23. III	Do.
Carson City	39 09.6	119 45.2	My 4, 5	17 01.7	63 45.1	24724	11	23. III	Do.
Elko	40 51	115 45.8	My 19, 20	18 05.4	66 22.4	23040	11	23. III	Do.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

NEW JERSEY.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*West* ° ′	° ′	γ			
Morristown	40 48.1	74 26.9	Jy 5, 6	9 38.9	71 54.5	18763	19	20.12	W. M. H.
Belvidere	40 50	75 04.7	Jy 19, 20	6 53.5	72 18.2	18360	19	20.12	Do.
Newton	41 03.4	74 45.9	Jy 16	8 24.0	72 26.3	18213	19	20.12	Do.

NEW YORK.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*West* ° ′	° ′	γ			
Fire Island	40 37.9	73 13.5	Jy 26	9 13.3	72 09.9	18406	19	20.12	W. M. H.
West Hampton	40 49.1	72 39.2	Au 25, 26	10 20.3	72 03.6	18494	19	20.12	Do.
West Hampton A	40 49.1	72 39.2	Au 27, 28	10 20.7	72 02.3	18477	19	20.12	Do.
West Hampton	40 49.1	72 39.2	Au 27, 28	10 20.7	72 05.2	18467	8	21.12	J. E. B.
Oyster Bay	40 51.6	73 31.0	Au 1-3	9 28.1	72 06.1	18507	19	20.12	W. M. H.
Setauket	40 57.0	73 06.7	Au 8, 9	9 19.3	72 23.8	18145	19	20.12	Do.
White Plains	41 01.5	73 46.4	Se 22, 23	9 59.0	71 47.3	18733	19	21.12	Do.
Montauk Point	41 02.5	71 55.0	Au 16-22	10 05.5	71 58.6	18397	19	20.12	Do.
Greenport	41 06.3	72 21.7	Au 11, 12	10 25.2	72 07.3	18546	19	20.12	Do.
New City	41 08.8	74 00.3	Au 30, Se 1	9 50.4	72 16.0	18327	19	21.12	Do.
Goshen	41 25.0	74 18.8	Se 3-6	8 50.3	72 32.5	18037	19	21.12	Do.
Carmel	41 25.0	73 40.6	Se 26, 27	10 35.9	72 29.5	18148	19	21.12	Do.
Monticello	41 38.3	74 42.6	Se 8-10	8 09.5	72 49.4	17619	19	21.12	Do.
Poughkeepsie	41 42.8	73 54.9	Se 19, 20	9 21.7	73 04.1	17582	19	21.12	Do.
Kingston	41 56.7	73 59.4	Se 13-15	10 03.5	72 48.6	17680	19	21.12	Do.
Delhi	42 15.4	74 56.1	Je 24-26	9 33.7	73 27.5	17422	37	21.12	G. B. P.
Oxford, old sta.	42 26.8	75 36.0	Je 29	8 49.2	73 23.9	17456	37	21.12	Do.
Oxford, new sta.	42 27.2	75 34.9	Je 27-29	9 04.2	73 26.8	17438	37	21.12	Do.
Buffalo	42 54.1	78 54.9	My 10	6 15.2	73 46.4	17141	21	24.12	L. A. B.

NORTH CAROLINA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*West* ° ′	° ′	γ			
Wadesboro	34 57.6	80 03.2	Oc 21, 22	0 08.5	66 45.0	22930	19	55.12	F. M. L.
Salisbury	35 40.0	80 30.2	Ap 21	0 34.0	67 13.7	22452	10	56.3	W. H. B.

NORTH DAKOTA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*East* ° ′	° ′	γ			
Fargo	46 51.0	96 47.1	Je 29, 30	11 31.5	75 35.6	15742	19	31.12	H. W. F.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

OHIO.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*West* ° ′	° ′	γ			
Ironton	38 31.8	82 39.8	Au 11	0 43.7	70 36.3	19962	10	56.34	J. W. G.
Gallipolis	38 48.9	82 14.2	Au 3, 4	0 54.0	70 18.9	20291	10	56.34	Do.
McArthur	39 15.0	82 28.4	Au 13	0 00.1	70 32.5	20247	10	56.34	Do.
Athens	39 19.7	82 06.3	Au 19, 20	0 30.8	70 35.5	20049	10	56.34	Do.
Marietta	39 25.4	81 28.2	Jy 30	2 08.6	70 51.8	19857	10	56.34	Do.
Logan	39 32.9	82 24.4	Au 17, 18	0 29.6	70 47.9	19932	10	56.34	Do.
McConnelsville	39 39.3	81 49.8	Au 26	0 57.6	71 07.6	19919	10	56.34	Do.
New Lexington	39 43.3	82 11.4	Au 24, 25	0 55.2	71 04.7	19888	10	56.34	Do.
Caldwell	39 45.1	81 31.2	Se 24	2 14.1	70 55.5	19670	10	56.3	Do.
Woodsfield	39 46.0	81 08.0	Se 27, 28	1 42.0	70 54.2	19730	10	56.3	Do.
Zanesville	39 57.6	82 02.8	Au 29	1 19.4	71 11.7	19772	10	56.34	Do.
Cambridge	40 02.8	81 35.1	Se 22, 23	2 16.1	71 22.2	19346	10	56.3	Do.
				East					
Newark	40 03.8	82 24.9	Au 31, Se 1	0 04.7	70 56.9	19926	10	56.34	Do.
				West					
St. Clairsville	40 05.7	80 54.7	Se 29, 30	1 06.4	71 39.7	19150	10	56.3	Do.
Coshocton	40 16.8	81 51.2	Se 3	2 03.0	71 34.7	19290	10	56.34	Do.
Cadiz	40 18.2	81 01.7	Oc 3	2 02.9	71 26.4	19219	10	56.3	Do.
Steubenville	40 23.5	80 42.0	Oc 5, 6	1 38.9	72 06.4	18718	10	56.3	Do.
New Philadelphia	40 28.5	81 25.0	Se 21	2 21.9	71 40.0	19101	10	56.3	Do.
Millersburg	40 33.8	81 54.4	Se 7	2 24.9	71 55.2	18906	10	56.34	Do.
Carrollton	40 35.6	81 04.8	Se 19	1 50.2	71 42.2	18988	10	56.3	Do.
Lisbon	40 46.6	80 45.3	Se 15	3 00.0	72 07.1	18726	10	56.3	Do.
Canton	40 49.1	81 23.9	Se 12, 13	2 12.4	72 06.3	18827	10	56.3	Do.
Wooster	40 49.2	81 56.1	Se 8, 9	1 33.3	71 51.0	19150	10	56.34	Do.

OKLAHOMA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*East* ° ′	° ′	γ			
Lawton	34 37.4	98 24.0	De 30, Ja 2	9 44.9	63 57.3	25385	11	23. III	W. M. H.
Mangum	34 51.8	99 30.9	De 21–23	10 26.1	63 37.7	25659	11	23. III	Do.
Anadarko	35 04.0	98 16.6	De 28, 29	9 57.2	64 18.7	25207	11	23. III	Do.
Cordell	35 17.5	99 01.2	De 15–18	10 10.3	64 31.1	24985	11	23. III	Do.
Oklahoma	35 30.5	97 33.6	Ja 4, 5	9 33.4	65 05.7	24580	11	23. III	Do.
Chandler	35 42.5	96 51.9	Ja 19, 20	9 23.0	65 37.0	24026	11	23. III	Do.
Watonga	35 50.6	98 24.4	De 9–12	10 01.6	65 28.0	24392	11	23. III	Do.
Guthrie	35 53.1	97 26.3	Ja 7, 9	9 29.5	65 32.9	24234	11	23. III	Do.
Enid	36 23.5	97 54.7	No 30, De 1	9 51.2	65 49.4	24126	11	23. III	Do.
Pawhuska	36 39.8	96 21.5	No 23, 24	9 01.0	66 28.3	23662	11	23. III	Do.
Alva	36 48.2	98 41.4	De 7, 8	10 35.2	66 14.1	23870	11	23. III	Do.
Newkirk	36 53.7	97 03.9	No 26, 27	9 22.0	66 31.6	23465	11	23. III	Do.

PHILIPPINE ISLANDS.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	*East* ° ′	1904	*East* ° ′					
Point, Guimaras	10 25	122 32	Mh 26	1 49.0	....	.....	734	.....	R. D. B.
Dan, Negros	10 31	122 47	Fe 26	1 29.6	....	.....	734	.....	F. B. L.
White, Panay	11 41.1	122 24.4	Oc 29	1 18.0	....	.....	734	.....	Do.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

PORTO RICO.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*West* ° ′	° ′	γ			
Mosquito, Vieques Island	18 08.3	65 30.1	Mh 29	0 48.1	49 16.6	*29258**	C	34.12	N. H. H.
Porto Rico Magnetic Obs'y	18 08.9	65 26.4	De–Ja	1 22.3	49 37.1	29010	31	18.14	P. H. D.
Mayaguez	18 11.8	67 08.6	Ap 14, 15	1 22.3	49 19.0	*29330**	C	34.12	N. H. H.
Obispo Cayo	18 20.6	65 37.2	Ap 1	1 39.6	49 19.8	*29592**	C	34.12	Do.
Obispo Cayo	18 20.6	65 37.2	My 31	1 57.0	49 22.6	*29537**	C	34.12	Do.

RHODE ISLAND.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*West* ° ′	° ′	γ			
Kingston	41 29.2	71 31.7	Au 25	11 40.0	72 37.7	17858	8	21.12	J. E. B.
Newport	41 30.5	71 19.7	Au 22	12 07.2	72 37.0	17862	8	21.12	Do.
Bristol	41 38.9	71 15.8	Au 19	12 09.7	72 48.6	17762	8	21.12	Do.
East Greenwich	41 39.8	71 27.2	Au 23, 24	12 18.1	72 42.9	17727	8	21.12	Do.
Providence	41 45.5	71 27.8	Au 17, 18	12 06.5	72 46.6	17702	8	21.12	Do.

SOUTH CAROLINA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*East* ° ′	° ′	γ			
Greenwood	34 11.1	82 08.4	Ap 7	0 18.2	65 45.5	23537	10	56.3	W. H. B.
Newberry	34 17.0	81 36.6	Ap 11–13	0 37.8	65 29.1	24149	10	56.3	Do.
Anderson	34 29.7	82 39.6	Ap 4	0 37.8	65 53.7	23762	10	56.3	Do.
Union	34 43.0	81 36.4	Ap 19, 20	0 01.6	65 37.6	24042	10	56.3	Do.
Walhalla	34 47.0	83 03.2	Mh 30	0 57.8	66 10.4	23618	10	56.3	J. W. G.
Pickens	34 53.2	82 42.4	Ap 1	0 15.3	66 16.3	23487	10	56.3	Do.
				West					
Spartanburg	34 57.5	81 56.1	Ap 15–17	0 13.5	66 18.1	23398	10	56.3	W. H. B.

TEXAS.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*East* ° ′	° ′	γ			
Sierra Blanca	31 10.2	105 22.6	Ja 27, 28	11 36.8	58 50.6	28011	11	23.III	W. M. H.
El Paso	31 45.0	106 29.5	Ja, Fe	12 03.2	59 22.2	27760	11	23.III	Do.
Odessa	31 51.5	102 23.1	Ja 24–26	10 54.6	60 19.9	27292	11	23.22	Do.

UTAH.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		*East* ° ′	° ′	γ			
Ogden	41 13.1	111 59.9	My 23, 24	17 39.7	67 27.4	22422	11	23.III	W. M. H.

*For the values in italics the total intensity determined by Lloyd's method was combined with the observed dip.

TABLE I.—*Magnetic observations on land, July 1, 1904, to June 30, 1905*—Continued.

VIRGINIA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		West ° ′	° ′	γ			
Norfolk	36 52.4	76 16	Au 8	4 35.3	68 39.3	*21253**	C	33.12	E. M.
Do.	36 52.4	76 16	Fe 14	4 39.7	68 41.6	*21331**	C	33.12	Do.
Do.	36 52.4	76 16	Fe 11, 14	4 38.3	68 40.7	21357	19	171	J. P. A.
Do.	36 52.4	76 16	Mh 14	4 37.5	68 39.3	*21391**	C	34.12	D. C. S.

WASHINGTON.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′					
Seattle	47 39.6	122 18.4	My 11	23 15	....	.....	744	.....	H. L. B.

WEST VIRGINIA.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		West ° ′	° ′	γ			
Winfield	38 32.1	81 54.6	Au 5	1 44.0	69 54.4	20612	10	56.34	J. W. G.
Mason City	39 02.0	82 04.0	Au 1, 2	0 41.9	70 30.7	20127	10	56.34	Do.
West Union	39 18.1	80 46.7	Jy 28, 29	0 48.0	70 41.5	20083	10	56.34′	J. A. F.

WISCONSIN.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′	° ′	γ			
Madison	43 04.5	89 25.3	Je 22	4 54.6	73 47.1	17703	10	30.12	W. B. K.
Richland Center	43 20.9	90 22.6	Je 23	5 55.3	73 31.5	17639	10	30.12	Do.
Mauston	43 47.6	90 05.1	Je 27	5 14.7	73 56.5	17194	10	30.12	Do.
Mauston, M. L.	....	....	Je 26	5 06.6	73 58.9	17149	10	30.12	Do.
Montello	43 47.8	89 17.6	Je 28, 29	4 34.6	74 04.0	17168	10	30.12	Do.

WYOMING.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′	° ′	γ			
Green River	41 31.6	109 28.4	My 26, 27	16 49.6	68 25.8	21805	11	23.III	W. M. H.
Cokeville	42 04.1	110 58.6	My 30, 31	17 52.0	68 39.0	21607	11	23.III	Do.

FOREIGN COUNTRIES.

Station	Latitude	Longitude	Date	Declination	Dip	Horizontal intensity	Instruments M.	Instruments D. C.	Observer
	° ′	° ′		East ° ′	° ′	γ			
Colon, Canal Zone†	9 21.4	79 56.6	Mh 14, 30	4 29.9	33 51.0	32842	19	171	J. P. A.
Do.	9 21.4	79 56.6	Mh 14	4 38.0	33 49.9	....	C.	33.12	E. M.
Kingston, Jamaica	17 58.9	76 54.0	Mh 8, 9	1 29.2	47 22.1	31273	19	171	J. P. A.
Do.	17 58.9	76 54.0	Mh 8	1 29.9	47 22.1	*31318**	C.	33.12	E. M.
Do.	17 58.9	76 54.0	My 6	1 31.1	47 22.4	31300	19	171	J. P. A.
Do.	17 58.9	76 54.0	My 6	......	47 20.4	*31363**	..	33.12	E. M.

*For the values in italics the total intensity determined by Lloyd's method was combined with the observed dip.
† Under jurisdiction of the United States.

TABLE II.—*Magnetic observations at sea, July 1, 1904, to June 30, 1905.*

ATLANTIC OCEAN.

Place	Latitude	Longitude	Date	Declination	Dip	Total intensity	Ship	Number of headings	Sea
	° ′	° ′		° ′	° ′	γ			
Limon Bay, Panama	9 22	79 56	Ap 22	4 40 E	.. ..	.....	Bache	16	Hvy. sw.
Kingston, Jamaica	17 58	76 47	Mh 10	1 58 E	47 37	46344	Do.	16	Sm.
Do.	17 58	76 47	My 7	1 52 E	47 22	46260	Do.	16	Sm.
Fajardo Roads, P. R.	18 21	65 36	Ap 3	1 41 W	49 16	45388	Explorer	16	Sm.
Do.	18 21	65 36	My 31	1 38 W	49 26	45391	Do.	16	Mod. sw.
At sea	20 42	83 14	My 9	3 54 E	49 48	48494	Bache	8	Sm.
Do.	21 35	67 25	Mh 23	2 42 W	53 03	47674	Explorer	16	Rough
Do.	21 52	67 47	Je 4	1 49 W	53 02	47820	Do.	16	Hvy. sw.
Do.	22 10	74 20	Mh 4	0 47 E	.. ..	.....	Bache	2	Sm.
Do.	22 47	84 40	My 10	3 40 E	52 38	50068	Do.	8	Sm.
Do.	23 05	68 25	Je 4	2 05 W	54 33	48573	Explorer	3	Hvy. sw.
Do.	23 26	68 12	Mh 22	2 39 W	55 05	49390	Do.	3	Mod. sw.
Key West, Fla.	24 31	81 49	My 11	2 30 E	54 52	51194	Bache	16	Sm.
Do.	24 31	81 49	Je 9	2 10 E	55 00	51494	Do.	16	Sm.
At sea	24 55	68 43	Mh 22	2 50 W	56 48	50306	Explorer	16	Mod. sw.
Do.	26 48	69 46	Mh 21	3 20 W	58 57	52088	Do.	3	Mod. sw.
Do.	28 18	70 25	Mh 21	3 40 W	60 10	52654	Do.	16	Mod. sw.
Do.	30 08	71 25	Mh 20	4 38 W	62 03	54032	Do.	3	Hvy. sw.
Do.	30 56	81 12	Je 12	0 12 E	62 32	55252	Bache	8	Choppy
Do.	31 22	72 06	Mh 20	4 26 W	63 30	54938	Explorer	16	Mod. sw.
Do.	31 53	73 16	Je 7	3 33 W	64 06	54945	Do.	16	Hvy. sw.
Do.	33 12	73 02	Mh 19	2 52 W	65 08	55853	Do.	3	Rough
Do.	33 30	74 02	Je 7	3 50 W	65 06	56374	Explorer	3	Hvy. sw.
Do.	33 34	74 55	Mh 1	3 25 W	.. ..	.....	Bache	5	Rough
Do.	36 12	75 28	Je 14	. ..	67 45	57855	Do.	8	Sm.
Hampton Roads, Va.	36 57	76 06	Je 9	4 18 W	68 45	58306	Explorer	16	Lt. sw.
Do.	36 57	76 22	Au 10	4 22 W	68 43	58718	Bache	16	Sm.
Do.	36 58	76 21	Fe 14	4 54 W	68 38	58320	Do.	16	Sm.
Do.	36 58	76 21	Fe 18	4 20 W	.. ..	.....	Do.	16	Sm.
Do.	36 59	76 09	Mh 11	4 27 W	.. ..	.....	Explorer	16	Choppy
Do.	36 59	76 12	Jy 26	4 19 W	69 03	58901	Blake	16*	Sm.
Do.	37 00	76 12	Je 14	5 16 W	68 43	58369	Bache	16	Choppy
Do.	37 00	76 09	Mh 17	4 46 W	68 35	59076	Explorer	16	Sm.
At sea	37 53	75 05	No 3	4 55 W	.. ..	.....	Blake	3	Mod. sw.
Chesapeake Bay, Md.	38 20	76 23	No 5	5 18 W	69 46	59623	Do.	16	Sm.
At sea	38 51	74 28	No 3	. ..	70 08	.....	Do.	1	
Do.	39 00	74 24	No 3	4 20 W	.. ..	.....	Do.	3	Mod. sw.
Do.	40 08	72 34	Jy 27	9 40 W	71 27	59738	Do.	16	Mod. sw.
Do.	40 32	72 09	No 2	8 14 W	.. ..	.....	Do.	2	Sm.
Do.	40 43	71 54	No 2	. ..	71 32	59570	Do.	3	
Do.	41 10	71 12	No 2	. ..	71 35	.....	Do.	1	
Vineyard Sound, Mass.	41 23	70 52	Au 12	12 09 W	72 19	59486	Bache	8	Rough
At sea	43 15	68 51	No 1	15 15 W	73 02	59524	Blake	3	Mod. sw.
Frenchmans Bay, Me.	44 22	68 10	Oc 31	16 57 W	74 17	.....	Bache	16	Choppy
Do.	44 24	68 10	Oc 31	16 38 W	74 42	59982	Blake	16	Sm.
Do.	44 27	68 11	Au 1	16 16 W	74 30	59848	Do.	16	Sm.
Do.	44 27	68 13	Se 1, 13	16 44 W	.. ..	.....	Do.	16	Sm.
Do.	44 28	68 13	Au 16	16 16 W	74 32	59817	Bache	16	Sm.

*Declination from swing with port helm only.

TABLE II.—*Magnetic observations at sea, July 1, 1904, to June 30, 1905*—Continued.

PACIFIC OCEAN.

Place	Latitude	Longitude	Date	Declination	Dip	Total intensity.	Ship	Number of headings	Sea
	° ′	° ′		*East* ° ′	° ′	γ			
Near Oahu I., Hawaii	21 16	158 00	No 3	10 03	39 48	38900	Patterson	8*	Sm.
At sea	22 58	156 18	Mh 16	10 51	42 18	39650	Do.	16*	Mod sw.
Do.	29 05	158 50	Oc 10	11 50	47 23	41680	Do.	16*	Long sw.
Seattle, Wash.	47 36	122 21	Oc 20	23 26	.. ..	.....	McArthur	16	Sm.
Puget Sound, Wash.	47 53	122 29	My 17	24 12	.. ..	.....	Gedney	16	Sm.
Port Townsend, Wash.	48 15	122 56	Oc 25	22 14	.. ..	.....	Do.	16	Sm.
Kiska Harbor, Alaska	51 59	182 28	Se 5	9 26	.. ..	.....	McArthur	16	Sm.
Dutch Harbor, Alaska	53 54	166 31	Se 30	16 46	66 40	52360	Patterson	16	Sm.
Clarence Strait, Alaska	55 06	131 50	My 31	28 31	.. ..	.....	Gedney	16	Sm.
Davidson Inlet, Alaska	55 52	133 38	Au 6	29 19	.. ..	.....	Do.	16	Sm.

DESCRIPTIONS OF STATIONS.

Magnetic observers are instructed to mark every station in as permanent a manner as possible, either with a stone or a post of some durable wood, so that it may be available for future occupation. They are also required to furnish a detailed description, so that the station may be located even if the marking should be destroyed, and to determine the bearing of two or three prominent objects in addition to the one used as a reference mark in the azimuth and declination observations. The information is given in abridged form on the following pages for each of the stations occupied during the year. Further details can usually be obtained on application to the Superintendent of the Coast and Geodetic Survey. The usual method of marking a station is by a stone post about 3 feet long and 6 or 8 inches square, set so as to project an inch or two above ground and lettered on top U. S. C. & G. S., with a drill hole in the center to mark the exact point. Whenever the local authorities desired and were willing to bear the expense, a second stone was set to denote the true meridian.

The descriptions of stations are arranged alphabetically by States and by names of station.

ALABAMA.

Centerville, Bibb County.—The station is in the Centerville Cemetery, one-half mile southwest of the town. It is distant 23 feet from a double cedar tree, bearing 60° west of north, 14.4 feet from the wire fence on the east line of the grounds, and 130.3 feet from the west gate post at the entrance to the cemetery—the northeast corner of the grounds. The station is marked by a limestone post 5 by 6 by 30 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Point of cupola on the court-house (mark)	61 53.8 east of north
Presbyterian Church steeple	60 54.8 east of north
Methodist Church steeple	69 01.1 east of north

*Dip and intensity from observations on 3, 6, and 4 points respectively.

Descriptions of stations—Continued.

ALABAMA—Continued.

Citronelle, Mobile County.—The station of 1896 could not be reoccupied. The new station is about 1 mile northwest of the station of 1896, on the grounds of the Citronelle public school, in the northwest part of the town and northwest of the school building. It is 45.6 feet and 44.7 feet, respectively, from two pine trees bearing 5° east of north and 80° east of north, 71.1 feet from the northwest corner of the school building and 32.0 feet and 61.7 feet, respectively, from the picket fences on the west and north lines of the grounds. The station is marked by a yellow-pine post 2 feet long, sunk flush with the surface of the ground. A brass screw in the center marks the exact spot. The following true bearings were determined:

	° ′
Methodist Church spire (mark)	76 22.0 east of north
Small (false) west gable on house across street	63 09.1 east of north

Columbiana, Shelby County.—The station is on the grounds of the public school, east of the building. It is 132.8 feet and 149.0 feet, respectively, from the southeast and northeast corners of the building. It is also distant 67.8 feet from an oak tree 16 inches in diameter, bearing 60° west of north, and 54.6 feet from an oak tree 14 inches in diameter, bearing 5° west of south. The station is marked by a limestone post 5 by 7 by 30 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Point of cupola on new jail (mark)	51 44.4 west of south
North gable on Mr. Gilbert's house	3 04.0 east of south

Dadeville, Tallapoosa County.—The station is in the Dadeville Cemetery, one-half mile southeast of the town. The station is near the center of west side of grounds. It is 32.3 feet almost due east of the eleventh fence post north of the gate or entrance on the west side of grounds, 43 feet from an oak tree 20 inches in diameter, bearing 60° east of north, 50.5 feet from middle of a driveway east of station, and 59.9 feet and 60.5 feet, respectively, from the southwest and northwest corners of Mr. R. T. Ward's lot, which is inclosed by a picket fence. The station is marked by a limestone post 6 by 6 by 30 inches, set 28 inches in the ground, lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Cupola of court-house (mark)	69 42.6 west of north
Presbyterian Church spire	51 59.4 west of north
Methodist Church spire	89 26.5 west of south

Daphne, Baldwin County.—The station is on the grounds of the Daphne Springs Hotel, owned by William Dryer, southwest of the hotel building. It is 120.0 feet and 147.2 feet, respectively, from the southwest and southeast corners of the building. The station is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. A second stone was set 337 feet due south of this stone, marking a meridian line. This second stone is also lettered U. S. C. & G. S., 1905, and is sunk 2 inches below the surface of the ground. This stone is 166 feet from a board fence, measured at right angles, toward the southwest and 44 feet from a cedar tree 18 inches in diameter, bearing 45° east of north. The following true bearings were determined:

	° ′
Methodist Church spire (mark)	87 17.6 east of south
Southwest corner of court-house (2 feet below roof)	4 19.4 east of south

Fayette, Fayette County.—The station is on the grounds of the Methodist Church and is east of the building. It is 68.3 feet and 69.1 feet, respectively, from the southeast and northeast corners of the church building. The station is marked by a limestone post 6 by 6 by 30 inches, set 29 inches in the ground, lettered U. S. C. & G. S., 1905. The following true bearings were determined.

	° ′
Cupola on court-house (mark)	18 16.7 west of south
Cupola on public school building	4 21.5 west of north

Grovehill, Clarke County.—The station is near the end of the street running east from the court-house. It is 49.7 feet from the southeast corner of the lot on the north side of the street and

Descriptions of stations—Continued.

ALABAMA—Continued.

41.0 feet from the northeast corner of lot on south side of street. Also 83.7 feet from the fence on the east side of the cross street. It is almost on the west line of the cross street. The station is marked by a limestone post 6 by 6 by 30 inches, set about 1 inch below the surface of the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Point of cupola on court-house (mark)	89 48.5 west of south
Methodist Church spire	0 49.9 east of south

Jasper, Walker County.—The station is in the small cemetery just north of the Presbyterian Church. It is 53.4 feet and 79.0 feet, respectively, from the fences on the east and west lines of the ground, measured at right angles to fences, and 212 feet from the entrance on the south. The station is marked by a limestone post 6 by 6 by 30 inches, set 28 inches in the ground and lettered on top U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Methodist Church spire (mark)	13 13.0 east of south
Cupola of school building	45 41.3 east of south
Baptist Church spire	10 00.6 east of south
Presbyterian Church spire	8 05.8 east of south

Mobile, Mobile County.—The station of 1896 was reoccupied, but as it is no longer well suited for magnetic observations, on account of the proximity of electric-car lines, observations were also made at a new station about 5 miles farther west. The station of 1896 is in the large open space in the southwest corner of the grounds of the Catholic Male Orphan Asylum, in the lot adjoining St. Mary's Church. Observations were made about 65 feet west of the probable location of the old station—at a point 100 feet from the west fence and 160 feet from the south fence.

The new station is on the grounds of the Spring Hill College (Jesuit), 7 miles west of the Mobile court-house. The station is near the southwest corner of the athletic grounds of the college and is 59.0 and 53.6 feet, respectively, from the picket fences on the south and west lines of the grounds. It is also 230.2 feet from the lower left-hand corner of the west steps of the west wing of the main building. The station is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Cross on north end of college chapel (mark)	57 51.1 east of north
Rod on south gable of east wing of main hall	54 41.3 east of north
Base of cross on main hall	44 37.9 east of north

Russellville, Franklin County.—The station is on the grounds surrounding the county court-house and is east of the building, which faces west. It is 135.2 feet and 122.2 feet, respectively, from the southeast and northeast corners of the building, and 47.2 feet and 55.6 feet, respectively, from the woven-wire fences on the east and north lines of the grounds. The station is marked by a limestone post 5 by 6 by 30 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Point of dome on Christian Church (mark)	46 36.8 west of south
Baptist Church spire	48 45.6 west of south
Methodist Church spire	58 56.1 west of south

Talladega, Talladega County.—The station is on the grounds of the Alabama State School for the Blind, northwest of the main building. It is 173.3 feet from the northwest corner of the main building, 196.1 feet from the northwest corner of front school building, 57.0 feet from picket fence on west line of grounds, and 32.5 feet from the edge of the gravel driveway. The station is marked by a limestone post 5 by 6 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Cupola of J. B. Graham public school (mark)	57 58.6 west of south
Cupola on S. J. Johnson's brick house	83 28.6 west of south
Presbyterian Church spire	79 43.3 west of north

Descriptions of stations—Continued.

ALABAMA—Continued.

Tuscaloosa, Tuscaloosa County.—The station is on the grounds of the State University. It is 20.3 feet from a board fence east, 227.4 feet and 166.3 feet, respectively, from the southeast and northeast corners of Garland Hall, and 180.7 feet from the southeast corner of the boys' dormitory. The station is marked by a limestone post 5 by 6 by 30 inches, set 28 inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	°	′	
Base of flagstaff on main dome of State Hospital for the Insane (mark)	57	54.8	east of north
Point of small cupola left of main dome	55	52.3	east of north
Point of second cupola left of main dome	55	23.8	east of north

ALASKA.

Clarno, North Arm of Moira Sound.—The station is about 2500 feet west (magnetic) from the American Coral Marble Company's wharf and about 1000 feet from the mouth of a stream at the head of Clarno Cove. It is on a ledge of white marble about 20 feet from high-water mark on the north shore. There is a small abandoned house about 65 feet north of the station. The following true bearing was determined:

	°	′	
Sharp snow-covered mountain peak between two rounded snow-covered peaks of nearly the same altitude (mark)	78	44.8	west of south

Dutch Harbor, Unalaska Island.—The station of 1900 was reoccupied. It is on the west slope of the hill southeast of Dutch Harbor at an elevation of about 130 feet. It is on line from the azimuth mark to the astronomic station in Unalaska, being 115 feet south of the former.

Kiska, Kiska Island.—Three stations were occupied on Kiska Island. Station Astro is 23 feet south of the astronomic station of 1904 on the line to the azimuth mark. The station is near the northwest end of the harbor about 15 feet from the edge of the bluff and about 40 feet above high-water line. The azimuth mark bears 0′.2 east of true south.

Station Post is about five-eighths of a mile south-southwest from station Astro, 7 feet from topographic signal Post, with Post and triangulation station North Head in range. It is on the sea side of a sand dune, grassy on top, about 100 feet wide and 325 feet long and is about 100 feet from high-water line. The mark used was the triangulation signal North Head, which bears 84° 20′.4 east of true north.

Station Barrel was one of the signals used in the survey of Kiska Harbor during the summer of 1904, and was marked by a pine pole surmounted by a barrel. The station is on top of a sand dune at the extreme northern end of Kiska Harbor, about 1 600 feet northeast of the astronomical station and about 550 feet northeast of the shore end of the small wharf built by the U. S. S. *Petrel* in 1904. The mark used was the triangulation station Ledge, which bears 21° 07′.1 east of south.

Nut, Cordova Bay.—The station is the triangulation station on a rocky point about one mile north of the middle of the northern entrance to Hassiah Inlet. The following true bearings were determined:

	°	′	
Green, triangulation station (mark)	47	09.9	west of south
Twin Mountains, left peak	70	56.1	west of south
Twin Mountains, right peak	71	06.3	west of south

Sitka Magnetic Observatory.—In the absolute building. For description of the observatory, see Appendix 5, Report for 1902.

ARIZONA.

Yuma, Yuma County.—The station of 1903 being no longer available, a new station was established on the military reservation, which is to be turned into an irrigation plant and experimental farm. It is about 800 feet southeast of the Government office building and west of the reservoir and water tank near the S. P. R. R. station and 132 feet northeast of an iron post which marks the southern point of a meridian line. The station is marked by a field stone about 3 feet long, showing

Descriptions of stations—Continued.

ARIZONA—Continued.

6 inches above the ground, and having a cross cut in the top to mark the exact spot. The following true bearings were determined:

	° ′
Flagpole at Indian School (mark)	34 07.2 east of north
Top of roof of west building of Indian School	26 01.2 east of north
Top of water tank at reservoir	70 56.4 east of north
Highest point on Cago Muchacho Mountain	39 50.3 west of north

ARKANSAS.

Bentonville, Benton County.—The station is in the grounds of the Baptist Academy, one-third of a mile south of the town. It is northwest of the main academy building, and is 151.6 feet and 203.8 feet, respectively, from the northwest and northeast corners of the building and 167.6 feet from the northwest corner of the president's dwelling house. The station is marked by a limestone post 6 by 6 by 30 inches, set 28 inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Baptist Church spire (mark)	6 31.1 west of north
Schoolhouse cupola	44 43.4 west of north
Base of weather vane on court-house	1 11.8 east of north

Russellville, Pope County.—The station is on the grounds of the Russellville public school, which stands at the corner of East Jefferson street and Pine street. The station is southwest of the building and is 23.7 feet and 113.5 feet, respectively, from the board fences on the west and south lines of the grounds. It is also 49 feet from an elm tree 12 inches in diameter bearing 15° west of south. No measurements were taken to the school building, as a new building is to be put up next year. The station is marked by a limestone post 6 by 6 by 32 inches, set almost flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Christian Church tower, south gable (mark)	1 21.4 east of north
North gable of new frame house across the street	1 14.4 east of south

Vanburen, Crawford County.—The station is in Fairview Cemetery, just north of the town and is near the center of the grounds, being near the north side of the main east and west driveway. It is 22.9 feet from the cornerstone at the northwest corner of the southeast quarter, 17.1 feet from the stone at the southwest corner of the northeast quarter. It is also 10.6 feet from a small cedar tree bearing 20° east of north. The station is marked by a limestone post 6 by 6 by 30 inches, set 29 inches in the ground lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Methodist Church spire (mark)	10 55.4 west of south
Top of iron post at the right hand of the arch over entrance to cemetery	8 48.9 west of south

CALIFORNIA.

Bakersfield, Kern County.—The station is in the northeastern part of the grounds of the Bakersfield Driving Association, about 2 miles north of town, north of the grand stand and west of the stables. It is 52.5 feet from a fence to the north, 129.9 feet from a fence to the west, 172.2 feet from the northeast corner of the grand stand, and 154.7 feet from the northwest corner of the grand stand. The station is marked by a section of earthen pipe filled with cement, showing 1 inch above ground, and lettered U. S. C. & G. S., 1905, with a cross in the top to mark the exact spot. The following true bearings were determined:

	° ′
Public school belfry, corner H and Twenty-first streets (mark)	0 23.2 east of south
Flag pole on above school	0 24.9 east of south
Pole on Exchange Building	1 34.8 east of south
North point of tower on Union Ice Company	18 35.1 east of south
East edge of wall of house to north in Oil City	24 40.5 east of north

Descriptions of stations—Continued.

CALIFORNIA—Continued.

Banning, Riverside County.—The station is in the northwestern part of the grounds of the public school, a little to the west of north of the schoolhouse. It is 81 feet from a road to the west, 124.5 feet from a road to the north, and 330.5 feet northwest from the northeast corner of the school building. The station is marked by an oak stake, 3 by 4 by 30 inches, showing about 3 inches above ground, with a brass-headed tack in the top to mark the exact spot. The following true bearings were determined:

	° ′	
West edge of ball on Methodist Church steeple (mark)	28 00.6	east of south
West edge of ball on top of school flag pole	9 08.7	east of south
Highest point of St. Jacinto Mountain	55 43.0	east of south
Highest point of Gray Back Mountain	13 56.6	east of north

Calexico, San Diego County.—The station is in the eastern part of Rockwood Park, a little to the north of east of the Geological Survey triangulation tower and east of the railroad station, which is about one-half mile away. It is 161.4 feet northwest of the stake marking the southeast corner of the park and 192.8 feet a little west of south from the stake marking the northeast corner of the park. The station is marked by an oak stake 1¼ by 3 inches at the top, showing about 3 inches above ground, with a tack in the top to mark the exact spot. The following true bearings were determined:

	° ′	
Flagstaff on triangulation tower over water tank (mark)	74 25.6	west of south
S. P. R. R. oil tank	78 20.9	west of south
Flag pole to west	86 58.7	west of south
Flag pole near house to northwest	41 30.7	west of north

Escondido, San Diego County.—The station is in the southeastern part of the grounds of the Escondido High School, about one-half mile north of the town's center and a little east of south of the southeast corner of the school building. It is 166.9 feet from the High School property line to the south and 363.5 feet from the High School property line to the west. The station is marked by an oak stake 4 by 4 by 24 inches, beveled at the top to about 2½ by 2½ inches, and showing about 3 inches above the ground. A brass-headed tack in the center marks the exact spot. The following true bearings were determined:

	° ′	
Congregational Church steeple (mark)	68 49.6	west of south
Seventh-Day Adventist Church steeple	56 27.5	west of south
Catholic Church steeple	8 43.3	west of south
Flagstaff on Strevers & Company's store	89 31.1	west of south
Flagstaff on Stevens Bros.' store	78 06.6	west of north

Holtville, San Diego County.—The station is in the northern part of the town park and north of the Hotel Alamo, which was in process of construction. It is 70.8 feet from an irrigation ditch to the north and 78.4 feet from a road to the east. It is about 606 feet north of the curbstone of the sidewalk on the north side of the hotel. The station is marked by a pecan wood stake 1½ by 2½ inches, showing about 8½ inches above ground, with a tack in the top to mark the exact spot. The following true bearings were determined:

	° ′	
East corner of top of oil tank of Holtville and Interurban Railway (mark)	50 00.6	east of south
Eastern point of roof of Alamo Hotel	6 19.8	east of south
Eastern point of roof of Mr. Bowen's house	89 20.1	west of south
Stack at east head gate of reservoir	41 03.0	east of south
Center of notch at top of Signal Mountain	55 39.9	west of south

Imperial, San Diego County.—The station is in the northwest corner of lot No. 33, which is used as a park and is one-half mile northwest of the town's center. It is 68.3 feet from a property line to the west and 80.8 feet from a property line to the north. It is marked by a rough field sandstone 5½

Descriptions of stations—Continued.

CALIFORNIA—Continued.

by 6½ by 13 inches, lettered U. S. C. & G. S., 1905, and showing about 2 inches above ground. The following true bearings were determined:

	°	′	
Christian Church steeple (mark)	9	14.6	east of south
Top of flag pole on Imperial Land Company building	39	53.3	east of south
Top of Geological Survey triangulation tower	86	08.4	east of north
Southwestern ornamental point of roof of Mr. Muggleston's house	50	27.4	east of south

Indio, Riverside County.—The description of the station of 1897 not being at hand, a new station was established on Indian land about 700 or 800 feet a little east of south of the S. P. Railroad station. It is east of the schoolhouse and north of a road running east and west. It is 187.7 feet from a fence to the south and 235.8 feet from a fence to the west and about 213 feet northeast of a plank shack used as a jail. The station is marked by an oak stake 4 inches square on top, showing 5 inches above ground, with a tack in the top to mark the exact spot. The following true bearings were determined:

	°	′	
South edge of top of water tank (mark)	58	41.2	west of north
South edge of smokestack 2 miles away	58	08.6	west of north
South corner at top of school water tank	69	19.0	west of north

Randsburg, Kern County.—The station is in the northeastern part of the property of the Yellow Aster Mining and Milling Company, about one-half mile southwest of the town's center. It is on a hill overlooking the town, about 1 000 feet north of the office of the Yellow Aster Mining and Milling Company. It is 36.1 feet almost directly west of a post marked $\begin{smallmatrix}4\\2\\4\\0\end{smallmatrix}$ on the eastern boundary of the Yellow Aster property, 75.6 feet northwest of a post marked $\begin{smallmatrix}1\\2\\4\\0\end{smallmatrix}$ on the eastern boundary of the Yellow Aster property, and about 96 feet northwest of a small wooden house. The station is marked by a hickory post 6 by 4 by 36 inches, showing about 16 inches above ground, with a cross sawed in the top to mark the exact spot. The following true bearings were determined:

	°	′	
Flagstaff on cupola of schoolhouse (mark)	60	39.0	east of north
Methodist Church steeple	41	14.5	east of north
Cross on belfry of Episcopal Church	7	44.0	east of north
Weather vane on flagstaff of crushing mill No. 1	22	59.9	west of south

Redlands, San Bernardino County.—The station is in the northern part of the grounds of the Redlands High School, a little west of north of the main High School entrance, and about 1 mile south east of the town's center. It is 84.2 feet south of an electric-light pole, which is almost due north of the school flag pole, 107.5 feet a little north of west of the northern basket-ball post, 334 feet north of the northwest corner of the High School building, 85.7 feet from the south curbstone of the road to the north, and 210.7 feet from the west curbstone of the road to the east. The station is marked by a marble post 14½ by 5 by 5 inches, buried 3 inches under ground, and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	°	′	
Central ornamental point on roof of High School (mark)	35	32.9	east of south
Cupola on stable of Eldridge Lyon	13	11.8	east of south
West edge of ball on cupola of Lowell School	23	41.7	west of north
Cupola on Mr. Hill's house	0	49.9	west of south
Monument on top of St. Bernardino Mountain	71	59.0	east of north

Sacramento, Sacramento County.—The station of 1897 being no longer suitable for magnetic observations, a new station was established within the oval inclosed by the new race track in the suburb

Descriptions of stations—Continued.

CALIFORNIA—Continued.

called Oak Park, about 5 miles southeast of the town. It is near the point which is to be the center of the northern half circle of the race track, and is about 1 000 feet southeast of the County Hospital. It is 227.7 feet from a fence to the west and 358 feet from a fence to the north. The station is marked by a brownstone post 6 by 6 by 26 inches showing about 4 inches above ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Flagstaff on new Goldberg schoolhouse (mark)	9 51.9 west of south
Flagstaff on old Goldberg schoolhouse	19 16.7 west of south
Flagstaff on Oak Park schoolhouse	73 45.7 west of south
Flagstaff on County Hospital	26 35.4 west of north
Flag pole on Brighton schoolhouse	89 28.3 east of north

San Bernardino, San Bernardino County.—Observations were made over the stone marking the station of 1897. This stone is lettered U. S. with a small hole marking the center, and its top is about 4 inches in diameter. It is located near the middle of the west half of the city park, between E and F streets and south of Sixth street. It is about 52 feet from the fence line on F street and about 164 feet from the fence line on Sixth street, in line with the north fence of the pavilion, which is located in the center of the park. It is 4 feet from the border of the nearest walk way through the park. The following true bearings were determined:

	° ′
West point at top of roof of 577 E street (mark)	88 38.3 east of north
Cross on Catholic Church	15 45.0 east of south
North edge at base of flag pole on F Street School	64 20.9 west of south
North edge of ball on flagstaff on park pavilion	71 09.2 east of south

San Diego, San Diego County.—The station of 1897 was reoccupied. It is at Point Loma—about 8 miles by road from San Diego and about 1 000 feet west of the quarantine station. It is in line with the smokestack at the wharf and the southern tower on the Coronado Hotel. The station is marked by a redwood post 3 feet long, projecting about 1 foot above the ground; the top is 4 by 4 inches and is lettered U. S. MAG. on its north face and 1897 on its west vertical face. This post was located about 4 feet west of a small stub over which Assistant Putnam made observations in 1892. The following true bearings were determined:

	° ′
Top of old light-house on Point Loma (mark)	1 15.0 west of south
Flag pole on south cupola of Coronado Hotel	65 09.2 east of south
Cupola on Santa Fe Railroad station	80 30.3 east of north
Smokestack on power house at San Diego	80 15.9 east of north
Cupola on San Diego court-house	79 40.0 east of north
Ball on flag pole of Roseville School	19 13.0 east of north

Stedman, San Bernardino County.—The station is northwest of the center of the village, about 40 feet northeast of the highest point of a small hill about 670 feet west of the railroad track. It is almost directly west of the office of the Bagdad Chase Gold Mining Company. It is 216.5 feet northwest of the northwest corner of the company's house No. 22, and 268.6 feet west of the southwest corner of the shed back of the company's house No. 24. The station is marked by a pine stake 6 by 6 by 24 inches, showing about 10 inches above the ground, with a cross sawed in the top to mark the exact spot. The following true bearings were determined:

	° ′
East edge of roof of cupola of crushing mill (mark)	20 40.5 west of south
South edge of ball on village flag pole	70 49.6 east of south
North point on roof of company's office	87 21.4 east of north
West point on schoolhouse roof	45 01.6 east of south

Temecula, Riverside County.—The station is in the eastern part of a lot owned by Hugh McConville, very near the line dividing the lot from a space left for a road. It is about 800 feet north of the Sante Fe Railway station and about 1 000 feet southeast of the schoolhouse. It is 60.5 feet west of the southwest corner of a fence surrounding a wooden house to the east, 103.7 feet a little west of

Descriptions of stations—Continued.

CALIFORNIA—Continued.

south from the southeast corner of a fence surrounding a wooden house a little to the east of north, and about 112½ feet from a road to the south. The station is marked by a slab of coarse granite which had been in the ground for a long period, and is 3 feet long by 1½ feet wide. This stone is set flush with the ground and is lettered U. S. C. & G. S. 1905. A 1½-inch hole tapering to a point at the bottom marks the exact spot. The following true bearings were determined:

	° ′
Northern point of roof of Sante Fe Railway station (mark)	22 09.7 west of south
Flag pole on cupola of schoolhouse	11 18.6 west of north
Ball at top of rod on hay and grain store	37 26.3 east of south
Top of Sante Fe Railway oil tank	65 06.4 west of south

CONNECTICUT.

Brooklyn, Windham County.—The station is on the Windham County farm, about one-half mile northwest of the jail. It is about three-eighths of a mile north of the street, and about 100 yards from a road passing through the farm. The station is 219.0 feet east of the pasture wall and 155.0 feet west of the brook in same line. This line meets the brook 141.9 feet north of a stone bridge. It is also 194 feet south of a wall between two fields. It is on a small sand hill. The spot is marked by a marble post 3 feet long and 6 inches square, set 11 inches below the surface of the ground and lettered U. S. C. S. A ½-inch hole 1½ inches deep in center of stone marks the exact spot. The following true bearings were determined:

	° ′
Flag pole on jail (mark)	58 26.7 east of south
Congregational Church spire	78 13.9 east of south
Unitarian Church spire	84 57.8 east of south

Danbury, Fairfield County.—The station is on city land in a meadow about 1½ miles due east of the central part of the city, on the east side of a large hill called Shelter Rock. It is about one-fourth of a mile south of the east end of the city filtration beds and about one-eighth of a mile southeast of Starr's barn, which was used as a mark. The station is 211.9 feet from the north post of a gate and 59.5 feet south of a wire fence. The station and gate are in line with a spring in a pasture across the road. A meridian line was established, the south stone being 292.4 feet due south of the station and 84.8 feet from the nearest point of fence behind the road. Both stones are of granite 36 by 6 by 7 inches, with a ½-inch hole 2 inches deep in the center, and are lettered U. S. C. & G. S. The tops of the stones are about 2 inches below the level of the ground. The following true bearings were determined:

	° ′
Gable on Starr's barn (mark)	52 37.4 west of north
Water tank on private farm	37 44.6 east of south
Tip of gable on red barn	81 37.5 east of south

Hartford, Hartford County.—The station of 1890 being no longer suitable for magnetic observations, a new station was selected on a piece of land belonging to the city on the South Meadows, southeast of the town and about one-half mile from the terminus of the Huyshope avenue trolley line. It is about 125 yards from the river and 30 feet south of a cart path. The station is marked by a granite post 74 by 9 by 9 inches, its top dressed 6 inches square, and lettered U. S. C. S. The sides of the top are approximately north and south. A copper plug sunk in the center marks the exact spot. At the request of the city authorities a meridian line was established by setting a second stone similar to the first 236.5 feet due south of it, close to the south boundary of the city land and about 70 feet from a stone post marking the corner of the city property. The following true bearings were determined:

	° ′
Center one of 5 ventilating holes in front wall of powder house (mark)	28 31.4 east of south
Flag pole of Washington street school	89 05.6 west of south
Capitol dome	54 50.6 west of north
Good Shepherd Church spire	53 25.4 west of north
South Baptist Church spire	51 39.4 west of north

Descriptions of stations—Continued.

CONNECTICUT—Continued.

Litchfield, Litchfield County.—The station is about 3 miles south of the town of Litchfield, on a point of land projecting from the northwest shore into Bantam Lake. This point of land is known as the "Folly," and is owned by Doctor Allen, a New York physician. The station is 72.6 feet from the north corner of an old foundation wall and in line with this corner and a wooded point to the north of east. It is 185 feet from the shore, in the line above mentioned, and about 18 feet above the normal level of the lake. The station is marked by a block of granite, 2½ feet long, projecting about 3 inches above the ground. The center of this stone marks the exact spot. The following true bearings were determined:

	°	′	
Catholic Church spire (mark)	35	57.0	east of north
Congregational Church spire	33	35.5	east of north
Court-house spire	32	51.2	east of north
Cottage gable	8	20.7	west of south

Middletown, Middlesex County.—The station is on the grounds of the Connecticut Hospital for the Insane. It is on a hillside sloping gradually toward the Connecticut River, which is about one-third of a mile away to the north. It is 1 mile east of the asylum building. The valley branch of the N. Y., N. H. and H. Railroad runs along the bank of the river. The station is about 350 yards north of the highest part of the hill, but is on the watershed, i. e., the ground slopes gently downward to the east and west. It is marked by a granite post 3 feet long, sunk with the top 10 inches below the level of the ground. The top is dressed 6 inches square, edges approximately north and south, and is lettered U. S. C. S. A hole drilled in the center of the top marks the exact spot. The stone is 236 feet north of a fence crossing the hill, and a perpendicular from the stone to the fence touches the fence 40 feet east of the nearer post supporting a set of bars. The following true bearings were determined:

	°	′	
Tower on middle hospital of Connecticut Insane Asylum (mark)	63	14.2	west of south
Extreme western side of most westerly building of asylum	86	43.9	west of south
Catholic Church spire in Portland	44	52.0	west of north
Spire of church in Portland	34	39.8	west of north

New Haven, New Haven County.—The station of 1895 on the grounds of the Yale Astronomical Observatory was reoccupied. The cedar post bearing the screw to mark the station was found in good condition. It is about 200 feet north of the transit house, and due north of the eyepiece of the transit instrument. The northeast corner of foundation of square part of small observatory bears 35° 29′.8 east of south.

New London, New London County.—The station is on the grounds of the city almshouse, about 1 mile west of the city hall. It is in a small pasture, about 600 feet due west of water tank and 59.0 feet from the west post of gate leading into this pasture. It is 44.6 feet from the nearest point of the north wall and is in line with the northeast corner of the pasture fence and southeast corner of Detention Hospital, which is about 75 yards away. The pasture is about 80 by 85 yards and is full of granite bowlders. A second stone, marking a meridian line, was set 222.8 feet south from the station. It is 21.7 feet from the top of a bowlder in the south wall in line with the meridian. This bowlder is 25.6 feet from the southwest corner of the pasture. The north stone is 2½ feet long and 6 inches square and has its top about 1 inch above ground. The south stone is 27 inches long and 6 inches square and is set flush with the ground. Both stones are lettered U. S. C. S. The following true bearings were determined:

	°	′	
Gable on house (mark)	13	10.2	east of south
Tip of weather vane, south end of Memorial Hospital	50	14.3	east of north
Weather vane on private barn	0	32.4	east of north
South meridian stone	0	02.0	west of south
North edge top of water tower	80	14.5	east of north

Descriptions of stations—Continued.

CONNECTICUT—Continued.

Tolland, Tolland County.—The station is in a field belonging to Mr. Frank Newcomb about one-fourth mile due east of the Tolland Hotel. The region is known to be locally disturbed. The station is in the third field from the street and is 91.1 feet west from the nearest point of the wall next to an orchard and 139.9 feet north of the nearest point of the south wall. It is marked by a granite post 3 feet long and 7 inches square, the top 2 feet below the level of the ground and lettered U. S. C. S. A ½-inch hole 1 inch deep in the center marks the exact spot. The following true bearings were determined:

	° ′
Stable north of Tolland Hotel, weather vane (mark)	89 42.0 west of north
Tip of weather vane of house	14 47.8 west of south
South edge of south chimney of house	63 33.9 west of south
Tip of projecting rod to west	72 37.7 west of north

DELAWARE.

Wilmington, Newcastle County.—Two stations were occupied in Brandywine Park to the northward of Brandywine Creek. Station No. 1 is about midway between the Washington Street bridge and the Baltimore and Ohio Railroad bridge over the creek, being about half a mile from each. The station will be readily found by following the asphalt path through the park from Washington street to the end of the path. A low bluff is then in plain sight. On the summit of this bluff there is a small shanty, and the station is about 100 feet to the southeast of this shanty. It is marked by a hole bored in a rock. The following true bearings were determined:

	° ′
Pole on roof of high school (mark)	23 04.6 west of south
Top of post-office tower	4 24.4 east of south
Top of court-house tower	13 24.4 east of south
Grace Methodist Church spire	5 05.6 west of south

Station No. 2 is near to Eighteenth street, one-half mile west of Washington street, and about 800 feet east of station No. 1. It is in the baseball field, at the highest point of the same, about 25 feet south of Eighteenth street. The station was not permanently marked, as it is in a locally disturbed area.

DISTRICT OF COLUMBIA.

Washington.—Two stations have been occupied. The principal station is the small observatory in the yard adjoining the Coast and Geodetic Survey Office.

The second station is the one established in 1904 in the vacant field west of the "Brown Goode" cottage and the Ontario apartment house, on the bluff overlooking the Zoological Park and south of the present bear pit. It is about 50 feet south of the wire fence of the Zoological Park, about 18 feet southwest of a tree, and about 32 feet northeast of an oak tree 20 inches in diameter. It is marked by an oak stub. The mark used was the southeast corner of a small brick house on Cincinnati street, and bears 18° 58′.2 west of true south. The dome of the Ontario bears 61° 02′.8 east of true south.

FLORIDA.

Key West, Monroe County.—The station of 1903 was reoccupied very nearly and marked by a brass plug lettered U. S. C. & G. S., set in the coral rock about 6 inches below the surface of the ground. The station is on the grounds of the United States barracks, north of the hospital building. It is 79.0 feet and 98.5 feet, respectively, from the brick posts on the northeast and northwest corners of the porch of the hospital; it is also 66.3 feet from the north fence of the barracks. The following true bearings were determined:

	° ′
Northwest tower of armory	1 27.3 east of south
Southeast tower of armory	3 26.4 east of south

Descriptions of stations—Continued.

FLORIDA—Continued.

Miami, Dade County.—The station of 1903 was reoccupied. It is on the site of old Fort Dallas, on grounds owned by Mr. Tuttle and leased by the Seminole Club. It is 32.2 feet north of a poinciana tree, 71.8 feet southeast of the flag pole and 24.5 feet from an hibiscus north of west. The station is marked by a limestone post, 18 by 7 by 7 inches, set level with the ground and lettered on top U. S. C. & G. S., 1903. The following true bearings were determined in 1903:

	° ′
Presbyterian Church spire (mark)	20 35.0 east of north
North edge of city water tower	88 31.9 west of north
Southeast corner of Royal Palm Hotel	68 20.7 east of north

GEORGIA.

Atlanta, Fulton County.—The station of 1896 in the southwest corner of Grant Park was reoccupied. It is 16.4 feet from a sweet-gum tree to the north, 48.5 feet from the nearest side of a double sweet-gum tree to the southeast, and 27.5 feet from the middle of the road to the south. The station is marked by a white limestone post 30 by 8 by 6 inches, set flush with the ground and lettered on top U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Northeast corner of a barn (mark)	28 22.4 west of north
Blazed mark 3 inches square on an oak tree, 10 feet from the ground	8 13.5 west of north
Blazed mark 3 inches square on a magnolia tree, 5 feet from the ground	1 36.3 east of north

Athens, Clarke County.—The station is in the extreme southeast part of the town, in the center of a driveway in the southeastern part of the cemetery. It is on the south side of the Oconee River and on the south side of a triangular lot which is about 175 yards from the river. It is 82.3 feet, 57.4 feet, and 82.0 feet from the nearest corner of the monuments of Mary S. Carithers, Dr. Frank Jackson, and O. C. Gibson, respectively. It is marked by a marble post 8 by 8 by 20 inches, set with its top 3 inches below the surface and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Right edge of right chimney on Mrs. Compton's house (mark)	87 58.4 west of north
Right edge of right chimney on a second house	40 27.3 east of north
Right edge of right chimney on a third house	72 05.3 east of south

Augusta, Richmond County.—The station of 1900 was reoccupied within an inch. It is in May Park, at the eastern end of the city, near the middle of the west side of the park. It is 26.0 feet, 49.1 feet, 79.1 feet, 17.8 feet, and 49.1 feet, respectively, from a walk west, the fence west, a magnolia tree northeast, a walk east, and a magnolia tree south. The station is marked by a Bedford limestone post 7 by 7 by 36 inches and set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Thankful Baptist Church spire (mark)	61 03.0 east of north
Porch post on west side of door at 322 Calhoun street	22 07.4 east of south

Bainbridge, Decatur County.—The station is in the northeastern part of the city, in what is called the Fair Grounds, the property of Mr. George Griffin. It is south of the race track and northeast of the baseball diamond, in what would be the territory between the center and right fielders. It is about 85.3 feet from the outside edge of the race track, 285.4 feet from a blazed pine tree to the northwest, and 132.5 feet from a large oak tree to the southeast. The station is marked by a red cedar post 6 by 6 by 43 inches, set flush with the ground and having the letters U. S. burned in the top on either side of a half-inch hole. The following true bearings were determined:

	° ′
Right edge of mill smokestack (mark)	3 58.7 east of south
A large pine tree	66 20.9 west of north

Descriptions of stations—Continued.

GEORGIA—Continued.

Baxley, Appling County.—The station is in the northeastern part of the town in the large vacant lot just southwest from the school lot, where a fine public schoolhouse is soon to be erected. The station is in the east corner of the lot, 27.9 feet from the center of Barnes street and 39.4 feet from the center of Thomas street. The station is marked by a marble slab 2 by 10 by 20 inches, set with its top 8 inches below the surface of the ground. The following true bearings were determined:

	° ′
County jail spire (mark)	47 33.7 east of south
Old schoolhouse spire	11 45.5 east of south
Baptist Church spire	57 25.3 east of south

Blueridge, Fannin County.—The station is in the northwestern part of the town in the street which runs north of the public school. It is 131.2 feet north of the northwest corner of the schoolhouse, 45.3 feet from the schoolhouse fence, and 88.6 feet from the fence at the west end of the street. The station is marked by a marble post 8 by 8 by 20 inches, set with its top 1 inch above ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Baptist Church spire (mark)	54 19.7 east of south
Southwest corner of Blueridge Furniture Company building	41 25.9 east of south
Left edge of east chimney of Mr. Owensbee's house	46 49.2 west of south

Buenavista, Marion County.—The station is on the public school grounds in the northern part of the town. It is about 118 feet north of the schoolhouse, 65.6 feet from the west fence, and 2 feet to the eastward of the prolongation of the east edge of the building. The station is marked by a hard-wood post 5 by 10 by 30 inches, projecting about 1 inch above ground and having a half-inch hole in the center. The following true bearings were determined:

	° ′
Pinnacle on city water tank (mark)	4 04.2 east of south
Baptist Church spire	23 22.2 east of south
Methodist Church spire	38 45.8 east of south

Carrollton, Carroll County.—The station is in the public park about one-third of a mile northwest of the town square. It is about 65 feet from the road which runs north of the park and about 200 feet from the road which runs east of the park. It is also 36.4 feet from a blazed oak tree to the northeast and 79.4 feet from a large tree to the southeast. The station is marked by a limestone post, 5 by 6 by 30 inches, projecting about 5 inches above ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
McPherson's house spire (mark)	69 15.7 east of north
Blaze on pine tree	88 47.2 east of south
Blaze on oak tree	61 08.5 east of south

Clarkesville, Habersham County.—The station is in the eastern part of the town in a little-used street running east of Mr. Henry Asbury's house. It is 8.2 feet from the fence on the east side of the street, 27.9 feet from the fence on the west side, and 83.7 feet north of the prolongation of the north end of Mr. Asbury's house. The station is marked by a sandstone post 6 by 8 by 24 inches, projecting 1 inch above ground and lettered U. S. The following true bearings were determined:

	° ′
Court-house spire (mark)	53 14.2 west of south
Church spire	35 07.3 west of south
Left edge of south chimney on Hotel "Inn"	4 30.8 west of south

Douglas, Coffee County.—The station is on the school grounds south of the large brick schoolhouse. It is 166.0 feet from the southeast corner of the building, in line with the east face of the building. It is also 169.0 feet from the wooden school building to the northeast. The station is marked by a 4-inch terra-cotta drainpipe, 2 feet long, set with its top 6 inches below the surface. The top is

Descriptions of stations—Continued.

GEORGIA—Continued.

plugged with a piece of hard wood, in which were burned the letters U. S. The following true bearings were determined:

	° ′
Court-house spire (mark)	46 30.2 west of north
Schoolhouse spire	5 45.5 west of north
Episcopal Church spire	66 02.5 east of north
Tanner Hotel, southwest pole	67 21.4 west of north

Dublin, Laurens County.—The station is in the northwestern part of town, just north of the old Methodist Church, in a lot belonging to Captain Smith. It is 42.0 feet from the cemetery fence on the north, 93.5 feet from the center of the road on the east, and 117.8 feet from the projection at the northeast corner of the church. The station is marked by a marble post 6 by 6 by 25 inches set with the top 4 inches below the surface and lettered U. S. on top. The following true bearings were determined:

	° ′
Court-house spire (mark)	80 53.1 east of south
Presbyterian Church spire	60 06.2 east of north
Spire on Banking Company building	77 36.1 east of south

Dupont, Clinch County.—The old station could not be found, so a new one was established three or four hundred yards northeast of the railroad station. It is about 72 feet north of the Methodist Church, in line with the east side of the church, and about 57 feet from the center of the road which runs east of the church. The station is marked by a live-oak post 4 by 7 by 25 inches, set flush with the ground and having the letters U. S. dimly burnt on the top. The following true bearings were determined:

	° ′
Railroad water tank (mark)	24 26.2 west of south
Schoolhouse-Baptist Church, top of spire	9 27.1 east of north
South side of south chimney on hotel	46 36.7 east of south
South side of south chimney on A. J. Gibbs's house	83 37.0 west of north

Elberton, Elbert County.—The station is west of the court-house, in the public school grounds. It is about 279 feet southwest of the schoolhouse, 85 feet from the fence which extends south from the southwest corner of the schoolhouse, and 33 feet from the south fence of the grounds. The station is marked by a granite post 4 by 9 by 24 inches, set flush with the ground and lettered U. S. on its sloping top. The following true bearings were determined:

	° ′
Baptist Church pinnacle (mark)	67 57.8 east of south
Court-house dome	63 46.9 east of south
Methodist Church spire	55 11.1 east of south
Presbyterian Church pinnacle	28 11.5 east of south

Gainesville, Hall County.—The station is in the cemetery on West Broad street, in the western portion of the town. Entering the gate nearest town the station may be reached by going about 500 feet to the north and then turning into a cross drive to the east. The station is about 102 feet from the center of the north and south road, 70.5 feet from the nearest corner of Dr. L. T. Looper's monument, and 59.7 feet from the east fence. The station is marked by a marble post 8 by 8 by 24 inches, set with its top 1 inch below the surface and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Court-house spire (mark)	45 29.8 east of north
Baptist Church spire	45 57.2 east of north
Hobbs Chapel spire	78 40.6 east of south
Presbyterian Church spire	36 18.1 east of north

Gibson, Glascock County.—The station is in the public school grounds, about one-fourth of a mile northwest of the court-house. It is 106 feet from the street to the west, 40 feet from the fence to the

Descriptions of stations—Continued.

GEORGIA—Continued.

east, and 89.5 feet and 70.5 feet, respectively, from the southwest and southeast corners of the school building. It is marked by a Bedford limestone post 7 by 7 by 36 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The Baptist Church spire was used as a mark, and bears 41° 44′.6 west of true south.

Hawkinsville, Pulaski County.—The station is in the public school grounds in the southwestern portion of the town. It is 87.3 feet from the southeast corner of the fence which surrounds the small lot south of the schoolhouse and in line with the south fence. It is also 63.3 feet from a large tree to the northeast, 121.4 feet from the street to the east, and about 150 feet from the southeast corner of the schoolhouse. The station is marked by a granite post 7 by 9 by 25 inches, set flush with the ground and lettered U. S. on top. The following true bearings were determined:

	° ′
Court-house cupola (mark)	35 53.2 east of north
Baptist Church spire	1 12.8 east of north
J. L. Huggins's house, main spire	82 35.2 east of north

Jackson, Butts County.—The station is in the cemetery in the southwestern part of the city. It is in the southwestern part of the cemetery, about 98 feet from the south fence and 102 feet from the west fence. It is 90.6 feet from the northeast corner of the Webb monument and 121.9 feet from the southeast corner of the Harris monument. The station is marked by a rectangular stone 6 by 8 by 20 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Court-house spire (mark)	49 10.6 east of north
Baptist Church spire	65 24.3 east of north
Methodist Church spire	66 04.2 east of north

Jesup, Wayne County.—The old station being no longer available, a new station was established in the public school grounds in the southeastern part of the town. It is east of the schoolhouse in prolongation of the south side of the building, 143.1 feet from the southeast corner and 150.8 feet from the northeast corner. The station is marked by a Georgia marble post 6 by 6 by 24 inches, set with its top 6 inches below the surface and having a cross dimly cut in the top. The following true bearings were determined:

	° ′
Court-house spire (mark)	35 14.5 west of north
Methodist Church spire	50 49.1 west of north
Railroad water tank	44 26.4 west of north
Mr. Letter's house cupola	60 55.8 west of north

Lagrange, Troup County.—The station is in the southeastern part of the cemetery in the northeastern part of the city. It is 66.3 feet from the east fence of the cemetery and 56.8 feet from the south fence, 153.2 feet from the nearest corner of the Dillard monument, and 76.4 feet from a blazed maple tree just outside of the cemetery. The station is marked by a limestone post 5 by 6 by 30 inches, projecting about 1 inch above ground and lettered U. S. The following true bearings were determined:

	° ′
Court-house dome (mark)	30 18.7 west of south
Church spire	40 28.7 west of south
Cemetery pinnacle	61 40.1 west of south

Louisville, Jefferson County.—The station is in the grounds of the academy or high school, about one-half mile north of the court-house. It is on the boys' side of the lot, about 9 feet from the street. It is 146.0 feet and 166.7 feet, respectively, from the south and north corners of the academy building, and 104.6 feet from the southwest corner of the new kindergarten building. It is marked by a Bed-

Descriptions of stations—Continued.

GEORGIA—Continued.

ford limestone post 7 by 7 by 36 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
W. L. Phillips's windmill (mark)	61 40.0 east of north
J. C. Little's windmill	41 28.9 east of north
Standpipe of water tank	6 19.1 east of south
Baptist Church spire	30 18.3 east of south
M. E. Church spire	38 39.2 east of south

Observations were also made at a point 41.2 feet from the principal station in line to Phillips's windmill, (A).

Macon, Bibb County.—The station of 1900 being no longer available, a new station was established on the east side of the mile race track in Central City Park. It is 26.2 feet east of the track, 117.1 feet south of the grand stand, 196.8 feet south (measured along the track) of the starting point of the mile, and 213.2 feet west of a blazed tree. The station is marked by a marble post 9 by 9 by 24 inches, projecting 1 inch above ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Smith Art Hall, flagpole at south entrance (mark)	71 01.2 west of north
Center dome of Massee Hall	59 21.3 west of north
Pole on main stable at race track	83 45.6 west of north
Left edge of top of tall smokestack	65 11.4 west of south

Madison, Morgan County.—The station is in the eastern part of the town on the highest summit of the premises of Mr. L. B. Chambers. The station is between his house and a small cemetery, 177 feet from the house, and 92 feet from the brick wall enclosing the cemetery. The station is marked by a piece of marble 12 by 18 by 22 inches, set flush with the ground and lettered U. S. on top. The following true bearings were determined:

	° ′
Academy spire (mark)	57 31.3 west of south
Baptist Church spire	62 47.4 west of south
Old court-house spire	73 06.4 west of south
City hall spire	76 48.0 west of south

Mount Vernon, Montgomery County.—The station is in the northeast corner of the court-house square, between the court-house and the jail. It is 68.2 feet from the center of the street to the north, about 43 feet from the center of the street to the east, and 99.7 feet from the northeast corner of the court-house. The station is marked by two sandstones placed one above the other, the lower one being 18 inches below the surface and the upper one 8 inches below. A cross was cut in the upper surface of each. The following true bearings were determined:

	° ′
Baptist Church spire (mark)	7 13.6 west of north
Methodist Church spire	78 11.0 west of south

Reidsville, Tattnall County.—The station is in the public square on the west side of the court-house. It is 123.4 feet from the northwest corner of the court-house, 128.9 feet from the southwest corner, 98.4 feet from the north end of the lowest step and 5.9 feet north of the east and west line through the center of the court-house. It is marked by a granite post 4 by 10 by 48 inches, set flush with the ground. The following true bearings were determined:

	° ′
Methodist Church spire (mark)	13 57.4 west of south
Southwest corner of bank building	74 36.3 east of south
Left side of chimney on Folsom house	73 04.9 east of south

Sandersville, Washington County.—The station is on the schoolhouse grounds about a quarter of a mile southeast of the court-house. It is in the northwest corner of the grounds, in line with the

Descriptions of stations—Continued.

GEORGIA—Continued.

westernmost wall of the school building. It is 117.8 feet, 58.5 feet, 49.5 feet, and 69.2 feet respectively from the northwest corner of the schoolhouse, the northeast corner of the music rooms, the north fence, and the west fence. The station is marked by a drill hole in a limestone post 7 by 7 by 36 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Baptist Church spire (mark)	70 04.2 west of south
Court-house spire	60 21.9 west of north
Cohen's windmill	19 13.5 west of north

Swainsboro, Emanuel County.—The station is in the grounds of the new schoolhouse, about half a mile west of the court-house. It is about 170 feet from the fence to the northwest and 95 feet from the southwest line of the school property. It is also 185.7 feet, 139.6 feet, and 167.3 feet respectively from the north corner of the front portion of the school building, the west corner of the main portion, and the west corner of the small extension at the rear. The station is marked by a Bedford limestone post 7 by 7 by 36 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Court-house dome (mark)	80 55.5 east of north
M. E. Church spire	52 06.7 east of north
Baptist Church spire	83 32.3 east of south

Observations were also made at a second station, (A), 47.9 feet south-southwest of the first.

Sylvania, Screven County.—The station is on the academy grounds about one-fourth mile southwest of the court-house. It is 90.7 feet north of the northeast corner of the foundation of the academy building, 128.7 feet from the northwest corner, 24.9 feet northwest from a small tree 2 inches in diameter, and 23.3 feet southwest from another small tree 2 inches in diameter. The station is marked by a half-inch drill hole in the center of a stone 7 by 7 by 36 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
M. E. Church spire (mark)	9 29.3 east of north
Mr. Hilton's windmill	2 02.8 west of north
Water tank	28 35.8 east of north
Main spire on court-house	40 37.6 east of north
Baptist Church spire	83 16.8 east of north
House gable	30 36.4 west of south

Observations were also made at a point, (A), 39.8 feet from the station in line to the M. E. Church spire.

Thomaston, Upson County.—The station is in the southwest corner of the public school grounds, one block east and two blocks south from the court-house. There are four large oak trees to the east and southeast from the station. The nearest one was blazed and is 121.4 feet distant. The station is 215.2 feet from the southwest corner of the schoolhouse and about 52 feet from the center of the road west of the school-house. It is marked by a marble post 8 by 10 by 20 inches, projecting 1 inch above ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Court-house spire (mark)	28 37.1 west of north
Methodist Church spire	18 33.4 west of north
Mrs. Mathews's house, main cupola	50 04.8 west of north

Valdosta, Lowndes County.—The station of 1903 was reoccupied. It is in the main division of the Valdosta Cemetery, 60.3 feet from the south fence, 12 feet south of an old pine stump, and 58.1 feet east of the nearest occupied lot of the cemetery. The station is marked by a marble post 31 by 6

Descriptions of stations—Continued.

GEORGIA—Continued.

by 6 inches, sunk 2 inches below the ground and lettered on top U. S. C. & G. S., 1903. The following true bearings were determined in 1903:

	° ′
Tower on Dr. J. C. Wilson's residence (mark)	62 44.2 east of south
South edge of the largest chimney on Mrs. Kneller's residence	88 00.4 east of south
East edge of east chimney of Mr. Byrd Belote's residence	26 47.6 west of south

Washington, Wilkes County.—The station is in the cemetery in the southwestern part of the town. It is in the east and west road which crosses the entrance road about 675 feet from the gate at the northeast entrance, and about 165 feet from this entrance road. It is 57.7 feet from the fence on the east, 18.4 feet from the lot on the south, and 22.0 feet from the lot on the north. The station is marked by a red sandstone post 8 by 12 by 30 inches, set flush with the ground and lettered U. S. The following true bearings were determined:

	° ′
St. Joseph's Academy, boys' dormitory spire (mark)	22 30.0 east of north
St. Joseph's Academy, girls' dormitory spire	29 14.7 east of north
Catholic Church spire	27 33.3 east of north
Methodist Church spire	68 27.0 west of north

Waycross, Ware County.—The station of 1887 could not be found, and a new station was established in the north end of town in the north corner of the cemetery. It is in a walk about 87 feet from the northwest fence and about 94 feet from the northeast fence. It is about 2½ feet southwest of the south point at the intersection of two walks. The station is marked by a marble headstone 2 feet long with a triangular cross section about 7 by 7 by 10 inches, set with the top about 6 inches below the surface of the ground. The following true bearings were determined:

	° ′
Court-house spire (mark)	2 05.5 west of south
Left side of base of high chimney on Mr. Gasset's house	52 30.4 west of south
Left side of left-hand chimney on Mr. O'Haggen's house	54 47.9 west of south

Waynesboro, Burke County.—The station is on the academy grounds, about half a mile northwest of the court-house. It is southeast of the academy building, 84.2 feet from the southeast corner and 127.2 from the northeast corner. It is nearly midway between the second and third trees of the third north and south row (counting from the street). The station is marked by a stone post 7 by 7 by 36 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Court-house spire (mark)	50 02.4 east of south
Methodist Church spire	77 38.8 east of south
Presbyterian Church spire	83 09.2 east of north
New Baptist Church spire	13 17.4 east of north
Negro Church spire	17 05.8 west of north

HAWAII.

Honolulu Magnetic Observatory, Oahu Island.—The observatory is about 12½ miles west of Honolulu and about three-fourths of a mile south of the station Sisal on the Oahu Railway. The observatory is described in Appendix 5, Report for 1902.

Puu Olai, Maui Island.—The station is on the west coast of the island, on the flat near the beach just south of the triangulation station Puu Olai. It is also 188 feet nearly north of signal Mid. It is marked by a 4 by 4 inch wooden post, set 3 feet in the ground, projecting about 4 inches above the surface. The following true bearings were determined:

	° ′
Pointed peak beyond the rolling hills northeast of La Perouse Bay (mark)	78 42.4 east of south
Mid signal	1 28.1 east of south
Big signal	68 28.1 west of north
Puu Olai triangulation station	26 04.8 west of north

Descriptions of stations—Continued.

IDAHO.

Arco, Blaine County.—The station is in the northwest corner of the grounds surrounding the public school, about 1 800 feet west of the railroad station. It is 14.6 feet southeast of the stake marking the northwest corner of the public school grounds, 215.8 feet northwest of the northwest corner of the school building, and about 42 feet from a road to the north, running east and west from the town's center. The station is marked by an elm post 4 by 3 inches on top and about 4 by 4 inches at the center and 30 inches long, showing about 5 inches above ground. A cross sawed in the top marks the exact spot. The following true bearings were determined:

	° ′	
South edge at top of railroad water tank (mark)	31 57.1	east of north
North corner at top of roof of church	73 25.2	east of north
Rod on the south end of a barn	42 59.0	east of south

Blackfoot, Bingham County.—The station is on the grounds of the State insane asylum, in the northwest corner of the field just south of the grounds immediately surrounding the main asylum building. It is a short distance beyond the first fence south of the asylum office, between an irrigation ditch and a fence to the west, along a road running north and south. It is 77 feet from a fence to the north, 57.8 feet from a fence to the west, and about 9 feet west of the western bank of an irrigation ditch running north and south. It is marked by a glazed earthen pipe 6 by 24 inches, set flush with the ground and partly filled with cement and lettered U. S. C. & G. S., 1905. The following true bearings were determined.

	° ′	
Methodist Church steeple (mark)	81 32.1	west of north
Public school belfry	70 00.2	west of north
Baptist Church cupola	62 24.7	west of north
Flag pole on court-house cupola	72 22.9	west of north

Dubois, Fremont County.—The station is on Government land near the northeast corner of a fenced section of land which contains in its northern part a cemetery. The station is about a mile and a quarter east of the Oregon Short Line Railroad station. It is 94.2 feet east of the east fence, measured in line with the eastern point on the roof of a house, almost directly west from the magnetic station and in line with the center of the cemetery, and 120 feet southeast of the northeast corner of the fence. It is marked by an oak post 3 by 3 by 36 inches, showing about 1 foot above ground and having a cross sawed in the top. The following true bearings were determined:

	° ′	
Schoolhouse belfry (mark)	56 15.0	west of north
Tip of railroad water tank	49 34.0	west of north
North edge of railroad pumping station	46 15.3	west of north
Base of flagstaff on a store	53 34.7	west of north

Malad City, Oneida County.—The station is in the northeast corner of the public school grounds, about a mile and a half north of the town's center. It is 126.7 feet from the fence to the east, 117 feet from the fence to the north, and 379 feet from the northern corner of the school building. It is marked by an oak post 5 by 6 by 30 inches, showing 2 inches above ground, with a cross sawed in the top. The following true bearings were determined:

	° ′	
Tip of highest cupola on the tabernacle (mark)	58 48.5	west of south
Top of flagstaff in front of schoolhouse	2 23.7	east of south
Southwest edge of public schoolhouse	5 44.5	east of south

Minidoka, Lincoln County.—The station is on Government land, about half a mile south of the town's center. It is 15.9 feet south of the southern town section line and 229.4 feet a little south of east from the lava stone marking the southwest section of the town section. It is marked by a

Descriptions of stations—Continued.

IDAHO—Continued.

cedar post of irregular cross section about 6 by 4 by 48 inches, showing about 1½ feet above ground and having a cross sawed in the top. The following true bearings were determined:

	° ′
Schoolhouse belfry (mark)	7 01.9 east of north
Western edge of top of railroad water tank	0 52.4 east of north
East gable of pumping station	4 11.6 east of north

Pocatello, Bannock County.—The station is in the southern corner of the grounds of the Idaho State Academy, about 1½ miles east of the town's center. It is 72.7 feet from the fence to the southeast along Terry street and 62.3 feet from the fence to the southwest along Sixth avenue. It is marked by a lava post 8 by 8 by 30 inches, showing about 1 inch above ground and having a cross in the top to mark the exact spot. The following true bearings were determined:

	° ′
Episcopal Church steeple, cross (mark)	83 59.3 west of north
Catholic Church steeple	85 40.4 west of north
Presbyterian Church steeple	53 57.9 west of north
Court-house cupola	45 42.9 west of north

Shoshone, Lincoln County.—Observations were made over a lava block about 10 inches square on top and showing about 8 inches above ground. This stone is set firmly in a slanting position and marks the southeast corner of the township section. It is placed where a dry irrigation ditch running along the eastern side of the township, turns and runs along the southern side, about half a mile from the town's center. The land to the east belongs to the Oregon Short Line Railroad Company. The following true bearings were determined:

	° ′
Northwest corner of most easterly of railroad shops (mark)	79 06.8 east of north
Northwestern point at top of large brick smokestack	79 08.6 east of north
Southern gable of roof of middle railroad shop	73 24.9 east of north
Northwestern point at top of smokestack	63 31.1 east of north
Highest point on mountain range	13 37.0 east of north

Soda Springs, Bannock County.—The station is in the southeast corner of the town square, about 800 feet south of the water tank of the Oregon Short Line Railroad. It is 183 feet from the fence on the east side of the road to the east and 80.4 feet northwest of a post which is at the southeast corner of the town square, the corner from which the town survey was started. The station is marked by an oak stake 2½ by 5 by 28 inches, showing about 5 inches above ground and having a cross sawed in the top. The following true bearings were determined:

	° ′
Tip of railroad oil tank (mark)	0 13.2 west of north
West edge of flagstaff on schoolhouse belfry	5 00.5 west of north
Flagstaff on southwest corner of Idan Ha Hotel	24 14.9 west of north
Point at east end of roof of railroad station	8 53.1 west of north

ILLINOIS.

Bloomington, McLean County.—The station of 1891 was reoccupied. It is in the northwest corner of the grounds of the Illinois State Normal School, 60.3 feet and 141.6 feet from the north and west fences, respectively. The station is marked by a limestone post, 4 by 8 inches, projecting 6 inches above ground. The letters U. S. have been partly defaced. The following true bearings were determined:

	° ′
Rod on cupola of main university building (mark)	51 23.7 east of south
Northeast corner of main building just above stone foundation	62 17.2 east of south
Flagstaff on gymnasium	19 33.7 east of south

Descriptions of stations—Continued.

ILLINOIS—Continued.

Freeport, Stephenson County.—The station is in Taylor's Park, one-half mile east of the town, owned by Mr. J. B. Taylor. It is 126.1 feet from a line of ash trees on the east side (inside) of the race course, measured from a point 288 paces north of the starting wire and 112 paces south of a large culvert under the course. The station is marked by a Bedford stone post, 6 by 6 by 30 inches, sunk 29½ inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Staff on dome of court-house (mark)	56 23.5 west of south
Spire of First Presbyterian Church	56 08.7 west of south
Spire of St. Joseph Catholic Church	42 36.7 west of south
Cupola on pavilion in park	7 28.6 east of south

Havana, Mason County.—The station is in Laurel Hill Cemetery, 2 miles east of the town of Havana. It is in the intersection of the first alley south of the main east-and-west driveway with the second alley west of the main north-and-south driveway. It is 63.0 feet, 22.4 feet, and 76.4 feet, respectively, from the northwest corner of the base of the Schulte monument, the northeast corner of the Caldwell monument, and the southwest corner of the Teneyck monument. The station is marked by a limestone post 6 by 10 by 30 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Ball on cupola of public school (mark)	76 18.3 west of north
Spire on Lutheran Church	73 55.6 west of north

Hillsboro, Montgomery County.—The station is on the grounds of the Hillsboro High School, about three-quarters of a mile southwest of the court-house. It is southwest of the school building, and 374.0 feet and 380.3 feet, respectively, from the northwest and southeast corners of the building. It is also 51.7 feet and 45.6 feet from two large oak trees bearing, respectively, 40° east of north and 5° west of north. The station is marked by a sandstone post 5 by 7 by 30 inches, lettered U. S. C. & G. S., 1905, and set 31 inches in the ground. The following true bearings were determined:

	° ′
Baptist Church spire (mark)	26 18.0 east of north
Base of flagstaff on county court-house	25 47.6 east of north

Knoxville, Knox County.—The station is on the grounds of the St. Mary's School, in an inclosed park south of the buildings. It is 117.1 feet from the north fence of the park and 189.4 feet from the east fence. It is also 43.9 feet from a walnut tree 8 inches in diameter, bearing about 75° west of north. The station is marked by a Bedford limestone post 6 by 6 by 30 inches, set 29½ inches in the ground, and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Point of tower on Presbyterian Church (mark)	20 23.9 west of south
Apex of roof of Presbyterian Church	21 19.1 west of south
Ball on cupola of high school	1 41.6 east of south

Princeton, Bureau County.—The station is on the grounds of the Princeton High School, 79.4 feet from a line of trees along the north side of the grounds and 135.0 feet from a similar line on the west side. It is marked by a Bedford limestone post 6 by 6 by 30 inches, lettered U. S. C. & G. S., 1905, and sunk 29½ inches in the ground. The following true bearings were determined:

	° ′
Northeast corner of High School building (mark)	27 48.4 east of south
Middle of north gable of house on Thompson estate, south of the school building	3 43.2 east of south

Descriptions of stations—Continued.

INDIAN TERRITORY.

Claremore, Reservation No. 4.—The station is in the western part of the grounds surrounding the public school, which is northeast of the town's center. It is west of the schoolhouse and southwest of a small wooden church about 250 feet north of the schoolhouse. It is 56.9 feet from a fence to the south, 98.5 feet from the northwest corner of most western of two additional wooden schoolhouses, 190 feet west of the northwest corner of the main brick schoolhouse, and about 114 feet from a road to the north. The station is marked by a brownstone about 20 by 6 by 6 inches, set flush with the ground, and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Baptist Church steeple (mark)	6 04.8 east of south
Flag pole on cupola of Sequoyah Hotel	89 11.1 west of south
Cupola on John Bullock's house	87 29.4 west of north
Flag pole on building across the street from Sequoyah Hotel	87 40.6 west of north

Okmulgee, Reservation No. 9.—The station is in the southwest corner of the field immediately surrounding the Creek Indian School building, which is about 2 miles east of the town's center. It is 59.7 feet from a fence to the west, 59.4 feet from a fence to the south, 163.7 feet from the southwest corner of the school building, and 209.3 feet from the northwest corner of the school building. The station is marked by a sandstone 24 by 6 by 6 inches, showing about 1 inch above ground, and lettered in the usual way. The following true bearings were determined:

	° ′
Flag pole on west end of principal business block (mark)	82 37.0 west of south
Methodist Church spire	85 31.6 west of south
Flag pole in front of brick public school	89 03.5 west of south
Flag pole on cupola of Key Block	84 23.2 west of south

Sapulpa, Reservation No. 6.—The station is in the western part of the grounds surrounding the old wooden public schoolhouse, which will remain town property, and is about one-fourth of a mile east of the town's center. The station is west of the old schoolhouse, 75.7 feet from the northwest corner, 78.4 feet from the southwest corner, and about 78 feet from the road to the north and about 111 feet from the road to the west. It is marked by a sandstone, 18 by 6 by 6 inches, set flush with the ground, and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
South M. E. church steeple (mark)	51 10.2 west of south
Top of south edge of town water tank	69 42.3 west of south
North Methodist Church steeple	40 12.8 east of north
Bell tower on new brick school	85 28.9 east of south

Tahlequah, Reservation No. 6.—The station is in the southeastern part of the Presbyterian Mission School grounds, about one-half mile west of the center of town. It is 11.5 feet from a wooden fence to the north, 202.8 feet from a fence to the east, and 106.2 feet northwest from the northwest corner of the school building. It is also northeast of the Presbyterian Home, 235 feet from the northeast corner of the Home building. The station is marked by a brownstone, 28 by 6 by 6 inches, set flush with the ground, and lettered U. S. C. & G. S., 190&. The fence to the north is adjacent to a strip of land about 70 feet wide, which will probably be taken up by the mission. The following true bearings were determined:

	° ′
Presbyterian Church spire (mark)	83 27.3 east of south
Tip of bell tower to the southeast	41 48.1 east of south
South edge of vertical arm of cross on small wooden church	82 12.6 east of south
Flagpole on land office	73 23.0 east of south

Vinita, Reservation No. 2.—The station of 1888 being no longer available a new station was established upon rising ground in the southwestern corner of North Park, almost due west of the town water tank, south of Halsell College, and a short distance (about 200 feet) northeast of the house which is at this corner of the park, but across the road. It is northeast of the intersection of

Descriptions of stations—Continued.

INDIAN TERRITORY—Continued.

two roads at the southwest corner of the park, 121 feet from the road to the west, and 175 feet from the road to the south. The station is marked by a hard sandstone 30 by 6 by 6 inches, about 4 inches of which is above ground, which is lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Bell tower on public school (mark)	34 02.2 west of south
Church steeple on corner of South Smith street and main street of town	26 47.2 west of south
South M. E. Church steeple	18 42.1 west of south
Flag pole on Halsell College	22 58.6 east of north

Wagoner, Reservation No. 7.—The station is in the southwest corner of the town park, which is about 1 mile northeast of the town center. It is also nearly due north of the flag pole on Central College public school, about 1 mile away. It is 149.5 feet from the park fence to the west and 264.7 feet from the park fence to the south. It is east of two green painted houses in line across the road running along the west side of the park. The station is marked by a pecan-wood stake, 2 inches square, showing about 6 inches above ground, with a nail in the top marking the exact spot. The following true bearings were determined:

	° ′
Ball on flag pole of Central College public school (mark)	1 01.6 west of south
Cupola on brick public school	55 15.6 west of north
Top of large water tower	33 33.7 west of north
Eastern point at top of central cupola, city hall building	73 40.5 west of south

IOWA.

Keokuk, Lee County.—The station is very near the station of 1900, on lots formerly owned by Mr. H. H. Clark, now owned by Mrs. Huiskamp, corner of Second and Blondeau streets. It is 66.6 feet from the middle of the sidewalk along Blondeau street, 71.5 feet from the northeast corner of the Huiskamp residence, and 67.7 feet from the northwest corner of the same. It is also 34.8 feet from a wooden fence to the north. The station is marked by a Bedford stone post 6 by 6 by 30 inches, sunk 29½ inches in the ground, and lettered U. S. C. & G. S., 1905. The following true bearing was determined:

	° ′
Projecting cornice on building about 75 yards distant (mark) (Vertical line nearest the roof.)	14 54.7 west of south

KANSAS.

Abilene, Dickinson County.—The station of 1902 was reoccupied. It is on the grounds of the St. Joseph Academy, 333 feet slightly east of south of the college building and 293 feet from the west line of a highway along the edge of the grounds. The station is marked by a limestone post 7 by 7 by 36 inches, projecting 6 inches above the ground and lettered on top U. S. C. & G. S., 1902. The following true bearings were determined:

	° ′
East edge of water tank in Abilene cemetery (mark)	27 04.8 west of south
West edge of standpipe	9 05.8 west of south
Flag pole, schoolhouse	1 20.2 west of south

Baldwin, Douglas County.—Observations were made in the absolute house of the magnetic observatory. The mark used is the flagstaff on Science Hall, Baker University, and bears 48° 20′.6 west of true north.

Cimarron, Gray County.—The station is on the grounds of the public school. It is 148.8 feet and 151.4 feet, respectively, from the northwest and northeast corners of the building. The station is

Descriptions of stations—Continued.

KANSAS—Continued.

marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Presbyterian Church steeple (mark)	18 20.4 west of south
M. E. Church steeple	6 25.6 east of south
Base of flagstaff on the New West Hotel	53 16.9 west of south

Clay Center, Clay County.—The station is in a little-used street on the north side of the city. It is near the south side of Anthony avenue, between Sixth and Seventh streets, about the middle of the block. It is 149.3 feet southeasterly from the southeast corner of George Mauch's house, in a straight line toward the chimney on Elmer Spurrior's house. It is 67.0 feet from the fence along the north side of the street. The station is marked by a hole in the top of a limestone post 6 by 6 by 30 inches, set flush with the surface and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Flag pole on high school (mark)	8 31.7 east of south
Spire on court-house tower	7 13.8 west of south
M. E. Church spire	13 23.5 west of south

Concordia, Cloud County.—The station is in the city park, on high ground toward the western side, in what is now center field of baseball grounds. There is an elm tree (6 inch) to the southward, 58.9 feet distant, and an elm tree (6 inch) to the northward, at the foot of the hill, 153.9 feet distant. The station is 2.7 feet to the west of a line joining the two trees. It is marked by a sandstone post 8 by 8 by 19 inches, set flush with the top of the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
U. B. Church spire (mark)	45 33.2 east of north
Court-house tower	30 09.5 east of north
Schoolhouse tower	3 57.6 east of north
Tip of standpipe	29 30.2 west of north

Dighton, Lane County.—The station is on the grounds of the public school, northeast of the building. It is 143.1 feet, 110.2 feet, and 159.0 feet, respectively, from the southeast, the northeast, and the northwest corners of the school building. It is 51.8 feet from a wire fence on the east line of the school grounds and 64 feet from an iron pump that bears 10° east of north. The station is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Base of flagstaff on court-house (mark)	5 15.2 west of south
M. E. Church steeple	6 45.1 east of south
Christian Church steeple	33 44.8 west of south

Dodge City, Ford County.—The station is in the northern part of the city, on the grounds of the Second Ward school, northwest of the school building. It is 163.3 feet and 196.9 feet, respectively, from the northwest corner of the building and the left-hand corner of the steps to the entrance at the southwest corner of the building. It is 59.6 feet from the west line of the grounds and 65.5 feet from the north line. It is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered on top U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Catholic Church spire (mark)	11 41.2 west of south
Baptist Church steeple	11 02.4 west of south

Eldorado, Butler County.—The station is on the county fair grounds within the race track. It is northeast of the grand stand and in line with the north gables of the floral hall and grand stand. It is also in line with the highest chimney on William Bailey's house, to the northwest, and the quarter-mile pole. It is 157 feet east from the inner edge of the race track. The station is marked by a native

Descriptions of stations—Continued.

KANSAS—Continued.

limestone post 5 by 7 by 31 inches, set flush with the ground and lettered on top U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Central School cupola (mark)	58 48.9 west of south
City standpipe, north edge	55 11.8 west of south
Cupola on city building	22 55.7 west of south

Ellis, Ellis County.—The station is on pasture land belonging to Mr. C. M. Raynesford about three-fourths of a mile southwest of the town of Ellis. It is on a hill 40 or 50 feet above the general level and is on the south side of and back about 250 feet from what is known as Spring Creek. The hills along the south side of the river are outcropping limestone. The station is also 60 paces south of a stone ice house belonging to Mr. Raynesford, on the south bank of the river. It is marked by a limestone post 6 by 6 by 30 inches, set 28 inches in the ground and lettered U. S. C. & G. S., 1904, having a ½-inch hole as a center mark. The following true bearings were determined:

	° ′
Mr. Raynesford's house, east gable (mark)	71 03.6 west of north
Base of flagstaff on public school	67 53.6 east of north

Ellsworth, Ellsworth County.—The station is near the middle of the south side of a farm belonging to the State Home for Soldiers' Widows (Bryckerdyke Home), being the southwest quarter of section 29, township 15 south, range 8 west of the sixth principal meridian. It is on a high ridge, unfit for cultivation, about 40 feet west of an outcropping ledge of sandstone and 66 feet north of the osage hedge bounding the farm on the south. The precise point is marked by a hole in a limestone post 6 by 6 by 30 inches, set about 4 inches above the surface of the ground and marked U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Chimney on school building (mark)	87 23.4 east of south
Tower, Ellsworth County court-house	27 30.8 east of north
Water tower Ellsworth city waterworks	13 36.4 east of north
Tower on Larkin residence	11 17.5 east of north
Triangulation signal on hill	32 41.8 east of south

Garden City, Finney County.—The station is on the fair grounds, within the oval race track. It is 321.7 feet from the northwest corner of the judges' stand, 166.6 feet from the inside edge of the race track, north, and 157 feet from an old reservoir (dirt embankment), bearing about 30° west of south. The station is marked by a limestone post 6 by 6 by 30 inches, set 29 inches in the ground and lettered on top U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Presbyterian Church steeple (mark)	34 43.9 east of north
Flagstaff on city fire department building	45 35.4 east of north
South side school cupola	88 34.7 east of south
Flagstaff on judges' stand	7 44.5 east of south

Gove, Gove County.—The station is on the grounds of the public school, southwest of the building. It is 96.8 feet and 128.8 feet, respectively, from the southwest and southeast corners of the school building, and about 70 feet from the west boundary of the school grounds. The station is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered on top U. S. C. & G. S., 1904, and having a ½-inch hole as a center mark. A second stone, 6 by 12 by 24 inches, was set due south from the magnetic station, marking a meridian line 882.6 feet long. This stone is about on the south edge of a street running east and west (no road nor fences). The following true bearings were determined:

	° ′
M. E. Church spire (mark)	17 11.2 east of south
Point of arch over door of town hall	31 21.8 east of south

Descriptions of stations—Continued.

KANSAS—Continued.

Great Bend, Barton County.—The station of 1878 being no longer available, a new station was established on the grounds of the Catholic school, in the western part of the city. It is 249.2 feet and 255.5 feet, respectively, from the southeast and northeast corners of the building, 166.0 feet from the southwest corner of a frame house across the street northeast, and 62.2 feet from the edge of the street along the east side of the grounds. The station is marked by a limestone post 6 by 8 by 30 inches, set 29 inches in the ground and lettered on top U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Flagstaff on court-house (mark)	81 50.1 east of south
Point of ornament on south end of roof of Catholic hospital	76 28.4 east of south

Greensburg, Kiowa County.—The station of 1902 was reoccupied. It is near the east center of the block that is bounded on the north by Florida avenue and on the east by Sycamore street. It is 6 feet west of the edge of Sycamore street, and on the south line of an alley. It is 22.6 feet from the corner post on the southeast corner of the northeast quarter of the block (northeast quarter is fenced with a wire fence). It is also 43.2 feet and 66.3 feet, respectively, from the northeast corner of a shed to the west and a windmill pump bearing 10° west of south. The station is marked by a rough sandstone post, not lettered, projecting a few inches above ground. The following true bearings were determined:

	° ′
United Brethren Church spire (mark)	71 50.5 west of south
M. E. Church spire	51 17.2 west of north

Hays, Ellis County.—The station of 1892 could not be found. A new station was established as near as could be determined to where the station of 1892 had been. It is about 5 miles northeast of Hays, and is, as near as could be determined, at the north center of section 24, township 13, range 18 west of the sixth principal meridian. It is about 8 feet north of the north line of section 24, and is in the road that separates section 13 from 24. It is 27.8 feet from a small locust tree bearing 60° west of south. The station is marked by a limestone post 6 by 6 by 42 inches, set 35 inches in the ground and lettered U. S. C. & G. S., 1904. The following true bearing was determined:

	° ′
Catholic Church spire in Hays (mark)	50 35.4 west of south

Hutchinson, Reno County.—The station is on the east side of the grounds of the Central Kansas State Fair Association, three-quarters mile north of the business section of the city. It is east of Agricultural Hall, and is 64.2 feet west of the east boundary fence, 115.6 feet southwest from the southwest corner of the east horse sheds, 93 paces southeast from a windmill, and 72.1 feet and 56.4 feet, respectively, from the small elms standing southward from it. The station is marked by a Bedford limestone post 6 by 6 by 27 inches, set flush with the surface of the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Agricultural Hall, east gable (mark)	81 56.2 west of north
Flag pole on Kansas Grain Company's elevator	23 35.4 west of south
High School tower	4 21.8 east of south

Jetmore, Hodgeman County.—The station is on the grounds of the public school. It is 153.3 feet and 153.1 feet, respectively, from the northwest and southwest corners of the building. It is also 70 feet and 150 feet, respectively, from the west and south boundaries of the school grounds. The station is marked by a limestone post 8 by 8 by 32 inches, lettered on top U. S. C. & G. S., 1904, and having a half-inch hole for a center mark. The following true bearings were determined:

	° ′
Point of cupola on court-house (mark)	46 40.6 east of south
Congregational Church steeple	55 05.0 east of south
M. E. Church spire	70 10.2 east of south

Descriptions of stations—Continued.

KANSAS—Continued.

Junction City, Geary County.—The station of 1888 being no longer available, a new station was established on the Fort Riley Military Reservation, on a high bluff to the west of the post, 122.6 feet a little east of north from the northwest corner of inclosure about Major Ogden memorial monument, and a little to the west of the straight line from the monument to the Fort Riley reservoir. The precise point is marked by a hole in the top of a limestone post 6 by 6 by 27 inches, set about 8 inches above the surface of the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Geary County court-house spire (mark)	37 15.3 west of south
Fort Riley reservoir, tip	15 26.3 east of north
Spire on Fort Riley headquarters	65 01.9 east of south

Kingman, Kingman County.—The station is within the race course of the Kingman County Cattlemen's Picnic Association, their grounds being south of the creek and immediately south of the Santa Fe depot. Measurements were taken from the station as follows: To the southwest corner of the judge's stand, northeast, 262.7 feet; to the southwest corner of the amphitheater, northerly, 202.4 feet; and to inner edge of race track, north of west, in line of mark (produced), 86.5 feet. The precise point is marked by a limestone post 6 by 6 by 36 inches, set with its top slightly above the surface of the ground, and lettered U. S. C. & G. S. The following true bearings were determined:

	° ′
County poorhouse, west chimney, right edge (mark)	66 11.9 east of south
Schoolhouse flag pole, base	5 35.1 east of north
Flag pole on central tower of city hall	5 07.9 west of north

Kinsley, Edwards County.—The station is on the public school grounds in the north part of the city, west and a little north of the school building. It is 121.1 feet and 144.1 feet, respectively, from the northwest and southwest corners of the building, and 44 paces from the south line of the grounds. (No street on the west and nothing to mark the west line of grounds.) The station is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Congregational Church spire (mark)	13 35.2 east of south
M. E. Church steeple	7 37.3 east of south
Court-house cupola	27 47.5 west of south

Lakin, Kearney County.—The station is in the Lakin Cemetery, 1 mile northeast of the town. It is in the main driveway running north and south, and a little over halfway from the center of the grounds to the south edge. It is 45.1 feet from the southeast corner of the base of a tombstone bearing the name James Oscar Martin, 70.5 feet from the southeast corner of a lot inclosed by a picket fence (small tombstone bearing name H. F. Meyer). It is also 198.5 feet and 136.4 feet, respectively, from a windmill due north and a wire fence on the south line of the grounds. The station is marked by a limestone post 6 by 6 by 30 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Lakin public school cupola, point (mark)	41 58.1 west of south
Presbyterian Church steeple	34 21.8 west of south

Larned, Pawnee County.—The station is in the Larned Cemetery, 1½ miles west of town. It is near the east side of the broad driveway running north and south through the center of the cemetery. There is also a broad driveway running east and west, and where these two driveways meet there is formed a central square. The station is 199.0 feet and 203.9 feet, respectively, from locust trees on the southeast and southwest corners of this central square. It is also 14.4 feet from the edge of the driveway east, and 27.8 feet from a mulberry tree 4 inches in diameter bearing 35° east of north, and 162

Descriptions of stations—Continued.

KANSAS—Continued.

paces from the south entrance of the cemetery. The station is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Cupola on Second Ward school (mark)	84 08.5 east of north
Base of flagstaff on Third Ward school	79 53.1 east of south

Leoti, Wichita County.—The station is located on the grounds of the public school, northeast of the building. It is 83.8 feet and 102.6 feet, respectively, from the northeast and southeast corners of the building. It is also 41.4 feet from a wire fence on the east side of the ground and 49.8 feet from a wire fence on the north. The station is marked by a limestone post 6 by 6 by 30 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1904, and having a ½-inch hole as a center mark. The following true bearings were determined:

	° ′
M. E. Church steeple (mark)	71 13.8 west of north
Clyde Freeland's dwelling, north gable	9 53.0 west of south

Lincoln Center, Lincoln County.—The station is located near the northwest corner of the grounds of the Kansas Christian College. It is 15.0 feet east of the hedge along the west boundary of the grounds, 75.0 feet south of the wire fence along the north boundary, 45.3 feet from a mulberry tree northeast, and 24.9 feet from a hackberry tree southeast. It is about 260 feet west and a little north of the northwest corner of the college building. The station is marked by a hole in the top of a limestone post 6 by 6 by 30 inches, set flush with the surface and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Professor Whittaker's house, west gable (mark)	88 29.8 east of south
Flag pole on schoolhouse	6 18.4 east of north
Tip of court-house tower	21 36.0 east of north

Lyons, Rice County.—The station is in the public cemetery, 1 mile north of the business center of the city, in a street running through the grounds west from the main gate. Distances from the station are as follows: Southeasterly to northwest corner of tool house, 78.7 feet, and to nearest corner of monument marked "Lawrence," 38.0 feet; westerly to center of stone post marking block corner, 57.0 feet; northwesterly to nearest corner of monument marked "Curwen," 50.3 feet. The precise point is marked by a hole in the top of a Bedford limestone post 6 by 6 by 30 inches, set flush with the surface and marked U. S. C. & G. S., 1904. An attempt was made to set meridian stones in cooperation with D. C. Wolfe, county surveyor, and it was found that the line fell upon the base of a tombstone marked "Deeds," about 7 inches from the east edge. The point was temporarily marked and Mr. Wolfe agreed to secure some proper tools and mark it permanently by a small round hole. Distance from station 185.8 feet due south. The following true bearings were determined:

	° ′
Findley's barn, east gable (mark)	59 38.6 west of north
Schoolhouse tower	12 56.0 west of south
Tower on Aikin residence	12 14.0 west of south
Liberty pole, northeast of court-house	1 51.0 west of south
Flag pole on new mill	2 02.3 east of south

McPherson, McPherson County.—The station is on the grounds of McPherson College, a little more than 1 mile east of the business center of the city. Measurements were made from the station, northeasterly to the southwest corner of the main building, 323.5 feet; westerly to the mulberry hedge bounding the grounds, 41.5 feet; southwesterly to an elm tree, 38.5 feet; southerly to two red cedars, 33.0 feet and 33.7 feet, respectively, the former being the most easterly of a group. The precise point

Descriptions of stations—Continued.

KANSAS—Continued.

is marked by a hole in the top of a Bedford limestone post 6 by 6 by 27 inches, set flush with the surface and marked U. S. S. & G. S., 1904. The following true bearings were determined:

	° ′	
Court-house tower (mark)	87 10.3	west of south
High School tower	84 32.8	west of south
Baptist Church spire	88 11.6	west of south
Old schoolhouse	89 48.3	west of north
McPherson College tower	45 59.5	east of north

Ness City, Ness County.—The station is on the public school grounds, northeast of the building. It is 162.9 feet and 195.0 feet, respectively, from the northeast and southeast corners of the building, 23 paces from the north line of the grounds and 19 paces from the east line (no fence on either). The station is marked by a limestone post nearly round, 7 inches in diameter and 32 inches long, lettered on top U. S. C. S., 1904, and having a ¼-inch hole in the center. The following true bearings were determined:

	° ′	
Flagstaff on Ness County Bank (mark)	62 41.6	west of south
M. E. Church steeple	79 47.7	west of south
Presbyterian Church steeple	82 46.1	west of north

Newton, Harvey County.—Observations were made on the grounds of Bethel College, 1½ miles north of Newton. The station is on the western part of the grounds, southwest of Bethel College, on an east and west street. It is 19.4 feet south of north line of trees along an east and west street, and 16.0 feet west of west line of trees along a north and south street, also 20.5 feet from the nearest tree (small elm) to the northeast. The station is marked by a limestone post 31 by 6¾ by 5 inches, dressed on top and lettered U. S. C. & G. S., 1904, set to project about 1 inch above the ground. The following true bearings were determined:

	° ′	
Tip of cupola on Mr. Coppe's barn (mark)	78 57.9	west of south
Methodist Church spire	4 57.3	west of south
Catholic Church spire	0 44.3	west of south
Base of Bethel College flag pole	60 30.2	east of north

Parsons, Labette County.—The station is near the intersection of Grand avenue and Eleventh street in the southwestern corner of Forest Park, east of the new East Side schoolhouse, and a little east of south of the park dancing pavilion. It is 149.6 feet a little east of south of the nearest stone support of the park dancing pavilion, 138.4 feet a little north of west of a large oak tree, and 206.5 feet from the park fence to the south. It is marked by a limestone post 28 by 6 by 6 inches, about 1 inch of which is above ground, and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′	
Flag pole on East Side School, south edge of ball (mark)	69 15.1	west of north
East point of roof largest house to southwest	64 45.0	west of south
Lightning rod on house west of south	28 21.8	west of south
Western edge of ball on flag pole of park dancing pavilion	25 15.4	west of north

Pratt, Pratt County.—The station is on grounds belonging to the Cemetery Association lying outside, but immediately adjacent to the cemetery as now inclosed and used, and on the west side of it. It is on open ground intended to be used as a lawn or garden plat and not to be sold for lots. Measurements were made as follows: Directly east along the street line produced, to nearest block corner, 60 feet; southeasterly to the northwest corner of monument marked "Emma Reed," 76.8 feet; northeasterly to southwest corner of monument marked "Clarkson Toms," 76.2 feet. The precise location

Descriptions of stations—Continued.

KANSAS—Continued.

of the station is marked by a hole drilled in a limestone post 6 by 6 by 36 inches, set slightly above the surface and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
City water tank, highest point (mark)	53 51.5 west of south
Schoolhouse flag pole	47 02.6 west of south
Windmill at west end of house on distant horizon	0 45.6 west of south

Russell, Russell County.—The station is on the grounds of the court-house, northeast of the building. It is 115.0 feet, 148.0 feet, and 107.4 feet, respectively, from the northeast corner of the court-house, the northwest corner of the steam-heating plant, and the southwest corner of a church that stands on the northeast corner of the block. The station is marked by a limestone post 6 by 6 by 30 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole one-half inch deep in the center marks the point. The following true bearings were determined:

	° ′
Base of flagstaff on public school (mark)	66 15.1 west of south
East gable of frame house across the street	81 32.6 west of south
Lutheran Church spire	50 11.0 west of north

Salina, Saline County.—The station is on the grounds of the Kansas Wesleyan University at a point 327.6 feet northeast of the northeast corner of the main building, 209.2 feet south and a little east of the southeast corner of the dwelling across the street and 300 feet (about) west of the tracks of the McPherson Branch, Union Pacific Railroad. It is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Figure 1 in 1886 on corner stone of the university building (mark)	62 04.5 west of south
Ladies' dormitory east gable	65 57.4 west of north
Old Logan School spire	16 07.2 east of north

Scott, Scott County.—The station is on the grounds of the public school, southeast of the building. It is 110.0 feet and 84.6 feet, respectively, from the northeast and southeast corners of the building; 41 paces from a wire fence on the south and 45 paces from a wire fence on the east line of the school grounds. The station is marked by a limestone post 6 by 6 by 30 inches, set 30 inches in the ground and lettered U. S. C. & G. S., 1904, and having a ½-inch hole as a center mark. The following true bearings were determined:

	° ′
Point on water tank of Missouri Pacific Railroad (mark)	36 28.7 west of north
M. E. Church steeple	36 54.9 west of south

Seneca, Nemaha County.—The station is in the county fair grounds in the southwestern part of the town. It is within the oval race track, near the north end of same. It is 221.3 feet from the northwest corner of the judge's stand, which point bears 80° 36′.2 east of south. It is also 100 feet distant from the edge of the track due north and 164.5 feet from a maple tree 12 inches in diameter across the track and bearing 40° west of north. The station is marked by a limestone post 8 by 8 by 28 inches, set almost flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Point of cupola on large dwelling house (mark)	64 51.2 east of south
Catholic Church spire	51 08.2 east of north
Flagstaff on High School building	51 42.7 east of north

St. John, Stafford County.—The station is near the east end of the fair grounds, about three-quarters of a mile from the business section of the village. It is south of the race track and east of the grand stand. From it the southwest corner of Tudor elevator is seen in line with the southwest corner of the judge's stand. The east gable of ticket office at main entrance is nearly in line with the southwest corner of the grand stand. It is 50.8 feet southward from the fence along the race track,

Descriptions of stations—Continued.

KANSAS—Continued.

147.4 feet eastward from the southeast corner of the amphitheater, about 50 paces from the wire fence along the east boundary of the grounds, 82 paces northeast from the corner of nearest hall, and 63 paces southeast from the corner of judge's stand. The precise point is marked by a hole in the top of a Bedford limestone post 6 by 6 by 27 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Schoolhouse tower	26 35.9 west of north
Court-house flagpole (mark)	34 47.2 west of north
Baptist Church spire	40 44.5 west of north
Kansas Grain Company elevator, north gable	74 59.6 west of north

Tribune, Greeley County.—The station is on the grounds of the county court-house, southwest of the building. It is 143.8 feet and 86.3 feet, respectively, from the northwest and southwest corners of the building. It is also 59.8 feet from a wire fence on the south side of the grounds and 54.3 feet from a wire fence on the west. It is about 40 rods north from the Missouri Pacific Railroad. The station is marked by a limestone post 6 by 6 by 30 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1904, having a ½-inch hole as a center mark. The following true bearings were determined:

	° ′
Point of cupola on public school (mark)	86 23.1 west of north
Top of water tank, Missouri Pacific Railway	58 19.7 west of south

Wakeeney, Trego County.—The station is on the grounds of the public school, southwest of the building. It is 115.5 feet, and 176.7 feet, respectively, from the southwest and southeast corners of the building, about 20 paces from the west line of the school ground and 18 paces from the south line. The station is marked by a limestone post 6 by 6 by 30 inches, set almost flush with the ground and lettered U. S. C. & G. S., 1904. A meridian line was established here, the south monument being 370 feet from the magnetic station and in direct line toward the mark. It is about 8 feet from the east edge of the street that passes along the west side of the school grounds. The north monument was set 644.5 feet due north of this stone. These stones are limestone posts 6 by 10 by 36 inches, set 30 inches in the ground, and are not lettered. Each stone has a ½-inch hole to mark the exact point. The following true bearings were determined from the magnetic station:

	° ′
Large spire on court-house (mark)	12 49.6 west of south
Small spire on court-house	9 51.5 west of south
Presbyterian Church spire	1 04.6 west of south
M. E. Church spire	16 47.7 east of south

Wallace, Wallace County.—The station is on the grounds of the public school, southwest of the building. It is 102.3 feet and 116.4 feet, respectively, from the southwest corner of the entrance at the south side of the building and the southwest corner of the main part of the building. It is 40 feet north of the edge of the road that passes along the south side of the grounds and 75 paces from the east edge of the grounds. The station is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
M. E. Church spire (mark)	6 55.0 west of south
Base of flagstaff on Union Pacific Railway Company's building	0 14.2 west of south

Washington, Washington County.—The station is on the grounds of the Baptist Seminary, one-half mile north of Washington and is southwest of the building. It is 122.6 feet and 149.3 feet, respectively, from the southwest and southeast corners of the building. The station is marked by a marble post 6 by 8 by 35 inches, set 31 inches in the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Base of flagstaff on court-house (mark)	9 44.6 east of south
Right-hand edge of standpipe	10 42.5 east of south
Left point of High School cupola	10 02.5 east of south
Right point of High School cupola	9 25.7 east of south
Presbyterian Church spire	0 46.9 west of south

Descriptions of stations—Continued.

KANSAS—Continued.

Westmoreland, Pottawatomie County.—The station is on the grounds of the county court-house, northeast of the building. It is 84.9 feet, 61.6 feet, and 28.8 feet, respectively, from the northeast corner of the main part of the court-house, a stone walk leading to the court-house from the east side of the grounds, and a board fence along the east side of the grounds. The station is marked by a limestone post 8 by 8 by 36 inches, set flush with the ground, and lettered U. S. C. & G. S., 1904. The following true bearing was determined:

	° ′
Christian Church spire (mark)	69 34.2 east of north

Wichita, Sedgwick County.—The station of 1888 was abandoned as unsatisfactory, owing to proximity of street railway. The new station is located on grounds belonging to Fairmount College, being about 3 miles east and 3 miles north of the old station. It is in an open field now being used as pasture, and is about 1 500 feet north and a little east of the main college building, near the northeast intersection of Holyoke and Twentieth streets. It is about 28 feet north of the center of Twentieth street and 29½ feet east of the center of Holyoke street. These streets are marked by grading and gutters, although never traveled. The station is 25 paces east of the east line of B. M. Nease's house and 150 paces north of its northeast corner. It is marked by a limestone post 6 by 6 by 36 inches, set with its top slightly above the surface, and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Flagpole on court-house (mark)	49 33.8 west of south
Flagpole on city hall	41 16.0 west of south
Highest point of Fairmount College	3 15.8 east of south
Irving School spire	74 56.0 west of south

Winfield, Cowley County.—The station of 1902 was reoccupied. It is in the northwest corner of the campus of Southwest Kansas College, 330.5 feet from the northwest corner of the college building, 117 feet from the porch of the house on the north side of the road, and 28.4 feet from a pine tree to the southwest. The station is marked by a limestone post 36 by 8 by 7 inches, set flush with the ground, and lettered U. S. C. & G. S., 1902. The following true bearings were determined:

	° ′
Flagpole on Badin block (mark)	57 18.2 west of south
Center of cupola of schoolhouse	49 04.3 west of south
Flagpole on city hall	49 58.2 west of south

KENTUCKY.

Elizabethtown, Hardin County.—The station is in Elizabethtown Cemetery, about 30 yards from the main entrance or northeast gate. It is in the edge of the driveway, near the northeast corner of the Wintersmith lot, 5.9 feet from the northeast edge of a large square stone marking the northeast corner of the lot, and 23.5 feet from the northwest edge of a similar stone marking the northwest corner of the lot. No permanent mark was considered necessary. The following true bearings were determined:

	° ′
Court-house cupola (mark)	33 55.7 west of north
City standpipe	74 05.4 west of south
Elizabethtown College cupola	71 24.6 west of north
M. E. Church cupola	44 20.1 west of north
Catholic Church cupola	44 08.8 west of north
Presbyterian Church cupola	41 25.8 west of north
Baptist Church cupola	40 44.1 west of north

Greensburg, Green County.—The station is located about 100 yards northeast of the railroad depot, in the yard of Mr. J. S. Durham, 26.8 feet from his south fence and 29.6 feet from the west

Descriptions of stations—Continued.

KENTUCKY—Continued.

fence. It is marked by a stone 8 by 8 by 30 inches buried 24 inches deep, and lettered on top U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Presbyterian Church cupola (mark)	53 58.9 west of north
Railroad depot, east gable	39 09.9 west of south
Court-house, north gable	88 03.9 west of south
Baptist Church cupola	51 13.9 west of north

Hopkinsville, Christian County.—The station is on a reserve plot of ground in the rear of the Latham Hotel, by some called Hotel Park, but really private grounds at this time. It is 77.8 feet from the north fence, 52.0 feet from the east fence, 74.4 feet from the south fence, and 74.6 feet from the west fence. It is marked by an oak peg about 12 inches long driven flush with the ground. (It was the intention to mark the station with a stone but it was found impracticable because of the delay necessary to secure permission.) The following true bearings were determined:

	° ′
Virginia Street Baptist Church cupola (mark)	9 35.4 east of north
Baptist Church cupola	3 17.0 east of south
Cumberland Presbyterian Church, north gable	67 23.0 west of south
Latham Hotel, southeast edge	78 12.5 west of south
Latham Hotel, northeast edge	19 30.5 west of north

Leitchfield, Grayson County.—As the station of 1881 is no longer suited for magnetic observations a new station was established. It is on the east side of Water street a little south of the center of Main Cross street. It is marked by a sandstone post 7 by 15 by 30 inches buried nearly flush with the ground. A ⅝-inch drill hole in the center marks the exact point, which is 41.65 feet from the northeast corner of G. H. Gardner's front yard fence, and 12.55 feet from the fence on the east side of Water street. The following true bearings were determined:

	° ′
Cupola on A. T. Arnold's house (mark)	48 58.8 west of north
Catholic Church cupola	36 07.0 west of north
M. E. Church cupola	28 26.0 west of north
Baptist Church cupola	27 06.4 west of north
Court-house cupola	82 29.4 west of north
Christian Church cupola	53 45.0 west of north
Public school cupola	10 15.1 east of north

Louisville, Jefferson County.—As the station of 1896 is no longer suited for magnetic observations a new station was established. It is in Cherokee Park near the south end of the golf links, nearly south of the eastern stone marking the grave of a Federal soldier, and 138.8 feet distant. There is at present a row of trees west of this grave and the station is 119.6 feet from the first, 100.9 feet from the second, and 97.4 feet from the third. These trees bear, respectively, north 1° 24′ east, north 22° 26′ west, and north 41° 06′ west. The gravestone bears north 9° 34′ east. The present golf shelter is west of north, and is seen between trees 2 and 3 above, and is about 130 feet from the station. The following true bearings were determined:

	° ′
Belvoir flat, middle chimney (mark)	68 38.7 west of south
Chimney on W. B. Belknap's house	82 02.6 west of north
Clifton Catholic Church cupola	8 14.8 east of north
First pavilion, south edge	82 25.8 east of north
Murphy's residence cupola	17 50.9 east of south

Descriptions of stations—Continued.

LOUISIANA.

Belle Isle, St. Mary Parish.—The station is on the northeast slope of Bald Hill, about 100 feet northeast of the east end of the officers' boarding house. It is marked by a wooden plug driven nearly flush with the ground. The mark used was the apex of the northwest gable of the old boarding house, which bears 66° 13′.0 east of true north. For map of surroundings see Bulletin No. 4, Louisiana Geological Survey, "Salt in Louisiana."

Berwick Bay, St. Mary Parish.—The station is in Captain Phare's field, just northwest of the site of Fort Berwick, now occupied as a sawmill. It is about one-half mile above the ferry landing. The point is marked by a cypress stake about 4 feet east of the end of an open drainage ditch, about 300 feet from the highway and an equal distance from the breastwork of old Fort Berwick. The mark used was a vertical gauge on the most prominent elevated water tank in Morgan City, and bears 74° 46′ east of true north.

Franklin, St. Mary Parish.—The station of 1903 was reoccupied. It is the north stone of a meridian line established in 1902 by Dr. G. D. Harris, of the State Geological Survey. This line is 554.5 feet long and is in a pasture across Bayou Teche, opposite the wharves; part of this pasture is now used as a race track. The meridian line is marked by two sandstone posts about 8 inches square, with a hole filled with lead in the center of the top of each. The south stone is about 100 feet from the bayou and close to a fence; the north stone is about 100 feet north and somewhat more than 100 feet east of the inner fence of the race track. From this stone the flag pole on the jail bears 37° 10′.8 west of true south. The west edge of the city standpipe bears 88° 25′.6 west of true south.

Grande Côte, Weeks Island, salt mine, Iberia Parish.—The station of 1904 was reoccupied. It is a little north of west from Weeks's residence, in the northwestern part of the island. It is south of a road leading past the residence to a landing on the south bank of Weeks Bayou.

Lafayette, Lafayette Parish.—The station of 1904 was reoccupied. It is 390 feet due south of the south monument of the meridian line previously established by Dr. G. D. Harris, back of the grounds of the Industrial School.

Shell Point, Iberia Parish.—No description.

MAINE.

Bar Island, Hancock County.—Two stations were occupied on Bar Island. Station No. 1 is on the northern shore of the island on range with the signal erected on Bald Rock and Crabtree Ledge Light-house. It is about 15 feet above high-water line and is marked by a cross cut on a buried rock. A 2-inch sapling is driven in the ground beside the rock. The mark used was the hydrographic signal erected on Bald Rock, of which the bearing as scaled from the plane-table sheet is 7° 50′ west of true north.

Station No. 2 is on the southeast side of the island and on the north side of the harbor. It is about 8 feet above high-water mark on an outcropping ledge of rock. From this station Egg Island Light-house is visible over the eastern end of the Bar Harbor Breakwater, this line of sight passing about over the middle of the eastern half of the breakwater. The station was not marked. Egg Rock Light-house was used as a mark, and its bearing as scaled from the plane-table sheet is 46° 35′ east of true south.

Beans Island, Hancock County.—The station is on the highest part of the western end of the island. A higher part of the island is to the eastward. The best way to reach the station is to land at a small beach on the northwest side of the island and walk due south about 325 feet. The station is marked by a cross cut on a bowlder. A 2 by 4 stake is driven nearby. The following true bearings were determined:

	° ′
Crabtree Ledge Light-house (mark)	61 55.2 west of south
Flagstaff on point just south of Jellison Cove	43 52.6 west of north
Dome of Bluff Hotel	20 00.3 west of north

Descriptions of stations—Continued.

MAINE—Continued.

Jordans Island, Hancock County.—The station is on the northwest point of Jordans Island, on the south side of the entrance to Stave Island Harbor and just abreast of Yellow Island. It is about 6 feet from the edge of the rocky bluff shore line and about 12 feet above mean high-water mark. The station is not marked. Crabtree Ledge Light-house was used as a mark and its bearing, as scaled from the plane-table sheet, is 49° 21′ west of north.

MARYLAND.

Baltimore, Baltimore City County.—The station is in Patterson Park, about 400 feet south of the band stand, 60 feet east-northeast from the path, 50 feet northwest from the roadway, and 15 feet east of a large maple tree. The station is some distance from the station of 1904 and the above band stand is not the one referred to in the description of the former station. The station was not marked. Declination observations were also made at a point 20 feet distant from the station.

Cheltenham, Prince George County.—The station is at the Coast and Geodetic Survey magnetic observatory, on the grounds of the State Reform School.

La Plata, Charles County.—Observations were made at approximately the spot where the principal observations were made in 1897, namely, in the open field south of the court-house yard, due south of the south meridian stone and about 50 feet south of the middle of the road. The station was not marked. The following true bearings were determined:

	° ′
East end of ridgepole on barn (mark)	13 39.9 west of north
North meridian stone	0 02.2 west of north
South meridian stone	0 04.1 west of north
Northwest corner of court-house	8 23.5 east of north

Linden, Montgomery County.—The old station was reoccupied. It is in the middle of Prof. M. H. Doolittle's rear garden, 94.1 feet northwest of the northeast corner of the frame dwelling house and 84.1 feet northeast of the northwest corner of the same building. The station is marked by a sandstone post 6 inches square, projecting 6 inches above the ground. A small drill hole in the center of the upper surface marks the point. The following true bearings were determined:

	° ′
Ventilator of Dr. Fox's barn (mark)	89 18.4 east of south
Lightning rod of cottage west of Mr. Doolittle's house	62 35.5 west of south

Oakland, Garrett County.—The station of 1897 was reoccupied. It is the south end of a meridian line established in that year by L. A. Bauer. It is in the grounds in front of the court-house, about 75 feet from the southwest corner, about 90 feet from northwest corner, and about 36 feet from the board walks on the south and west sides of the grounds. The station is marked by a granite post 7 by 7 inches, lettered S. M., 1897. There is another stone in the northwest corner of the court-house grounds 82.5 feet due north of the magnetic station. The following true bearings were determined:

	° ′
Northeast gable of Oakland Hotel (mark)	76 49.4 west of north
Lowenstein's house, northeast gable	47 28.5 west of south
Southeast gable of Commercial Hotel	46 39.8 west of north
Proctor's flagpole	25 36.5 west of north

MASSACHUSETTS.

Boston, Suffolk County.—The station of 1896, on Castle Island, was reoccupied as nearly as the changed surroundings would permit. The station is approximately in line between the Long Island Light-house and the extreme south wall of Walworth Manufacturing Company's building in South Boston, and also approximately in line between the south entrance to Fort Independence and a large tank on a distant hill to the south. It is also 11 paces to the east of a line connecting the south

Descriptions of stations—Continued.

MASSACHUSETTS—Continued.

entrance of the fort with the stone marking a triangulation (?) station at the southeast end of the island and 54 paces west of the sea wall at the southeast end of the island. The station is marked only with a small wooden peg. The following true bearings were determined:

	° ′
Marine Park head house, center flagpole (mark)	68 25.8 west of south
White spire in South Boston	81 57.8 west of south
Long Island Light-house	81 06.7 east of south
Southeast edge of fort, below top coping	34 01.6 east of north
Southwest edge of fort, above foundation	17 16.8 west of north

MISSISSIPPI.

Ackerman, Choctaw County.—The station is on land belonging to Mr. C. A. Torbert, northwest of his dwelling house. It is 75.0 feet from the northwest corner of a picket fence inclosing the yard around his house, 56.2 feet from the fence on the west line of the property, 50 feet from an oak tree 12 inches in diameter bearing 15° west of south, and 22.5 feet from an oak tree 12 inches in diameter bearing 45° east of north. The station is marked by a limestone post 6 by 6 by 36 inches projecting 2 inches above ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Court-house cupola (mark)	4 59.6 east of north
Presbyterian Church steeple	40 27.8 west of north
Methodist Church steeple	22 08.0 east of north

Brookhaven, Lincoln County.—The station of 1901 was reoccupied. It is on the grounds of the Whitworth Female College, east of the main building. It is 96.2, 78.2, and 88.7 feet, respectively, from the main building, the southeast corner of the president's house, and the fence on the south line of the grounds. The station is marked by a limestone post 6 by 6 inches projecting about 4 inches above ground, lettered U. S. C. & G. S. The following true bearings were determined:

	° ′
Presbyterian Church spire (mark)	2 23.0 east of south
High school cupola	36 51.9 west of south
Apex of front cornice on Inez Hotel	88 12.8 east of south

Canton, Madison County.—The station is on the grounds of the Canton cemetery and is toward the northwest corner of the grounds. It is in the middle of a driveway 8 feet wide. It is 66.2 feet from the fence on the west line of the cemetery and 99.0 feet from the fence on the north line. The station is marked by a limestone post 6 by 6 by 30 inches set 29 inches in the ground and lettered on top U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Point of cupola on court house (mark)	58 40.9 west of north
Cupola of the public school building	83 55.5 west of north
Colored M. E. Church steeple	69 47.3 west of north
Presbyterian Church steeple	48 43.1 west of north

Clarksdale, Coahoma County.—The station is on the grounds of the county court-house, southeast of the building. It is 36.1 feet and 47.6 feet, respectively, from the wire fences on the east and south lines of the grounds and 108.0 feet from the southeast corner of the building. The station is marked by a limestone post 6 by 4 by 36 inches set flush with the ground and having a ½-inch hole as a center mark. The following true bearings were determined:

	° ′
M. E. Church spire (mark)	78 24.4 east of south
Point of cupola on the jail	87 37.0 west of south
Episcopal Church spire	84 28.4 east of north

Descriptions of stations—Continued.

MISSISSIPPI—Continued.

Fayette, Jefferson County.—The station is on the grounds of the Fayette Academy and High School, southwest of the building. It is 156.2 feet from the southwest corner of the school building and 70.5 feet and 53.7 feet, respectively, from a large red-oak tree 6 feet in diameter at base, bearing 10° west of south, and a board fence on the west line of the grounds. It is also 150 paces from the Natchez and Jackson branch of the Yazoo and Mississippi Valley Railway. The station is marked by a limestone post 6 by 6 by 32 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Point of court-house cupola (mark)	84 55.8 west of north
McClure & Harper store, apex center of front cornice	60 59.5 west of north
M. E. Church steeple	44 55.2 west of north

Greenville, Washington County.—The station of 1890 could not be reoccupied. The new station is in the Gentile cemetery, one mile due south of the court-house. It is on the south edge of the large circular driveway and is 173.0 feet and 168.0 feet, respectively, from two red-oak trees bearing 5° west of south and 10° east of south. It is also 73 paces from an iron fence on the east line of the grounds. The two oak trees are on the south line of the grounds. The station is marked by a limestone post 6 by 6 by 30 inches set flush with the ground and lettered on top U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Point of court-house cupola (mark)	1 33.0 east of north
Colored Methodist Church steeple	50 45.9 west of north

Hazlehurst, Copiah County.—The station is on land belonging to Mr. W. S. Howard, in the north part of the town. It is about 100 yards northeast of Mr. Howard's dwelling and just south of an open summer house in a circular reserve. It is 26.0 feet from the south edge of the summer house and 20.3 feet and 21.4 feet, respectively, from two small pecan trees bearing south 60° east and south 60° west. The station is marked by a limestone post 6 by 6 by 30 inches set 29 inches in the ground, lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Base of flagstaff on the court-house (mark)	9 43.0 west of south
Baptist Church spire	7 08.4 east of south
Methodist Church spire	6 49.4 west of south
Top of tank of city waterworks	13 33.1 west of south

Indianola, Sunflower County.—The station is in the yard surrounding the dwelling house of Dr. H. C. Kent, which is a new frame structure. It is southeast of the building and 30.6 feet and 29.5 feet, respectively, from the picket fences, on the south and east lines of the yard. It is also 43.0 feet from the southeast corner of the house. The station is marked by a limestone post 5 by 5 by 24 inches, lettered on top U. S. C. & G. S., 1905, and set flush with the ground. The following true bearings were determined:

	° ′
Point of court-house cupola (mark)	2 22.2 west of south
P. C. Chapman's house cupola	22 16.8 west of south
Presbyterian Church steeple	74 18.2 west of south

Kosciusko, Attala County.—The station is on the property of Mr. William Galloway, in the southeast part of the town, and is in the yard in front of the dwelling house. It is 101.7 feet and 99.1 feet, respectively, from the southwest and southeast corners of Mr. Galloway's house and 54.6 feet back from the fence along the west line of the yard. The house is occupied at the present time by Mr. B. F. Taylor, a merchant of Kosciusko. The station is marked by a limestone post 6 by 6 by 30 inches set flush with the ground and lettered on top U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Spire of the new Presbyterian Church (mark)	15 16.2 west of north
Court-house cupola	45 49.0 west of north

Descriptions of stations—Continued.

MISSISSIPPI—Continued.

Liberty, Amite County.—The station is on the lot of the Baptist Church, southeast of the building. It is 51.6 feet and 71.8 feet, respectively, from the southeast and northeast corners of the building. It is also 94.1 feet from the east side of the road or street passing east of the lot. The station is marked by a limestone post 5 by 7 by 32 inches, sunk flush with the ground and lettered on top U. S. C. & G. S., 1905. An iron bar 1¼ by 1¾ by 45 inches was set 195 paces due north of this stone to mark a meridian line. It was left projecting about 1 inch out of the ground. This bar is 12 feet from the picket fence around Mr. N. S. McLain's house and opposite the southeast corner of the yard. The following true bearings were determined:

	° ′
Point of court house cupola (mark)	15 26.8 east of south
Middle gable of Mr. N. S. McLain's house	3 45.6 west of north

Macon, Noxubee County.—The station is on the grounds of the Macon public school, west of the building. It is 122.1 feet and 109.0 feet, respectively, from the southwest and northwest corners of the school building, and 42.6 feet from a cedar tree 12 inches in diameter, bearing 80° west of north. The station is marked by a limestone post 6 by 6 by 32 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Court-house cupola (mark)	21 26.5 west of south
Presbyterian Church steeple	18 43.6 west of south
Methodist Church steeple	48 33.6 west of south

Magnolia, Pike County.—The station is on an open square of ground belonging to the city of Magnolia and reserved for school purposes, near the middle of the south part of the square. It is 51 feet, 144 feet, and 153.8 feet, respectively, from the south line of the grounds, the middle of Prewett street east, and the west line of the grounds. This square is in block 30 and is about one-fourth mile northwest of the court-house. The station is marked by a limestone post 6 by 6 by 30 inches, set 28 inches in the ground and lettered U. S. C. & G. S., 1905. A similar post was set 345 feet north of this post, marking a meridian line. This north stone is at the south edge of the sidewalk on the north side of Myrtle street and is unlettered, but has a center mark. The following true bearings were determined:

	° ′
Presbyterian Church spire (mark)	85 38.4 east of north
North gable of west wing of B. F. Walker's house	49 03.4 east of north

Meadville, Franklin County.—The station is on land belonging to Mr. J. A. Haley and is about 75 feet southwest of proposed site of frame house Mr. Haley expects to erect during the summer of 1905. It is 28.3 feet from the southeast corner of Mr. V. H. Torrey's yard, 92.8 feet from the northeast corner of his lot, and 72.7 feet from the southeast corner of his house. It is also just beyond the end of the first side street running south from the main thoroughfare after passing the Masonic Hall going east. The station is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered on top U. S. C. & G. S., 1905. An iron spindle or wagon skein was sunk just below the ground 420 feet due north of the marked stone. This spindle is 30 inches from the fence along the north side of the main street and is between the footpath and the fence. The following true bearings were determined:

	° ′
Court-house cupola (mark)	63 14.5 east of north
Masonic Hall, east gable	43 09.1 west of north

Rolling Fork, Sharkey County.—The station is on top of a large prehistoric mound, situated on what is known as the "Mound Plantation," belonging to Mr. D. L. Moore, of Harrisburg, Ky. It is three-fourths of a mile almost due south of the county court-house. The mound is said to be 70 feet high and is about 100 feet in diameter on the top. The station is about 10 feet northeast of the center. No trees are on top large enough for reference marks. The station is marked by a lime-

Descriptions of stations—Continued.

MISSISSIPPI—Continued.

stone post 5 by 5 by 32 inches, set 30 inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Presbyterian Church steeple (mark)	13 18.3 east of north
Point of cupola on court-house	6 19.8 west of north
Methodist Church steeple	7 41.3 west of north

Rosedale, Bolivar County.—The station is in the north part of the town on land belonging to Mr. Charles Scott. It is 89.9 feet from a board fence south, 111.9 feet from a double pecan tree bearing about 75° east of south, and 20.7 feet from a sycamore tree 14 inches in diameter, bearing 30° west of north. The station is marked by a limestone post 5 by 5 by 32 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Cupola on Mr. Frank Scott's house (mark)	0 26.8 east of south
Baptist Church spire	8 58.2 east of south
Episcopal Church spire	18 44.3 east of south

Tunica, Tunica County.—The station is on the grounds of the county court-house, southwest of the building. It is 37.5 feet and 39.1 feet, respectively, from the board fences on the south and west lines of the grounds. It is also 84.4 feet and 147.4 feet, respectively, from the southwest corner of the porch at the main entrance of the building and the southeast corner of the building. The station is marked by a red-cedar post 6 inches in diameter, 32 inches long, set flush with the ground. A 38-caliber brass shell driven in the top of the post marks the exact spot. The following true bearings were determined:

	° ′
Methodist Episcopal Church spire (mark)	20 56.1 west of south
East gable of Leo Lesser's store	65 57.6 west of north
South gable of R. C. Irwin's house	6 24.6 west of north

Waynesboro, Wayne County.—The station is on the large square of land belonging to the county adjoining the court-house square, and is southwest of the court-house. It is 225.7 feet from the southwest corner of the jail, 197.0 feet from the southwest corner of the school building, and 159.5 feet from the southeast corner of the school building. The station is marked by a yellow-pine post 2 feet long, sunk flush with the ground. A brass screw marks the exact spot. The following true bearings were determined:

	° ′
Baptist Church spire (mark)	57 15.7 east of north
South gable of J. P. Wetherbee's house	50 17.0 west of north

Woodville, Wilkinson County.—The station is on the grounds of the Woodville public school, west of the building. It is 122.9 feet and 134.0 feet, respectively, from the southwest and northwest corners of the school building. It is also 41.8 feet from a board fence on the west line of the grounds. The station is marked by a limestone post 6 by 6 by 30 inches, set flush with the ground and lettered on top U. S. C. & G. S., 1905. A ½-inch hole, one-half inch deep marks the center. The following true bearings were determined:

	° ′
Methodist Church spire (mark)	6 10.1 west of north
Baptist Church steeple	57 43.4 east of north

MISSOURI.

Greenville, Wayne County.—The station is on the grounds of the Greenville public school, north of the building. It is 85.3 feet and 68.2 feet, respectively, from the northwest and northeast corners of the building. It is also 54.3 feet from the east line of the school grounds. The station is marked

Descriptions of stations—Continued.

MISSOURI—Continued.

by a sandstone post 6 by 6 by 32 inches, lettered U. S. C. & G. S., 1905, and set 30 inches in the ground. The following true bearings were determined:

	° ′
Baptist Church spire (mark)	65 10.9 west of south
Christian Church spire	53 46.6 west of south
Cupola on Masonic Hall, east gable	62 49.2 west of south

Houston, Texas County.—The station is on the grounds of the Houston public school, southeast of the building. It is distant 111.6 feet and 121.9 feet, respectively, from the southeast corner of the east wing and the southwest corner of the main part of the building. It is also 45.5 feet and 84.1 feet, respectively, from the picket fences on the east and south lines of the grounds. The station is marked by a sandstone post 6 by 6 by 32 inches, set 31 inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Christian Church spire (mark)	63 35.4 east of north
M. E. Church South, spire	81 55.7 east of north
M. E. Church North, spire	68 17.6 east of south

Mount Vernon, Lawrence County.—The station is on the grounds of the public school in the east part of the town, and is northwest of the building. It is 119.0 feet and 152.2 feet, respectively, from the northwest and northeast corners of the building. The station is marked by a limestone slab 3 by 8 by 32 inches, set 31 inches in the ground, lettered U. S., and having a cross for a center mark. The following true bearings were determined:

	° ′
Point above center of face of clock on tower of court-house, east side (mark)	69 24.2 west of north
Bisection of smallest part of ornament on corner of store southeast corner of court-house square	77 15.9 west of north

NEVADA.

Carson City, Ormsby County.—The station of 1894 being no longer available, a new station was established in the western part of the county fair grounds, about one-half mile east of the town center. It is within the oval of the race track due north of the judge's stand, a little east of north of the grand stand, and just north of a fence running east and west dividing the oval in approximate halves. It is 78 feet east of the fence surrounding the race track, 72.2 feet north of the fence running east and west through the oval, and 98.6 feet southeast of the seven-eighths mile post on the race track. The station is marked by a granite post 8 by 8 by 30 inches, with a cross cut in the top to mark the exact spot, and showing 1 foot above ground. The following true bearings were determined:

	° ′
Top of flagstaff on cupola of State Orphans' Home (mark)	24 44.9 west of south
Top of flagstaff on cupola of pavilion	67 30.7 west of south
Top of flagstaff on State capitol building	80 09.2 west of south
Top of flagstaff on judge's stand	2 06.2 west of south

Elko, Elko County.—The station of 1881 was reoccupied. It is on the grounds of the County Hospital, formerly the State University, in the rear of the main building. It is 232.8 feet from the southwest corner of the building, 62.5 feet from a fence to the north, 12.6 feet from a fence to the west, and 149.9 feet from the cemetery fence to the south. It is marked by a blue glass bottle buried 1 foot below the surface of the ground. The following true bearings were determined:

	° ′
Court-house flagstaff (mark)	2 32.0 west of south
Top of Episcopal Church steeple	5 59.4 west of south
Presbyterian Church spire	3 38.2 east of south
High School flagstaff	9 39.2 west of south

Descriptions of stations—Continued.

NEVADA—Continued.

Hawthorne, Esmeralda County.—The station is in the northwestern part of town in the northwest corner of the court-house grounds. It is about 6 feet south of the property line to the north and about 39 feet east of the property line to the west. It is 223 feet a little west of north from the northwest corner of the court-house and 241.6 feet northwest of the northeast corner of the court-house. The station is marked by an oak stake, 4 by 5 inches, showing about 4 inches above ground, with a cross sawed in the top to mark the exact spot. The following true bearings were determined:

	° ′
Ornamental point of south gable of house (mark)	14 07.8 west of south
Low pyramidal mountain peak	45 37.9 west of south
Center of highest point Mount Grant	73 08.8 west of north
Flagstaff on schoolhouse	70 28.2 east of north

Sodaville, Esmeralda County.—The station is on Government land about 10 feet east of the eastern township line and almost directly in line with a post marking a point in the township boundary and the highest point on White Mountain. This post is about 1 200 feet almost directly east of the railroad station and is northwest of a crushing mill not in operation. It is also about 150 feet south of a small shack or dugout, with only the roof showing above ground. The station is 91.9 feet a little east of north of the above post and 110 feet south of the shack or dugout. It is marked by an oak stake, 2½ by 2 inches, showing about 6 inches above ground, with a cross sawed in the top to mark the exact spot. The following true bearings were determined:

	° ′
Highest point on White Mountain (mark)	22 30.2 west of south
South edge at top of smokestack on crushing mill	50 11.2 west of south
Flagstaff on building adjoining railroad station	62 34.2 west of south
Top of flagstaff on building in town	62 12.2 west of south

Yerington, Lyon County.—The station is near the line between two fields owned by Mr. Henry Hansen, about 800 feet east of Mr. Hansen's house. It is a little over one-fourth of a mile east of south of the schoolhouse. It is a short distance east of the southeast corner of a field which extends to and just north of Mr. Hansen's house. It is 253 feet a little north of east of the hay derrick, 74.5 feet east of the southeast corner of a fence surrounding the field described, and 313.3 feet north of a fence on the northern border of a road to the south, running east and west. The station is marked by a red tufa post 6 by 6 by 24 inches, lettered U. S. C & G. S., 1905, on the south side, with a hole in the top to mark the exact spot. The following true bearings were determined:

	° ′
Top of flagpole on schoolhouse (mark)	11 36.9 west of north
Top of belfry on Methodist Church	18 00.1 west of north
Ball on flagstaff of post-office	23 01.8 west of north

NEW JERSEY.

Belvidere, Warren County.—The station is on a formation of limestone on a hill about one-fourth of a mile north of the town center. It is on the property of Mr. Aaron Keyser, northeast of Mrs. Mackey's house, and northwest of a house where there was at one time a seminary. These two houses are about 100 feet apart, and the latter is owned by the Philadelphia Trust Company. Two old fence lines and two old roads form a small square in which the station is located. It is 44.4 feet northeast of the northeast corner of the fence and hedge surrounding the house of Mrs. Mackey, 91.8 feet northwest of the northwest corner of the hedge surrounding the old seminary building, 79.2 feet northwest of a large maple tree, 54.6 feet southeast of the southernmost of three maple trees which are along an old road and in a row extending north and south. The station is marked by a marble post 30 by 6 by 6 inches, sunk until 1 inch is above ground, and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Baptist Church spire (mark)	5 50.1 east of south
Base of flagpole on silk factory	1 08.2 east of south
Northwest edge of Mrs. Mackey's house	46 36.2 west of south
East edge of ball on cupola of old seminary building	36 08.3 east of south

Descriptions of stations—Continued.

NEW JERSEY—Continued.

Morristown, Morris County.—The station is in the northeast corner of the grounds of the Morristown School—about 2 miles northeast of the town's center—northeast of the main school building, north of the baseball diamond, and about 34 feet south of a row of bushes marking a property line. It is 69½ feet a little to the south of east from a large lone apple tree which forms part of an old orchard, and 139.1 feet a little to the north of west from the northeastern edge of a short, high board fence forming the back stop of the baseball diamond. The station is marked by a Georgia sandstone post 28 by 6 by 6 inches, sunk flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Ball on cupola of school dining room building (mark)	51 20.3 west of south
East edge of ball on cupola of main school building	58 34.8 west of south
East edge of ball on cupola of upper house, northeast wing of school.	55 01.8 west of south
Cupola of Andrew Colb's barn in Parcipany	21 59.4 west of north

Newton, Sussex County.—The station is upon a slate formation upon a hill overlooking the town. It is in the northern part of the grounds of the Newton Collegiate Institute, a little to the east of north from the dormitory building and nearly in line with the eastern side of the same. It is 28.8 feet from a fence to the north and 56.4 feet from a fence to the west—both fences being boundaries to the immediate grounds of the school. It is also about 162 feet northeast from the northeast corner of the dormitory building, and is just 19.2 feet north from the northern edge of a rock 3.7 feet by 1.6 feet, which shows flush with the ground. The station is marked by a marble post 29 by 6 by 6 inches, sunk 1 inch below the surface of the ground and lettered U. S. C. and G. S., 1904. The following true bearings were determined:

	° ′
Episcopal Church spire (mark)	59 31.0 east of south
First Presbyterian Church spire	66 50.3 east of south
St. Joseph's Catholic Church spire	43 36.6 east of south

NEW YORK.

Buffalo, Erie County.—The station of 1885 being no longer available, a new station was established, as near to the old one as the changed surroundings would permit. The present station is in the parade grounds of Fort Porter, in front of the main barracks and in the rear of the stone building known as the "Castle" and occupied by the commandant of the fort. It is roughly at the intersection of two lines, one connecting the middle of door 11 of the barracks and the northwest corner of the Castle and the other joining the southwest corner of the adjutant's quarters and the southwest corner of the building 34 and 35. Owing to possible changes the station was only marked with a tent peg, about 15 inches long and 1½ inches square, driven flush with the ground. This station is 108.7 feet from the extreme northwest corner of the Castle and 84.2 feet from the board fence in the rear of it. The following true bearings were determined:

	° ′
Spire of Episcopal Church at Old Ladies' Home (mark)	20 04.9 east of north
Southwest corner, above water table, of building No. 34–35	70 44.3 west of south

Carmel, Putnam County.—The station is on the western shore of Lake Gleneida, on a strip of land surrounding the lake, owned by the city of New York. The land is held to protect the lake, which is used as a water supply. The station is in a field southeast of Mr. Weeks's house and is about three-fourths of a mile southwest of the town. It is 75 feet from the western edge of the lake, 140.6 feet from a stone wall to the north, 232 feet from a stone wall to the west, 118 feet northwest of an oak tree on the border of the lake, and 128.5 feet southeast of an oak tree in the northwest corner of the field. The location of the stone is known to Mr. Manning, the superintendent of the grounds. The station is marked by a marble post 30 by 5½ by 5½ inches, lettered U. S. C. & G. S., 1904, having its top extending about 4½ inches above the ground. The following true bearings were determined:

	° ′
Presbyterian Church spire (mark)	74 08.0 east of south
Methodist Church steeple	71 45.1 east of north
Tip of red cupola	61 14.1 east of south
North edge of roof of railroad station	51 20.0 east of south

Descriptions of stations—Continued.

NEW YORK—Continued.

Delhi, Delaware County.—The station is on the county farm, 2 miles southwest of the village, on the hillside southwest of the dwellings. It is about 63 yards southwest of the nearest corner of the smaller dwelling, about 100 yards southeast of the nearest corner of the barn. The station is marked by a marble post 5 by 8 by 24 inches, lettered on top U. S. C. & G. S., 1905, and showing 3 inches above the ground. The following true bearings were determined:

	°	′	
Northwest gable of E. B. Sheldon's house (mark)	30	01.5	east of north
West gable of R. B. McFarlane's barn	78	38.3	east of north
East gable of T. D. Middlemist's barn	71	30.5	west of north
Tip of ventilator on farm barn	38	01.5	west of north

Fire Island, Suffolk County.—The station is on the western part of the island on a piece of marshy ground near the Fire Island life-saving station. It is northeast of the life-saving station, northwest of Baker Lawrence's house, southeast of Harry S. Smith's house, and southwest of the light-house which is a little over one-half mile distant. It is 129.2 feet from the northeast corner of the life-saving station, nearly in line with the light-house, 96.9 feet from the southeast corner of Orlando Peterson's house in direction a little north of east, about 42 feet east of a path running north to the Great South Bay, and 73.9 feet north of the northwest corner of a long, low board shed. The station is marked by a marble post 54 by 6 by 6 inches, projecting 18 inches above ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	°	′	
Point at top of roof on Western Union telegraph tower (mark)	74	17.9	east of north
Ball on top of light-house	45	15.5	east of north
Top of flagpole on Surf Hotel	53	37.4	east of north

Goshen, Orange County.—The station is in the southeastern part of the grounds of the Goshen Driving Association, in the eastern part of the oval within the jogging track. It is northeast of the stables and barn of Parkway farm, 148.4 feet north of the nearest root of a large lone oak tree on the southern edge of the jogging track, 185.7 feet west of the wooden fence on the eastern border of the jogging track, and 145.3 feet a little west of south from the nearest root of a large oak tree on the northeastern edge of the jogging track. The station is marked by a marble post 30 by 5½ by 5½ inches, projecting 3 inches above ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	°	′	
Rod on court-house cupola (mark)	86	58.3	west of north
West edge of horizontal arm of cross of Presbyterian Church steeple	79	51.6	west of south
Methodist Church steeple	84	16.8	west of north
Cupola on county building	86	26.2	west of south
Verticle arm of church steeple cross	64	11.3	west of north

Greenport, Suffolk County.—The station is in the northern part of the school grounds, just south of a row of six large trees extending east and west and almost in a line north of the back entrance of the school building. It is 18.8 feet southwest from a maple tree—the third from the east in the above row—18.5 feet southeast from a linden tree, the third from the west, 102.6 feet from a fence to the east, 64.1 feet from a fence to the west, 76 feet from a fence to the north, 200 feet from the northwest corner of the high school building, and 208.5 feet from the northwest corner of the public school building. The station is marked by a marble post 30 by 10 by 10 inches, sunk flush with the ground and marked U. S. C. & G. S., 1904. The following true bearings were determined:

	°	′	
Spire of Catholic Church (mark)	45	27.4	west of south
Top of spire of kindergarten	12	02.4	west of south
Spire of public school	5	59.8	east of south
South edge of top of nearer of two smokestacks on ice plant	88	41.8	east of north

Descriptions of stations—Continued.

NEW YORK—Continued.

Kingston, Ulster County.—The station is about 2 miles northeast of town in the southwest part of the grounds of the almshouse, in a group of apple trees. It is 137.2 feet from a wooden fence to the south, 238 feet west of the almshouse flag pole and 164.5 feet south of the southwest corner of a small outhouse west of the almshouse. The station is marked by a marble post 30 by 5½ by 5½ inches, lettered U. S. C. & G. S., 1904, and sunk with the top about 2 inches above ground. The following true bearings were determined:

	° ′
Presbyterian Church spire (mark)	59 51.9 west of south
First Dutch Reformed Church steeple	71 21.3 west of south
Point on top of red cupola	68 16.9 west of south
Point on top of white cupola	66 28.3 west of south

Montauk Point, Suffolk County.—The station is on the grounds of the Ditch Plain life-saving station, about 2½ miles southeast of the railroad station, and almost due south of Mr. Dickenson's house. It is 110.9 feet a little east of north from the northeast corner of the main building of life-saving station, 115 feet east of the northeast corner of the work shop, and 156.2 feet northwest from the northwest corner of the box surrounding the well. The station is marked by a marble post 30 by 6 by 6 inches, lettered U. S. C. & G. S., 1904, and showing 4 inches above the ground. The following true bearings were determined:

	° ′
Montauk Inn water-tower (mark)	69 18.1 west of north
Highest point of roof on third house	40 52.7 east of north
Point on west end of roof of Mr. Baker's house	67 05.2 east of north

Monticello, Sullivan County.—The station is in the southern part of the oval within the race track of the Monticello Driving Association, nearly due south from the judge's stand. It is about 1 mile southwest of the railroad station. It is 120.1 feet from the fence line to the south, 191 feet from the fence line to the west, and 164.8 feet from the fence line to the east. The location of the station is known to Mr. Coney, who owns a large section of the ground surrounding the race track. The station is marked by a marble post 30 by 5½ by 5½ inches, lettered U. S. C. & G. S., 1904, and showing 4 inches above the ground. The following true bearings were determined:

	° ′
Rod on center of barn belonging to Monticello Driving Association (mark)	15 47.0 west of north
Rod on east end of barn	14 47.2 west of north
Rod on east end of house	3 07.6 west of north
Flag pole on judge's stand	16 16.6 west of north

New City, Rockland County.—The station is in the northwest corner of the New City fair grounds, northeast of the exhibition building and northwest of the grand stand. It is 50.1 feet west of a large chestnut tree, 65.6 feet from a board fence to the north, 206.1 feet north of the northeast corner of the covered part of the grand stand, and 132.9 feet northeast of the northwest corner of the exhibition building. The station is marked by a marble post 30 by 6 by 6 inches, sunk flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
New City public school cupola (mark)	37 09.9 east of south
Spire on Mr. Verdon's barn	16 22.8 east of north
Ball on flag pole near railroad station	22 23.4 east of south

Oxford, Chenango County.—Two stations were occupied. Station A is on the grounds of the Woman's Relief Corps Home, about 1½ miles east of the village. It is in line with the northeast end of the Home building, produced to the west and 65 feet from a large tree and in line with it and the southwest corner of the building. There is another tree 93.7 feet southeast from the station. The

Descriptions of stations—Continued.

NEW YORK—Continued.

station is marked temporarily by a stake, which will later be replaced by a suitable stone. The following true bearings were determined:

	° ′
Southeast gable of barn across the valley (mark)	3 15.8 west of north
Baptist Church spire	58 36.5 west of south
St. Paul Church spire	51 26.4 west of south

Station B is as near the station of 1885 as could be determined from the description. It is on the crest of the small hill back of Mrs. Dodge's house and barn, on Scott street, at the end of Taylor street. It is about 10 feet east of a line joining a small tower on the bank building and a church spire beyond. The station is not marked.

Oyster Bay, Nassau County.—The station is about 2 miles southeast of the town in a field of the Moyser Brothers' farm. This field is just northwest of and adjoining the grounds about the Moyser Brothers' house. The station is in the northwestern part of this field, 188.9 feet from a fence to the northwest, 163.7 feet from the road fence to the southwest, about 270 feet from a fence to the northeast, and 84.2 feet a little to the west of north from a rather large rock which shows above ground to the extent of 1 by 1½ feet. The station is marked by a marble post 30 by 6 by 6 inches, projecting 4 inches above ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Spire on Moyser Brothers' barn (mark)	20 10.4 east of south
East edge of ball on Moyser Brothers' flag pole	19 17.3 east of south
East gable of Moyser Brothers' barn	23 25.1 east of south
West edge of Moyser Brothers' house	9 01.8 east of south

Poughkeepsie, Dutchess County.—The station is in College Hill Park, in the northeast part of a field, which is northeast of the park building. This field is next to and south of the field to be used as a children's playground. The station is 147.9 feet southeast of a large chestnut tree on an old property line to the north, 90 feet from this old property line to the north, and 106 feet a little to the south of west of a large rock showing above ground to the extent of about 22.5 feet by 10 feet. The station is marked by a marble post 30 by 5½ by 5½ inches, set 1 inch above the surface and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Point at top of roof at north end of College Hill building (mark)	62 45.3 west of south
Point at top of greenhouse east of College Hill building	56 01.2 west of south
Point on roof of red water tower	79 50.3 east of south
South edge of base of flag pole north of College Hill building	66 30.6 west of south

Setauket, Suffolk County.—The station is on the grounds of the Emma S. Clark Memorial Library, on a slight rise of ground, about 223 feet back and west of the library building. It is 121.3 feet from a fence to the south, 115.7 feet from a fence to the north, 206.3 feet from a fence to the west, and 203 feet east of a lone apple tree a little to the east of the west fence. The station is marked by a marble post 30 by 6 by 6 inches, sunk flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Episcopal Church spire (mark)	6 11.8 west of north
Setauket public school cupola	8 00.1 east of north
Presbyterian Church spire	26 58.1 east of north
Benjamin T. Jayne's monument	63 06.6 east of north

West Hampton, Suffolk County.—The station is in the southwest corner of the grounds of the Union public school, between West Hampton and West Hampton Beach, and about three-quarters of a mile east of West Hampton. It is 71 feet from a board fence to the west, 61.3 feet from a board fence to the south, 187 feet southwest of the southwest corner of the school building, and 217 feet southwest of the southeast corner of the school building. The station is marked by a marble post 30 by 6 by 6

Descriptions of stations—Continued.

NEW YORK—Continued.

inches, lettered U. S. C. & G. S., 1904, and sunk 1 inch below the surface of the ground. The following true bearings were determined:

	° ′
Top of south edge of cylinder of water tank of R. A. Ward (mark)	65 25.6 west of south
Vane (figure of bull) on R. L. Cutter's barn	25 05.5 west of north
Spire on J. W. Rockefeller's barn	18 12.2 west of north
Ball on schoolhouse flagstaff	50 11.4 east of north

Observations were also made at a point 45 feet from the principal station, in line to R. A. Ward's water tank.

White Plains, Westchester County.—The station is in the extreme southeast corner of the grounds of the Bloomingdale Asylum for the Insane, about 1½ miles southeast of the town center. It is in an apple orchard just southeast of the Bloomingdale stables. It is 162.5 feet from a stone wall to the south, 74.5 feet from a stone wall to the east, 71.3 feet a little west of north from an apple tree. The station is marked by a marble post 30 by 5½ by 5½ inches, sunk with the top about 3 inches above ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Cupola of Howard Willis's barn (mark)	17 26.8 east of south
Tip of flag pole on tower on Whitelaw Reid's house	71 15.4 east of north
Ball on flag pole of public school	22 03.5 east of north
Southwestern tower of Bloomingdale Asylum	50 56.2 west of north
Cupola on Bloomingdale Asylum	45 15.0 west of north

NORTH CAROLINA.

Salisbury, Rowan County.—The station is in Chestnut Hill Cemetery 17.7 feet due south of the south stone of the meridian line established by Mr. J. B. Baylor in 1898. This stone is in a grass plot near to the point where the main road from the south enters the cemetery. The north stone stands near the center of the cemetery near the highest point of the main north and south road. Each stone is about 8 by 8 inches on top and projects about 10 inches above ground. The following true bearings were determined at the magnetic station:

	° ′
Lutheran Church spire (mark)	47 55.8 east of north
Smokestack, Salisbury cotton mill	85 34.1 east of south
North meridian stone	0 01.2 west of north

Wadesboro, Anson County.—The station of January, 1904, was reoccupied. It is near the southwest corner of W. B. Little's front yard. It is 22.4 feet from the west fence, 21.4 feet from the south fence, and 82 feet from the southwest corner of the house. It is marked by a brown stone 36 by 8 by 10 inches, projecting 6 inches above the ground and having a drill hole in the top. The following true bearings were determined in January, 1904:

	° ′
Pee Dee Institute cupola (mark)	15 46.8 west of north
John Mill's house cupola	1 36.6 east of north
Public school cupola	45 15.6 east of north
Cotton mill, southeast edge	39 06.1 west of south

NORTH DAKOTA.

Fargo, Cass County.—The station is in the Riverside Cemetery 2¼ miles south of the center of the city, on a strip of ground reserved for park effects, skirting the brow of the hill along the river; it is about 250 feet north of the pump house and immediately southeast of the Morris monument. Observations were made over the drill hole in the top of a Kettle River sandstone monument 8 by 10 by 20

Descriptions of stations—Continued.

NORTH DAKOTA—Continued.

inches, the top cut 8 by 8 and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Largest spire on City High School (mark)	16 59.2 west of north
Pole on large red barn	27 26.6 west of south
South edge of chimney on small farmhouse	59 35.1 west of south
Spire on Fargo College, main building	10 47.9 west of north

OHIO.

Athens, Athens County.—The station of 1898, on the grounds of the Ohio University, was reoccupied. It is 149.7 feet and 134.4 feet, respectively, from the southeast and southwest corners of the Engineering Hall, 166.1 feet from the southeast corner of the main building, and 96 feet from the edge of the curbstone on the north side of Mulberry street. It is marked by a sandstone post having a copper station mark lettered U. S. C. & G. S. The following true bearing was determined:

	° ′
Cupola on east wing of Insane Asylum (mark)	46 08.2 west of south

Cadiz, Harrison County.—The station is on the grounds of the Cadiz public school, in the large open space south of the school building. It is 170.6 feet and 175.2 feet, respectively, from the southeast and southwest corners of the school building. It is also 112.5 feet from a board fence on the west. The station is marked by a sandstone post 6 by 8 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. A drill hole one-half inch deep in the center marks the point. The following true bearings were determined:

	° ′
United Presbyterian Chuch spire (mark)	52 27.5 west of north
Court-house	42 32.6 west of north
East gable of large barn	73 59.8 west of south

Caldwell, Noble County.—The station is in the Olive Cemetery one-half mile east of Caldwell, north of three stone vaults at the left of the road going into the cemetery. It is 96 feet from the middle of the north end of the east vault, which point of the vault bears 11° east of south. It is 87.6 feet from the middle point of the vault next to the east vault, and this bears 5° west of south. It is just on the outside edge of a driveway that comes from the north and turns west just at this point. The station is marked by a sandstone post 6 by 6 by 36 inches, set 34 inches in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole in the center marks the point. The following true bearings were determined:

	° ′
North gable on R. M. Wells's house (mark)	41 02.9 west of south
Olive schoolhouse	48 32.6 east of south

Cambridge, Guernsey County.—The station is in the Northwood Cemetery, 1 mile north of the court-house. It is on the most southern point of section 7 of the cemetery plot, where the driveway known as Summit avenue divides, one branch going to the northeast and the other to the northwest. The station is marked by a marble post 25 by 6 by 6 inches, set 23 inches in the ground, and the bottom embedded in a base composed of cement, sand, and gravel, extending down 1 foot below the stone. It is lettered U. S. C. & G. S., 1904. A hardwood stub was driven in the ground 430.7 feet due south of the magnetic station. This stub was to be replaced by a stone post similar to the one marking the station. The following true bearings were determined:

	° ′
Spire on Children's Home (mark)	21 45.0 east of south
East Side High School tower	11 25.9 east of south

Canton, Stark County.—Observations were made over the north monument of the meridian line established by the United States Geological Survey in 1900. This line is on the Stark County fair grounds within the oblong race track, and is 765 feet long. The line is approximately in the center

Descriptions of stations—Continued.

OHIO—Continued.

of the oblong, the south monument being much closer to the race track than the north one. The station is 540 feet from a street-car line, a single trolley system running north and south. The following true bearings were determined:

	° ′
Base of flagstaff at main entrance of grounds (mark)	0 44.2 east of south
South monument	0 00.9 west of south
Cupola on large barn to southwest	14 02.5 west of south
Flagstaff at left of entrance to Floral Hall	31 12.0 west of south

Carrollton, Carroll County.—The station is on the Carroll County fair grounds and is within the oblong race track. It is in the middle of the oblong in an east and west direction, and is 93 feet from the north end of the inclosure. The station is marked by a sandstone post 8 by 9 by 32 inches, set 28 inches in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole, one-half inch deep in the center, marks the point. The following true bearings were determined:

	° ′
Head of statue on court-house tower (mark)	18 44.8 west of south
Roof of judge's stand (apex)	26 29.5 west of south

Coshocton, Coshocton County.—The station is in the grounds of the Coshocton High School at the corner of Eighth and Chestnut streets, nearly north of the central part of the building. It is 137.2 feet, 132.8 feet, and 66.2 feet, respectively, from the northwest and northeast corners of the building and from the edge of the brick walk on the west side of Eighth street. It is marked by a marble post 6 by 6 by 32 inches, set 31 inches in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole in the center marks the exact point. The following true bearings were determined:

	° ′
Catholic Church spire (mark)	19 21.4 east of south
First Baptist Church spire	70 11.5 west of south
Court-house flagstaff	76 18.7 west of south

Gallipolis, Gallia County.—The station is on the grounds of the High School Academy, formerly "Gallia Academy." It is 120.1 feet from the west corner of the building, 135 feet from the south corner, 55 feet from a large elm tree 30 inches in diameter bearing 45° east of north, and 94.6 feet from a sugar maple tree 16 inches in diameter bearing 45° east of south. It is 19 paces from a board fence on the southwest. The station is marked by a marble post 22 inches long, set flush with the ground and lettered U. S. C. & G. S., 1904. A cross in center of stone marks the point. The following true bearings were determined:

	° ′
Presbyterian Church tower, spire on northwest corner (mark)	73 16.2 east of south
Mr. Blanche's house, east gable	49 28.8 west of north
Academy building, southeast corner	67 27.2 east of north

Ironton, Lawrence County.—The station is on the property of Mr. William Kelly, on the top of a high bluff northeast from the city. The prominent point of the hill may be seen at the end of Chestnut street; the city extends to the line of the hills. The station is 83.8 feet from a locust tree bearing about 10° east of north and 54 feet from the edge of the bluff, which drops perpendicularly about 40 feet. This line to the edge of the bluff bears 40° west of south. The station is marked by a freestone post 4 by 6 by 32 inches, set 29 inches in the ground and lettered on top U. S. C. & G. S., 1904. A cross in the center marks the point. The following true bearings were determined:

	° ′
Catholic Church steeple (mark)	85 36.2 west of south
Spencer Methodist Episcopal Church	70 03.1 west of north
High School cupola	73 36.2 west of north

Lisbon, Columbiana County.—The station is in the southwestern part of the cemetery, in the northeastern part of the city. It is 41.2 feet from an ash tree 12 inches in diameter bearing 75° west

Descriptions of stations—Continued.

OHIO—Continued.

of north, 57.9 feet from a maple tree 8 inches in diameter bearing 45° east of south, 57 feet from the middle of road to the east, and 48.6 feet from the middle of the road to the south. The station is marked by a sandstone post 6 by 6 by 30 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1904. A second stone, similarly lettered, was set 450.5 feet north of the first, marking a meridian line. The following true bearing was determined:

	° ′
North gable on Harry Shock's house	31 16.2 east of south

Logan, Hocking County.—The station is in the Oak Grove Cemetery, the main entrance of which is at the end of Market street, going north. It is 135.4 feet from the northwest corner of the sexton's dwelling, 54 feet from a sycamore tree 10 inches in diameter bearing 15° east of south, and 12.1 feet from a marble post 6 by 6 inches, marking the boundary of the road. This point bears about 75° east of south. The station is also 11.5 feet from the corner where a walk meets the driveway to the north. It is marked by a marble post 24 inches long, set flush with the ground and lettered on top U. S. C. & G. S., 1904. A ½-inch hole in the center marks the point. The following true bearing was determined:

	° ′
Base of flagstaff on High School (mark)	5 43.4 west of south

McArthur, Vinton County.—The station is on the grounds of the McArthur High School. It is back about 200 feet from the street and is 18 feet, 123.9 feet, and 135.6 feet, respectively, from a stone walk on the west, the southeast, and the southwest corners of the High School building. The station is marked by a sandstone post 6 by 6 by 32 inches, set 30 inches in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole in the center marks the exact spot. The following true bearings were determined:

	° ′
Presbyterian Church spire	57 56.5 east of south
Shivley's house, north gable	28 24.1 west of south

McConnelsville, Morgan County.—The station is on the grounds of the McConnelsville High School, near the west side of the grounds, next to Main street. It bears about 75° west of south from the school building and is in an open space on a little rise of ground. It is 22 feet from an elm tree bearing 22° east of north, 49 feet from a sugar maple due south, 63.5 feet from a soft-maple tree bearing 38° west of south, and 21.9 feet from the edge of the brick walk on the east side of Main street. It is marked by a marble post 6 by 6 by 30 inches, set 29 inches in the ground, and lettered U. S. C. & G. S., 1904. A ½-inch hole one-half inch deep marks the center. The following true bearing was determined:

	° ′
Spire on post-office building	13 58.8 west of south

Marietta, Washington County.—The station of 1898 was reoccupied. It is in the grounds of the Marietta College Observatory, about 75 feet northwest of the small equatorial. It is marked by a sandstone post, with copper station mark. Some 500 or 600 feet south of the station a similar stone was set in 1898 to mark the true meridian. In 1904 this stone was found to bear 0° 01′.6 west of south. The following true bearing was determined:

	° ′
Cupola on Mr. Wilson's house	51 34.6 west of south

Millersburg, Holmes County.—The station is in the grounds of the Millersburg High School, about 500 feet north from Main street, and near and just beyond the entrance of a driveway to the school grounds (little used). It is 22 feet from a hard-maple tree 12 inches in diameter bearing 15° west of north, 53.8 feet from a hard-maple tree 10 inches in diameter bearing 5° east of south, 77 feet from a maple tree 10 inches in diameter bearing 12° 27′ west of south (mark No. 2), and about 45 feet from the middle of an unnamed street passing along the west side of the grounds (very little used on account of the steep hill). The station is marked by a sandstone post 6 by 6 by 30 inches set 28 inches

Descriptions of stations—Continued.

OHIO—Continued.

in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole one-half inch deep marks the point. The following true bearings were determined:

	° ′
German Church spire (mark)	44 47.8 west of south
New frame house, north gable	61 10.8 east of south
Frame house across the street, east gable	54 52.0 west of south

Newark, Licking County.—The station is in the grounds of the Woodside Grammar School, near the southwest corner of the grounds. It is 135.5 feet from the left-hand corner of the stone foundation of porch at the south entrance of the school building, 133.7 feet from the northwest corner of main part of building, 23 feet from an elm tree 28 inches in diameter bearing 18° east of north, and 13.5 feet from an elm tree 22 inches in diameter bearing 82° east of south. It is also about 40 feet from the edge of Eleventh street. The station is marked by a granite post 5 by 7 by 28 inches, set 26 inches in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole one-half inch deep in the center marks the exact point. The following true bearing was determined:

	° ′
Apex of roof of Mr. Wymer's house (mark)	4 41.2 west of south

New Lexington, Perry County.—The station is in the grounds of the public school. It is 162.5 feet, 44 feet, 25 feet, and 25 feet, respectively, from the south corner of the school building, a large elm tree 20 inches in diameter bearing 25° east of north, a locust tree 12 inches in diameter bearing 75° east of north, and the brick walk leading from the street up to the school building. It is marked by a limestone post 5 by 6 by 30 inches, set 28 inches in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole one-half inch deep in the center marks the exact point. The following true bearings were determined:

	° ′
Flagstaff on Park Hotel (mark)	46 48.1 west of south
Vane on court-house	12 28.9 west of south
Catholic Church spire	85 45.9 west of south

New Philadelphia, Tuscarawas County.—The station is on the grounds of the County Infirmary 3 miles southeast of New Philadelphia. It is on a narrow hill about 200 yards north from the buildings and is 63.6 feet from the mouth of a large cistern which bears 15° east of north. The station is marked by a sandstone (Berea) post 5 by 7 by 36 inches, set 32 inches in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole one-half inch deep in the center marks the point. The following true bearings were determined:

	° ′
North cupola on large new barn (mark)	0 49.7 east of south
Infirmary spire	12 24.3 west of south

St. Clairsville, Belmont County.—The station is on the county fair grounds. Observations were made over the north monument of the meridian line established by the United States Geological Survey. It is within the oval race track. The line is 435 feet long. The north monument is 12 by 16 inches and projects about 24 inches out of the ground, having a copper bench mark in the top. The following true bearings were determined:

	° ′
South monument (mark)	0 00.0
Judge's stand, northwest corner	50 50.2 west of south
Gable on flat-roofed house to north	3 56.6 west of north

Steubenville, Jefferson County.—Observations were taken over the south monument of a meridian line, the date of establisment of which could not be ascertained. It is located on the grounds of the County Infirmary and is in an open field. This south monument is about a quarter of a mile east of south from the infirmary buildings. It is a sandstone post 16 by 16 inches, projecting 30 inches out of the ground. The north monument is similar in size aud is just inside of the fence along the

Descriptions of stations—Continued.

OHIO—Continued.

south side of the road leading to the infirmary. It is almost directly across the road from a farm house an eighth of a mile east of the entrance to the infirmary grounds. The following true bearings were determined:

	° ′
Infirmary barn cupola (mark)	32 00.8 west of north
Point on water tank	39 48.1 west of north

Woodsfield, Monroe County.—The station is on the grounds of the Woodsfield High School, near the northeast corner of the grounds. It is 151.9 feet and 178.8 feet, respectively, from the northeast and southeast corners of the school building. These two corners bear, respectively, 78° 52′.3 west of north and 79° 17′.8 west of south. It is also 43 feet and 15 feet, respectively, from a picket fence east and a maple tree 4 inches in diameter bearing 25° west of north. The station is marked by a sandstone post 7 by 7 by 30 inches, set 29 inches in the ground, and lettered U. S. C. & G. S., 1904. A ½-inch hole drilled one-half inch deep in the center marks the point. The following true bearing was determined:

	° ′
Catholic Church spire	34 58.2 west of south

Wooster, Wayne County.—The station is in the grounds of the Wooster University, northwest of the astronomical observatory. It is 96.3 feet and 102.9 feet, respectively, from the northwest corner of the main part of the building, and the northwest corner of the west wing of the building. The station is marked by a granite post 6 by 6 by 32 inches, set 29 inches in the ground and lettered U. S. C. & G. S., 1904. A ½-inch hole, one-half inch deep, marks the exact spot. The following true bearing was determined:

	° ′
Grammar School cupola (mark)	1 10.9 east of south

Zanesville, Muskingum County.—The station is on the grounds of the Muskingum County Infirmary, 2½ miles northwest of the town of Zanesville. It is 140.1 feet and 149.0 feet, respectively, from the northwest corner of the building and the left-hand corner of the steps at the entrance to the building. It is also 43.2 feet and 44.3 feet, respectively, from a soft maple tree 15 inches in diameter bearing 6° east of south and a catalpa tree 20 inches in diameter bearing 76° east of south. It is marked by a marble post 6 by 6 by 28 inches, set 27 inches in the ground and lettered on top U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Southwest corner of infirmary building, just above stone basement (mark)	16 50.0 west of south
Northeast corner of infirmary building	33 35.8 east of south

OKLAHOMA.

Alva, Woods County.—The station is in the western part of the grounds of the Northwestern Normal School, about one-third of a mile south of the town center. It is west of the school building and northwest of the school water tank. It is 318.7 feet from the property line to the north, 325.7 feet from the northwest tower of the school building, and 336.3 feet from the southwest corner of the school building. The station was to be marked by Mr. Henry Meier, instructor in languages, who was formerly in the astronomical service. The following true bearings were determined:

	° ′
Steeple of Baptist Church (mark)	16 21.5 east of north
Congregational Church steeple	13 14.0 east of north
Presbyterian Church steeple, east edge of ball	0 08.5 west of north
City Hall cupola	18 30.3 east of north
Northwest tower of Normal School	86 07.6 east of north

Anadarko, Caddo County.—The station is in the southeastern part of the town park reservation, on a bluff overlooking a part of the park, which at times is flooded with water. It is about three-quarters

Descriptions of stations—Continued.

OKLAHOMA—Continued.

of a mile a little to the southwest of the town center, a little to the west of south of the waterworks, and about 700 feet from the water tank. It is 25 feet from the edge of the bluff to the south, 31 feet from the edge of the bluff to the west, and 211 feet from the park fence to the southeast. The station is marked by a cement compound post 24 by 6 by 6 inches, lettered U. S. C. & G. S., 1904, and showing about 3 inches above ground. The exact spot is marked by a small hole in the center of the C. The following true bearings were determined:

	° ′
South Methodist Church steeple (mark)	85 49.1 east of south
Cross on Catholic Church steeple	78 56.6 east of north
East edge of ball on water tank	68 26.6 east of north

Chandler, Lincoln County.—The station is in the northwest corner of the northeast town park, about 1 mile northeast of the town center. It is 60.5 feet from the park fence to the north, and 141 feet from the park fence to the west. The station is marked by a limestone post 6 by 6 by 18 inches, showing about 1 inch above ground, and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Cross on steeple of Catholic Church (mark)	19 00.6 west of south
Cupola on Hoffman building	16 04.2 west of south
Flag pole on West public school	41 25.2 west of south
Flag pole on East public school	20 02.6 east of south

Cordell, Washita County.—The station is in the northwest corner of the ground surrounding the public school, about 1 000 feet southeast of the town center. It is northwest of the schoolhouse and about one-fourth mile southeast of the town water tank. It is 129.4 feet from the northwest corner of the schoolhouse, and 186.6 feet from the northeastern corner of the schoolhouse. It is marked by an oak stake about 2 inches in diameter and 1½ feet long, driven in very hard ground and sawed off flush with the ground. A small nail in the top marks the exact spot. The following true bearings were determined:

	° ′
East edge of ball on water tank (mark)	28 08.8 west of north
Small wooden church steeple	17 27.3 west of north
Center of ball on red cupola on house	18 13.9 west of north
Bell tower on public school	52 15.5 east of south

Enid, Garfield County.—The station is in the northern part of the oval within the race track of the Enid fair grounds, about halfway between the eastern and western extremities. It is southeast of the grand stand and about due west of the Rock Island Railroad water tank. It is 147.8 feet south of the northern inside fence of the race track, 143.8 feet southeast from the nearest point on the judge's stand, and about 339 feet north of the southern inside fence of the race track. The station is marked by a Bedford limestone 24 by 6 by 6 inches, with about 4 inches showing above the ground, and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Cross on front steeple of Catholic Church (mark)	9 04.0 east of north
Cross on back steeple of Catholic Church	8 13.0 east of north
Flag pole of Frantz Hotel	35 10.5 east of north
Rock Island Railroad water tank	85 34.4 east of north

Guthrie, Logan County.—The station is in the northwestern part of Highland park about 354 feet a little north of west of a small square wooden house, and about 39 feet north of the northern apex of an oval which is laid out in building lots. It is about 390 feet east of a small gulch, through which a stream runs, and about 1 mile northeast of the town center. There are no convenient permanent objects from which to take measurements, but the location of the station is known to Mr. B. S. Reeves, the county surveyor, and to Mr. William Taylor. The station is marked by a limestone post

Descriptions of stations—Continued.

OKLAHOMA—Continued.

6 by 6 by 24 inches, showing 2 inches above the ground, and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Flag pole on Capital Hill public school (mark)	9 10.6 west of south
Cross on Catholic Church steeple	52 26.5 west of south
Flag pole on cupola of high school	72 48.6 west of north

Lawton, Comanche County.—The station is on the central part of the grounds of the Indian school, which is about 2½ miles a little east of north of the town center. It is north of the central brick school building and west of the school stable. It is 299.3 feet north of the northern fence around the school buildings and 498.4 feet west of the western wall of the school stable building. The station is marked by an oak stake 2 inches in diameter, projecting 6 inches above the ground, which is very hard. The exact spot is marked by a brass rivet driven in the top of the stake. The following true bearings were determined:

	° ′
Flag pole of City National Bank (mark)	23 29.3 west of south
First Methodist Church spire	27 46.2 west of south
Cross on steeple of Catholic Church, vertical arm	39 42.0 west of south
Water tank, Fort Sill Military Reservation	2 47.9 west of north
Church near Catholic Church (steeple)	38 22.8 west of south

Mangum, Greer County.—Observations were made within a few inches of the station occupied in 1900. The station is about 524 feet south of a small deserted house, and is in what is known as the Crabtree pasture. It is on a small semicircular promontory at the head of a gulch, directly north of and overlooking the river, and is about 300 yards southwest of the court-house square. The station is marked by an oak stake about 2 feet long and 2½ inches square, with a nail in the top to mark the exact spot. The following true bearings were determined:

	° ′
Distant windmill (mark)	31 34.2 west of south
Methodist Church spire	18 13.8 east of north
Belfry of stone schoolhouse	20 50.3 east of north

Newkirk, Kay County.—The station is in the northeast corner of the ground surrounding the public school, which is about 500 yards north of the city hall. It is 60.3 feet from a fence to the north, 56.7 feet from a fence to the east, and 165.6 feet northeast of the northeast corner of the school building. The station is marked by an eolite stone 24 by 6 by 6 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Bell tower on city hall (mark)	3 44.7 west of south
East edge of ball on town water tank	1 06.1 east of south
East edge of ball on flag pole of high school	30 06.2 west of south

Oklahoma, Oklahoma County.—The station is on the grounds of the military college, about 2 miles north of the town center. It is in the northwest corner of the grounds, a little north of west of the main college building and north of the college stable. It is 213 feet north of the northeast corner of the college stables, 211 feet a little north of west of the northwest corner of the woodwork surrounding a small water tank, and about 40 feet from a country road to the north. The station is marked by a marble post 18 by 6 by 6 inches, about 3 inches showing above ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Cross on steeple of Catholic Church (mark)	25 05.2 east of south
Top of town water tank	43 00.0 east of south
Extreme western edge of university building	7 37.8 east of south

Pawhuska, Osage Reservation.—The station is in the eastern part of the grounds of the Osage Indian School, northeast of the girls' dormitory, and southeast of the main school building. It is 221.9 feet

Descriptions of stations—Continued.

OKLAHOMA—Continued.

from the southeast corner of the main school building, 180.1 feet from the northeast corner of the girls' dormitory, and 87.8 feet from a cinder path to the east. The station is marked by a sandstone post 24 by 6 by 6 inches, set flush with the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
Lightning rod on southeast corner of Indian agent's house	26 43.8 west of south
Southern edge of ornamental top of cupola on main school building	9 05.4 west of north
Flag pole on boys' dormitory	39 53.0 east of north

Watonga, Blaine County.—The station is in the northwestern part of the town park reservation, about 1 mile southwest of the town center. It is southeast of a distant water tank and west of Mr. Beals's house, which is about 300 feet distant. There are no permanent marks from which to measure, but taking two lots to the north across the road on the northern side of the park it is about 189 feet from the southwest corner of the most western of these lots and about 210 feet from the southeast corner of the most eastern one. The setting of the stone, which will be a common field stone lettered in the usual way, was left to Mr. D. A. Beals, who is a brother of the one mentioned above, and who lives about 1 000 feet to the southwest of the station. The following true bearings were determined:

	° ′
Methodist Church steeple (mark)	59 57.0 west of north
Baptist Church steeple	49 09.4 west of north
Town water tank	64 30.2 west of north
Flag pole on public school	64 54.0 west of north
Rock Island Railroad water tank	69 09.3 west of north

PORTO RICO.

Mayaguez.—The station of 1904 could not be occupied, as a building has been erected upon its site. A new station was therefore chosen about 125 feet from the old one. The station is nearly in the center of the field in front of the United States military hospital (1898), 35 paces from the northwest corner of the hospital fence, 39 paces from the hospital gate, and 29 paces from the eastern edge of the board fence on the north. The station is temporarily marked by an oak stake. The following true bearings were determined:

	° ′
Nearest edge of smokestack on sugar mill (mark)	55 39.4 west of north
Southwest tangent United States barracks	15 57.4 west of north
Southwest tangent United States military hospital	29 37.4 east of south

Mosquito, Vieques Island.—The station is on Point Caballo, Vieques Island, on the northwest shore of the island. It is on the beach, on a line connecting the hydrographic signals Mosquito and Caballo Blanco, and about 25 feet distant from the former and 15 feet below its base. The station is not marked. The bearing of the line connecting Mosquito with Caballo Blanco is 42° 45′ east of true north.

Obispo Cayo.—The station of 1903 was reoccupied. It is on the northeast shore of Obispo Cayo, about 10 paces from the water and 12 feet from high-water mark. It is about the middle of an opening in the mangroves, which extend for about 60 feet along the beach. All the horizon from Cape San Juan Light-house to Palominos Island is visible from the station. The station is marked by an oak stake driven flush with the ground and covered with sand. The following true bearings were determined:

	° ′
Cape San Juan Light-house (mark)	1 47.0 east of north
Hydrographic signal Nob	50 02.0 east of north
Hydrographic signal Palominos	81 59.0 east of north

Porto Rico Magnetic Observatory, Vieques Island.—In connection with the establishment of a temporary magnetic observatory at Fort Isabel, a station for absolute observations was established on the hill east of the fort about halfway up.

Descriptions of stations—Continued.

RHODE ISLAND.

Bristol, Bristol County.—The station is near what is called Bristol Ferry, about 2 miles south of the center of the town. It is on the highest point of land on a ledge belonging to Mr. Charles West. It is about 200 yards west of the ferry road and about 40 yards south of a street running west from the ferry road. The station is about 80 yards north of Mr. Cassatt's house and another house is about 60 yards west. Two crosses are cut 27.9 feet apart in the ledge, exactly in line with mark (white church spire in Bristol). The station is between these crosses, 12.6 feet from the north one and 15.3 feet from the south one. The following true bearings were determined:

	° ′
Bristol Church spire (mark)	19 43.6 west of north
State capitol	31 39.4 west of north
Stone tower of church (Warwick?)	66 59.2 west of north
Muscle Bed Shoals Light-house	25 16.8 west of south

East Greenwich, Kent County.—The station is on the grounds of the East Greenwich Academy, about one-half mile west of the railroad station. It is on the east side of the ball grounds, and is 134 feet south of Church street and 230 feet north of Rector street. It is also 206.0 feet east of the east wall of an old burying ground, 210.2 feet from the northwest corner of the academy building, and 129.9 feet from the southwest corner of Olney Cottage. The station is marked by a spruce post 4 by 4 by 24 inches, sunk with its top 2 inches below the level of the ground. The following true bearings were determined:

	° ′
Southeast corner of top of basement wall of Mr. E. A. Gould's house (mark)	52 39.6 west of north
Northwest corner of academy building, top of basement wall	73 19.1 east of south
Tip of tower at northeast corner of academy building	78 29.4 east of south

Kingston, Washington County.—The station is on the grounds of the Rhode Island Agricultural College, on the open square south of Lippitt Hall. It is 236.3 feet east of the northeast corner of the dormitory and 175.0 feet southwest of the flag pole. The northeast corner of the dormitory bears 81° 22′ west of north and the flag pole 47° 49′ east of north. The station is marked by a marble post 30 by 10 by 10 inches set about 2 inches below the level of the ground and lettered U. S. C. S. A ½-inch hole in the center marks the exact spot. A second stone marking a meridian line was set 290 feet south of the station and 51.3 feet slightly southeast of a tree. This stone is of granite, 36 by 7 by 7 inches, set flush with the ground and unlettered; it has a 1-inch hole about 2 inches deep in the center of top, which bears 0° 02′.0 west of south from the magnetic station. The following true bearings were determined:

	° ′
Congregational Church spire (mark)	12 17.9 east of south
Boarding hall lightning rod	66 32.5 west of south
Cap of north tower Davis Hall	82 51.9 west of north
Experiment station weather vane	51 56.0 west of north
Dairy barn weather vane	14 42.5 west of north

Newport, Newport County.—The station is about 30 feet northeast of the station of 1896 on Coasters Harbor Island. The barracks, a large new building recently erected, is about 200 feet to the west. The station is almost in line with the south side of barracks and is distant 160.7 feet from the road in front of the barracks. It is 171.4 feet northwest of the west end of a wall. It is in line with the northwest corner of War College and northwest corner of the reservoir, about two-thirds of the way from War College to reservoir. The following true bearings were determined:

	° ′
Rod supporting weather vane on central tower of headquarters (mark)	10 26.2 east of south
St. Mary's Catholic Church, Newport	30 37.0 east of south
Weather vane central tower War College	30 38.8 west of south
Thorndike Hotel, Jamestown, flag pole	65 10.6 west of south

Descriptions of stations—Continued.

RHODE ISLAND—Continued.

Providence, Providence County.—The old station on grounds of Brown University is too near the new engineering building to be satisfactory. A new station was selected on city property on grounds of the Socanosset reservoir, about 5 miles (air line) southwest of City Hall. The station is in a pasture south of the center of the reservoir, about 125 yards west from a house where the gate keeper lives, and about 120 yards from the nearest wall of reservoir. It is 36.4 feet from a wire fence on the north side and 47.1 feet due east of an oak tree. It is also 61.3 feet due west of an ash tree. A second stone marking a meridian line was set 251.7 feet due south of the station. This stone is 18.1 feet northeast of an ash tree and 188.7 feet from the south wall of a pasture. The stones are each 4 feet long, 12 inches square at bottom and 6 inches square at top, set flush with the ground, and lettered U. S. C. S. A small hole 1½ inches deep marks the exact spot. The following true bearings were determined:

	° ′
Tower main hall Rhode Island Reform School for Boys (mark)....	37 53.3 east of south
Flag pole Socanosset School....	50 42.1 east of south
Spire on barn Insane Asylum....	1 38.4 east of south

SOUTH CAROLINA.

Anderson, Anderson County.—The station is on the grounds of the graded school, about one-half mile southwest of the court-house. It is southeast of the building, 69.5 feet and 107.2 feet, respectively, from the southeast and northeast corners of the building. It is also 56.7 feet and 75.9 feet, respectively, from the woven-wire fences on the east and south lines of the grounds. The station is marked by a marble post, 4 by 8 by 30 inches, set flush with the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Colored Baptist Church spire (mark)....	1 13.2 east of south
Cupola on Dr. S. M. Orr's residence....	78 05.7 west of south
Presbyterian Church spire....	12 55.2 east of north
Cupola on Town Hall....	85 24.9 east of north

Greenwood, Greenwood County.—The station is in the playgrounds of the public school, about one-half mile east of the railroad station. It is southeast of the school building, 135.0 feet from the southwest corner and 184.4 feet from the southeast corner of the building, and 39.7 feet east from the west fence of the playgrounds. The station is marked by a marble post, 4 by 8 by 24 inches, projecting 1 inch above the ground and lettered U. S. C. & G. S., 1905. A small drill hole in the center of the top marks the station. The following true bearings were determined:

	° ′
Baptist (white) Church spire (mark)....	38 04.9 west of north
Colored Baptist Church spire....	66 18.7 east of north
Spire on cornice of Riley block....	81 56.1 west of north

Newberry, Newberry County.—The station is in the southeast corner of the campus of the Newberry (Lutheran) College, about 1 mile north of the court-house. It is on the second or lower terrace directly in front of the main entrance of Holland Hall, and 87 paces therefrom and 200.7 feet from the fence separating the campus from the athletic field. The station is marked by a 4 by 8 by 24 inch marble post, projecting 1 inch above the ground and lettered U. S. C. & G. S., 1905. The small drill hole in the center of the top marks the station. The following true bearings were determined:

	° ′
Lutheran Church spire (mark)....	22 30.2 east of south
Presbyterian Church spire....	35 43.9 east of south
Graded School spire....	19 22.9 east of south
Church spire....	17 57.8 east of south

Pickens, Pickens County.—The station is on the grounds of the Methodist Church, across the street, north, from the Hiawatha Hotel. It is 72.4 and 87.1 feet, respectively, from the southeast and

Descriptions of stations—Continued.

SOUTH CAROLINA—Continued.

southwest corners of the church, 45.6 feet from the fence on the east, 18.2 feet from an oak tree 12 inches in diameter to the east, and 16 feet from an oak tree 12 inches in diameter bearing 60° west of south. The station is marked by a rough granite stone 30 inches long, almost level with the surface of the ground and having a cross cut in the center. The following true bearings were determined:

	° ′
Point of cupola on jail (mark)	29 31.0 west of south
Colored Baptist Church cupola	28 51.0 west of south
Cupola on J. P. Carey's residence	77 01.8 west of south
Base of flagstaff on High School	89 52.3 east of south

Spartanburg, Spartanburg County.—The station of 1896 was reoccupied. It is on the campus of the Wofford College, in front of the main building. It is 219.8 feet nearly south from the Coast and Geodetic Survey primary triangulation station "Wofford" on the roof of the college building. It is 73.6 feet north of the south fence, and 30.2 feet east from the path leading from main building to Science Hall. The station is marked by a stone post about 6 inches square, with its upper surface just above the ground. On this surface are cut the letters U. S. C. S., also M. S. The following true bearings were determined:

	° ′
Spire on 72 East Main street (mark)	30 46.2 east of south
Presbyterian Church spire	34 04.7 east of south

Union, Union County.—Observations were made over the south stone of the meridian line in the grounds of the graded school, established by the United States Geological Survey. The ends of the meridian line are marked by 8 by 8 inch stone posts, projecting about 8 inches above the surface of the ground and having set in their top surfaces the bronze station mark of the U. S. G. S. The north meridian stone is in the angle of the fence north of the school building, on the west side. It is 9.3 feet from the north fence and 9.4 feet from the fence in line with the west side of the building. The south meridian stone is 70.5 feet east from the curbing of the street to the west of the building, about 10 feet north of the sidewalk on the south side of the grounds, and 93.7 feet from the southwest corner of the building, and about 325 feet due south of the north meridian mark. The following true bearings were determined:

	° ′
Colored Baptist Church spire (mark)	70 29.7 west of south
Railway water-tank spire	70 53.0 west of south

Walhalla, Oconee County.—The station is on the grounds of the Walhalla public school, west of the building. It is 73.2 feet and 99.4 feet, respectively, from the southeast and southwest corners of the school building, and 97.3 feet from the southwest corner of the bell tower. The station is marked by a marble post, 6 by 6 by 20 inches, set in a base of cement and gravel, the top flush with the ground. The stone is lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Lutheran Church spire (mark)	68 59.9 west of south
Right-hand post on cornice of Doctor Bell's drug store	15 18.0 east of south

TEXAS.

El Paso, El Paso County.—The station of 1895 being no longer suited for magnetic observations, a new station was established on ground owned by the El Paso Water Company, about 1½ miles west of the town center. It is east of reservoir No. 2 and about 1 000 feet a little north of east of a Geological Survey bench mark. It is also about one-quarter of a mile north of the Smelter trolley road, almost due east of the post-office, and a little west of south of a small Mexican adobe village. It is 171.4 feet east of the eastern corner of a white wooden fence surrounding reservoir No. 2, and 276 feet northeast of the southern corner of this same fence. The station is marked by a coarse marble post,

Descriptions of stations—Continued.

TEXAS—Continued.

18 by 6 by 6 inches, lettered U. S. C. & G. S., 1905, and showing about 3 inches above the ground. The following true bearings were determined:

	° ′
Flagpole on tower of court-house (mark)	52 23.4 east of south
First Baptist Church spire	60 00.4 east of south
Flagstaff on tower of post-office	43 33.2 east of south
Catholic Church steeple	57 57.2 east of south

Odessa, Ector County.—The station is in the northeast corner of the ground surrounding the county court-house, about in the center of town. It is northeast of the court-house and east of the jail. It is 60 feet from the fence to the north, 61.7 feet from the fence to the east, and 138.8 feet northeast of the northeast corner of the court-house. The station is marked by an oak stake, 18 by 1 by 1½ inches, projecting 4 inches above the ground, with a small rod of silver in the top to mark the exact spot. The following true bearings were determined:

	° ′
Eastern corner at extreme top of water tank on store opposite railroad station (mark)	24 36.7 east of south
Top of windmill tower 1 mile distant	68 45.5 east of south
Bell tower of church	55 00.4 west of north

Sierra Blanca, El Paso County.—The station of 1888 being no longer available, a new station was established a little to the west of north of the Southern Pacific and Texas Pacific Railroad station, and a little to the east of south of Mr. Love's house. It is 46.7 feet northwest of the northwest corner of a white fence surrounding a deserted house belonging to the Texas Pacific Railroad, and about 489 feet to the east of north of the northeastern rail of the Texas Pacific Railroad track. The station is marked by an ash stake, 18 by 1 by 1½ inches, showing 2 inches above ground, and having a small nail in the top marking the exact spot. The following true bearings were determined:

	° ′
Central cupola on railroad station (mark)	21 23.0 west of south
East corner of top of Southern Pacific oil tank	71 11.3 west of south
Southern point of top of roof on Mr. Love's house	17 37.2 west of north

UTAH.

Ogden, Weber County.—The station is about half-mile west of the west bank of Weber River, west of the Southern Pacific Railroad station, and just south of two piers. These piers formed part of an observatory which has disappeared. They are about 5 feet high and 1½ feet square, and the eastern pier is inscribed with the latitude, longitude, and elevation. It is also marked with the name Wheeler, U. S. A., 1873. The station is 45.4 feet south of the southeast corner, near the ground, of the eastern pier, and 46.0 feet a little east of south from the southwest corner near the ground of the western pier. The station is also 99 feet from a fence corner to the south. The following true bearings were determined:

	° ′
First M. E. Church spire (mark)	80 31.8 east of north
St. Joseph's Catholic Church spire	81 10.7 east of north
Spire on clock tower of Southern Pacific Railroad station	84 37.8 east of north
Flagstaff on Grand Opera House	88 49.4 east of north

VIRGINIA.

Norfolk, Norfolk County.—The station of 1897 was reoccupied. It is in the northeast suburb of the city in Lafayette Park. It is in the open space just south of the road leading to the new pavilion. It is marked by a heavy granite post sunk 4 feet in the ground. The top of this post is dressed 4 inches square and is lettered U. S. C. S., with a small hole and bolt marking the exact point. It extends about 4 inches above the surface of the ground. The true meridian is marked by this stone and another heavy granite post north of this one near the woods.

Descriptions of stations—Continued.

WASHINGTON.

Seattle, King County.—The station of 1903 in the grounds of the State University was reoccupied. It is about 600 feet north of the administration building, 315 feet from the southwest corner of the gymnasium, and 20 feet west of the path between the administration and gymnasium buildings. The station is marked by a stone post, 8 inches square, projecting 5 inches above ground and lettered U. S. C. & G. S., 1903. The following true bearings were determined in 1904:

	° ′
East corner of the administration building (mark)	23 08.5 west of south
Spire of the administration building	28 33.5 west of south

WEST VIRGINIA.

Mason City, Mason County.—The station is in the Odd Fellows Cemetery, called Moore's Hill Cemetery. It is on the north edge of a circular reserve on a prehistoric mound. It is about 50 feet from a large locust tree bearing about 5° east of north and an equal distance from a second locust tree almost due east from the station. The station is marked by a sandstone post 36 inches long set 34 inches in the ground and lettered U. S. C. & G. S., 1904. The following true bearings were determined:

	° ′
M. E. Church steeple at Clifton (mark)	32 40.4 west of south
Middleport schoolhouse tower	51 22.2 west of south
Catholic Church spire, Pomeroy, Ohio	25 18.8 west of north
Episcopal Church spire, Pomeroy, Ohio	1 08.2 east of north
Baptist Church steeple, Pomeroy, Ohio	4 31.2 east of north

West Union, Doddridge County.—The station of 1900 was reoccupied as nearly as could be determined from its description. Observations were made on the school grounds southwest of the building. The station is 65.4 feet west of north from the south stone of the meridian line established by the United States Geological Survey in 1898. This stone is a sandstone column, 45 by 8 by 8 inches, set 39 inches in the ground with a copper plate in the center of the top. The station is 60.6 feet, 134.7 feet, and 135.6 feet, respectively, from the fence to the south, the southwest, and southeast corners of the school building. The following true bearings were determined:

	° ′
Steeple of white church (mark)	55 41.8 west of north
Court-house tower	16 40.6 west of north
North meridian monument	6 44.7 east of north
Northwest gable of Howell House	87 19.4 east of south

Winfield, Putnam County.—Observations were made very near to the magnetic station of 1900, over a point 135 feet north of the south stone of the meridian line established by the United States Geological Survey in 1898. This south meridian stone is in the court-house grounds opposite the jail. It consists of a column of sandstone, 42 by 8 by 8 inches, set 36 inches in the ground. The north meridian stone is 36 by 8 by 8 inches, set 36 inches in the ground, its top flush with the brick walk. It is near the back of Martin's store, within 10 inches of the inner edge of the walk. The following true bearing was determined:

	° ′
Aluminum bolt in top of north stone (mark)	0 03.0 west of north

WISCONSIN.

Madison, Dane County.—The station of 1900 was reoccupied. It is on the grounds of the Wisconsin State Agricultural Farm, in a timothy meadow. It is north of the main barn, 277.5 feet from a permanent wire fence along the east side of the meadow and 98.4 feet from a semipermanent wire fence along the south side. This latter fence is 100 feet north of the original fence line that is permanently marked by a cement block, in which the end post was set. The station is marked by a

Descriptions of stations—Continued.

WISCONSIN—Continued.

stone post, 8 by 8 by 36 inches, sunk 6 inches below the surface and lettered U. S. C. & G. S. The following true bearings were determined:

	° ′
Tower on C. E. Buell's residence (mark)	7 26.7 west of south
Cupola on dairy barn	18 39.4 west of south
West edge of flue on Mr. J. T. W. Jenning's residence	9 58.4 west of south
Northeast corner of flue on Prof. B. H. Meyer's residence	16 48.4 west of south

Mauston, Juneau County.—The station is in the Oakwood Cemetery in the rear street about 20 feet north of the central driveway. It is 64.4 feet from a line of elm trees along the west side of the grounds, 103.1 feet from the base of the Patterson monnment, and 74.2 feet from the corner post of the Sherwood lot. The station is marked by a Bedford stone post, 6 by 6 by 30 inches, set flush with the surface and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Middle of a prominent flue on Mr. I. L. Allsbacher's residence (mark)	84 58.5 east of north
Apex of Allen monument	85 44.8 east of north
Middle of urn on Hart monument	70 14.5 east of south

Observations were also made at a point 99.8 feet due north of the south stone of the meridian line established by the United States Geological Survey in the High School grounds.

Montello, Marquette County.—The station is in the Montello Cemetery, toward the north end, in the first alley east of the main street. It is 114.5 feet from the base of the Angus monument, to the southwest; 98.1 feet from the base of the Cooper monument to the southeast. It is about 150 feet from the semicircular bank of Montello Creek. The station is marked by a Bedford stone post, 4 by 6 by 30 inches, sunk flush with the surface of the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Rod on cupola of High School building (mark)	71 04.1 east of south
Cross on spire of new Catholic Church	69 04.8 east of south
Staff on ventilator of High School	71 41.8 east of south

Richland Center, Richland County.—The station is on the grounds of the Richland High School, due east of the north line of the building. It is 363.0 feet from the nearest corner of the building and 103.4 feet from the temporary wire fence on the north side of the grounds and 54.2 feet from a similar fence on the east side. The station is marked by a Bedford stone post, 6 by 6 by 29½ inches, sunk 29½ inches in the ground and lettered U. S. C. & G. S., 1905. The following true bearings were determined:

	° ′
Ball on spire of Catholic Church (mark)	71 45.4 west of north
Ball on cupola of High School building	80 32.3 west of south
Southeast edge of High School building	78 33.2 west of south

WYOMING.

Cokeville, Uinta County.—The station is on Government land about a mile and a half west of the town center, at the edge of some low hills. The road running west from town turns and runs south at the foot of the hills. The station is west of the road and southwest of the angle in the road. It is 71.7 feet west from a fence east of the road and 128.6 feet southwest from the northwest corner of the fence. It is marked by an oak stake, 3 by 4 by 30 inches, showing 6 inches above ground and having a cross sawed in the top. The following true bearings were determined:

	° ′
Cupola on front of schoolhouse (mark)	45 20.9 east of north
Cupola on northeast corner of Stoner Hotel	32 54.2 east of north
Church spire	43 12.7 east of north
Ball at the top of railroad water tank	32 52.5 east of north

Descriptions of stations—Continued.

WYOMING—Continued.

Green River, Sweetwater County.—The station is on Government land about one-fourth mile north of the town center in a V-shaped piece of land between two hills, and east of a peculiar rock formation of nearly cylindrical form, on which stands a flag pole. It is about 60 feet from a hill to the west, 120 feet from a hill to the east, and 360 feet from the hills to the north. It is 434.5 feet north of the northwest corner of the fence surrounding the cemetery and almost in line with this corner and the chimney of the second house east on the south side of the cemetery. It is marked by an oak stake, 4 by 6 inches, showing about 4 inches above ground and having a cross sawed in the top. The location is known to Joseph Payne, a local surveyor. The following true bearings were determined:

	° ′
Flagstaff on front of schoolhouse (mark)	24 10.4 west of south
Northwest point on jail cupola	54 34.3 west of south
Flagstaff on southeast corner of Brew house	50 36.6 west of south
Northern one of two small cupolas on soda works	1 24.7 east of south

FOREIGN COUNTRIES.

*Colon, Canal Zone.**—The station is on the west bank of the canal entrance, about 20 feet from high-water line. It is 394 feet north-northwest from North Base triangulation station. The station is marked by a stone post, 30 by 6 by 6 inches, lettered U. S. C. & G. S. 1905, and projecting 9 inches above ground. The following true bearings were determined:

	° ′
Toro Point Light-house (mark)	59 52.8 west of north
South gable of house No. 2, engineers' residences	20 21.6 west of north
Middle Marconi pole	22 23.5 east of north
North Base triangulation station	69 06.7 east of south

Kingston, Jamaica.—The station is on the north side of Kingston Harbor, almost due north of Port Royal naval station. It is on an estate belonging to Miss Perry, between the dwelling house and the shore, about 250 feet from the latter. There is a large tropical tree 66 feet east of north of the station, a smaller one 128 feet to the north-northwest, and a negro house about 100 yards to the southwest. The station is marked by a stone post, 30 by 6 by 6 inches, projecting 3 inches above ground, and lettered U. S. C. & G. S. 1905. The following true bearings were determined:

	° ′
Commodore's Lookout, Port Royal (mark)	29 24.3 west of south
Plumb Point Light-house	36 31.4 east of south

* Under the jurisdiction of the United States.

APPENDIX 4

REPORT 1905

PRECISE LEVELING

FROM RED DESERT, WYOMING, TO SEATTLE, WASHINGTON

1903–1904

By JOHN F. HAYFORD

Inspector of Geodetic Work; Assistant, Coast and Geodetic Survey

CONTENTS.

PRECISE LEVELING FROM RED DESERT, WYOMING, TO SEATTLE, WASH., 1903-4.

By JOHN F. HAYFORD,
Inspector of Geodetic Work; Assistant, Coast and Geodetic Survey.

The leveling between Red Desert, Wyoming, and Owyhee, Idaho, was done in 1903 and is reported upon in full in Appendix 6 of the Report for 1904, "Precise Leveling from Red Desert, Wyoming, to Owyhee, Idaho." When the elevation brought from the eastward by this leveling was carried forward from Owyhee to the tide gauge at Seattle, the discrepancy found, though well within allowable limits, was sufficiently large to make it necessary to distribute it back over the line as far as Red Desert. Hence, it is found desirable in this appendix to show the elevations resulting directly from the leveling between Red Desert and Owyhee, together with the elevations as corrected.

The leveling between Owyhee, Idaho, and Hunts Junction, Washington, was done by Mr. F. H. Sewall, Aid, May 5–October 4, 1904, and that between Seattle and Hunts Junction by Mr. G. Clyde Baldwin, Aid, May 7–October 1, 1904. The line follows the Oregon Short Line Railroad from Owyhee to Huntington, Oreg.; the Oregon Railroad and Navigation Company to Pendleton, Oreg.; the Washington and Columbia River Railroad to Hunts Junction, Washington, and thence the Northern Pacific Railroad to Seattle. The first three railroad companies named facilitated the leveling by allowing Mr. Sewall and his party to use velocipede cars over their lines. The velocipede cars were not used over the Northern Pacific Railroad; the officers of that road, however, showed many favors to Mr. Baldwin and his party which aided them in their work. The party slept, but did not get their meals, in a freight car fitted up with bunks which was hauled from siding to siding as the work progressed.

INSTRUMENTS AND RODS.

Mr. Sewall used precise level No. 8 and Mr. Baldwin No. 7. Both these instruments are of the most recent type and are fully described in Appendix 3 of the Report for 1903, pages 200–211.

The value of a 2-millimeter division on the level vial of either instrument, No. 7 or No. 8, is slightly less than 2″. The telescope of each of these instruments has a clear aperture of 4.2 centimeters and a focal length of 41 centimeters.

Mr. Sewall used rods R_2 and S. Mr. Baldwin used rods V and W. These rods are of the type described on pages 418–419 of Appendix 8 of the Report for 1899. The rods are of the direct-reading type and carry a centimeter graduation on which readings are made to millimeters by estimation.

The lengths of the 3-meter intervals marked on each of the rods by a fine graduation on metallic plugs in its face, as determined by the National Bureau of Standards, before and after the field work and reduced to 0° Centigrade, are as follows:

	Rod R_2	Rod S		Rod V	Rod W
March, 1904	$3^m+0^{mm}.7$	$3^m+1^{mm}.2$	April, 1904	$3^m+1^{mm}.4$	$3^m+1^{mm}.7$
Jan., 1905	$3+0\ .9$	$3+1\ .4$	Jan., 1905	$3+1\ .1$	$3+1\ .6$

Each rod was measured with a steel tape at least twice each month while in the field. The reading of the rod thermometer was always noted in connection with these measurements, and care was taken that the rods and tape should be at the temperature of the atmosphere, so that reliable comparisons could be made. These measurements were made in order to detect, if possible, any change in the lengths of the rods during the season. They do not give the absolute lengths of the rods at any time, as the error of the tape with which the measurements were made is not known.

The National Bureau of Standards' measurements of rods R_2 and S, used by Mr. Sewall, indicate a slight lengthening of these rods during the season. The field measurements did not fix the time of this lengthening. On the contrary, they indicate a slight shortening during the season of about this same amount. The level computations were made by using the mean length for the two rods as derived from the Bureau of Standards' measurements, namely, 0.35 millimeter per meter too long at 0° C.

The Bureau of Standards' measurements of the rods V and W, used by Mr. Baldwin, indicate a slight shortening during the season. The field measurements of the rods indicate that this change took place as two sudden changes, between July 6 and July 12 and between August 12 and August 25. Accordingly, the computations were made on the assumption that the rods preserved their length as measured at the Bureau of Standards in April, 1904, until July 7; that their lengths were a mean between the two Bureau of Standards' measurements during the period July 8–August 12, and after August 12 were as shown by the Bureau of Standards' measurements of January, 1905. The three values of the excess of length per meter at 0° C. thus used in the computation were, respectively, +0.52, +0.48, and +0.45 millimeter.

The index corrections for the rods as determined at Washington on April 13, 1904, were as follows, in millimeters: For R_2, —0.5; for S, —0.8; for V, —0.4, and for W, —0.4. A new determination of the index corrections of rods V and W, December 22, 1904, agreed with that given above within 0.1 millimeter.

The methods of observation are stated in detail on pages 211–222 of Appendix 3 of the Report for 1903.

First Connection Between the Atlantic and Pacific Oceans by Precise Leveling.

The level net extending from the Atlantic coast as far west as Cheyenne, Wyo., comprises 48 circuits, including those in which water leveling along the Atlantic and Gulf of Mexico forms one side. The principal connections with sea level are at Sandy Hook, N. J., and at Biloxi, Miss. This net and its adjustment are fully described in Appendix 3 of the Report for 1903, "Precise Leveling in the United States." The line of leveling westward from Cheyenne, over the Union Pacific Railroad and connecting lines, is a single line without any checks by circuits, though each portion of the line was, as usual, leveled at least twice. The computed elevations along the single line, starting with the adjusted elevations at Cheyenne, were, as shown in the following tabulation, 2047.6741 meters for bench mark B_3 at Red Desert, Wyoming; 903.6997 meters for bench mark W_4 at Owyhee, Idaho, and the eastern end of Mr. Sewall's leveling; and 127.5028 meters for bench mark P_3 at the western end of Mr. Sewall's line near Hunts Junction, Washington.

Mr. Baldwin began his leveling on bench marks at Seattle, of which the elevation had been fixed with reference to mean sea level at that point by tidal observations, with an automatic gauge, during five years, 1899–1903. The computed elevation of bench mark P_3 at the eastern end of his line was found to be 127.3153 meters, or 187.5 millimeters less than that found by Mr. Sewall by leveling from the eastward.

Two questions at once arise in connection with this discrepancy. Is it probably due simply to the errors of observations concerned in fixing the elevation of bench mark P_3? How shall this discrepancy be distributed in fixing the elevations hereafter to be used as standard for the bench marks along the line from Seattle eastward?

The probable error of the elevation of the mean sea-level surface at Seattle, as computed from the eastward from sea-level connections on the Atlantic and Gulf of Mexico, through the precise level net to Cheyenne and the single line of levels to Seattle, is $\pm$ 76 millimeters. The actual discrepancy is two and one-half times as large as this. According to the doctrine of chances, such a discrepancy, two and one-half times the probable error, should occur about once in ten times. An observation is not ordinarily rejected unless the discrepancy is from three and one-half to five times the probable error of the observation. From the point of view of the method of least squares no reason exists, therefore, for believing that this discrepancy is not due simply to errors of observation.

The probable error of $\pm$76 millimeters given above takes account of the errors in the tidal observations as well as of the errors in all the leveling concerned. The probable errors of elevations in the level net, as far west as Cheyenne, were computed from the adjustment of the level net and depend upon the discrepancies developed in the 48 circuits in the net. For the line westward from Cheyenne it was assumed that the probable error of a kilometer of completed line is $\pm$1.04 millimeters, the value found for leveling of this class in the adjustment of the level net.*

The conclusion that the discrepancy of 187.5 millimeters (0.615 foot) is due simply to errors of observation, and moreover, that these errors are exceedingly small, may be emphasized by the following considerations. As already stated, the principal connections with sea level on the eastern coast are at Sandy Hook, N. J., and at Biloxi, Miss. The shortest line of leveling of the highest grade of accuracy between Seattle and Sandy Hook is 7 700 kilometers long (4 800 miles), via Cheyenne, Wyo., Sioux City, Iowa, St. Louis, Mo., Chicago, Ill., through Lakes Michigan, Huron, and Erie, and by Oswego, N. Y. If it is assumed that the discrepancy is an accumulated error of leveling through this line, the average rate of accumulation is 0.025 millimeter per kilometer (1 foot in 7 700 miles). The shortest line of leveling of the highest grade of accuracy from Seattle to Biloxi is 5 700 kilometers long (3 500 miles), via Cheyenne, Wyo., Norfolk, Nebr., Abilene, Kans., Fort Worth, Tex., and Shreveport, La. If it

* See Appendix 3, Report for 1903, p. 379.

be assumed that the discrepancy is an accumulated error of leveling through this line, the average rate of accumulation is 0.033 millimeter per kilometer (1 foot in 5 700 miles).

The results of the tidal observations at Seattle are as follows:

Calendar year	Mean sea level on tide staff		Residuals
	Feet	*Meters*	*Meters*
1899	13.8192	4.2121	+0.0199
1900	13.9742	4.2593	−0.0273
1901	13.7697	4.1970	+0.0350
1902	13.9439	4.2501	−0.0181
1903	13.9158	4.2415	−0.0095

The mean is 13.8846 feet=4.2320 meters±0.008 meter. The elevations given in this appendix for bench marks Tidal 4, Tidal 5, F and G near the tide gauge depend upon the above determination of mean sea level.

Mean sea level was fixed, as used in the adjustments of the precise level net, by six years of tidal observations at Sandy Hook and by five years at Biloxi. The total range in the six annual means at Sandy Hook was 0.098 meter (0.322 foot), and in the five annual means at Biloxi, 0.030 meter (0.100 foot).

Evidently the tidal observations contributed but a small portion of the errors which combined make up the discrepancy of 187.5 millimeters.

Evidently, also, it is unnecessary in order to account for the discrepancy to assume that mean sea level on the Pacific is at a different elevation from that on the Atlantic and Gulf; or, more specifically, that mean sea level is at different elevations at Seattle, Biloxi, and Sandy Hook. The discrepancy found is within the possible limits of error of the precise leveling alone, even though it be assumed that the leveling in question is of as high a grade of accuracy as any yet done anywhere in the world.

Having reached the conclusion that the discrepancy of 187.5 millimeters is due to errors in leveling, the question arises, how shall this discrepancy be distributed in fixing elevations hereafter to be used as standard? The theoretically best elevations would be obtained by making a new adjustment of the precise level net, including the new line and new connection with mean sea level at Seattle. To adopt such elevations resulting from a new adjustment of the net as standard elevations hereafter to be used would cause great inconvenience to all who are using the thousands of elevations already published, by introducing many small corrections. The problem is to make such a distribution of the discrepancy as will produce the minimum disturbance in past publications and the minimum inconvenience in the revision of past computations, and at the same time give standard elevations which are so near to the theoretically best elevations that the loss in accuracy by such an arbitrary adoption of standard values will not be serious.

After careful consideration it was decided to hold unchanged all elevations as published at Red Desert, Wyoming, and eastward of that point, and to distribute the discrepancy of 187.5 millimeters at a uniform rate (0.097 millimeter per kilometer) from Seattle to Red Desert. The corrected elevations printed in this appendix and to be used as standard are computed on that basis.

This arbitrary decision makes the adopted elevation of Red Desert about 100 millimeters greater than the theoretically best elevation. The agreement between the adopted and the theoretically best elevations is closer than this for points either to the eastward or westward of Red Desert, approaching exact agreement as the point considered is supposed to approach the places at which connections have been made with mean sea level.

The doctrine of chances indicates that there is about one chance in five that the adopted elevation at Red Desert is nearer the truth than the theoretically best elevation derivable from the observations.

RESULTS AND THEIR ACCURACY.

The direct results of the leveling and the adopted corrected elevations are shown in the following tables, in which all the permanent bench marks are given.

If no distance is given in the fourth column, the bench mark is in the main line of levels. If a distance is given in the fourth as well as the third column, the bench mark is on a spur and the distance given in the fourth column shows the point at which the spur branches from the main line.

Each short section, usually from 1 to 2 kilometers long, into which the line was divided by permanent and temporary bench marks, was leveled at least twice, once in the forward and once in the backward direction. On each section upon which a forward and backward measure differed by more than $4^{mm}\sqrt{K}$ (in which K is the distance leveled between adjacent bench marks in kilometers), both the forward and backward measures were repeated until two such measures fell within the limit stated. The fifth column gives the total discrepancy accumulated at each permanent bench mark between the elevation as computed from the backward lines and from the forward lines separately. The sixth column gives the elevations which result directly from the leveling. The last column gives the adopted corrected elevation. All elevations are referred to mean sea level.

RED DESERT, WYOMING, TO OWYHEE, IDAHO, LINE.

The following four tables, showing the direct results of the leveling between Red Desert and Owyhee are reproduced here* with an additional column headed "Corrected elevations," showing the present adopted elevations.

*From Appendix 6, Report for 1904.

Results of leveling, Red Desert to Azusa, Wyo.

Place	Permanent bench mark	Distance to bench mark*	Distance to base of spur*	Total discrepancy (B-F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Near Red Desert, Wyo.	Z_2	−1.0			† 2050.9061	2050.9061
Red Desert, Wyo.	B_3	0.0		0.0	‡ 2047.6741	2047.6741
Tipton, Wyo.	C_3	11.7		+ 5.4	2132.5399	2132.5388
Near Table Rock, Wyo.	D_3	20.4		+15.6	2087.8008	2087.7988
Near Monell, Wyo.	U. P. 779	30.0	29.1	§	2057.1249	2057.1221
Monell, Wyo.	E_3	30.6		+34.8	2056.5452	2056.5422
Bittercreek, Wyo.	F_3	38.7		+58.0	2040.4953	2040.4915
Near Black Buttes, Wyo.	G_3	49.9		+53.0	2020.4359	2020.4311
Black Buttes, Wyo.	U. P. 793	53.2	52.7	§	2016.6834	2016.6783
Hallville, Wyo.	H_3	62.0		+55.9	1998.2346	1998.2286
Hallville, Wyo.	U. P. 799	62.2	62.0	+53.7	1998.4713	1998.4653
Near Point of Rocks, Wyo.	U. P. 804	70.2	70.1	+48.1	1985.0710	1985.0642
Near Point of Rocks, Wyo.	I_3	72.7		+51.0	1983.9406	1983.9335
Near Point of Rocks, Wyo.	U. P. 810	79.9	79.7	+43.7	1968.4864	1968.4787
Near Salt Wells, Wyo.	J_3	87.0		+37.3	1948.4257	1948.4173
Near Baxter, Wyo.	U. P. 823	100.6	100.3	+59.7	1920.4722	1920.4625
Baxter, Wyo.	K_3	101.3		+62.7	1921.9076	1921.8978
Rock Springs, Wyo.	L_3	111.8		+64.3	1909.3503	1909.3394
Rock Springs, Wyo.	M_3	111.9		+63.9	1908.4995	1908.4886
Rock Springs, Wyo.	N_3	112.0	111.9	+63.7	1912.8302	1912.8193
Rock Springs, Wyo.	O_3	112.2	111.9	+63.0	1916.5712	1916.5603
Ah Say, Wyo.	U. P. 835	120.2	120.0	+57.9	1895.3612	1895.3496
Near Wilkins, Wyo.	P_3	123.6		+60.6	1890.0678	1890.0558
Wilkins, Wyo.	U. P. 839	126.6	126.5	+60.4	1884.3311	1884.3188
Greenriver, Wyo.	Q_3	136.0	135.9	+64.2	1855.0536	1855.0404
Greenriver, Wyo.	R_3	136.2	135.9	+65.6	1864.7786	1864.7654
Greenriver, Wyo.	S_3	136.1	135.9	+64.5	1858.3998	1858.3866
Greenriver, Wyo.	T_3	136.7		+61.0	1855.2436	1855.2303
Near Peru, Wyo.	U_3	147.3		+60.3	1941.1731	1941.1588
Near Bryan, Wyo.	V_3	159.5		+82.3	1884.1850	1884.1695
Near Marston, Wyo.	W_3	164.1		+80.6	1883.2550	1883.2391
Near Marston, Wyo.	X_3	172.0		+85.2	1901.9158	1901.8991
Near Azusa, Wyo.	Y_3	176.0		+77.9	1897.1105	1897.0934
Near Azusa, Wyo.	‖105	176.9		+76.8	1901.5869	1901.5697

* From bench mark B_3 at Red Desert.
† This elevation supersedes that given on page 580 of Appendix 3 of the Report for 1903.
‡ This is the adopted initial elevation for this line. It is taken from page 580 of Appendix 3 of the Report for 1903.
§ The spur was a single line of levels, that is, run in one direction only.
‖ This is a temporary bench mark which is identical with temporary bench mark 160 of the line Ogden, Utah to Azusa, Wyo.

Results of leveling, Ogden, Utah, to Azusa, Wyo.

Place	Permanent bench mark	Distance to bench mark*	Distance to base of spur*	Total discrepancy (B–F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Ogden, Utah	B	0.0		0.0	1309.8520	1309.8113
Ogden, Utah	A	0.8	0.0	−2.0	1308.8588	1308.8181
Ogden, Utah	† Transit	1.6	0.0	−0.6	1331.5447	1331.5040
Ogden, Utah	C	0.2		+0.7	1310.5028	1310.4621
Uinta, Utah	D	12.4		+8.4	1370.2906	1370.2511
Near Devils Gate, Utah	E	21.6		+14.2	1468.4360	1468.3974
Near Strawberry, Utah	F	23.2		+14.3	1473.2076	1473.1691
Near Morgan, Utah	G	37.3		+5.5	1534.8343	1534.7972
Morgan, Utah	H	39.4		+3.9	1542.6755	1542.6386
Near Croydon, Utah	I	51.2		+13.6	1596.1208	1596.0850
Echo, Utah	J	64.5		+27.8	1664.3951	1664.3606
Echo, Utah	Geol. Echo	64.9	64.9	+30.0	1665.8418	1665.8074
Near Emory, Utah	K	72.5		+43.4	1748.8870	1748.8533
Emory, Utah	L	79.8	79.7	+40.5	1802.5713	1802.5383
Castle Rock, Utah	M	91.1		+29.7	1899.1592	1899.1273
Wasatch, Utah	N	104.7		+26.4	2077.0235	2076.9929
Wyuta, Utah	O	113.3	112.2	+18.3	2051.7570	2051.7272
Evanston, Wyo.	6770 Evanston	122.5		+14.0	2055.4599	2055.4311
Evanston, Wyo.	A_6	122.6	122.5	+13.5	2056.8023	2056.7735
Evanston, Wyo.	6779 Evanston	123.0	122.5	+14.9	2058.1170	2058.0882
Knight, Wyo.	B_6	136.6	136.5	+20.8	2152.0971	2152.0696
Altamont, Wyo.	C_6	144.2		+30.2	2200.0837	2200.0570
Springvalley, Wyo.	D_6	154.7	154.7	+38.2	2136.8874	2136.8617
Leroy, Wyo.	E_6	166.3		+40.5	2040.1089	2040.0843
Bridger, Wyo.	F_6	174.1		+43.2	2020.3063	2020.2825
Near Bridger, Wyo.	G_6	178.9		+44.6	2005.7702	2005.7468
Carter, Wyo.	§ H_6	190.3	190.2	+41.4	1980.6998	1980.6775
Carter, Wyo.	I_6	190.5	190.2	+42.4	1981.4967	1981.4744
Elkhurst, Wyo.	J_6	200.1	200.0	+38.1	1958.9540	1958.9327
Near Hampton, Wyo.	K_6	203.6	203.0	+39.3	1951.2577	1951.2367
Church Buttes, Wyo.	L_6	217.3		+37.4	1935.1996	1935.1800
Church Buttes, Wyo.	M_6	217.5		+35.4	1936.1780	1936.1584
Garrett, Wyo.	N_6	224.9		+20.3	1932.8922	1932.8733
Near Granger, Wyo.	O_6	234.9		+9.6	1911.1951	1911.1772
Granger, Wyo.	P_6	236.0	235.8	+11.5	1909.9982	1909.9804
Near Granger, Wyo.	‡ 160	242.7		+14.7	1901.5869	1901.5697

* From bench mark B at Ogden.

† The elevation of this bench mark, as fixed by the vertical angles measured in connection with the triangulation along the thirty-ninth parallel and spanning the long interval from Pikes Peak to the Pacific, was 1338.1 ± 2.5 meters. See "The Transcontinental Triangulation," pages 339–340. The correction now necessary to this elevation, namely, 1331.5 − 1338.1 = 6.6 meters, is well within the allowable limit fixed by the probable error of 2.5 meters.

‡ This is a temporary bench mark which is identical with the temporary bench mark numbered 105 in the line Red Desert to Azusa.

§ This bench mark was reported in 1905 as having sunk about 0.052 meter.

Results of leveling, Ogden, Utah, to Pocatello, Idaho.

Place	Permanent bench mark	Distance to bench mark *	Distance to base of spur *	Total discrepancy (B–F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Ogden, Utah	B	0.0			1309.8520	1309.8113
Hot Springs, Utah	P	14.1		−12.7	1301.3750	1301.3329
Willard, Utah	Q	22.8	22.8	−29.1	1299.7616	1299.7187
Brigham, Utah	R	34.8		−32.5	1308.6707	1308.6266
Honeyville, Utah	S	48.7	48.7	−23.4	1298.1642	1298.1187
Dewey, Utah	T	57.7		−35.6	1317.0955	1317.0492
Bear River, Utah	U	71.7		−47.9	1370.0458	1369.9981
Cache Junction, Utah	V	78.6		−35.6	1355.5697	1355.5213
Cache Junction, Utah	W	78.9		−34.8	1353.3253	1353.2769
Ransom, Utah	X	92.0	91.9	−42.5	1358.8935	1358.8438
Near Cornish, Utah	Y	100.3		−41.0	1378.6045	1378.5540
Weston, Idaho	A	104.8	104.7	−44.9	1403.0582	1403.0073
Dayton, Idaho	B	114.6	114.6	−49.1	1445.7993	1445.7474
Garner, Idaho	C	120.9		−46.3	1447.6636	1447.6111
Garner, Idaho	D	121.0		−46.3	1446.1971	1446.1446
Near Oxford, Idaho	E	130.8		−54.2	1446.7948	1446.7414
Near Swan Lake, Idaho	F	141.8		−63.0	1455.5997	1455.5452
Downey, Idaho	G	152.7		−48.7	1480.2214	1480.1658
March Valley, Idaho	H	164.9		−48.1	1445.6716	1445.6149
McCammon, Idaho	I	179.1		−43.9	1448.8462	1448.7881
Near Onyx, Idaho	J	188.2		−44.6	1407.8990	1407.8400
Inkom, Idaho	K	196.5		−39.1	1378.8024	1378.7426
Inkom, Idaho	L	196.6		−37.6	1377.3778	1377.3180
Portneuf, Idaho	M	205.7		−41.6	1367.2810	1367.2203
Pocatello, Idaho	A_3	216.1		−30.4	1358.4231	1358.3614
Pocatello, Idaho	B_3	216.6		−30.3	1360.0109	1359.9491

* From bench mark B at Ogden, Utah.

Results of leveling, Pocatello to Owyhee, Idaho.

Place	Permanent bench mark	Distance to bench mark*	Distance to base of spur*	Total discrepancy (B–F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Pocatello, Idaho	B_3	0.0			1360.0109	1359.9491
Pocatello, Idaho	C_3	0.2	0.0	−1.4	1363.2993	1363.2375
Pocatello, Idaho	City	0.2	0.0	†	1359.9874	1359.9256
Pocatello, Idaho	D_3	1.0	0.1	+3.1	1360.4577	1360.3959
Pocatello, Idaho	E_3	1.1	0.1	+2.3	1361.7103	1361.6485
Near Pocatello, Idaho	F_3	6.6	6.4	+0.6	1343.7149	1343.6525
Near Michaud, Idaho	G_3	17.2	17.2	−14.2	1349.7748	1349.7114
Bannock, Idaho	H_3	26.5		−22.6	1344.4073	1344.3430
Near American Falls, Idaho	I_3	36.2		−11.1	1336.2591	1336.1938
American Falls, Idaho	O.S.L.	40.8		−15.3	1321.5038	1321.4381
Snake River Bridge, Idaho	O.S.L.	41.4	40.8	†	1319.886	1319.820
American Falls, Idaho	J_3	41.9		−15.8	1319.2248	1319.1590
Near Napati, Idaho	K_3	52.7		−6.5	1364.2599	1364.1930
Near Wapi, Idaho	L_3	63.3	63.2	−16.4	1347.4214	1347.3535
Wapi, Idaho	O.S.L.	68.1		−13.3	1341.0995	1341.0311
Near Wapi, Idaho	M_3	72.8		−18.0	1316.0037	1315.9349
Near Yale, Idaho	N_3	82.5		−18.5	1297.8298	1297.7600
Minidoka, Idaho	O.S.L.	94.4		−17.4	1305.1422	1305.0713
Minidoka, Idaho	O_3	94.6		−16.9	1303.5344	1303.4635
Near Colburne, Idaho	P_3	104.4		−22.5	1298.0632	1297.9913
Near Colburne, Idaho	Q_3	113.1		−24.9	1321.9904	1321.9177
Kimama, Idaho	O.S.L.	121.3		−13.9	1302.1868	1302.1133
Kimama, Idaho	R_3	121.5	121.3	−15.2	1299.2164	1299.1429
Senter, Idaho	S_3	132.0	131.9	−18.0	1284.9038	1284.8292
Owinza, Idaho	T_3	144.2		−20.8	1281.4945	1281.4187
Near Owinza, Idaho	U_3	150.9		−22.8	1260.2493	1260.1729
Dietrich, Idaho	V_3	161.1		−32.2	1240.6111	1240.5337
Shoshone, Idaho	W_3	173.4		−23.8	1209.4807	1209.4021
Shoshone, Idaho	X_3	173.8	173.4	−22.3	1208.0095	1207.9309
Shoshone, Idaho	Y_3	173.9	173.4	−22.6	1209.1371	1209.0585
Near Tunupa, Idaho	Z_3	186.2		−39.9	1141.9470	1141.8672
Near Tunupa, Idaho	A_4	188.9	188.8	−40.7	1129.5857	1129.5056
Gooding, Idaho	B_4	199.2		−48.5	1087.9545	1087.8734
Fuller, Idaho	C_4	209.9	209.8	−41.3	1036.3805	1036.2984
Bliss, Idaho	D_4	219.9		−46.3	993.2193	993.1362
Ticeska, Idaho	E_4	230.9		−44.8	938.5376	938.4534
King Hill, Idaho	F_4	243.7		−39.0	772.4007	772.3153
Glenns Ferry, Idaho	G_4	257.5	257.4	−27.9	779.7057	779.6189
Glenns Ferry, Idaho	H_4	258.0	257.4	−28.9	785.2471	785.1603
Near Glenns Ferry, Idaho	I_4	264.8		−29.4	759.7866	759.6991
Medbury, Idaho	J_4	275.6	275.5	−40.9	778.8807	778.7922
Chalk Spur, Idaho	K_4	284.3	284.3	−47.2	879.4133	879.3239
Near Mountain Home, Idaho	L_4	295.4		−52.7	937.2135	937.1231
Mountain Home, Idaho	M_4	305.1		−47.9	958.4987	958.4073
Mountain Home, Idaho	N_4	305.2	305.1	−47.0	956.5221	956.4307
Mountain Home, Idaho	O_4	305.4	305.1	−47.1	957.7475	957.6561
Near Mountain Home, Idaho	P_4	314.1	314.0	−53.5	969.6170	969.5248
Cleft, Idaho	Q_4	322.8		−51.7	981.1317	981.0386
Near Orchard, Idaho	R_4	334.2		−46.0	962.9716	962.8774
Near Orchard, Idaho	S_4	343.6		−46.6	958.4451	958.3500
Near Owyhee, Idaho	T_4	356.5		−53.2	912.0282	911.9318
Near Owyhee, Idaho	U_4	357.0		−55.4	909.0921	908.9957
Owyhee, Idaho	V_4	358.1		−56.9	903.4415	903.3450
Owyhee, Idaho	W_4	358.3		−58.5	903.6997	903.6032

* From bench mark B_3 at Pocatello, Idaho.
† The spur was a single line of levels.

OWYHEE, IDAHO, TO HUNTS JUNCTION, WASHINGTON, LINE.

When commencing this line at Owyhee, Mr. Sewall leveled between bench marks W_4 and V_4. The observed difference of elevation was $V_4 - W_4 = -0.2580$ meter. The same difference observed in 1903 (see preceding tabulation) was -0.2582 meter. This agreement within 0.2 millimeter indicated that the bench marks were undisturbed. The computation of the Owyhee–Hunts Junction line was based on the elevation of W_4 as fixed in 1903, namely, 903.6997 meters.

Results of leveling, Owyhee to Hunts Junction, Washington.

Place	Permanent bench mark	Distance to bench mark *	Distance to base of spur *	Total discrepancy (B-F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Owyhee, Idaho	W_4	0.0		0.0	903.6997	903.6032
Near Mora, Idaho	X_4	7.8	7.8	+ 6.1	862.3655	862.2682
Mora, Idaho	Y_4	12.7		+14.8	843.0104	842.9126
Near Mora, Idaho	Z_4	14.4	14.2	+10.4	837.9583	837.8604
Near Kuna, Idaho	A_5	22.4		+14.3	805.8148	805.7161
Near Kuna, Idaho	B_5	23.0		+15.7	805.0755	804.9767
Near Kuna, Idaho	C_5	24.8		+20.3	798.5782	798.4792
Near Nampa, Idaho	D_5	28.9	28.8	+26.5	775.5850	775.4857
Nampa, Idaho	E_5	35.7		+29.7	758.0485	757.9485
Nampa, Idaho	F_5	35.8	35.7	+29.3	758.9420	758.8420
Nampa, Idaho	H_5	36.0	35.7	+28.7	758.0265	757.9265
Nampa, Idaho	G_5	35.9	35.7	+30.0	758.1911	758.0911
Nampa, Idaho	I_5	36.0	35.7	+30.7	756.9665	756.8665
Nampa, Idaho	O. S. L.	36.1	35.7	+31.6	757.0133	756.9133
Near Nampa, Idaho	J_5	40.8		+28.8	743.4358	743.3353
Near Nampa, Idaho	K_5	43.7		+22.9	738.0100	737.9092
Near Caldwell, Idaho	L_5	48.8		+ 9.7	725.4013	725.3000
Caldwell, Idaho	M_5	49.9	48.8	+ 7.5	723.7524	723.6511
Caldwell, Idaho	N_5	50.1	48.8	+ 8.8	723.1104	723.0091
Caldwell, Idaho	O_5	50.2	48.8	+ 8.7	721.8665	721.7652
Caldwell, Idaho	P_5	50.2	48.8	+ 8.1	723.0648	722.9635
Near Caldwell, Idaho	Q_5	51.7		+ 3.2	717.2221	717.1205
Near Caldwell, Idaho	R_5	54.4		− 2.6	711.3282	711.2264
Near Notus, Idaho	S_5	61.6	61.4	− 4.1	703.5320	703.4295
Near Notus, Idaho	T_5	64.6	64.6	+ 2.7	698.0338	697.9310
Near Parma, Idaho	U_5	71.3	71.0	+ 9.1	682.3893	682.2859
Near Parma, Idaho	O. S. L.	74.2	74.2	+ 5.9	677.6755	677.5718
Near Parma, Idaho	V_5	77.2		+ 3.6	672.5043	672.4003
In Idaho, near Nyssa, Oreg.	W_5	81.7		− 4.0	671.0253	670.9208
In Idaho, near Nyssa, Oreg.	X_5	84.0		− 0.8	667.3039	667.1992
Near Nyssa, Oreg.	F	85.4		− 1.1	665.7853	665.6805
Near Nyssa, Oreg.	G	86.9		+ 2.8	664.6431	664.5381
Near Nyssa, Oreg.	H	90.3		− 4.4	660.5591	660.4538
Near Ontario, Oreg.	J	95.1	94.9	− 6.4	657.7404	657.6346
Near Ontario, Oreg.	I	96.3		− 2.4	658.3766	658.2707
Ontario, Oreg.	2143H	103.3		+ 4.1	655.6636	655.5570
Ontario, Oreg.	K	103.4	103.3	+ 4.4	656.9458	656.8392
Ontario, Oreg.	L	103.6	103.3	+ 3.8	656.7377	656.6311
Ontario, Oreg.	M	103.4	103.3	+ 4.1	656.9220	656.8154
Ontario, Oreg.	N	105.1		+ 5.9	654.7443	654.6376
Near Payette, Idaho	Y_5	105.8		+ 4.0	654.6435	654.5367
Near Payette, Idaho	2139H(1)	106.5		+ 2.4	654.4602	654.3533
Near Payette, Idaho	Z_5	109.2		+ 4.6	653.4861	653.3790
Payette, Idaho	A_6	109.8		+ 3.9	654.9341	654.8269

* From bench mark W_4 at Owyhee, Idaho.

Results of leveling, Owyhee to Hunts Junction, Washington—Continued.

Place	Permanent bench mark	Distance to bench mark	Distance to base of spur	Total discrepancy (B-F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Payette, Idaho	B_6	110.0	109.8	+ 2.9	655.8973	655.7901
Payette, Idaho	C_6	110.3	109.8	+ 3.0	655.4553	655.3481
Near Payette, Idaho	2139H(2)	111.4		+ 4.3	654.2211	654.1137
Near Crystal, Idaho	2123H	116.4	116.3	+ 9.8	649.4738	649.3660
Near Crystal, Idaho	D_6	116.4	116.3	+ 9.8	648.1159	648.0081
Near Weiser, Idaho	2112H	121.0	121.0	+12.9	646.1267	646.0184
Near Weiser, Idaho	E_6	125.5		+12.9	644.0785	643.9698
Near Weiser, Idaho	2113H	125.8		+13.3	646.3490	646.2402
Near Weiser, Idaho	F_6	130.5		+17.8	642.3626	642.2534
Weiser, Idaho	2107H	131.1		+17.5	644.5440	644.4347
Weiser, Idaho	G_6	131.3	131.1	+18.6	646.6613	646.5520
Weiser, Idaho	H_6	133.1	131.1	+16.1	645.7483	645.6390
Near Eaton, Idaho	2122H	135.4		+ 8.8	649.1833	649.0736
Near Eaton, Idaho	I_6	139.1	138.6	− 2.6	644.3573	644.2473
Near Eaton, Idaho	2097H	140.2		− 4.0	641.4111	641.3009
Near Eaton, Idaho	J_6	142.0	141.8	− 7.2	639.5735	639.4632
Near Olds Ferry, Idaho	2087H	144.7		− 4.9	638.3738	638.2632
Near Olds Ferry, Idaho	2086H	149.5		− 7.0	638.0908	637.9797
Olds Ferry, Idaho	K_6	153.4	153.1	− 6.4	631.7481	631.6367
Near Olds Ferry, Idaho	2070H	154.6		−10.7	633.2048	633.0932
Near Olds Ferry, Idaho	2069H	159.5		−12.7	633.0699	632.9579
Near Huntington, Oreg.	2079A	164.0		−21.2	635.8426	635.7301
Near Huntington, Oreg.	O	164.8		−24.0	635.9697	635.8572
Near Huntington, Oreg.	P	166.0		−20.1	648.1646	648.0519
Near Huntington, Oreg.	Q	166.2		−20.5	639.0172	638.9045
Huntington, Oreg.	2105A	168.0	167.9	−18.2	644.0325	643.9196
Huntington, Oreg.	R	168.1	167.9	−18.9	644.7891	644.6762
Near Huntington, Oreg.	S	169.9		−19.3	649.6737	649.5607
Near Huntington, Oreg.	T	171.0		−20.1	654.8913	654.7782
Near Huntington, Oreg.	U	172.3		−17.7	659.9153	659.8020
Near Huntington, Oreg.	V	173.9		−20.7	665.6495	665.5361
Near Huntington, Oreg.	2215A	176.2		−23.3	677.4346	677.3209
Near Huntington, Oreg.	W	176.7	176.2	−25.2	679.2649	679.1512
Near Huntington, Oreg.	X	178.2		−17.4	683.4770	683.3632
Near Huntington, Oreg.	Y	180.8		−21.6	695.6925	695.5784
Near Weatherby, Oreg.	2369A	185.6		−26.2	724.3545	724.2399
Near Weatherby, Oreg.	Z	188.0	187.3	−30.8	734.4534	734.3387
Near Weatherby, Oreg.	A_2	188.5		−33.1	735.2936	735.1788
Near Durkee, Oreg.	2518A	193.5		−39.4	769.9333	769.8180
Near Durkee, Oreg.	B_2	196.7	196.4	−32.7	780.5774	780.4618
Durkee, Oreg.	2647A	201.1		−27.3	809.0514	808.9353
Near Durkee, Oreg.	C_2	204.6		−26.0	834.0893	833.9729
Near Durkee, Oreg.	D_2	206.2	206.2	−22.2	858.7595	858.6429
Unity, Oreg.	3139A	212.6		−18.6	958.9831	958.8659
Near Unity, Oreg.	E_2	213.0		−16.7	957.2496	957.1324
Near Pleasant Valley, Oreg.	F_2	219.3		− 9.7	1076.9181	1076.8003
Pleasant Valley, Oreg.	3818A	225.0		−14.7	1166.3435	1166.2251
Near Encina, Oreg.	G_2	229.2	228.9	−20.0	1205.2709	1205.1521
Near Norton, Oreg.	H_2	234.0	233.8	−16.5	1132.6088	1132.4896
Norton, Oreg.	3646A	235.5		− 9.6	1113.7470	1113.6276
Near Baker City, Oreg.	I_2	242.1	241.8	+ 2.9	1065.4173	1065.2973
Baker City, Oreg.	3433A	246.0	245.1	+ 6.0	1048.7138	1048.5935
Baker City, Oreg.	J_2	246.4	245.1	+ 6.4	1049.5215	1049.4012
Baker City, Oreg.	K_2	246.8	245.1	+ 6.0	1050.5255	1050.4052
Baker City, Oreg.	L_2	247.0	245.1	+ 4.6	1051.1504	1051.0301
Near Baker City, Oreg.	M_2	250.0	250.0	+ 9.1	1027.9828	1027.8620
Near Wingville, Oreg.	3338A	255.2	254.8	+13.7	1019.8403	1019.7190
Near Haines, Oreg.	N_2	259.6	259.5	+13.4	1014.0624	1013.9407

Results of leveling, Owyhee to Hunts Junction, Washington—Continued.

Place	Permanent bench mark	Distance to bench mark	Distance to base of spur	Total discrepancy (B-F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Near Haines, Oreg.	O_2	264.8		+12.0	1018.3178	1018.1955
Hutchinson, Oreg.	3372A	269.2		+16.2	1030.0791	1029.9564
Near North Powder, Oreg.	P_2	273.8		+14.5	1003.5859	1003.4628
North Powder, Oreg.	3233A	276.9		+15.4	988.1758	988.0524
North Powder, Oreg.	Q_2	277.1	276.9	+15.4	992.5400	992.4166
Near North Powder, Oreg.	R_2	282.2	282.0	+22.2	975.2654	975.1415
Near North Powder, Oreg.	S_2	282.4		+21.3	971.9801	971.8561
Near North Powder, Oreg.	T_2	282.7		+21.4	971.8977	971.7737
Near North Powder, Oreg.	3228A	284.5		+20.4	986.1046	985.9804
Near Telocaset, Oreg.	U_2	286.9	286.9	+28.8	1005.8370	1005.7126
Near Telocaset, Oreg.	V_2	291.4		+30.9	1047.9886	1047.8638
Near Telocaset, Oreg.	3440A	291.9		+31.9	1050.5024	1050.3775
Near Telocaset, Oreg.	W_2	296.5		+37.3	989.9263	989.8010
Near Union Station, Oreg.	3021A	301.2		+44.8	922.6495	922.5237
Near Union Station, Oreg.	X_2	305.8	305.8	+48.1	857.3679	857.2417
Union, Oreg.	Y_2	311.5	307.7	+49.2	851.1909	851.0645
Union, Oreg.	Z_2	311.6	307.7	+49.2	850.1022	849.9758
Union, Oreg.	G.S.Union	311.7	307.7	+47.9	849.9475	849.8211
Union, Oreg.	A_3	311.7	307.7	+47.6	851.2507	851.1243
Near Union Station, Oreg.	2705A	309.3		+47.2	826.4288	826.3022
Near Union Station, Oreg.	B_3	312.0		+48.0	823.1040	822.9772
Near Union Station, Oreg.	2696A	317.9		+51.2	823.5123	823.3849
Near Lagrande, Oreg.	C_3	320.6		+51.3	825.3529	825.2252
Near Lagrande, Oreg.	D_3	324.0		+55.0	832.5332	832.4052
Lagrande, Oreg.	2773A	327.7	327.1	+58.8	847.1412	847.0129
Lagrande, Oreg.	E_3	327.8	327.1	+58.1	848.8943	848.7660
Lagrande, Oreg.	F_3	328.1	327.1	+59.4	849.8303	849.7020
Lagrande, Oreg.	G_3	328.2	327.1	+59.4	849.3155	849.1872
Lagrande, Oreg.	2782A	328.3	327.1	+60.4	849.7128	849.5845
Near Lagrande, Oreg.	H_3	331.3		+62.4	868.0134	867.8847
Near Lagrande, Oreg.	I_3	332.1		+62.6	871.4006	871.2718
Perry, Oreg.	2897A	334.3		+60.9	884.8391	884.7101
Near Hilgard, Oreg.	J_3	338.3		+64.2	904.3939	904.2645
Hilgard, Oreg.	3001A	340.9		+59.8	916.7151	916.5855
Near Hilgard, Oreg.	3581A	349.5		+75.5	1093.7619	1093.6314
Near Kamela, Oreg.	K_3	354.5		+72.2	1203.7079	1203.5769
Kamela, Oreg.	4199A	358.4		+70.6	1282.0561	1281.9248
Near Meacham, Oreg.	3958A	362.3		+80.5	1208.6685	1208.5368
Near Meacham, Oreg.	L_3	365.4		+86.7	1145.2812	1145.1492
Meacham, Oreg.	3672A	368.2		+90.8	1121.5285	1121.3962
Near Meacham, Oreg.	3454A	372.0		+86.7	1054.8642	1054.7315
Near Meacham, Oreg.	M_3	373.6		+85.7	1021.5872	1021.4544
Near Meacham, Oreg.	N_3	376.1		+91.7	972.0211	971.8880
Near Meacham, Oreg.	O_3	378.1		+93.3	933.3187	933.1854
Near Meacham, Oreg.	P_3	380.9		+95.1	882.0846	881.9511
Near Meacham, Oreg.	Q_3	383.5		+88.4	846.4132	846.2794
Near North Fork, Oreg.	2570A	388.2		+80.0	785.1608	785.0266
Near North Fork, Oreg.	R_3	388.6		+79.5	780.9003	780.7660
Near North Fork, Oreg.	S_3	390.7		+84.6	755.9581	755.8236
Near North Fork, Oreg.	T_3	391.5		+83.2	745.5427	745.4081
Near North Fork, Oreg.	2264A	396.4		+87.0	691.7724	691.6374
Near North Fork, Oreg.	U_3	397.1		+87.1	684.9492	684.8141
Near North Fork, Oreg.	V_3	399.8		+94.3	657.9428	657.8074
Near Bingham Springs, Oreg.	2023A	403.7		+98.3	618.1557	618.0200
Near Bingham Springs, Oreg.	W_3	407.7		+100.3	580.1746	580.0385
Near Bingham Springs, Oreg.	X_3	411.1		+102.7	554.6808	554.5443
Bingham Springs, Oreg.	1744A	413.5		+105.9	533.2542	533.1175
Near Bingham Springs, Oreg.	Y_3	417.5		+104.1	504.0219	503.8848

Results of leveling, Owyhee to Hunts Junction, Washington—Concluded.

Place	Permanent bench mark	Distance to bench mark	Distance to base of spur	Total discrepancy (B-F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Near Cayuse, Oreg.	1523A	423.3		+ 95.9	465.8251	465.6875
Near Cayuse, Oreg.	Z_3	424.1		+ 95.6	463.7764	463.6387
Near Cayuse, Oreg.	A_4	428.8		+ 91.1	437.0962	436.9580
Near Cayuse, Oreg.	B_4	430.0		+ 92.9	428.0866	427.9483
Near Mission, Oreg.	1355A	432.2		+ 92.9	414.1829	414.0444
Near Mission, Oreg.	C_4	434.9		+ 90.1	405.3510	405.2122
Mission, Oreg.	1205A	439.8		+ 92.9	368.5936	368.4544
Pendleton, Oreg.	D_4	447.9	446.2	+106.8	326.7368	326.5969
Pendleton, Oreg.	E_4	448.0	446.2	+107.6	326.0572	326.9173
Pendleton, Oreg.	F_4	448.0	446.2	+107.4	327.8844	327.7445
Pendleton, Oreg.	1074A	448.1	446.2	+106.9	328.6256	328.4857
Near Pendleton, Oreg.	G_4	447.3		+103.9	334.8248	334.6848
Near Pendleton, Oreg.	H_4	449.9		+109.2	357.8432	357.7030
Near Fulton, Oreg.	I_4	453.9		+106.7	422.9427	422.8021
Near McCormack, Oreg.	J_4	460.3		+102.6	503.7548	503.6136
Near Warren, Oreg.	K_4	466.7		+ 93.8	530.2213	530.0794
Near Helix, Oreg.	L_4	474.8		+ 80.7	548.3946	548.2520
Near Killian Junction, Oreg.	M_4	479.5		+ 82.7	542.8518	542.7087
Near Killian Junction, Oreg.	N_4	481.3		+ 77.6	507.2295	507.0862
Near Stanton, Oreg.	O_4	482.9		+ 73.9	474.4955	474.3521
Near Canon, Oreg.	P_4	490.9		+ 69.8	317.7830	317.6388
Near Hunts Junction, Wash.	R_3	494.6		+ 60.4	244.7327	244.5881
Near Hunts Junction, Wash.	Q_3	500.6		+ 67.9	144.2874	144.1423
Near Hunts Junction, Wash.	P_3	501.8		+ 65.6	127.5028	127.3575

Principal maximum values of total discrepancy (B–F) in main line.

Distance	B-F	B-F per kilometer
km.	*mm.*	*mm.*
39.2	+ 35.2	+0.90
59.8	− 6.8	−0.11
93.2	− 9.7	−0.10
193.5	− 39.4	−0.20
380.9	+ 95.1	+0.25
413.5	+105.9	+0.26
449.9	+109.2	+0.24
At end 501.8	+ 65.6	+0.13

SEATTLE–HUNTS JUNCTION, WASHINGTON, LINE.

The computation of this line was started with the elevation 6.0549 meters for bench mark Tidal 4, corresponding to the reading 4.2320 meters (13.8846 feet) for mean sea level on the tide staff as fixed by tidal observations during the years 1899–1903. The leveling fixing the relation between the tide staff and the bench marks near it was done by Mr. Baldwin in connection with this line. Previously, wye levels had been run between the tide staff and some of these bench marks, and they served to show that the tide staff and bench marks were stable.

Results of leveling, Seattle to Hunts Junction, Washington.

Place	Permanent bench mark	Distance to bench mark*	Distance to base of spur*	Total discrepancy (B–F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Seattle, Wash.	Gauge	—0.5		— 3.2	3.2051	3.2051
Seattle, Wash.	Tidal 5	—0.2		— 2.9	6.5641	6.5641
Seattle, Wash.	Tidal 4	0.0		0.0	6.0539	6.0539
Seattle, Wash.	G	0.5		— 3.2	7.6538	7.6539
Seattle, Wash.	City 1	0.5	0.5	— 2.9	7.5700	7.5701
Seattle, Wash.	City 2	1.4		— 3.5	3.3356	3.3358
South Seattle, Wash.	City 3	4.8		— 7.8	3.1381	3.1386
Near Argo, Wash.	N. P.	7.7		—11.4	6.1441	6.1449
Near Black River, Wash.	N. P.	12.7		—23.6	6.5222	6.5235
Black River, Wash.	H	16.8		—27.2	6.2588	6.2605
Near Black River, Wash.	I	17.0		—29.2	10.4238	10.4255
Kent, Wash.	J	27.7		—38.6	12.2950	12.2977
Kent, Wash.	K	27.9		—37.6	12.9229	12.9257
Near Thomas, Wash.	L	30.1		—36.6	16.0999	16.1029
Auburn, Wash.	M	36.0		—33.3	22.6070	22.6105
Auburn, Wash.	N	36.3		—32.4	25.5166	25.5202
Near Auburn, Wash.	O	37.1		—31.7	30.3112	30.3149
Near Covington, Wash.	P	48.8		—20.9	100.8087	100.8135
Covington, Wash.	Q	49.7		—17.6	105.5479	105.5528
Near Ravensdale, Wash.	R	58.6		—31.2	175.7384	175.7441
Ravensdale, Wash.	S	60.6		—26.5	188.5426	188.5485
Near Ravensdale, Wash.	T	62.3		—24.4	198.4634	198.4695
Near Ravensdale, Wash.	U	63.9		—22.8	214.9862	214.9925
Near Palmer Junction, Wash.	V	70.6		—17.0	258.4409	258.4478
Palmer Junction, Wash.	W	71.0		—15.4	261.5756	261.5825
Near Palmer Junction, Wash.	X	75.1		— 7.9	284.1421	284.1494
Near Eagle Gorge, Wash.	1046T	80.0		— 5.6	319.0255	319.0333
Near Eagle Gorge, Wash.	Y	81.4		— 4.7	329.2369	329.2449
Canton, Wash.	Z	88.0		+ 0.4	367.1461	367.1547
Canton, Wash.	1205T	88.1		— 0.7	367.6057	367.6143
Maywood, Wash.	1335T	94.6		—12.7	407.2035	407.2127
Hot Springs, Wash.	1531T	102.6		—17.7	466.9747	466.9847
Hot Springs, Wash.	A_1	102.9	102.6	—17.5	462.7538	462.7638
Near Hot Springs, Wash.	B_1	104.5		—22.5	479.5737	479.5839
Lester, Wash.	1614T	105.8		—19.9	492.2697	492.2800
Near Weston, Wash.	C_1	111.5		—22.2	601.8809	601.8918
Near Borup, Wash.	D_1	114.1		—20.1	656.9592	656.9703
Stampede, Wash.	2776T	120.3		—15.8	846.5169	846.5286
Near Stampede, Wash.	E_1	120.7		—13.0	856.5502	856.5620
Near Stampede, Wash.	F_1	122.3	122.2	—18.0	868.5054	868.5173
Martin, Wash.	2782T	124.8		—23.7	848.5563	848.5685
Near Easton, Wash.	G_1	132.9		—33.1	682.3770	682.3900
Easton, Wash.	H_1	137.4		—32.1	660.4101	660.4235
Easton, Wash.	I_1	137.7		—32.2	661.1254	661.1388
Near Nelson, Wash.	J_1	146.0		—21.7	632.1785	632.1927
Nelson, Wash.	2030T	148.2		—20.4	619.1873	619.2017
Clealum, Wash.	K_1	158.8		—20.0	582.3041	582.3196
Clealum, Wash.	L_1	158.9	158.8	—19.0	583.3528	583.3683
Clealum, Wash.	M_1	159.0		—20.6	582.0072	582.0227
Teanaway, Wash.	1838T	165.6		—22.5	560.3289	560.3450
Bristol, Wash.	1784T	172.0		—25.0	544.0754	544.0921
Near Bristol, Wash.	N_1	176.5		—29.0	533.8064	533.8236
Near Thorp, Wash.	O_1	181.2		—26.3	521.6908	521.7084
Near Thorp, Wash.	1658T	184.2		—33.5	505.6549	505.6728
Thorp, Wash.	1634T	186.7		—34.9	498.1080	498.1262
Thorp, Wash.	P_1	186.9	186.7	—35.0	497.8466	497.8648

*From bench mark Tidal 4 at Seattle, Wash.

Results of leveling, Seattle to Hunts Junction, Washington—Continued.

Place	Permanent bench mark	Distance to bench mark	Distance to base of spur	Total discrepancy (B-F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Near Thorp, Wash.	U. S. Base	191.4		−34.5	483.0405	483.0591
Ellensburg, Wash.	Q_1	198.4		−31.0	462.0635	462.0828
Ellensburg, Wash.	1571T	199.6		−32.5	478.9756	478.9950
Ellensburg, Wash.	R_1	200.4		−32.8	468.3794	468.3989
Ellensburg, Wash.	S_1	201.0		−31.5	461.7141	461.7337
Thrall, Wash.	T_1	208.5		−22.4	435.3003	435.3206
Umtanum, Wash.	1350T	220.5		−30.7	411.4813	411.5028
Near Umtanum, Wash.	U_1	221.4		−33.4	407.6580	407.6795
Canyon, Wash.	V_1	226.8		−27.6	395.0937	395.1158
Roza, Wash.	1249T	234.5		−24.6	380.7660	380.7888
Roza, Wash.	W_1	234.6		−25.0	379.5001	379.5229
Selah, Wash.	1147T	248.2		−23.4	349.7623	349.7864
Near Selah, Wash.	X_1	249.0		−23.1	347.0784	347.1026
Near Wenas, Wash.	Y_1	253.0		−17.8	334.5173	334.5419
North Yakima, Wash.	1067T	259.4		−13.3	325.2673	325.2925
North Yakima, Wash.	Z_1	259.6		−11.5	324.5985	324.6238
North Yakima, Wash.	A_2	259.7	259.6	−12.4	325.3700	325.3953
North Yakima, Wash.	B_2	259.9	259.6	−12.1	323.8379	323.8632
North Yakima, Wash.	C_2	260.3	259.6	−14.7	325.6841	325.7094
Near Yakima City, Wash.	D_2	267.4		− 3.7	290.2677	290.2937
Wapato, Wash.	855T	278.3		+11.5	260.6208	260.6479
Wapato, Wash.	E_2	278.5	278.3	+12.1	260.1685	260.1956
Near Wapato, Wash.	F_2	283.0		+16.4	247.6517	247.6792
Toppenish, Wash.	755T	289.9		+14.7	230.2265	230.2547
Toppenish, Wash.	G_2	290.1		+13.9	229.8224	229.8506
Toppenish, Wash.	H_2	290.2		+14.5	230.4094	230.4376
Near Alfalfa, Wash.	717T	297.1		+ 9.0	218.4183	218.4472
Alfalfa, Wash.	I_2	297.9		+ 5.8	217.7395	217.7685
Satus, Wash.	674T	306.7		+12.8	205.4044	205.4342
Near Satus, Wash.	J_2	307.6		+13.9	203.8127	203.8426
Near Mabton, Wash.	717T	313.9		+12.4	218.3168	218.3473
Mabton, Wash.	715T	319.8		+ 7.1	217.9640	217.9951
Near Mabton, Wash.	K_2	320.4		+ 5.7	217.3580	217.3892
Byron, Wash.	696T	330.0		+16.8	212.2214	212.2535
Near Byron, Wash.	L_2	331.4		+15.5	210.5864	210.6186
Prosser, Wash.	M_2	338.4		+12.6	201.3813	201.4142
Prosser, Wash.	661T	338.7		+11.0	201.5197	201.5526
Prosser, Wash.	N_2	338.9	338.7	+10.4	203.3083	203.3412
Prosser, Wash.	O_2	338.8	338.7	+ 9.7	201.5743	201.6072
Near Prosser, Wash.	P_2	339.7		+ 8.6	205.2327	205.2657
Gibbon, Wash.	627T	348.3		+17.6	191.1530	191.1869
Chandler, Wash.	534T	355.5		+22.2	162.8157	162.8503
Near Kiona, Wash.	Q_2	362.3		+16.4	148.3833	148.4185
Kiona, Wash.	515T	365.0		+12.6	156.8420	156.8775
Kiona, Wash.	R_2	365.0		+12.6	156.6095	156.6450
Near Kiona, Wash.	S_2	366.6		+13.6	164.2579	164.2935
Near Badger, Wash.	640T	373.1		+19.8	195.1126	195.1489
Badger, Wash.	T_2	376.4	376.3	+15.6	206.1426	206.1792
Near Badger Wash.	605T	381.1		+14.1	184.3726	184.4096
Relief, Wash.	567T	390.4		+13.7	172.7357	172.7736
Near Relief, Wash.	U_2	390.6		+11.7	171.6054	171.6434
Kennewick, Wash.	V_2	398.9		+ 0.7	111.9806	112.0194
Kennewick, Wash.	362T	399.0		− 0.5	110.2040	110.2428
Kennewick, Wash.	W_2	399.1	399.0	+ 0.2	108.1501	108.1889
Near Kennewick, Wash.	X_2	400.6		+ 1.9	107.2736	107.3125
Near Pasco, Wash.	Y_2	401.5		+ 2.1	107.1997	107.2387
Near Pasco, Wash.	Z_2	402.7		+ 0.7	114.7385	114.7776

Results of leveling, Seattle to Hunts Junction, Washington—Concluded.

Place	Permanent bench mark	Distance to bench mark	Distance to base of spur	Total discrepancy (B-F) at bench mark	Observed elevation	Corrected elevation
		km.	*km.*	*mm.*	*m.*	*m.*
Pasco, Wash.	378T	403.1		+ 0.5	115.1134	115.1526
Pasco, Wash.	A_3	403.5		+ 0.8	115.1680	115.2072
Near Pasco, Wash.	B_3	408.5		− 0.1	108.8557	108.8954
Near Pasco, Wash.	C_3	408.6		− 0.4	108.8983	108.9380
Near Pasco, Wash..	D_3	408.7		0.0	108.8901	108.9298
Near Pasco, Wash.	E_3	408.7		− 0.4	108.8879	108.9276
Near Pasco, Wash.	F_3	408.8		+ 0.3	108.8983	108.9380
Near Pasco, Wash.	G_3	408.9		− 0.4	108.8817	108.9214
Near Pasco, Wash.	H_3	409.0		− 0.4	108.8971	108.9369
Near Pasco, Wash.	I_3	409.0		− 0.1	108.8627	108.9025
Near Hunts Junction, Wash.	341A	418.3		− 0.3	104.4374	104.4781
Near Hunts Junction, Wash.	J_3	419.8		− 4.1	99.7394	99.7802
Near Hunts Junction, Wash.	K_3	423.0		− 9.2	104.0998	104.1409
Hunts Junction, Wash.	L_3	425.9		−11.0	98.9016	98.9430
Hunts Junction, Wash.	M_3	426.2		−11.6	97.7112	97.7526
Near Hunts Junction, Wash.	N_3	433.0		−17.8	121.3392	121.3813
Near Hunts Junction, Wash.	O_3	433.1		−17.7	122.6715	122.7136
Near Hunts Junction, Wash.	P_3	434.6		−16.3	127.3153	127.3575

Principal maximum values of total discrepancy (B–F) in main line.

Distance	B-F	B-F per kilometer
km.	*mm.*	*mm.*
27.7	−38.6	−1.39
86.6	+ 0.7	+0.01
285.0	+16.7	+0.06
330.0	+16.8	+0.05
355.5	+22.2	+0.06
At end 434.6	−16.3	−0.04

Rail Elevations.

The following elevations for the top of the rail in front of each of the railroad stations named were determined during the progress of the leveling, usually by a single rod reading taken from one of the instrument stations on the main line of levels. They are computed upon the same basis as the corrected elevations in the preceding tables.

Elevation of top of rail in front of railroad stations, Owyhee, Idaho, to Seattle, Wash.

	Meters.
Owyhee, Idaho	903.61
Mora, Idaho	843.41
Kuna, Idaho	817.46
Nampa, Idaho	756.58
Caldwell, Idaho	721.62
Notus, Idaho	706.68
Parma, Idaho	677.95
Lannans Spur, Idaho	670.55

	Meters.
Nyssa, Oreg	664.23
Arcadia, Oreg	661.69
Ontario, Oreg	656.29
Payette, Idaho	654.40
Weiser, Idaho	644.33
Eaton, Idaho	641.43
Olds Ferry, Idaho	633.23
Huntington, Oreg	642.75
Weatherby, Oreg	732.22
Durkee, Oreg	809.02
Unity, Oreg	954.15
Pleasant Valley, Oreg	1 164.16
Encina, Oreg	1 208.40
Norton, Oreg	1 113.11
Baker City, Oreg	1 047.01
Haines, Oreg	1 016.06
Hutchinson, Oreg	1 027.72
North Powder, Oreg	988.22
Telocaset, Oreg	1 051.05
Union, Oreg	828.05
Nodine Spur, Oreg	823.61
Hot Lake, Oreg	823.33
Lagrande, Oreg	848.65
Tie Spur, Oreg	895.68
Hilgard, Oreg	916.89
Steel Spur, Oreg	1 028.93
Spring Spur, Oreg	1 200.92
Kamela, Oreg	1 281.63
Murdock Spur, Oreg	1 162.79
Nibley Spur, Oreg	1 135.10
Meacham, Oreg	1 121.82
Huron, Oreg	887.39
Allens Spur, Oreg	858.06
North Fork, Oreg	704.24
Bingham Springs, Oreg	533.13
Thorn Hollow, Oreg	479.02
Cayuse, Oreg	430.84
Mission, Oreg	370.21
Pendleton, Oreg	326.14
Fulton, Oreg	465.19
McCormack, Oreg	491.49
Warren, Oreg	522.92
Helix, Oreg	536.02
Apex, Oreg	582.62
Killian Junction, Oreg	549.25
Stanton, Oreg	506.48
Vansycle, Oreg	428.64
Canon, Oreg	278.84
Hunts Junction, Wash	98.39
Kennewick, Wash	111.57
Kiona, Wash	157.05
Prosser, Wash	201.73
Satus, Wash	206.14
Toppenish, Wash	231.14

	Meters.
Wapato, Wash	261.29
Yakima City, Wash	298.91
Roza, Wash	380.88
Umtanum, Wash	411.22
Thrall, Wash	437.20
Thorp, Wash	498.68
Bristol, Wash	544.04
Clealum, Wash	581.89
Nelson, Wash	620.73
Easton, Wash	661.50
Upham, Wash	744.76
Martin, Wash	853.89
Stampede, Wash	847.40
Borup, Wash	740.01
Lester, Wash	491.17
Maywood, Wash	404.15
Canton, Wash	367.03
Eagle Gorge, Wash	334.58
Palmer Junction, Wash	260.69
Kanasket, Wash	257.77
Ravensdale, Wash	187.17
Covington, Wash	106.91
Wynaco, Wash	62.71
Auburn, Wash	23.92
Christopher, Wash	16.70
Thomas, Wash	15.76
Kent, Wash	13.33
O'Briens, Wash	10.23
Orilla, Wash	9.12
Argo, Wash	5.25

STATISTICS OF LINES.

The principal items of information in regard to the two lines, Owyhee to Hunts Junction and Seattle to Hunts Junction, are given in the tables below in the same form as the tables on pages 224–225 of Appendix 3 of the Report for 1903, arranged in such a manner as to be conducive to comparison between lines.

The number of permanent bench marks includes all with which the leveling was directly connected, regardless of whether they are new bench marks or bench marks previously established by some other party or organization.

The average distance between bench marks was obtained by dividing the total length of the main line by the number of permanent bench marks.

The speed was obtained by dividing the total length of the line by the interval in months from the date of the first leveling to the date of the last, inclusive. The expression "total length" refers to the completed line. Each completed section of the line was leveled at least twice, and in some cases four or more times. To obtain the speed in terms of single line, one must therefore multiply the speed here given by a factor somewhat greater than two.

The discrepancy in millimeters per kilometer was obtained by dividing the total discrepancy on the main line by the length of the main line.

The probable error of the mean result for a section was computed by the formula

$$r'' = 0.674\sqrt{\frac{\Sigma d^2}{4s}}$$

in which d is the discrepancy between the forward and backward leveling over a section and s is the number of sections. The probable error for 1 kilometer, r_1, was derived by assuming that the average length of a section is to 1 kilometer as $(r'')^2$ is to r_1^2.

	Owyhee, Idaho, to Hunts Junction, Wash.	Seattle, Wash., to Hunts Junction, Wash.
Observer	F. H. S.	G. C. B.
Instrument	8	7
Rods	R_2 and S	V and W
Date of first leveling	May 5, 1904	May 7, 1904
Date of last leveling	Oct. 4, 1904	Oct. 1, 1904
Length of main line, km.	502	435
Length of side lines, km.	25	4
Total length, km.	527	439
Total length, miles	327	273
Number permanent bench marks	184	131
Average distance between permanent B. Ms., in km.	2.7	3.3
Speed, km. per month	105	91
Speed, miles per month	65	57
Percentage run more than twice	23	17
Discrepancy (B–F), total, mm.	+65.6	−16.3
Discrepancy (B–F), in mm. per km.	+0.43	+0.04
Probable error for 1 km., in mm.	±0.9	±0.9
Velocipede cars used	Yes	No

Comments on the Leveling.

Both parties made use, as a rule, of the railroad rails as supports for the rods, as the parties did in 1903.* The results again indicate that this practice is conducive to both speed and accuracy.

Mr. Baldwin ran his line through the Stampede tunnel, 2 miles long. It would have been slow and difficult to run the line around it. The most serious delays in the tunnel were caused by the smoke left by trains. This was avoided in part by doing the leveling at night when there were fewer trains than during the day. Acetylene bicycle lamps were used to illuminate the faces of the rods. The rodmen carried pocket lamps and the recorder used a miner's lamp.

The average speed made by Coast and Geodetic Survey parties with this type of precise level has been 105 kilometers (65 miles) of completed leveling per month. Though these two lines of 1904 were run under unusually difficult conditions over heavy mountain grades, and in a region where the available boarding places were far apart, the speed of one of the parties was as great as the average, and for the other party, which had the additional hindrance of not being allowed to use velocipede cars, the speed did not fall much below the average. Mr. Sewall stated in his report on the

*See Appendix 6, Report for 1904, pp. 416–419.

season's operations that more than 70 miles of the line leveled by him was on grades of from 1.7 to 2.3 per cent.

Mr. Sewall ran 22.6 kilometers (14 miles) of single line in 9 hours on June 1, a cloudy day, all of which proved to be within the required limit of accuracy. The fastest mile was done in 19 minutes, with 8 instrument stations, or at the rate of 3.2 miles per hour.

Before the season of 1904, though the parties were urged to establish many permanent bench marks. their instructions required simply that "the distance between successive bench marks shall nowhere exceed 15 kilometers." In 1904 their instructions stated that "there shall be no portion of the line 100 kilometers long in which there are not at least 20 permanent bench marks. * * * It is desired that the number of bench marks shall, in general, greatly exceed that necessary to keep within the limits." The result was that the average distance between permanent bench marks in 1904 was only 3 kilometers, about one-half as great as the average for lines run for several years past. This tends to make the leveling slower and more costly, but makes its record, as marked on the ground, much more permanent and convenient.

Mr. Sewall adjusted his instrument but six times during the season. From July 25 to October 4 the angle between the line of collimation and the tangent to the level vial at its middle point was found to be greater than 6″, namely, 6″.6 on only one day. The adjustment was tested once each day.

On all the precise leveling a careful record of weather conditions is kept. A special investigation of the leveling here reported upon was made to determine if possible whether any relation existed between the direction of the sun with reference to the direction of progress, and the errors. The investigation indicated a slight tendency for leveling which progresses toward the sun to carry the elevations too low.

Description of Bench Marks.*

GENERAL NOTES DESCRIBING DIFFERENT FORMS AND MARKINGS OF BENCH MARKS.

Note 1.—The bottom of a hole, 1¼ inches square and ¼ inch deep, cut in the top of a granite post 4 feet long, the upper 6 inches dressed to 6 inches square, usually set 3½ feet in the ground, with the top marked

U S
□
B M

Note 2.—The bottom of a hole, about 3 centimeters square and 5 millimeters deep, cut in the top of a stone post about 15 by 20 centimeters on the upper face, set 1.2 meters in the ground and projecting 15 centimeters above, with the top marked

U S
□
B M

Note 3.—The bottom of a hole, usually 2.5 centimeters square and 5 millimeters deep, cut in the top of a stone post about 15 centimeters square, projecting 0.2 meter from the ground.

* Any person who finds that one of the bench marks here described is disturbed, or that the description no longer fits the facts, is requested to send such information to the Superintendent, Coast and Geodetic Survey, Washington, D. C.

NOTE 4.—A section of galvanized iron pipe 75 millimeters in diameter, 1.4 meters long, the lower 15 centimeters flared by splitting in the middle and spreading, and the upper 3 centimeters threaded to receive a red metal cap lettered "U. S. Coast and Geodetic Survey B. M. $250 fine or imprisonment for disturbing this mark." The bench mark is the intersection of cross lines cut on this cap.

NOTE 5.—A brass plate, 10 centimeters in diameter, cemented firmly into stone or brick flush with the surface. It is provided with a stem at the back, about 6 centimeters in length with grooves, in which are drilled holes to allow the cement to flow into the depressions and hold the plate firmly in place. The raised center of the plate is marked by cross lines and the letters U S B M. The intersection of the cross lines is the bench mark.

NOTE 6.—A section of iron pipe set in the ground, on the top of which is firmly riveted a brass cap marked "U. S. Geological Survey B. M. $250 fine for disturbing this mark. Elevation above sea feet. Datum ." Each cap is stamped with the approximate elevation in feet and a letter to indicate the datum plane. This elevation and the datum letter form the name by which the bench mark is designated in this publication.

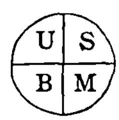
NOTE 7.—An aluminum or brass tablet inscribed as described in Note 6. The datum letter is T.

U S
NOTE 8.—The bottom of a square hole lettered □ cut in stone or brick.
B M

NOTE 9.—A copper bolt set or leaded into stone or brick, marked

U S
○
B M

NOTE 10.—A copper bolt leaded into stone or brick, marked on the head with a stencil



NOTE 11.—A copper bolt set, without lead into stone or brick, and marked on the head with a stencil as in Note 10.

NOTE 12.—An iron post with a brass cap inscribed as described in Note 6. The datum letter is H, and the date 1903 is added.

NOTE 13.—An aluminum tablet inscribed as described in Note 6. The datum letter is H, and the date 1903 is added.

NOTE 14.—An iron post with a brass cap inscribed as described in Note 6. The datum letter is A.

NOTE 15.—An aluminum tablet inscribed as described in Note 6. The datum letter is A.

NOTE 16.—A copper bolt about 5 centimeters long and 1 centimeter in diameter, not marked, leaded into stone or brick. When set horizontally, the intersection of cross lines on the face is the bench mark.

NOTE 17.—The bottom of a hole, usually 2.5 to 3 centimeters square and 0.5 centimeter deep, cut in stone or brick and unlettered.

NOTE 18.—A red metal disk lettered "U. S. Coast and Geodetic Survey B. M. $250 fine or imprisonment for disturbing this mark." The disk is 3 inches in diameter, with a 3-inch stem at the back in which are circular grooves. It is set with cement flush with the surface. When set in a vertical surface, the horizontal mark of a cross cut upon it is the bench mark.

NOTE 19.—The intersection of cross lines, with the letters U. S. B. M. in the angles, cut with a chisel in the horizontal surface of a girder at the east end of a truss of the Washington and Columbia River Railway bridge over Snake River.

RED DESERT, WYOMING, TO OWYHEE, IDAHO.

For descriptions of the bench marks between these points see Appendix 6 of Coast and Geodetic Survey Report for 1904.

OWYHEE, IDAHO, TO HUNTS JUNCTION, WASHINGTON.

V_4—*Owyhee, Ada County, Idaho.*—See page 430 of Appendix 6, Coast and Geodetic Survey Report for 1904.

W_4—*Owyhee, Ada County, Idaho.*—See page 430 of Appendix 6, Coast and Geodetic Survey Report for 1904.

X_4—Three miles east of *Mora, Ada County, Idaho,* on the railroad right of way, 1 telegraph pole east of mile pole 442, 30 meters south of the track. (Note 3, p. 216, a limestone post lettered

U S
□
B M

Y_4—*Mora, Ada County, Idaho,* directly opposite station sign, 2 poles west of mile pole 445, about 22 meters south of the center of the track, on the railroad right of way. (Note 3, p. 216, a lava stone post.)

Z_4—About 1 mile west of *Mora, Ada County, Idaho,* 8½ telegraph poles east of mile pole 446 and 4 meters north of the track; in the top of the capstone of a red sandstone culvert, 7.5 centimeters from the north edge and 7.5 centimeters from the west edge. (Note 17, p. 217.)

A_5—About 2 miles west of *Kuna, Ada County, Idaho,* 20 meters east of mile pole 451, in an offset of the west abutment of bridge 222, south of the track; 35 centimeters from the east edge and 30 centimeters from the south edge. (Note 17, p. 217.)

B_5—Nearly 2½ miles west of *Kuna, Ada County, Idaho,* 4½ poles east of mile pole 451½, in the right of way, about 18 meters south of the center of the track and about 1 meter south of the line of telegraph poles. (Note 3, p. 216, a lava stone post.)

C_5—About 3½ miles west of *Kuna, Ada County, Idaho,* on the railroad right of way, 2 poles east of mile pole 452½ and about 3 meters south of the center of the track, in the native rock of a deep lava cut, about 0.7 meter above the ground. (Note 16, p. 217.)

D_5—About 4 miles east of *Nampa, Canyon County, Idaho,* 3 poles east of mile pole 455, on the right of way, about 27 meters south of the center of the track and about 0.7 meter from the fence. (Note 2, p. 216, a sandstone post.)

O. S. L.—*Nampa, Canyon County, Idaho*, east of the station, near mile pole 459, the top of the southeast corner of the southeast capstone, supporting column of the water tank.

E_5—*Nampa, Canyon County, Idaho*, in the west end of the Dewey Palace Hotel lawn, about 4.5 meters from the sidewalk along the west end of the lawn and equidistant from the walks along the sides of the lawn. (Note 2, p. 216, a lava stone post.)

F_5—*Nampa, Canyon County, Idaho*, in the west face of the Citizens' State Bank building (of brick), about 25 centimeters from the southwest corner. (Note 16, p. 217.)

G_5—*Nampa, Canyon County, Idaho*, in the north face of the brick building occupied by the Tuttle Mercantile Company, 0.9 meter from the northeast corner of the building and 1 meter above the ground. (Note 16, p. 217.)

H_5—*Nampa, Canyon County, Idaho*, in the east face of the brick building occupied by Leeson Furniture Company, 0.2 meter from the northeast corner and 1 meter above the ground. (Note 16, p. 217.)

I_5—*Nampa, Canyon County, Idaho*, in the brick depot of the Oregon Short Line Railroad, in the top of the lower step at the women's entrance facing the track, 0.15 meter from the west edge and 0.20 meter from the north edge of the step. (Note 17, p. 217.)

J_5—Near *Nampa, Canyon County, Idaho*, opposite the eighth telegraph pole west of mile pole 462, about 5 meters north of the track, in the top of a red sandstone culvert, 0.3 meter from the west edge and 0.15 meter from the north edge of the capstone. (Note 17, p. 217.)

K_5—About 5 miles west of *Nampa, Canyon County, Idaho*, at mile pole 464, on the railroad right of way, about 18 meters south of the center of the track. (Note 2, p. 216, a sandstone post.)

L_5—Three-fourths of a mile east of *Caldwell, Canyon County, Idaho*, south of the track, in the west abutment of a bridge, 0.3 meter from the east edge and 0.3 meter from the south edge. (Note 8, p. 217.)

M_5—*Caldwell, Canyon County, Idaho*, in the brick building occupied by Baker Brothers' grocery, in the face of the west wall, 6 meters from the northwest corner of the building and 1.2 meters above the ground. (Note 16, p. 217.)

N_5—*Caldwell, Canyon County, Idaho*, in the brick building occupied by the Steunenberg Banking and Trust Company, in the face of the west wall, about halfway between the north and south corners of the building and 1.2 meters above the sidewalk. (Note 16, p.217.)

O_5—*Caldwell, Canyon County, Idaho*, in the brick building occupied by the Saratoga Hotel, in the limestone step of the first door south of the northeast corner of the building, about 0.15 meter from the east edge and 0.1 meter from the south edge. (Note 17, p. 217.)

P_5—*Caldwell, Canyon County, Idaho*, in the brick building occupied by the First Natonal Bank, in the east wall of the building, 0.6 meter from the southeast corner and 1.2 meters from the ground. (Note 16, p. 217.)

Q_5—One mile west of *Caldwell, Canyon County, Idaho*, 10 meters east of mile pole 469, on the railroad bridge over the Boise River, south of the track, in the top of the west abutment, 0.2 meter from the east edge and 0.2 meter from the south edge. (Note 17, p. 217.)

R_5—About 2½ miles west of *Caldwell, Canyon County, Idaho*, 5 poles west of mile pole, 470½ south of the track, in the offset of the west abutment (of concrete) of bridge 312, 0.3 meter from the south edge and 0.3 meter from the east edge of the abutment. (Note 17, p. 217.)

S_5—Near *Notus, Canyon County, Idaho*, 3¾ poles west of mile pole 475, in the top of the west wall of a culvert of concrete, 8 meters south of the track, 0.1 meter from the east edge and 0.1 meter from the south edge. (Note 17, p. 217.)

T_5—About 2 miles west of *Notus, Canyon County, Idaho*, 1 pole west of mile pole 477, 45 meters north of the track, in the southwest corner of the ranch of Asa Anderson, 2.4 meters east of a telephone pole and 6 meters north of the road. (Note 2, p. 216, a sandstone post.)

U_5—About 2 miles east of *Parma, Canyon County, Idaho*, 4½ poles west of mile pole 481, 6 meters north of the track, in the top of the east wall of the sandstone culvert, 0.1 meter from the north edge and 0.1 meter from the west edge. (Note 17, p. 217.)

O. S. L.—Near *Parma, Canyon County, Idaho*, 1.5 meters west of mile pole 483, section 70, on the right of way, 15 meters south of the track; the top of an iron rod sunk in a concrete bed, projecting 5 centimeters above the ground.

V_5—About 2 miles west of *Parma, Canyon County, Idaho*, 4½ poles east of mile pole 485, in the west wall of a sandstone culvert north of the track, 0.2 meter from the east edge and 0.2 meter from the north edge. (Note 17, p. 217.)

W_5—In *Canyon County, Idaho*, about 3 miles east of *Nyssa, Malheur County, Oreg.*, 6½ poles north of mile pole 487½, on the railroad right of way, 30 meters west of the track, 3 meters north of the road, and 3 meters east of the fence. (Note 2, p. 216, a sandstone post.)

X_5—In *Canyon County, Idaho*, about 1¾ miles south of *Nyssa, Malheur County, Oreg.*, in the north (sandstone) abutment of bridge 327 of the Oregon Short Line Railroad over the Boise River; in the top of the offset east of the track, 0.1 meter from the south edge and 0.1 meter from the east edge. (Note 17, p. 217.)

F—About 1 mile south of *Nyssa, Malheur County, Oreg.*, in the north abutment of bridge 328 of the Oregon Short Line Railroad over Snake River; in the sandstone offset east of the track, 0.2 meter from the south edge and 0.25 meter from the east edge. (Note 8, p. 217.)

G—*Nyssa, Malheur County, Oreg.*, in the capstone (sandstone) of the northeast pillar of the railroad water tank, 0.1 meter from the north edge and 0.1 meter from the east edge. (Note 17, p. 217.)

H—About 2 miles north of *Nyssa, Malheur County, Oreg.*, on the railroad right of way, opposite mile pole 493, 27 meters east of the track. (Note 2, p. 216, a sandstone post.)

I—About 4 miles south of *Ontario, Malheur County, Oreg.*, in the north abutment of bridge 331 of the Oregon Short Line Railroad, 6½ poles south of mile pole 497, 0.2 meter from the west edge, and 0.2 meter from the south edge of the offset, in concrete. (Note 17, p. 217.)

J—About 5 miles south of *Ontario, Malheur County, Oreg.*, one-half pole south of mile pole 496, in a limestone culvert of the Oregon Short Line Railroad, about 6 meters east of the track, 0.07 meter from the east edge, and 0.1 meter from the north edge of the culvert. (Note 17, p. 217.)

2143 H—*Ontario, Malheur County, Oreg.*, at the corner of Main street and the street leading to the railroad station, 3.6 meters east of the northeast corner, at the Carter House. (Note 12, p. 217.)

K—*Ontario, Malheur County, Oreg.*, in the west face of the brick building of the Carter House, 1 meter north of the side door, and 1.5 meters above the ground. (Note 16, p. 217.)

L—*Ontario, Malheur County, Oreg.*, in the north face of the brick building occupied by the Oregon Forwarding Company, 1.5 meters east (?) of the northeast corner, and 1.5 meters above the ground. (Note 16, p. 217.)

M—*Ontario, Malheur County, Oreg.*, in the south face of the brick building occupied by Griffin & Staples's dry goods store, 1 meter west of the southeast corner, and 1.5 meters above the ground. (Note 16, p. 217.)

N—About 1 mile north of *Ontario, Malheur County, Oreg.*, in the top of the north abutment of bridge 334 of the Oregon Short Line Railroad over Malheur River, in the top of the sandstone offset, west of the track, 0.35 meter from the west edge and 0.4 meter from the south edge. (Note 17, p. 217.)

Y_5—Near *Payette, Canyon County, Idaho*, about 1¾ miles north of *Ontario, Malheur County, Oreg.*, in the north abutment of bridge 335 of the Oregon Short Line Railroad over the Snake River, east of the track in the sandstone offset, 0.3 meter from the south edge and 0.35 meter from the east edge. (Note 8, p. 217.)

2139 H(1)—2.2 miles south of *Payette, Canyon County, Idaho*, on the right of way of the Oregon Short Line Railroad, 85 meters south of mile pole 503, 3 meters east of the track. (Note 12, p. 217.)

Z_5—About two-fifths mile south of *Payette, Canyon County, Idaho*, in the north abutment of bridge 338 of the Oregon Short Line Railroad over the Payette River, east of the track, in the sandstone offset, 0.35 meter from the east edge and 0.45 meter from the south edge. (Note 17, p. 217.)

A_6—*Payette, Canyon County, Idaho*, in the sandstone capstone of the middle pillar on the west side of the railroad water tank, 0.1 meter from the west edge and 0.1 meter from the south edge. (Note 17, p. 217.)

B_6—*Payette, Canyon County, Idaho*, in the north wall of the brick building occupied by the Moss Mercantile Company, 1.2 meters from the ground and 1.2 meters west of the northeast corner. (Note 16, p. 217.)

C_6—*Payette, Canyon County, Idaho*, in the north wall of the brick building occupied by the First National Bank, 1.2 meters above the ground and 1.2 meters west of the northeast corner. (Note 16, p. 217.)

2139 H(2)—0.9 mile north of *Payette, Canyon County, Idaho*, on the right of way of the Oregon Short Line Railroad, 8 meters south of mile pole 506, at the fence line west of the track. (Note 12, p. 217.)

2123 H—In Canyon County, 2.6 miles south of *Crystal, Washington County, Idaho*, on the right of way of the Oregon Short Line Railroad, at the first telegraph pole north of mile pole 509, west of the track. (Note 12, p. 217.)

D_6—About 2.6 miles south of *Crystal, Washington County, Idaho*, 4 poles north of mile pole 509, in a sandstone culvert east of the track, 0.2 meter from the east edge and 0.15 meter from the south edge. (Note 17, p. 217.)

2112 H—6.3 miles south of *Weiser*, *Washington County*, *Idaho*, on the right of way of the Oregon Short Line Railroad, at the first telegraph pole south of mile pole 512, west of the track. (Note 12, p. 217.)

E_6—About 3½ miles south of *Weiser*, *Washington County*, *Idaho*, 6 poles south of mile pole 515, in the south abutment of bridge 342, in the offset west of the track, 0.2 meter from the west edge and 0.12 meter from the north edge. (Note 17, p. 217.)

2113 H—3.3 miles south of *Weiser*, *Washington County*, *Idaho*, on the right of way of the Oregon Short Line Railroad, 1.2 meters north of mile pole 515, west of the track. (Note 12, p. 217.)

F_6—About one-third mile southeast of *Weiser*, *Washington County*, *Idaho*, in the top of the north abutment of the bridge over the Weiser River, in the sandstone offset east of the track, about 0.3 meter from the south edge and about 0.5 meter from the east edge. (Note 8, p. 217.)

2107 H—*Weiser*, *Washington County*, *Idaho*, at the railroad station, on the north margin of the highway, 9 meters east of the main track of the Oregon Short Line Railroad. (Note 12, p. 217.)

G_6—At *Weiser*, *Washington County*, *Idaho*, in the north wall of the brick building occupied by the Masonic Lodge, 3 meters north of the northwest corner (?), and 1.2 meters above the ground. (Note 10, p. 217.)

H_6—At *Weiser*, *Washington County*, *Idaho*, in the west wall of the brick courthouse at Oldtown, Weiser, about 1 mile east of the railroad station. (Note 18, p. 218.)

2122 H—3.2 miles southeast of *Eaton*, *Washington County*, *Idaho*, on the right of way of the Oregon Short Line Railroad, at the first telegraph pole west of mile pole 521, south of the track. (Note 12, p. 217.)

I_6—About 1 mile east of *Eaton*, *Washington County*, *Idaho*, 6 poles west of mile pole 522½, 27 meters south of the track of the Oregon Short Line Railroad, 1 meter south of the fence. (Note 2, p. 216, a sandstone post.)

2097 H—0.3 mile southeast of *Eaton*, *Washington County*, *Idaho*, on the right of way of the Oregon Short Line Railroad, at mile pole 524, west of the track. (Note 12, p. 217.)

J_6—About 1 mile west of *Eaton*, *Washington County*, *Idaho*, on the railroad right of way, 2 poles west of mile pole 525, 15 meters south of the track, and 4 meters east of a telegraph pole. (Note 4, p. 217.)

2087. H—5.2 miles east of *Olds Ferry*, *Washington County*, *Idaho*, on the right of way of the Oregon Short Line Railroad, 4.5 meters east of the fifth pole east of mile pole 527, 3 meters north of the track. (Note 12, p. 217.)

2086 H—2.2 miles east of *Olds Ferry*, *Washington County*, *Idaho*, 21 meters west of the seventh pole east of mile pole 530, 3 meters north of the track, on the right of way of the Oregon Short Line Railroad. (Note 12, p. 217.)

K_6—*Olds Ferry*, *Washington County*, *Idaho*, on the railroad right of way, 27 meters east of the track and 1 meter from the fence, 9 poles north of mile pole 532, and 3 poles south of the station sign. Note 3, p. 216, a limestone post, the top lettered

U S
□
B M

2070 H—About three-fourths mile west of *Olds Ferry*, *Washington County*, *Idaho*, on the right of way of the Oregon Short Line Railroad, 5.4 meters east of the track, opposite mile pole 533. (Note 12, p. .217)

2069 H—About 4 miles west of *Olds Ferry*, *Washington County*, *Idaho*, on the right of way of the Oregon Short Line Railroad, at the first telegraph pole west of mile pole 536, 2.4 meters from the fence north of the track. (Note 12, p. 217.)

2079 A—2.4 miles northeast of *Huntington*, *Baker County*, *Oreg*., on the right of way of the Oregon Short Line Railroad, in a bridge over the Snake River, 1 meter east of the west end, on a stone stringer south of the track. (Note 15, p. 217.)

O—About 2 miles northeast of *Huntington*, *Baker County*, *Oreg*., 12 poles south of mile pole 539, in the north abutment of bridge 380 of the Oregon Short Line Railroad over Burnt River, in the concrete offset east of the track, 0.3 meter from the east edge and 0.2 meter from the south edge. (Note 17, p. 217.)

P—About 1½ miles northeast of *Huntington*, *Baker County*, *Oreg*., 2 poles south of mile pole 540, in the north abutment of bridge 381 of the Oregon Short Line Railroad over Burnt River, in the sandstone offset east of the track, 0.2 meter from the south edge and 0.25 meter from the east edge. (Note 17, p. 217.)

Q—About 1 mile northeast of *Huntington*, *Baker County*, *Oreg*., east of the track, 7 poles south of mile pole 540, in the south abutment of bridge 382 of the Oregon Short Line Railroad over Burnt River, 0.3 meter from the south edge and 0.28 meter from the east edge of the sandstone offset east of the track. (Note 17, p. 217.)

2105 A—*Huntington*, *Baker County*, *Oreg*., on Washington street, in the front wall of the brick building of the Oregon Commercial Company, near the stairway between the grocery store and the drug store, in the sixth row of bricks above the stone foundation. (Note 15, p. 217.) Reported loose, 1903.

R—*Huntington*, *Baker County*, *Oreg*., in the front wall of the brick building occupied by the Owl Drug Company and the post-office, midway between the show-window and the stairway, west of the entrance to the store, 1.2 meters above the ground. (Note 10, p. 217.)

S—About 1 mile north of *Huntington*, *Baker County*, *Oreg*., in the north abutment of bridge 365 of the Oregon Railroad and Navigation Company, in the concrete offset east of the track, 0.25 meter from the south edge and 0.4 meter from the east edge. (Note 17, p. 217.)

T—About 2 miles north of *Huntington*, *Baker County*, *Oreg*., in the north abutment of bridge 364 of the Oregon Railroad and Navigation Company, in the concrete offset east of the track, 0.25 meter from the south edge, and 0.5 meter from the east edge. (Note 17, p. 217.)

U—About 3 miles north of *Huntington*, *Baker County*, *Oreg*., in the north abutment of bridge 362, in the concrete offset east of the track, 0.25 meter from the south edge and 0.5 meter from the east edge. (Note 17, p. 217.)

V—About 3¾ miles north of *Huntington*, *Baker County*, *Oreg*., in the north abutment of bridge 360, in the concrete offset east of the track, 0.25 meter from the south edge and 0.5 meter from the east edge. (Note 17, p. 217.)

2215 A—About 5 miles northwest of *Huntington*, *Baker County*, *Oreg*., on the right of way of the Oregon Railroad and Navigation Company, 108 meters south of bridge 356, 9 meters east of the track, 4 meters west of the fence. (Notê 14, p. 217.)

W—About 5½ miles northwest of *Huntington, Baker County, Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, about one-half mile north of mile pole 400, about 10 meters west of the track and 5 meters west of the whistle board. (Note 2, p. 216, a limestone post.)

X—About 6½ miles north of *Huntington, Baker County, Oreg.*, about one-half mile north of mile pole 399, in the south concrete abutment of bridge 355, in an offset of the abutment, 2.5 meters east of the track, 35 centimeters from the north edge, and 35 centimeters from the east edge. (Note 17, p. 217.)

Y—About 8 miles north of *Huntington, Baker County, Oreg.*, 3 poles north of mile pole 397, in the north concrete abutment of bridge 353, in an offset of the abutment east of the track, 1 meter from the east edge and 0.3 meter from the south edge. (Note 17, p. 217.)

2369 A—About 1½ miles south of *Weatherby, Baker County, Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, 180 meters west of the west portal of tunnel 6, 12 meters north of the track, 2.5 meters from the east corner of the fence. (Note 14, p. 217.)

Z—About one-fourth mile north of the station sign at *Weatherby, Baker County, Oreg.*, and about 7 miles south of Durkee, on the right of way of the Oregon Railroad and Navigation Company, 1 pole north of mile pole 391, 15 meters west of the track. (Note 4, p. 217.)

A_2—About three-fourths mile north of *Weatherby, Baker County, Oreg.*, about 6½ miles south of Durkee, in the north abutment of bridge 343, east of the track, in the concrete offset of the abutment, 45 centimeters from the south edge and 62 centimeters from the east edge. (Note 17, p. 217.)

2518 A—About 4¾ miles south of *Durkee, Baker County, Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, about 300 meters north of mile pole 389, 4 meters south of the wagon road, 7 meters north of the track, and 1.2 meters south of the fence. (Note 14, p. 217.)

B_2—About 2¾ miles southeast of *Durkee, Baker County, Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, about 1 pole north of mile pole 387, 15 meters east of the track. (Note 4, p. 217.)

2647 A—*Durkee, Baker County, Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, 0.6 meter east of the depot platform, 11 meters north of the track. (Note 14, p. 217.)

C_2—About 2 miles west of *Durkee, Baker County, Oreg.*, in the west concrete abutment of bridge 324, south of the track; in the offset of the abutment, 0.6 meter from the south edge and 0.4 meter from the west edge. (Note 17, p. 217.)

D_2—About 3¼ miles west of *Durkee, Baker County, Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, 9 meters west of mile pole 381, 0.6 meter from the fence. (Note 2, p. 216, a limestone post.)

3139 A—Fifty-five meters north of the section house at *Unity, Baker County, Oreg.*, and about 7 miles northwest of Durkee, east of the track, just east of a wagon road. (Note 14, p. 217.)

E_2—One-fourth mile north of the station sign at *Unity, Baker County, Oreg.*, and about 7½ miles northwest of Durkee, in the south concrete abutment of bridge 320, 4 poles north of mile pole 377, in the offset of the abutment east of the track, 0.2 meter west of the east edge and 0.2 meter from the north edge. (Note 17, p. 217.)

F_2—About 3½ miles southeast of *Pleasant Valley*, *Baker County*, *Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, 1.5 meters south of mile pole 373. (Note 2, p. 216.)

3818 A—*Pleasant Valley*, *Baker County*, *Oreg.*, 30 meters south of the track, 4.5 meters south of the southwest corner of the railroad house. (Note 14, p. 217.) Reported in battered condition (1904).

G_2—About one-half mile east of *Encina*, *Baker County*, *Oreg.*, 4 poles east of mile pole 367, 12 meters south of the track of the Oregon Railroad and Navigation Company, at a road crossing 3 meters east of a telegraph pole. (Note 4, p. 217.)

H_2—About 1 mile southeast of the siding at *Norton*, *Baker County*, *Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, 2 poles east of mile pole 364, in a concrete culvert south of the track. (Note 17, p. 217.)

3646 A—*Norton*, *Baker County*, *Oreg.*, 45 meters north of the section house. (Note 14, p. 217.)

I_2—About 2 miles south of *Baker City*, *Baker County*, *Oreg.*, in the north concrete abutment of bridge No. 307, east of the track, in an offset of the abutment, 45 centimeters from the east edge. (Note 17, p. 217.)

3433 A—*Baker City*, *Baker County*, *Oreg.*, in the astronomic pier in the front yard of the public high school. (Note 15, p. 217, except the tablet is of bronze.)

J_2—*Baker City*, *Baker County*, *Oreg.*, in the north face of the brick building of the Sage & Grace Mercantile Company, 1.2 meters above the ground and 3 meters east of the northwest corner of the building. (Note 10, p. 217.)

K_2—*Baker City*, *Baker County*, *Oreg.*, in the east face of the limestone building of the Order of Elks known as Elks Hall, 0.6 meter from the northeast corner, 1.2 meters above the ground. (Note 18, p. 218.)

L_2—*Baker City*, *Baker County*, *Oreg.*, in the north face of the limestone city hall building, 0.6 meter from the northwest corner, 1.2 meters above the ground. (Note 18, p. 218.)

M_2—About 3 miles north of *Baker City*, *Baker County*, *Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, at mile pole 354, 2 meters east of the track. (Note 2, p. 216, a limestone post.)

3338 A—1.5 miles north of *Wingville*, *Baker County*, *Oreg.*, about 6 miles north of Baker City, 180 meters east of Jenning's house, on the main road between Haines and Baker City, 20 meters west of the railroad track. (Note 14, p. 217.)

N_2—1.5 miles south of *Haines*, *Baker County*, *Oreg.*, and about 9 miles north of Baker City, on the right of way of the Oregon Railroad and Navigation Company, at mile pole 348, 27 meters west of the track. (Note 4, p. 217.)

O_2—About 2 miles north of *Haines*, *Baker County*, *Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, one-fourth mile north of mile pole 345, 15 meters east of the track at the fence corner north of the road crossing. (Note 4, p. 217.)

3372 A—*Hutchinson*, *Baker County*, *Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, 8 meters north of milepost 342 and 13 meters west of the track. (Note 14, p. 217.)

P_2—About 2 miles southwest of *North Powder*, *Union County*, *Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, 2½ poles south of mile pole 339, 15 meters east of the track at a fence corner. (Note 4, p. 217.)

3233 A—*North Powder, Union County, Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, 36 meters southwest of the station, and 10 meters south of the center of the track, at the northeast corner of the fence, 4 meters south of the wagon road. (Note 14, p. 217.)

Q_2—*North Powder, Union County, Oreg.*, in the southeast wall of the limestone building of the I. O. O. F., 1.2 meters southwest from the east corner and 1.4 meters above the ground. (Note 10, p. 217.)

R_2—About 2¾ miles northeast of *North Powder, Union County, Oreg.*, on the Oregon Railroad and Navigation Company right of way, one-fourth mile west of mile pole 334; the center of a cross in a square cut in the face of native lava rock, about 3 meters north of the center of the track, and lettered

U S
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B M

S_2—About 3¼ miles northeast of *North Powder, Union County, Oreg.*, on the Oregon Railroad and Navigation Company right of way, in the west concrete abutment of bridge 271, north of the track. (Note 8, p. 217.)

T_2—About 3½ miles northeast of *North Powder, Union County, Oreg.*, on the Oregon Railroad and Navigation Company right of way, in the west concrete abutment of bridge 270, north of the track. (Note 8, p. 217.)

3228 A—About 4½ miles northeast of *North Powder, Union County, Oreg.*, on the Oregon Railroad and Navigation Company right of way; 54 meters north of the north portal of tunnel 5, 4.2 meters east of the track. (Note 14, p. 217.)

U_2—About 3 miles southwest of *Telocaset, Union County, Oreg.*, on the Oregon Railroad and Navigation Company right of way, 27 meters north of the track, at mile pole 331. (Note 4, p. 217.)

V_2—About one-fourth mile south of *Telocaset, Union County, Oreg.*, on the Oregon Railroad and Navigation Company right of way, 4 poles south of mile pole 328, in the northwest fence corner of a road crossing. (Note 2, p. 216.)

3440 A—*Telocaset, Union County, Oreg.*, on the railroad right of way, 1 meter east of the east corner of the fence at the section house and 5.4 meters north of the center of the track. (Note 14, p. 217.)

W_2—About 3 miles north of *Telocaset, Union County, Oreg.*, on the railroad right of way, east of the track and in the line of the telegraph poles, 2 meters north of mile pole 325. (Note 4, p. 217.)

3021 A—About 4¼ miles south of *Union Station, Union County, Oreg.*, on the railroad right of way, 300 meters west of the second snowshed southeast of Union Station, 4.5 meters south of the track. (Note 14, p. 217.)

X_2—About 1¼ miles southeast of *Union Station, Union County, Oreg.*, on the railroad right of way, 8 poles southeast of mile pole 319, 12 meters east of the track. (Note 4, p. 217.)

Y_2—*Union, Union County, Oreg.*, in the east face of the brick and stone building occupied by Joseph Wright's store, 0.5 meter from the southeast corner and 1.2 meters above the ground. (Note 10, p. 217.)

Z_2—*Union, Union County, Oreg.*, in the brick building occupied by the Foster Brown Company, dry goods; in the top of the stone stringer, on the north side of the building, 0.6 meter from the northeast corner. (Note 18, p. 218.)

G. S. Union—*Union, Union County, Oreg.*, in the brick and stone building owned and occupied by the Grande Ronde Valley Lodge, No. 56, of Ancient Free and Accepted Masons; in the top of the stone stringer on the east face of the building, 1 meter from the southeast corner. (Note 15, p. 217, except the elevation and datum letter are not given.)

A_3—*Union, Union County, Oreg.*, in the west face of the brick building of the First National Bank, 1 meter from the northwest corner and 1.2 meters above the ground. (Note 10, p. 217.)

2705 A—About three-fourths mile northwest of *Union Station, Union County, Oreg.*, on the right of way of the Oregon Railroad and Navigation Company, 16 meters northeast of milepost 317, 2 meters south of fence. Iron post marked "2705 A."

B_3—About 3 miles northwest of *Union Station, Union County, Oreg.*, on the railroad right of way, one-fourth mile southeast of mile pole 315, and 3 meters northwest of a telegraph pole, 15 meters northeast of the track. (Note 4, p. 217.)

2696 A—About 6 miles northwest of *Union Station, Union County, Oreg.*, on the railroad right of way, 0.3 mile northwest of mile pole 312, 15 meters south of the track. (Note 14, p. 217.)

C_3—About 4 miles southeast of *Lagrande, Union County, Oreg.*, on the railroad right of way, 5 meters northwest of the first pole northwest of mile pole 310 and 12 meters northeast of the track. (Note 4, p. 217.)

D_3—About 2 miles southeast of *Lagrande, Union County, Oreg.*, on the railroad right of way, at trestle 212, 18 meters southwest of the track. (Note 4, p. 217.)

2773 A—*Lagrande, Union County, Oreg.*, on the railroad right of way, 50 meters northeast of the road crossing at First street, 9 meters north of the northwest corner of the railroad tool house, and 1.2 meters west of a telegraph pole. (Note 14, p. 217.)

E_3—*Lagrande, Union County, Oreg.*, in the north face of the brick building occupied by the grocery store of J. W. White, 0.3 meter from the northeast corner of the building and 1.2 meters above the ground. (Note 10, p. 217.)

F_3—*Lagrande, Union County, Oreg.*, in the front of the brick and stone building occupied by the Chicago Dry Goods Company, in the limestone pillar just south of the entrance to the stairway, 1.2 meters from the ground. (Note 18, p. 218.)

G_3—*Lagrande, Union County, Oreg.*, in the front of the brick and stone building occupied by the Lewis printing offices, near the southwest corner and in the top of the stone stringer below the window. (Note 18, p. 218.)

2782 A—*Lagrande, Union County, Oreg.*, in the north face of the brick building of the Foley Hotel in the third course of plaster facing of the wall on the Chestnut street side. (Note 15, p. 217.)

H_3—About 2½ miles north of *Lagrande, Union County, Oreg.*, on the railroad right of way, in the south concrete abutment of bridge 205, in an offset west of the track 1.2 meters from the nearer rail, 0.2 meter from the inside edge of the steel stringer. (Note 17, p. 217.)

I_3—About 3 miles north of *Lagrande, Union County, Oreg.*, on the railroad right of way, 6 poles north of mile pole 303, 10 meters south of the track near the road crossing. (Note 4, p. 217.)

2897 A—*Perry, Union County, Oreg.*, 0.6 meter east of the office of the Grande Ronde Lumber Company, 14 meters north of the center of the track. (Note 14, p. 217.)

J_3—About 1½ miles south of *Hilgard, Union County, Oreg.*, on the railroad right of way, 1 pole west of mile pole 299, 12 meters north of the track and 3 meters east of the pole. (Note 4, p. 217.)

3001 A—*Hilgard, Union County, Oreg.*, on the railroad right of way, 12 meters west of the first telegraph pole west of the depot, 7 meters north of the center of the track. (Note 14, p. 217.) (Slightly loose.)

3581 A—About 5½ miles north of *Hilgard, Union County, Oreg.*, on the railroad right of way, 36 meters east of mile pole 292, 5 meters south of the center of the track. (Note 14, p. 217.)

K_3—About 2½ miles south of *Kamela, Union County, Oreg.*, on the railroad right of way, 5 poles north of mile pole 289, 4 poles west of the signboard "Spring Spur," 15 meters east of the track. (Note 4, p. 217.)

4199 A—*Kamela, Union County, Oreg.*, on the railroad right of way, 13 meters south of the telegraph office, 0.4 meter north of the railroad tank, 4 meters west of the center of the track. (Note 14, p. 217.)

3958 A—About 3½ miles south of *Meacham, Umatilla County, Oreg.*, on the railroad right of way, 9 meters southwest of mile pole 284, 7 meters south of the center of the track. (Note 14, p. 217.)

L_3—About 1½ miles south of *Meacham, Umatilla County, Oreg.*, on the railroad right of way, 4 meters south of mile pole 282, 12 meters east of the track (Note 2, p. 216, a lava stone post.)

3672 A—*Meacham, Umatilla County, Oreg.*, on the railroad right of way, 50 meters north of the station and 5 meters east of the center of the track. (Note 14, p. 217.)

3454 A—About 2½ miles east of *Meacham, Umatilla County, Oreg.*, on the railroad right of way, 4 meters east of mile pole 278 and 4.5 meters north of the center of the track. (Note 14, p. 217.)

M_3—About 3½ miles east of *Meacham, Umatilla County, Oreg.*, on the railroad right of way, 2 poles south of mile pole 277, and 10 meters west of the track. (Note 2, p. 216, a lava stone post.)

N_3—About 5 miles southeast of *Meacham, Umatilla County, Oreg.*, on the railroad right of way, in the southwest concrete abutment of bridge 145, in the top of the offset west of the track. (Note 8, p. 217.)

O_3—About 6 miles southeast of *Meacham, Umatilla County, Oreg.*, on the railroad right of way, in the south abutment of bridge 137, in the offset west of the track. (Note 8, p. 217.)

P_3—About 8 miles southeast of *Meacham, Umatilla County, Oreg.*, on the railroad right of way, in the north concrete abutment of bridge 131, in the top of the offset east of the track. (Note 8, p. 217.)

Q_3—About 9½ miles southeast of *Meacham, Umatilla County, Oreg.*, on the railroad right of way, one-sixth mile east of mile pole 271, 12 meters south of the track. (Note 4, p. 217.)

2570 A—About 4½ miles west of *North Fork*, *Umatilla County*, *Oreg.*, on the railroad right of way, 162 meters south of the south end of bridge 115, 9 meters east of the center of the track. (Note 14, p. 217.)

R_3—About 4½ miles west of *North Fork*, *Umatilla County*, *Oreg.*, on the railroad right of way, in the north concrete abutment of bridge 115, in the top of an offset west of the track. (Note 8, p. 217.)

S_3—About 3 miles south of *North Fork*, *Umatilla County*, *Oreg.*, 0.5 mile south of mile pole 266, in the south abutment of a steel bridge in the offset east of the track. (Note 17, p. 217.)

T_3—About 2.5 miles south of *North Fork*, *Umatilla County*, *Oreg.*, at mile pole 266, 12 meters east of the track. (Note 2, p. 216.)

2264 A—About one-half mile north of *North Fork*, *Umatilla County*, *Oreg.*, 45 meters east of the section house, 10 meters south of the track. (Note 14, p. 217.)

U_3—About 1 mile northwest of *North Fork*, *Umatilla County*, *Oreg.*, in the north abutment of bridge 106, in the top of the offset east of the track. (Note 18, p. 218.)

V_3—About 2½ miles northwest of *North Fork*, *Umatilla County*, *Oreg.*, 4 poles northwest of mile pole 261, iron pipe in the line of the poles northeast of the track. (Note 4, p. 217.)

2023 A—About 6 miles southeast of *Bingham Springs* (*Gibbon*), *Umatilla County*, *Oreg.*, one-half mile east of mile pole 258, 7 meters south of the track, 10 meters east of the whistling post. (Note 14, p. 217.)

W_3—About 3½ miles southeast of *Bingham Springs* (*Gibbon*), *Umatilla County*, *Oreg.*, 2 poles southeast of mile pole 256, 18 meters west of the track. (Note 4, p. 217.)

X_3—About 1½ miles southeast of *Bingham Springs* (*Gibbon*), *Umatilla County*, *Oreg.*, in the east abutment of bridge 86, in the top of the offset north of the track. (Note 18, p. 218.)

1744 A—*Bingham Springs* (*Gibbon*), *Umatilla County*, *Oreg.*, 47 meters east of the depot, 11 meters north of the track, 1.2 meters east of the first telegraph pole from the depot. (Note 14, p. 217.)

Y_3—About 2½ miles west of *Bingham Springs* (*Gibbon*), *Umatilla County*, *Oreg.*, opposite mile pole 250, 12 meters north of the track. (Note 2, p. 216.)

1523 A—About 4 miles east of *Cayuse*, *Umatilla County*, *Oreg.*, about one-half mile west of mile pole 247, 90 meters west of a road crossing, 4 meters north of the track, and 1.2 meters east of a telegraph pole. (Note 14, p. 217.)

Z_3—About 3½ miles east of *Cayuse*, *Oreg.*, in the top of a pillar of bridge 66, 2.4 meters from the south rail, 0.6 meter from the west edge, 0.9 meter from the south edge. (Note 17, p. 217.)

A_4—About one-half mile east of *Cayuse*, *Umatilla County*, *Oreg.*, one-half pole west of mile pole 243 and 6 meters north of the track. (Note 4, p. 217.)

B_4—About 0.3 mile west of *Cayuse*, *Umatilla County*, *Oreg.*, in the east abutment of a steel bridge, in the offset north of the track. (Note 17, p. 217.)

1355 A—About 5½ miles east of *Mission*, *Umatilla County*, *Oreg.*, 270 meters west of mile pole 241, 6 meters south of the track and 4 meters north of a wagon road. (Note 14, p. 217.)

C_4—About 3 miles east of *Mission*, *Umatilla County*, *Oreg.*, 6 poles east of mile pole 239, stone post, 5 meters south of the track. (Note 2, p. 216.)

1205 A—*Mission*, *Umatilla County*, *Oreg.*, 225 meters northeast of mile pole 236, 7.5 meters north of the track, 1 meter east of the telegraph pole west of the switch for the siding. (Note 14, p. 217.)

D_4—*Pendleton*, *Umatilla County*, *Oreg.*, at the entrance to the brick building of the Cruise Hotel, opposite the side entrance of the St. George Hotel, in the top of the west end of the stone step. (Note 18, p. 218.)

E_4—*Pendleton*, *Umatilla County*, *Oreg.*, in the stone runner of the entrance to the building of brick occupied by the Delta confectionery store, on Main street. (Note 18, p. 218.)

F_4—*Pendleton*, *Umatilla County*, *Oreg.*, in the east wall of the brick building of the Umatilla Implement Company, 1.2 meters above the ground, 0.2 meter from the southeast corner. (Note 10, p. 217.)

1074 A—*Pendleton*, *Umatilla County*, *Oreg.*, in the second block of the plaster base of the west entrance (on south side) of the Umatilla County court-house. (Note 15, p. 217.)

G_4—About 1 mile east of *Pendleton*, *Umatilla County*, *Oreg.*, in the west abutment of the steel bridge over the Umatilla River, in the top of the offset, north of the track. (Note 18, p. 218.)

H_4—About 2.5 miles northeast of *Pendleton*, *Umatilla County*, *Oreg.*, on the right of way of the Washington and Columbia River Railroad, 10 meters north of the track. (Note 2, p. 216.)

I_4—About 2 miles southwest of *Fulton*, *Umatilla County*, *Oreg.*, at mile pole 35, on the right of way of the Washington and Columbia River Railroad, 10 meters west of the track. (Note 4, p. 217.)

J_4—About 1 mile north of *McCormack*, *Umatilla County*, *Oreg.*, at mile pole 31, on the right of way of the Washington and Columbia River Railroad, 10 meters north of the track. (Note 4, p. 217.)

K_4—About 1 mile north of *Warren*, *Umatilla County*, *Oreg.*, at mile pole 27, on the right of way, 10 meters west of the track. (Note 4, p. 217.)

L_4—About 1.2 miles north of *Helix*, *Umatilla County*, *Oreg.*, at mile pole 22, on the right of way, 12 meters west of the the track. (Note 4, p. 217.)

M_4—Near *Killian Junction*, *Umatilla County*, *Oreg.*, 1 pole south of mile pole 19; a square hole cut in a concrete culvert, east of the track, on the right of way. (Note 17, p. 217.)

N_4—Near *Killian Junction*, *Umatilla County*, *Oreg.*, at mile pole 18, on the right of way, 15 meters west of the track. (Note 4, p. 217.)

O_4—About 1 mile north of *Stanton*, *Umatilla County*, *Oreg.*, at mile pole 17, in the concrete culvert west of the track. (Note 8, p. 217.)

P_4—About 1.2 miles south of *Canon*, *Umatilla County*, *Oreg.*, 1 pole north of mile pole 12, on the right of way, 5 meters west of the track. (Note 2, p. 216.)

R_3—About 10 miles south of *Hunts Junction*, *Wallawalla County*, *Wash.*, 0.3 mile north of mile pole 10, on the right of way, 10 meters west of the track. (Note 2, p. 216.)

Q_3—About 6 miles southeast of *Hunts Junction*, *Wallawalla County*, *Wash.*, at mile pole 6, on the right of way, 15 meters west of the track. (Note 2, p. 216.)

P_3—Near *Hunts Junction*, *Wallawalla County*, *Wash.* (See p. 241.)

SEATTLE TO HUNTS JUNCTION, WASH.

Tidal 4=City—*Seattle*, *King County*, *Wash.*, a square cut on the northern end of the doorsill on the west side of the Rainier Grand Building on Post street, about 1.368 meters south of Madison street and about 0.2 meter from the edge of the sill on Post street. As a city bench mark, its elevation is given as 13.790 feet above city datum.

Tidal 5—*Seattle*, *King County*, *Wash.*, the top surface of an iron hinge on a window in the rear of the old Seattle Athletic Club Building, now the Seneca Hotel, on Post street, 2.402 meters north of Seneca street and 0.681 meter above the lower edge of the window sill.

G—*Seattle*, *King County*, *Wash.*, in the Pioneer Park at the intersection of First avenue, James street, and Yesler way, 5.350 meters from the east fence of the park, 5.430 meters from the west fence, and 4.070 meters south of the totem pole. (Note 1, p. 216.)

City 1—*Seattle*, *King County*, *Wash.*, at the entrance of the Puget Sound National Bank, corner of James street and First avenue; a square outlined in the granite step, 0.020 meter from the edge of the step and 0.030 meter from the granite base supporting the column at the side of the doorway, the face of which is inscribed "City Datum."

City 2—*Seattle*, *King County*, *Wash.*, on the foundation for the chimney of the Rainier Heat, Light, and Power Company's generating plant, 76 meters southeast of Hill's gas works and 5 meters from the siding of the Columbia and Puget Sound Railway; a cross cut in the upper surface of the top stone on the west side of the foundation, 0.03 meter from the west edge of the stone.

City 3—*South Seattle*, *King County*, *Wash.*, 23 meters west of the intersection of Charlestown street and Eighth avenue south and about 11 meters north of C. M. Felt's fence; the top of a tack or nail driven into the root of a maple tree. As that portion of the root is dead it is not likely to last many years. (1904.)

N. P.—About seven-eighths kilometer south of *Argo*, *King County*, *Wash.*, 65 meters south of the south cattle guard for the first railroad crossing south of Argo, 11.55 meters from the east right of way fence, 3.055 meters from the center of the nearest Columbia and Puget Sound rail, and 1.53 meters from the center of the nearest Northern Pacific rail; a shallow circular depression in the center of a cylindrical post of concrete set flush with the surface of the gravel between the tracks and marked N P on the top.

N. P.—About 4 kilometers north of *Black River* and near the old spur known as Van Asselts in *King County*, *Wash.*, 14 meters south of the crossing for logging teams, 1.52 meters from the center of the nearest Northern Pacific rail, and 1.66 meters from the nearest Columbia and Puget Sound rail; a shallow circular depression in the center of a cylindrical post of concrete set flush with the surface of the gravel between the tracks and marked N P on the top.

H—*Black River*, *King County*, *Wash.*, opposite the Northern Pacific Railroad depot, 11.55 meters east of the nearest Columbia and Puget Sound rail and 1.925 meters west of the right of way fence. (Note 1, p. 216.)

I—About one-fourth kilometer south of *Black River*, *King County*, *Wash.*, on the sandstone abutment for the approach to the Northern Pacific bridge over Black River, on the north end of the bridge and on the west side of the track; a copper bolt (Note

9, p. 217) leaded into the concrete cap, 1.34 meters from the nearest rail, 0.42 meter from the south, and 0.190 meter from the west edge of the abutment.

J—*Kent, King County, Wash.*, in the southwest corner of Mr. Ed. Brotchi's yard on Railroad avenue, 0.2 meter from the west fence and 0.2 meter from the south fence inclosing the yard. (Note 1, p. 216.)

K—*Kent, King County, Wash.*, at the southwest corner of Gowe street and First or Front street, as commonly known in the town, a cross cut in the head of the northeast corner bolt holding the cap of the water hydrant, 2.8 meters south of the edge of Gowe street pavement and 3.8 meters from the corner of a store building; 0.26 meter above the ground.

L—About 2 kilometers south of *Kent*, and 0.8 kilometer north of *Thomas, King County, Wash.*, on the concrete abutment west of the track at the north end of the Northern Pacific bridge over White River; a copper bolt (Note 9, p. 217) leaded into the upper surface of the northwest corner of the abutment, 0.1 meter from each edge and 2.22 meters from the nearest rail.

M—*Auburn, King County, Wash.*, 73 meters north of the small Northern Pacific Railway station, in Mr. Gilmore's yard, about 20 meters northeast of his house, 2 meters west of the fence inclosing his yard, and 14.35 meters from the nearest rail. (Note 1, p. 216.)

N—*Auburn, King County, Wash.*, in front of R. C. Kinleyside's hardware and furniture store; a metal disk in the cement sidewalk, 2.74 meters from its outer edge and 0.16 meter from the building. (Note 5, p. 217.)

O—About three-fourths kilometer east of *Auburn, King County, Wash.*, in the top of the concrete abutment for the approach of the Northern Pacific Railway bridge over White River; the bottom of a hole 32 millimeters square, cut 6.4 millimeters deep (Note 8, p. 217), 0.365 meter from the east edge, 0.18 meter from the south edge of the abutment, and 1.465 meters from the nearest rail.

P—0.9 kilometer west of the station at *Covington, King County, Wash.*, in the west abutment of the concrete approach to the Northern Pacific Railway bridge 2 over Jenkins Creek, 6 rails west of the nearest switch stand; a metal disk (Note 5, p. 217), flush with the upper surface, 0.3 meter from the east, 0.2 meter from the south edge of the abutment, and 1.5 meters south of the nearest rail of the track.

Q—*Covington, King County, Wash.*, 36 meters west of the station of the Northern Pacific Railway, 9 meters south of the main-line track, and 10 meters south of milepost 224; about in the line of telegraph poles and in the Northern Pacific right of way. (Note 1, p. 216.)

R—1.9 kilometers west of *Ravensdale, King County, Wash.*, on the N. P. Ry. concrete arch culvert 1Q, 3 meters north of the track; a copper bolt, with the letters U. S. B. M. stenciled in the head, leaded into the upper surface at the northeast corner, 0.35 meter from the east and 0.1 meter from the north edge of the culvert.

S—*Ravensdale, King County, Wash.*, 60 meters west of the N. P. Ry. station, 20 meters south of the main track, and 0.6 meter east of the railway section house. (Note 1, p. 216.)

T—1.7 kilometers east of *Ravensdale, King County, Wash.*, on the N. P. Ry. concrete arch culvert 1L over Beaver Creek, 4.3 meters south of the railway track; a copper bolt in the upper surface of the culvert, 0.157 meter from the east and 0.15 meter from the south edge. (Note 10, p. 217.)

U—3.2 kilometers east of *Ravensdale*, *King County*, *Wash.*, on a concrete arch culvert near mile pole 215, 2.5 meters north of the N. P. Ry. track; a copper bolt (Note 10, p. 217) in the upper surface, 0.15 meter from the west and 0.15 meter form the north edge.

V—Between *Kanashat and Palmer Junction*, *King County*, *Wash.*, about 50 meters east of mile pole 211, in the top of the concrete abutment for the approach at the west end of the bridge of the N. P. Ry. over Green River, the tenth crossing over that stream; a copper bolt (Note 10, p. 217), 0.17 meter from the east, 0.11 meter from the south edge, and 1.5 meters south of the nearest rail.

W—*Palmer Junction*, *King County*, *Wash.*, about 90 meters west of the N. P. Ry. station, 2 meters south of the line of telegraph poles, and 9.19 meters south of the nearest rail on the Tacoma branch of the N. P. Ry. (Note 1, p. 216.)

X—About 4 kilometers east of *Palmer Junction*, *King County*, *Wash.*, 6 meters east of tunnel No. 8 and 3 meters north of the N. P. Ry. bridge 211 over Green River; a copper bolt set in the natural rock.

1046T—About 2.4 kilometers west of *Eagle Gorge*, *King County*, *Wash.*, on the south end of the east concrete abutment of the N. P. Ry. bridge 210 over Green River; a copper bolt about 3 centimeters in diameter set vertically in the top of the abutment, 0.56 meter from the west and 0.53 meter from the south edge, 1.15 meters south of the nearest rail; the head of the bolt was marked U. S. G. S. B. M. 1046T.

Y—About 0.8 kilometer west of *Eagle Gorge*, *King County*, *Wash.*, on the south end of the east concrete abutment of N. P. Ry. bridge 209 over Green River; a copper bolt (Note 11, p. 217) set in the top of the abutment, 0.15 meter from its west edge and 1.55 meters from the rail.

Z—*Canton*, *King County*, *Wash.*, 60 meters east of the station, in the N. P. Ry. section-house yard, 12.2 meters south of the section house, and 9.7 meters north of the nearest main-track rail. (Note 1, p. 216.)

1205 T—*Canton*, *King County*, *Wash.*, 120 meters east of the railway station, 2.48 meters east of the tool house of the N. P. Ry., 5.77 meters from the nearest rail. (Note 6, p. 217.)

1335 T—*Maywood*, *King County*, *Wash.*, about 0.34 kilometers east of the station in the N. P. Ry. section-house yard, 0.58 meter east of the section house, and 16.7 meters north of the nearest rail of the main track. (Note 6, p. 217.)

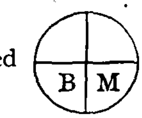
1531 T—*Hot Springs*, *King County*, *Wash.*, about 17 meters east of the southeast corner of the depot, about 5½ meters north of the center of the main track of the N. P. Ry., and about 1 meter east of the first telegraph pole east of the depot. The bench mark was loose and leaning badly; it was straightened up and made firm with concrete, care being taken to disturb its elevation as little as possible. (Note 6, p. 217.)

A_1—*Hot Springs*, *King County*, *Wash.*, in the lawn of the Kloeber Hotel, about 10 meters east of the walk leading to the depot, and about 3 meters south of the south porch of the hotel. (Note 1, p. 216.)

B_1—About 1.85 kilometers east of *Hot Springs*, *King County*, *Wash.*, in the top of the retaining wall for the east concrete abutment of N. P. Ry. bridge 201, 0.3 meter from the east and 1.65 meters from the north edge, 1.3 meters north of the rail. (Note 18, p. 218.)

1614 T—*Lester, King County, Wash.*, in the brick projection at the southwest corner of the N. P. Ry. roundhouse, about 1.5 meters above the ground. (Note 7, p. 217.) This bench mark is reported to have been removed and placed in a different position when the roundhouse was repaired.

C_1—About 1.5 kilometers east of *Weston, King County, Wash.*, in the vertical surface of the side of a rock cut, 16 meters west of mile pole 183, 2.45 meters north of the nearest rail, and 0.7 meter above the level of the top of the rail. (Note 18, p. 218.)

D_1—About 2.2 kilometers west of *Borup, King County, Wash.*, on the N. P. Ry. right of way, about 31 meters east of the west end of the third rock cut east of mile pole 182, 1.95 meters south of the nearest rail; a copper bolt stenciled 

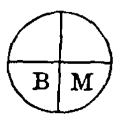
set vertically in the natural rock.

2776 T—*Stampede, King County, Wash.*, about 23 meters southwest of the N. P. Ry. station, about 3 meters north of the edge of the bluff forming the north bank of Deer Creek, and about 15 meters south of the main track. (Note 6, p. 217.) This bench mark was loose and was made firm with concrete, care being taken to disturb its elevation as little as possible.

E_1—About 370 meters east of *Stampede, King County, Wash.*, at the south side of the west entrance to Stampede Tunnel, in the vertical surface of the rock, about 3 meters south of the nearest rail, and about 1 meter above the level of the rails at that point. (Note 18, p. 218.)

F_1—About 1.7 kilometers east of *Stampede, King County, Wash.*, on the north side of the track in Stampede Tunnel, near the half-way point and at the head of the grade in the tunnel, in the vertical brick wall forming the west side of a manhole, 2.15 meters north of the nearest rail, 1.55 meters above the floor, and 0.45 meter north of the side of the tunnel. (Note 18, p. 218.)

2782 T—About 340 meters east of the station at *Martin, Kittitas County Wash.*, on the bank above the track, about 12 meters east of the old station house, about 6 meters south of the main track. This bench mark was loose and was made firm with concrete, care being taken not to disturb its elevation. (Note 6, p. 217.)

G_1—About 4.5 kilometers west of *Easton, Kittitas County, Wash.*, at the south end of the west concrete abutment of N. P. Ry. bridge 161 over Cabin Creek, about 195 meters east of mile pole 168 Pascal; a copper bolt stenciled 

set in the upper surface, 0.35 meter from the east and 0.18 meter from the south edge, and 1.67 meters south of the nearest rail.

H_1—*Easton, Kittitas County, Wash.*, in front and 5.5 meters south of A. O. Johnson's house, 2.35 meters east of Johnson Brothers' store, and 2.2 meters north of the fence inclosing the yard. (Note 1, p. 216.)

I_1—*Easton, Kittitas County, Wash.*, in the northeast corner of the yard surrounding A. J. Adams' residence, about 14 meters north of the house, 0.74 meter from the north fence, and 0.62 meter west of the east fence inclosing the yard; about 100 meters south of the N. P. Ry. main track. (Note 4, p. 217.)

J_1—About 1.8 kilometers west of *Nelson*, *Kittitas County*, *Wash.*, on the west concrete abutment of bridge 151; a copper bolt (Note 9, p. 217) leaded firmly into the top surface, 0.35 meter from the west edge and 0.18 meter from the south edge of the abutment, 1.67 meters south of the nearest rail. The top of the bolt was hammered into a rounded form.

2030 T—*Nelson*, *Kittitas County*, *Wash.*, about 70 meters south of the main track, 0.3 meter north of the fence, and 3.2 meters east of the wagon road. (Note 6, p. 217.)

K_1—*Clealum*, *Kittitas County*, *Wash.*, at the corner of Pennsylvania avenue and Railroad street, 3.17 meters east of the southeast corner of D. B. Burcham's building and 17.8 meters northwest of the band stand; a cross cut in the head of the southeast bolt used in fastening the cap of a fire hydrant.

L_1—*Clealum*, *Kittitas County*, *Wash.*, at the corner of Pennsylvania avenue and First street, in the stone wall at the northwest corner of Mr. Heckman's store, facing Pennsylvania avenue, 0.24 meter from the northwest corner of the building, 0.37 meter north of the south edge of the stone, and 1.2 meters above the sidewalk. (Note 18, p. 218.)

M_1—*Clealum*, *Kittitas County*, *Wash.*, in the northeast corner of Mrs. E. F. Shipman's yard, 2 meters northeast of the northeast corner of the house, 1.65 meters west of the east fence, and 2 meters south of the north fence. (Note 4, p. 217.)

1838 T—*Teanaway*, *Kittitas County*, *Wash.*, about 45 meters west of the station signboard and about 40 meters north of the main track. (Note 6, p. 217.)

1784 T—*Bristol*, *Kittitas County*, *Wash.*, 0.6 meter southeast of the southeast corner of the station and 1.64 meters north of the nearest rail. (Note 6, p. 217.)

N_1—About 4.4 kilometers east of *Bristol*, *Kittitas County*, *Wash.*, about 155 meters east of mile pole 141, a copper bolt (Note 10, p. 217) in the upper surface of a rock projecting from the side of a rock cut, 2.41 meters north of the nearest rail.

O_1—About 5.5 kilometers west of *Thorp*, *Kittitas County*, *Wash.*, about 45 meters east of mile pole 138, on a culvert over an irrigation ditch; a copper bolt (Note 10, p. 217) 1.5 meters west of the east edge, 0.2 meter north of the south edge of the abutment, and 1.5 meters south of the nearest rail.

1658 T—About 2.5 kilometers west of *Thorp*, *Kittitas County*, *Wash.*, at the first road crossing west of Thorp, about 42 meters north of the track. (Note 6, p. 217.)

1634 T—*Thorp*, *Kittitas County*, *Wash.*, at the intersection of Main street and Taneum Creek road. (Note 6, p. 217.)

P_1—*Thorp*, *Kittitas County*, *Wash.*, in the southwest corner of A. J. Schele's yard, 0.65 meter east of west fence, 0.65 meter north of south fence, and 12.67 meters southwest of the southwest corner of the house. (Note 4, p. 217.)

U. S. Base—About 4.7 kilometers east of *Thorp*, *Kittitas County*, *Wash.*, about 18 meters east of the road crossing and about 10 meters north of the track; the bottom of a hole 2.5 centimeters square, cut about 6 millimeters deep, in the top of a stone post marked "U. S. Base."

Q_1—*Ellensburg*, *Kittitas County*, *Wash.*, in the stone foundation of the Northern Pacific roundhouse, on the west side of the building, about 8 meters south of the northwest door; the bottom of a hole 2.5 centimeters square, cut about 6 millimeters deep, lettered U. S. B. M.

1571 T—*Ellensburg, Kittitas County, Wash.*, in the stone coping forming the top of a brick pier, marked ASTR PIER, in the State Normal School grounds. (Note 7, p. 217.)

R_1—*Ellensburg, Kittitas County, Wash.*, in the north stone front of the Washington State Bank, about 1.25 meters above the sidewalk. (Note 18, p. 218.)

S_1—*Ellensburg, Kittitas County, Wash.*, in the yard surrounding the residence of Ernest Maddux, 1.33 meters from the east fence, and 1.15 meters north of the south fence. (Note 4, p. 217.)

T_1—*Thrall, Kittitas County, Wash.*, opposite mile pole 122, about 20 meters south of the nearest rail, and 10 meters north of the wagon road. (Note 4, p. 217.)

1350 T—*Umtanum, Kittitas County, Wash.*, about 25 meters west of the depot, and opposite the section house, about 16 meters south of the nearest rail. (Note 6, p. 217.)

U_1—About 0.9 kilometer east of *Umtanum, Kittitas County, Wash.*, on the east concrete abutment of the bridge over Umtanum Creek; a copper bolt (Note 10, p. 217) in the upper surface. 0.25 meter north of the south edge, 0.25 meter from the west edge of the abutment, and 1.55 meters south of the nearest rail.

V_1—At the siding at *Canyon, Kittitas County, Wash.*, in the top of the granite foundation of the water tank, at the northeast corner; the bottom of a rectangular hole, 5 centimeters long, 2.5 centimeters wide, and 6 millimeters deep. The letters U. S. B. M. were cut near the bench mark.

1249 T—*Roza, Kittitas County, Wash.*, opposite the station, about 55 meters south of the nearest rail and 0.8 meter north of the right of way fence. (Note 6, p. 217.)

W_1—*Roza, Kittitas County, Wash.*, in the southwest corner of the section house yard, 1 meter north of the fence, 1.55 meters east of the first telegraph pole east of the depot. (Note 4, p. 217.)

1147 T—*Selah, Yakima County, Wash.*, 0.85 meter west of the fence inclosing the section house yard, and 4.75 meters south of the nearest rail. (Note 6, p. 217.)

X_1—About 0.8 kilometer east of *Selah, Yakima County, Wash.*, in the upper surface of the center pier of masonry for the Northern Pacific Railway bridge over the Yakima River, about 2 meters below the level of the rail and about 1 meter outside the line of the north rail. (Note 18, p. 218.)

Y_1—Seventy-five meters west of the station at *Wenas, Yakima County, Wash.*, opposite mile pole 94 and about 10 meters north of the nearest rail. (Note 4, p. 217.)

1067 T—*North Yakima, Yakima County, Wash.*, in the pilaster of the northwest corner of the entrance to the city hall building, on Front street, about 0.5 meter above the level of the sidewalk. (Note 7, p. 217.)

Z_1—*North Yakima, Yakima County, Wash.*, in the west end of the east of the east N. P. R. R. Park, about 6.1 meters inside and east of the west fence inclosing the park. (Note 4, p. 217.)

A_2—*North Yakima, Yakima County, Wash.*, in the vertical stone wall at the northeast corner of Sloan's drug store; 0.32 meter east of the door, 0.33 meter from the edge of the wall, and about 1.2 meters above the sidewalk. (Note 18, p. 218.)

B_2—*North Yakima*, *Yakima County*, *Wash.*, in the upper surface of the stone doorsill of the stairway entrance on the east side of the First National Bank building, 0.18 meter from the outer edge of the doorsill. (Note 10, p. 217.)

C_2—*North Yakima*, *Yakima County*, *Wash.*, in the surface of the cement walk leading from the residence of Mrs. Moore, 222 North Second street, to the sidewalk, about 2.7 meters west of the sidewalk and 0.61 meter south of the north edge of the cement walk. (Note 18, p. 218.)

D_2—About 1½ miles east of *Yakima City*, *Yakima County*, *Wash.*, on the east concrete abutment of the Northern Pacific bridge over Atahnan Creek; the bottom of a hole 2½ centimeters square and 6 millimeters deep, lettered U. S. □ B. M., 0.25 meter east of the west edge, 0.3 meter north of the south end of the abutment, and about 1.3 meters south of the nearest rail.

855 T—*Wapato*, *Yakima County*, *Wash.*, about 40 meters east of the depot and 11 meters south of the nearest rail on the main track. (Note 6, p. 217.)

E_2—*Wapato*, *Yakima County*, *Wash.*, in Alexander E. McCredy's yard, 9.05 meters west of the house, 8.60 meters south of the front fence, and about 19 meters east of his store. (Note 4, p. 217.)

F_2—About 4.5 kilometers east of *Wapato*, *Yakima County*, *Wash.*, in the upper surface of the south end of the east concrete abutment for the Northern Pacific bridge 77, over an irrigation ditch, 0.2 meter from the west and south edges of the abutment, and 1.5 meters south of the nearest rail. (Note 18, p. 218.)

755 T—*Toppenish*, *Yakima County*, *Wash.*, 32.9 meters east of the Northern Pacific depot, 6.85 meters south of the nearest rail of the main track, and very near the northeast corner of the little park east of the depot. (Note 6, p. 217.)

G_2—*Toppenish*, *Yakima County*, *Wash.*, 21.07 meters west of the northwest corner of the section house and about 1 meter inside the fence inclosing the yard, and 11.34 meters south of the nearest rail of the main track. (Note 4, p. 217.)

H_2—*Toppenish*, *Yakima County*, *Wash.*, in the upper surface of the concrete foundation supporting the pillars for the Northern Pacific water tank, under the northern one of the two western pillars, 0.26 meter north of the south edge, and 0.25 meter from the east (?) edge, 7 meters north of the nearest rail of the main track. (Note 11, p. 217.)

717 T—At the first wagon road crossing over the railroad west of the siding at *Alfalfa*, *Yakima County*, *Wash.*, about 0.8 kilometer west of mile pole 66, 0.9 meter east of the fence for the road crossing and 13 meters south of the nearest rail. (Note 6, p. 217.)

I_2—*Alfalfa*, *Yakima County*, *Wash.*, 6.20 meters west of mile pole 66, and 1.75 meters east of a telegraph pole, in line with the telegraph poles, and 14.67 meters south of the nearest rail of the main track. (Note 4, p. 217.)

674 T—*Satus*, *Yakima County*, *Wash.*, 14 meters west of the northwest corner of the depot, and 9.85 meters south of the nearest rail of the main track. (Note 6, p. 217.)

J_2—About 0.9 kilometer east of *Satus*, *Yakima County*, *Wash.*, 1.78 meters west of the second telegraph pole east of mile pole 60, 10.89 meters south of the nearest rail and in line with the telegraph poles. (Note 4, p. 217.)

717 T—Near *Mabton*, *Yakima County*, *Wash.*, nearly opposite milepost 56, 36 meters south of the nearest rail and 2.8 meters north of the railway fence. (Note 6, p. 217.)

715 T—*Mabton*, *Yakima County*, *Wash.*, 16.50 meters east of the southeast corner of the Northern Pacific section house and just outside section house yard fence, 9.75 meters north of the nearest rail of the main track. (Note 6, p. 217.)

K_2—About 0.5 kilometer east of *Mabton*, *Yakima County*, *Wash.*, 4.35 meters west of the nearest (first) telegraph pole east of milepost 52, and in line with the telegraph poles, 15.45 meters south of the nearest rail of the main track. (Note 4, p. 217.)

696 T—*Byron*, *Yakima County*, *Wash.*, 126 meters east of milepost 46, 38 meters south of the nearest rail of the main track, 4 meters south of the center of the Prosser-Mabton wagon road, near the corner of an orchard fence. (Note 6, p. 217.)

L_2—About 1.3 kilometers east of the siding at *Byron*, *Yakima County*, *Wash.*, 2.5 meters west of the third telegraph pole west of mile pole 45, in line with the telegraph poles, and 10 meters south of the nearest rail. (Note 4, p. 217.)

M_2—*Prosser*, *Yakima County*, *Wash.*, in the upper surface of the concrete foundation supporting the pillars of the Northern Pacific water tank, at the southeast side of the southern one of the two eastern pillars, 0.45 meter east of the west edge of the foundation and 0.07 meter west of the east edge, 7.55 meters south of the nearest rail of the main track. (Note 11, p. 217.)

661 T—*Prosser*, *Yakima County*, *Wash.*, 53.5 meters west of the northwest corner of the Northern Pacific depot, in the corner of an orchard, 12 meters north of the nearest rail of the main track and 0.8 meter east of the sidewalk. (Note 6, p. 217.)

N_2—*Prosser*, *Yakima County*, *Wash.*, in the vertical surface of the east end of the south brick wall of the Nelson Rich block, on Sixth street, 1.51 meters above the foundation of the building and 0.21 meter from either edge of the south wall. (Note 18, p. 218.)

O_2—*Prosser*, *Yakima County*, *Wash.*, in front of the show window of the Carl A. Jensen block, on Bennett avenue, in the top of the concrete coping, 1 meter west of the east edge and 2.95 meters east of the entrance to the drug store in the block. (Note 18, p. 218.)

P_2—About 0.9 kilometer east of *Prosser*, *Yakima County*, *Wash.*, 116 meters east of mile pole 40, opposite the third telegraph pole east of the mile pole, 5.4 meters north of the nearest rail. (Note 4, p. 217.)

627 T—*Gibbon*, *Yakima County*, *Wash.*, about 0.7 kilometer east of milepost 35, and about 45 meters north of the nearest rail of the main track. (Note 6, p. 217.)

534 T—*Chandler* (siding), *Yakima County*, *Wash.*, 45 meters east of mile pole 30, about 4.7 meters north of the center of the main track, and about 0.5 meter west of the southwest corner of the fence surrounding the yard of the Northern Pacific section house. (Note 6, p. 217.)

Q_2—About 2.7 kilometers west of *Kiona*, *Yakima County*, *Wash.*, 0.4 kilometer east of milepost 26; a copper bolt set vertically in a ledge of natural rock, 3.03 meters south of the nearest rail and on a level with the track. (Note 11, p. 217.)

515 T—*Kiona*, *Yakima County*, *Wash.*, in the northeast corner of the railroad park west of the depot, 8.3 meters west of the northwest corner of the station and 3.47 meters south of the nearest rail of the main track. (Note 6, p. 217.)

R_2—*Kiona, Yakima County, Wash.*, in the southeast corner of the railroad park north of the track, 7.48 meters north of the nearest rail of the main track, 13.40 meters north of the northeast corner of the station and 1.40 meters northwest of the corner post of the park fence. (Note 1, p. 216.)

S_2—1.6 kilometers east of *Kiona, Yakima County, Wash.*, 1.52 meters east of the second telegraph pole west of mile pole 23 and 15.5 meters south of the track, in line with the telegraph poles. (Note 6, p. 217.)

640 T—Nearly 3 kilometers west of *Badger, Yakima County, Wash.*, about 10 meters north of mile pole 19 and about 13 meters north of the track. (Note 6, p. 217.)

T_2—*Badger, Yakima County, Wash.*, 21 meters north of mile pole 17, 27.8 meters north of the nearest rail of the main track near the line of the Northern Pacific right of way. (Note 1, p. 216.)

605 T—About 4.7 kilometers east of *Badger, Yakima County, Wash.*, 0.95 meters east of the first telegraph pole east of mile pole 14, and 15.25 meters south of the nearest rail, in line with the telegraph poles. (Note 6, p. 217.)

567 T—*Relief* (siding), *Yakima County, Wash.*, 0.75 meter east of the seventh telegraph pole west of mile pole 8, and 15.50 meters south of the nearest rail of the main track, in line with the telegraph poles. (Note 6, p. 217.)

U_2—Near *Relief, Yakima County, Wash.*, 3.9 meters east of the first telegraph pole west of mile pole 8, 15.50 meters south of the track, in line with the telegraph poles. (Note 1, p. 216).

V_2—*Kennewick, Yakima County, Wash.*, near the building of the Northern Pacific Irrigation Company, on Front street, about 38 meters west of Yakima street, 0.5 meter from the north and west walls of an alcove in the northwest corner. (Note 4, p. 217.)

362 T—*Kennewick, Yakima County, Wash.*, about 30 meters southeast from the southeast corner of the old station now used for a freight depot, about 10 meters southeast of the nearest rail of the main track, and about 3 meters northwest of the northwest corner of the section house. (Note 6, p. 217.)

W_2—*Kennewick, Yakima County, Wash.*, in the yard surrounding the residence of L. E. Moore, 5.1 meters southwest of the southwest corner of the house, 5 meters east of the fence inclosing the yard in front of the house, and 70 meters north of the main track of the Northern Pacific Railway Company. (Note 1, p. 216.)

X_2—About 2 kilometers east of *Kennewick, Yakima County, Wash.*, at the west end of the Northern Pacific Railway bridge over Columbia River, on the south side of the track, in the top of the concrete cap for the concrete pier, about 0.15 meter from the east and west edges, and 2.20 meters below the level of the track. (Note 18, p. 218.)

Y_2—About 2 kilometers west of the depot at *Pasco, Franklin County, Wash.*, at the east end of the Northern Pacific Railway bridge over Columbia River, on the south side of the track, in the top of the concrete cap for the concrete pier, about 0.15 meter from the east and west edges and about 2.20 meters below the level of the track. (Note 18, p. 218.)

Z_2—About 1 kilometer west of *Pasco, Franklin County, Wash.*, 83 meters southwest of the first switch stand, in line with the telegraph poles, 12.2 meters southeast of the nearest rail. (Note 4, p. 217.)

378 T—*Pasco, Franklin County, Wash.*, at the northwest corner of the brick roundhouse of the Northern Pacific Railway Company, in the center of the third course of bricks above the stone foundation. (Note 7, p. 217.)

A_3—*Pasco, Franklin County, Wash.*, in the yard surrounding the Hotel Pasco, on Court street, 0.70 meter west of the sidewalk in front of the hotel, 10.35 meters east of the east side of the hotel, and 57.50 meters south of the main track. (Note 1, p. 216.)

B_3—Near *Pasco, Franklin County, Wash.*, on the Washington and Columbia River Railroad bridge over Snake River, on top of the granite retaining wall for the west abutment, 0.3 meter west of the east edge of the granite capstone, and 2.3 meters south of the nearest rail. (Note 18, p. 218.)

C_3—Near *Pasco, Franklin County, Wash.*, on the Washington and Columbia River Railroad bridge over Snake River, at the first pier from the west end, 1.25 meters south of the nearest rail. (Note 19, p. 218.)

D_3—Near *Pasco, Franklin County, Wash.*, on the Washington and Columbia River Railroad bridge over Snake River, on the girder at the west end of the truss at the third pier from the west end, 1.25 meters south of the nearest rail. (Note 19, p. 218.)

E_3—Near *Pasco, Franklin County, Wash*, on the Washington and Columbia River Railroad bridge over Snake River, at the fourth pier from the west end of the bridge, 1.25 meters south of the nearest rail. (Note 19, p. 218.)

F_3—Near *Pasco, Franklin County, Wash.*, on the Washington and Columbia River Railroad bridge over Snake River, at the fifth pier from the west end of the bridge, 1.25 meters south of the nearest rail. (Note 19, p. 218.)

G_3— Near *Pasco, Franklin County, Wash.*, on the Washington and Columbia River Railroad bridge over Snake River, at the sixth pier from the west end of the bridge, 1.25 meters south of the nearest rail. (Note 19, p. 218.)

H_3—Near *Pasco, Franklin County, Wash.*, on the Washington and Columbia River Railroad bridge over Snake River, at the seventh pier from the west end of the bridge, 1.25 meters south of the nearest rail. (Note 19, p. 218.)

I_3—In *Wallawalla County, Wash.*, near *Pasco, Franklin County, Wash.*, on the Washington and Columbia River Railroad bridge over Snake River, on the top of the granite retaining wall for the east abutment, 0.3 meter east of the west edge of the granite capstone, and 1.2 meters south of the nearest rail. (Note 18, p. 218.)

J_3—About 6.4 kilometers northwest of *Hunts Junction, Wallawalla County, Wash.*, opposite and about 25 meters northwest of mile pole 5, and 2.4 meters southeast of the first telegraph pole northwest of mile post 5, 11.2 meters northeast of the nearest rail, in the line of the telegraph poles. (Note 4, p. 217.)

341 A—About 7 kilometers northwest of *Hunts Junction, Wallawalla County, Wash.*, 2 meters northwest of the first telegraph pole southeast of mile pole W6, 11.2 meters northeast of the nearest rail. (Note 14, p. 217.)

K_3—About 3.2 kilometers northwest of *Hunts Junction, Wallawalla County, Wash.*, 1.6 meters northwest of the first telegraph pole southeast of mile pole 3, 11.2 meters northeast of the nearest rail, in line with the telegraph poles. (Note 4, p. 217.)

L_3—*Hunts Junction, Wallawalla County, Wash.*, in the northeast corner of the Washington and Columbia River Railroad section-house yard, 3 meters west of the nearest rail on the main track, 0.8 meter south of the north fence, and 0.8 meter west of east fence, inclosing the yard. (Note 1, p. 216, a lava post.)

M_3—*Hunts Junction*, *Wallawalla County*, *Wash.*, in the southeast corner of the yard surrounding the residence of the storekeeper for the Washington and Columbia River Railroad, 18 meters west of the nearest rail of the main track and 0.7 meter from the south and east fences inclosing the yard. (Note 4, p. 217.)

N_3—Near *Hunts Junction*, *Wallawalla County*, *Wash.*, at the west end of the Washingon and Columbia River Railway bridge over Walla Walla River, in the top of the concrete abutment, 1.4 meters from the east and south edges and 1.8 meters south of the nearest rail. (Note 18, p. 218.)

O_3—Near *Hunts Junction*, *Wallawalla County*, *Wash.*, at the east end of the Washington and Columbia River Railway bridge over Walla Walla River, in the top of the abutment, 0.8 meter west of the east edge, 0.5 meter north of the south edge, and 1.8 meters south of the nearest rail. (Note 18, p. 218.)

P_3—About 8.4 kilometers southwest of *Hunts Junction*, *Wallawalla County*, *Wash.*, about 2 meters south of the seventh telegraph pole southwest of mile pole 5 and 12 meters south of the nearest rail. (Note 4, p. 217.)

56—05——16

APPENDIX 5

REPORT 1905

TRIANGULATION ALONG THE NINETY-EIGHTH MERIDIAN, LAMPASAS TO SEGUIN, TEXAS

By JOHN F. HAYFORD
Inspector of Geodetic Work; Assistant, Coast and Geodetic Survey

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ILLUSTRATIONS.

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TRIANGULATION ALONG THE NINETY-EIGHTH MERIDIAN, LAMPASAS TO SEGUIN, TEX.

By John F. Hayford,

Inspector of Geodetic Work; Assistant, Coast and Geodetic Survey.

GENERAL STATEMENT.

During the months of November and December, 1903, and the early part of January, 1904, a double triangulation party under the direction of Mr. O. W. Ferguson, Assistant, extended the primary triangulation along the ninety-eighth meridian southward from the line May–Gabriel, on which the triangulation in 1902 closed, to the line Serita–Stockdale. The line May–Gabriel is the southern limit of the Lampasas base net. The line Serita–Stockdale is the southern limit of the first figure to the southward of the Seguin base net. The triangulation of 1903–4 adds, therefore, to the triangulation along the ninety-eighth meridian heretofore published, one section between bases and one figure more. The progress of the season of 1903–4, measured along the meridian, was 112 statute miles and the number of primary stations occupied 26.

Mr. O. W. Ferguson, Assistant, was in charge of the whole organization, including the second observing party, and made the observations in the first observing party. Mr. William H. Burger, Assistant, was in direct charge of the second party, acting as observer.

The primary triangulation along the ninety-eighth meridian was, at the close of the winter season of 1903–4, complete in so far as measurements of horizontal and vertical angles are concerned from the stations Drywood, S. Dak., and Layden, Minn., near the point where the boundary line between North Dakota and South Dakota meets the Minnesota boundary, to the stations Serita and Stockdale in the vicinity of Floresville, Tex. The range in latitude is from 45°38′ to 29°13′, or 16°25′. All the base measurements have been completed along this portion of the triangulation, except of the Brown Valley Base in the last figure to the northward. No astronomic determinations have been made along this triangulation except one determination of latitude and longitude made at Marlow, Ind. T., in advance of the triangulation and for a special purpose. The results of the ninety-eighth meridian triangulation, from the vicinity of the Page Base in the northern part of Nebraska to the junction with the portion published in this appendix, have been published.*

*See Appendix 3, Report for 1901, On the measurement of nine bases along the ninety-eighth meridian; Appendix 6, Report for 1901, Triangulation northward along the ninety-eighth meridian in Kansas and Nebraska; Appendix 3, Report for 1902, Triangulation in Kansas, and Appendix 4, Report for 1903, Triangulation southward along the ninety-eighth meridian in 1902.

The engineer, intent only upon securing the necessary information to enable him to extend this triangulation or to base other surveys upon it, will find the information he desires in the latter part of this appendix, commencing with the explanations of positions, lengths, and azimuths. The index printed at the end of the appendix, used in connection with the sketches, will enable him to find quickly the data he desires for any given locality.

The progress made in primary triangulation in the season 1903–4 in Texas was even more rapid than that of the season of 1902 from Kansas to Texas, which was commented upon* as being, so far as the writer was aware, the most rapid and economical triangulation of that grade of accuracy yet executed at that time. The increased rapidity of the triangulation in 1903–4 redounds to the credit of the two officers concerned in the observations. It also makes the field organization, the methods of observation, and the accuracy attained of special interest.

The field organization for the season of 1903–4 consisted of a building party, two observing parties, and five light keepers. The building party, under the immediate direction of Mr. J. S. Bilby, Signalman, erected the observing towers in advance of the observing parties, and marked the stations in a permanent manner. Mr. Bilby also made such revisions of the previous reconnaissance as were found necessary or desirable. The movements of the two observing parties were so planned that they were always at intervisible stations. Each observing party showed a heliotrope during the afternoon and a light at night to the other observing party. Each of the five light keepers showed, in general, two heliotropes or two lights, one to each observer. The movements of the light keepers were controlled by code signals sent by the Morse alphabet with the heliotropes or lights.

The organization and methods of building and observing were in most respects identical with those set forth fully in Appendix 4 of the Report for 1903, in connection with the triangulation of 1902. The more important points of difference are as follows:

The second observing party consisted of the observer, foreman, recorder, driver, and cook. In 1902 there was no foreman in the second observing party.

The outfits were somewhat lighter than in 1902 and but two teams instead of three were required to move the camp of the first observing party. The theodolites used, Nos. 168 and 145, both direction instruments with horizontal circles 12 inches in diameter, were of the same type as those used in 1902.

Mr. Burger made all pointings for horizontal angles by using an oblique cross in the diaphragm of the telescope. Mr. Ferguson used two parallel vertical lines about 20″ apart, as both observers did in 1902.

The instrument used by Mr. Burger also differed from the instrument used by Mr. Ferguson and from the two used in 1902, in the arrangement of the pointing lines in the micrometer microscope. Ordinarily, with each micrometer microscope, pointings upon the circle graduations have been made with one pair of parallel lines. In each micrometer on theodolite No. 145, as used by Mr. Burger, there were two pairs of parallel lines so placed that the interval subtended on the graduated horizontal circle

* See Appendix 4, Report for 1903, Triangulation southward along the ninety-eighth meridian in 1902, page 817.

between points midway between the lines of each pair was about four minutes of arc.* With the ordinary arrangement of lines in the microscope the practice is to make two readings in each position of the microscope, the one known as the backward reading being made upon the graduation which is adjacent to the zero of the micrometer and to the apparent left, and the other, called the forward reading, being made with the same movable lines and on a graduation adjacent to the zero of the micrometer and on the apparent right. With the new arrangement of lines one reading, called the backward reading, is made on the graduation adjacent to the zero and to the apparent left, with the apparent left-hand pair of parallel lines. The other, the forward reading, is made on the graduation adjacent to the zero of the micrometer and to the apparent right, with the apparent right-hand parallel lines. The minutes of the reading are taken from the backward reading as usual. With the new arrangement of lines but one turn of the micrometer head is necessary between corresponding backward and forward readings instead of five when a single pair of parallel lines is used. This is believed to be conducive to both speed and accuracy. For the elimination of the effects of errors of run upon the mean observed direction dependence was placed, as in 1902, upon making the mean value of the run small by adjustment and upon distributing the readings upon each station pointed upon approximately uniformly over the five-minute interval between adjacent graduations by the proper selection of the settings upon the initial station for the separate positions.† When one pair of parallel lines is used for both backward and forward readings the existence of a large error of run may be determined by inspection of the record of observations of directions. That is not the case when two sets of parallel lines are used. Mr. Burger was, therefore, required to make special observations to determine the run at least once a month. He was required to reduce the error of run by adjustment whenever it was found to be greater than 1″ for the mean of the three micrometers, or greater than 3″ for any one.

A second observation of the direction to a station to be determined by intersections was taken during this season only when it could be secured under conditions nearly as favorable to accuracy as the conditions when the first measurement was made, and without much delay to observations of the primary directions. In 1902 two observations were made on all intersection stations.

At least two observations of each vertical angle were taken on each day instead of one as in 1902.

No vertical angles were observed at night. Those taken at night in 1902 were found to be of too low a grade of accuracy to be of value.‡

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*The double sets of parallel lines were placed in this instrument and put into use during this season at the suggestion of the writer. This modification of the instrument and the corresponding change in the method of reading the circle was suggested to the writer by the Lake Survey practice of taking backward micrometer readings only and by a conversation with Prof. Asaph Hall, jr., and Mr. H. F. Johnston, assistant engineer, on a Lake Survey observing tower at Mackinac Island in August, 1903.

† See Appendix 4, Report for 1903, page 821.

‡ See Appendix 4, Report for 1903, pages 822–823, 921

PROGRESS OF OPERATIONS

Mr. Ferguson and several members of the triangulation party which had been under his direction in South Dakota during the preceding summer season, arrived at Lampasas, Tex., on October 25.

On November 4 the building party left Lampasas to begin the erection of signals. On December 28 the last of the 24 signals was completed. These signals, with an average height to the instrument of 28 feet, were erected at an average rate of 2.3 days per signal, making no deductions for Sundays, delays, and traveling between signals.

The two observers reached May, the first station occupied, on November 10. The second observer, having had no previous experience in primary triangulation, accompanied the first observer at May and Gabriel, the first two stations occupied. For the remainder of the season the two observing parties were never together. The observing period was 2.1 months, observations at the last of the 26 stations being completed on January 11.

In the following tables the stations occupied during the season by each of the two observers are arranged in order of time. The second column indicates the days on which observations on primary stations were taken; the third column, the number of such days; and the fourth column gives the approximate height of the instrument above the ground. The heliotrope or light was placed about 1.6 meters higher than the instrument.

Assistant O. W. FERGUSON, *Observer*.

Station	Days on which observations of primary horizontal angles were made	Number of days	Height of instrument above ground
			meters.
May	November 10, 12	2	19
Gabriel	November 14, 18	2	4
Buzzard	November 24, 26	2	14
Travis	November 27–28	2	4
Barton	December 1–2, 4	3	5
Cedar	December 5, 7	2	10
Carpenter	December 8–10	3	5
Krueger	December 14–15	2	9
Gus	December 18–19	2	9
Tieken	December 21–22	2	5
Seguin East Base	December 23–24, 26	3	15
Mott	December 28–29	2	9
Central	December 30–31, January 2	3	9
Lavernia	January 5, 7–8	3	10
Serita	January 9	1	5

Assistant WM. H. BURGER, *Observer.*

			meters
Post	November 24, 26	2	4
Shovel	November 28, December 1	2	4
Shingle	December 2, 4–5	3	4
Loneman	December 7–8	2	4
Hugo	December 10, 12, 14	3	15
Bear	December 16–19	4	4
Mission	December 21–22	2	10
Seguin West Base	December 23–24, 26	3	14
Herndon	December 28–29	2	9
Thomas	December 30–31, January 2, 7	4	14
Stockdale	January 8	1	14

For comparison with similar statistics for similar operations in previous seasons* the following statistics for this season are interesting as indicating the increased rapidity of the work.

	Ferguson	Burger
Number of observations of each primary direction	16	16
Total number of days of primary observation	34	28
Number of stations	15	11
Average number of days of primary observations	2.3	2.5
Maximum number of days of primary observations	3	4
Minimum number of days of primary observations	1	1

For the season of 1902 the average number of days of primary observations at a station was 2.7 for one observer and 3.8 for the other.

The ratio of the number of observing days at a station to the total number of days at a station, exclusive of the time before the first and after the last primary observation, was 0.77 for Mr. Ferguson and 0.70 for Mr. Burger. This ratio, which depends mainly upon the weather, has usually been from 0.77 to 0.86 for previous seasons along the ninety-eighth meridian. The comparison indicates that the weather was more unfavorable than usual in 1903–4.

The average interval from the last primary observation at one station to the first primary observation at the next during this season was 1.2 days for Mr. Ferguson and 0.6 for Mr. Burger. The difference between the two observers in this respect was mainly due to three serious delays of the first observer by bad weather. The rapidity of movement between stations and of preparation for observations is much greater than for any past season along the ninety-eighth meridian of which the results have yet been published. The average distance between stations as traveled was about 22 miles.

The average rate of progress for the whole season was 6.2 primary stations per month for each observer. The corresponding rate for the season of 1902 was 5.2 stations per month.

During the first half of the season of 1903–4 the second observer was getting his first experience in this class of work. The weather was more unfavorable during the first than during the last half of the season. For both these reasons the progress was much

*See Appendix 4, Report for 1903, pages 844–845.

more rapid for the last fifteen stations, commencing with Hugo and Krueger, namely, 7.9 stations per month for each observer. The fact that the work was done much more rapidly during the last than during the first half of the season is especially interesting in connection with the fact that the observations were much more accurate during the last than during the first part of the season.

STATEMENT OF ADJUSTMENTS.

No local adjustments of directions were made because they have become unnecessary since the present method of supplying missing observations in broken series has been followed.*

The quadrilateral formed by the stations Lavernia–Thomas–Stockdale–Serita was not adjusted. It will form a part of the next section to the southward.

The length and direction of the line May–Gabriel had been fixed by the adjustment of the section of triangulation between the Stephenville base net and the Lampasas Base.†

The length of the Seguin Base had been fixed by the base measurement. The length published for the Seguin Base, as reduced to sea level on the supposition that the elevation of Seguin West Base above mean sea level was 170 meters, is 6 794.611 meters.‡ The assumed elevation, 170 meters, was the best that was available for Seguin West Base at the time the report upon the base measurements was published. In the winter of 1903–4 the elevation of this point was determined by precise leveling and found to be of 189.09 meters.§

This increased the computed reduction to sea level by 0.020 meter and made the reduced length 6 794.591 meters.

The primary triangulation from the line May–Gabriel to the line Lavernia–Thomas at the southern edge of the Seguin base net was adjusted as a single section, holding fixed the direction and length of the line May-Gabriel and the length of the Seguin Base.

In the following condition equations the numbers assigned to the directions correspond to those shown on the two illustrations at the end of this appendix. The number of a direction inclosed in parentheses, thus (1), means the required correction to that direction. The 39 condition equations which refer to closures of triangles are given first, the 18 which refer to ratios of sides next, and the length equation last. In the side equations and the length equation the coefficients and absolute terms are expressed in terms of units of the sixth decimal place of logarithms.

The greater portion of the work of making this difficult adjustment was done by Mr. M. H. Doolittle.

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*See Appendix 4, Report for 1903, pages 821–822.

†See Appendix 4, Report for 1903, pages 851, 854, 862–864, and 885.

‡See Appendix 3, Report for 1901, pages 284–285.

§See Appendix 7, Report for 1904, Precise leveling from Holland to New Braunfels, Tex., page 439.

CONDITION EQUATIONS.

Lampasas base net to Seguin Base.

No.	″
1	$0=-1.60-(1)+(2)-(5)+(6)+(7)-(11)$
2	$0=+1.89-(2)+(3)-(10)+(11)-(17)+(18)$
3	$0=+3.57-(4)+(5)-(7)+(8)-(15)+(16)$
4	$0=-2.89-(9)+(10)-(18)+(19)-(20)+(21)$
5	$0=-0.66-(8)+(9)-(14)+(15)-(21)+(22)$
6	$0=+1.14-(13)+(14)-(22)+(24)-(30)+(31)$
7	$0=+0.43-(12)+(13)-(27)+(29)-(31)+(32)$
8	$0=+0.30-(23)+(24)-(27)+(28)-(30)+(32)$
9	$0=-0.82-(26)+(27)-(32)+(33)-(37)+(38)$
10	$0=+2.44-(33)+(34)-(36)+(37)-(39)+(40)$
11	$0=+1.57-(25)+(26)+(35)-(38)-(47)+(48)$
12	$0=+0.10-(35)+(36)-(40)+(41)-(46)+(47)$
13	$0=-0.68-(41)+(42)-(44)+(46)-(52)+(53)$
14	$0=+2.20-(42)+(43)-(51)+(52)-(54)+(56)$
15	$0=-2.45-(44)+(45)-(51)+(53)-(55)+(56)$
16	$0=-0.53-(50)+(51)-(56)+(57)-(59)+(60)$
17	$0=+0.27-(49)+(50)-(60)+(61)-(75)+(76)$
18	$0=+0.62-(57)+(58)+(59)-(65)-(66)+(67)$
19	$0=-0.41-(63)+(65)-(67)+(69)-(85)+(86)$
20	$0=+1.36-(62)+(63)-(86)+(88)-(95)+(98)$
21	$0=+0.18-(61)+(64)-(74)+(75)-(78)+(79)$
22	$0=-0.99-(62)+(65)-(67)+(68)-(97)+(98)$
23	$0=-0.88-(62)+(64)-(78)+(80)-(96)+(98)$
24	$0=-0.67-(63)+(64)-(78)+(81)-(84)+(86)$
25	$0=-1.58-(68)+(70)-(77)+(80)-(96)+(97)$
26	$0=+0.53-(73)+(74)-(79)+(81)-(84)+(87)$
27	$0=+0.52-(72)+(74)-(79)+(80)-(96)+(99)$
28	$0=+0.62-(81)+(83)+(84)-(91)-(107)+(108)$
29	$0=-0.48-(80)+(83)-(94)+(96)-(107)+(110)$
30	$0=-0.27-(88)+(89)-(92)+(95)-(104)+(105)$
31	$0=+0.64-(80)+(82)-(92)+(96)-(103)+(105)$
32	$0=+0.03-(82)+(83)-(102)+(103)-(107)+(111)$
33	$0=+0.13-(71)+(72)+(92)-(99)-(105)+(106)$
34	$0=+0.47-(101)+(102)-(111)+(112)-(115)+(118)$
35	$0=+0.24-(90)+(91)-(108)+(112)-(115)+(118)$
36	$0=-0.13-(92)+(93)-(101)+(105)-(117)+(118)$
37	$0=-0.01-(100)+(101)-(118)+(119)-(121)+(122)$
38	$0=-0.38-(112)+(113)-(114)+(115)-(123)+(124)$
39	$0=-0.63+(114)-(119)-(120)+(121)-(124)+(125)$
40	$0=-30.0-2.49(1)+5.40(2)-2.91(3)-2.84(4)+4.32(5)-1.48(6)-0.46(14)+2.26(15)$ $-1.80(16)+1.27(17)+0.28(18)-1.55(19)-3.19(20)+5.97(21)-2.78(22)$
41	$0=-0.4-1.48(12)+3.32(13)-1.84(14)-0.98(22)+4.47(23)-3.49(24)-4.03(27)+5.35(28)$ $-1.32(29)$
42	$0=-2.8-3.82(25)+5.65(26)-1.83(27)-2.24(32)+4.31(33)-2.07(34)-1.92(39)+4.58(40)$ $-2.66(41)-0.94(46)+3.30(47)-2.36(48)$
43	$0=+11.6-1.49(41)+2.69(42)-1.20(43)-2.81(44)+4.24(45)-1.43(46)-1.11(54)+4.20(55)$ $-3.09(56)$
44	$0=+2.0-3.61(49)+5.62(50)-2.01(51)-0.37(56)+2.84(57)-2.47(58)-1.57(66)+2.21(67)$ $-0.64(70)-1.78(74)+3.79(75)-2.01(76)-1.05(77)+2.43(78)-1.38(79)$
45	$0=+1.0-2.23(63)+4.47(64)-2.24(65)-0.64(67)+8.06(69)-7.42(70)-8.89(84)+10.94(85)$ $-2.05(86)$
46	$0=-2.4-0.97(62)+3.21(64)-2.24(65)-0.64(67)+3.76(68)-3.12(70)-5.48(96)+7.75(97)$ $-2.27(98)$
47	$0=-2.0-5.25(62)+5.38(63)-0.13(65)-1.29(67)+8.09(68)-6.80(69)-1.28(95)+1.70(97)$ $-0.42(98)$
48	$0=+1.8-13.94(61)+14.57(62)-0.63(64)-1.38(78)+9.12(79)-7.74(80)-0.80(96)+4.24(98)$ $-3.44(99)$
49	$0=+5.2-3.64(61)+5.87(63)-2.23(64)-2.15(73)+1.81(74)+0.34(75)+0.03(78)+3.11(79)$ $-3.14(81)$
50	$0=-6.31-0.158(71)+0.339(73)-0.181(74)-0.311(79)+13.976(81)-13.665(82)-12.167(103)$ $+12.404(104)-0.237(106)$
51	$0=+0.5-17.42(71)+19.44(72)-2.02(73)-3.85(87)+5.24(88)-1.39(89)-2.67(104)$ $+38.20(105)-35.53(106)$
52	$0=+4.1+1.81(73)-1.81(74)-3.11(79)+5.41(81)-2.30(83)+13.04(87)-13.04(91)-2.63(107)$ $+34.87(108)-32.24(109)$

Lampasas base net to Seguin Base—Concluded.

No.	″
53	0=+12.4−0.20(72)+0.20(74)−7.74(79)+8.89(80)−1.15(83)+2.79(94)−2.79(99)−1.57(107) +17.18(109)−15.61(110)
54	0=+1.3−1.39(88)+3.34(89)−1.95(90)−3.34(92)+3.52(93)−0.18(95)−1.93(116)+4.39(117) −2.46(118)
55	0=+0.0−1.95(89)+5.32(90)−3.37(91)−3.75(101)+3.93(102)−0.18(104)−0.21(108) +2.45(111)−2.24(112)
56	0=−4.6−1.52(93)+3.72(94)−2.20(95)−7.88(108)+8.09(110)−0.21(112)−1.05(115) +6.29(116)−5.24(117)
57	0=+0.2−1.93(100)+5.86(101)−3.93(102)−2.45(111)+2.94(112)−0.49(113)−0.35(120) +3.42(121)−3.07(122)−6.55(123)+9.67(124)−3.12(125)
58	0=−8.3−2.49(1)+2.49(2)−2.84(4)+2.84(5)−0.19(7)−0.97(8)+0.97(9)+0.19(11) −1.48(12)+1.48(13)+1.80(15)−1.80(16)+2.78(21)−3.76(22)+9.98(24)−1.83(26) +3.15(27)−1.32(29)+0.93(30)−0.93(31)−2.07(33)+2.07(34)−0.53(35)+0.53(36) +0.08(37)−0.08(38)+1.92(39)−1.92(40)−1.20(42)+1.20(43)−1.43(44)+2.37(46) −0.94(47)−3.61(49)+3.61(50)+0.79(52)−0.79(53)+1.11(54)−1.48(56)+0.37(57) +1.53(59)−1.55(60)−3.64(61)+3.64(63)−2.02(72)+2.02(73)+2.01(75)−2.01(76) +1.72(86)−1.72(87)−0.57(95)+0.57(99)

ACCURACY AS INDICATED BY CORRECTIONS TO OBSERVED DIRECTIONS.

The corrections to observed directions resulting from the figure adjustment which precedes are as follows. The numbers of the directions are shown on the two sketches at the end of this appendix.

Lampasas base net to Seguin Base.

Number of direction	Correction to direction	Number of direction	Correction to direction	Number of direction	Correction to direction	Number of direction	Correction to direction
	″		″		″		″
1	+0.597	33	+0.503	65	+0.181	97	+0.209
2	+1.143	34	−0.869	66	−0.053	98	+0.380
3	−0.546	35	+0.014	67	−0.290	99	−0.354
4	+0.013	36	+0.105	68	+0.227	100	−0.069
5	+0.340	37	−0.326	69	−0.334	101	+0.071
6	−0.353	38	+0.207	70	+0.449	102	−0.101
7	+0.693	39	+0.726	71	+0.431	103	+0.072
8	−0.764	40	+0.092	72	+0.197	104	+0.455
9	−0.194	41	+0.145	73	+0.230	105	−0.098
10	+0.123	42	−0.160	74	−0.384	106	−0.330
11	+0.142	43	−0.802	75	−0.305	107	−0.042
12	+0.399	44	+0.219	76	−0.168	108	−0.205
13	−0.007	45	+0.074	77	−0.603	109	−0.113
14	−0.550	46	+0.368	78	+0.199	110	+0.669
15	+1.298	47	+0.124	79	+0.125	111	−0.134
16	−1.140	48	−0.785	80	+0.131	112	−0.220
17	+0.164	49	+0.087	81	+0.152	113	+0.045
18	−0.058	50	−0.243	82	+0.052	114	+0.099
19	−0.106	51	+0.215	83	−0.056	115	+0.251
20	−0.998	52	−0.446	84	+0.002	116	−0.102
21	+1.623	53	+0.388	85	+0.403	117	−0.205
22	−0.137	54	+1.343	86	+0.192	118	+0.035
23	−0.253	55	−1.965	87	+0.059	119	−0.078
24	−0.235	56	+0.451	88	−0.650	120	−0.145
25	+0.500	57	+0.136	89	−0.383	121	+0.080
26	+0.034	58	+0.035	90	+0.121	122	+0.063
27	−0.094	59	−0.103	91	+0.255	123	−0.052
28	−0.118	60	+0.288	92	−0.021	124	−0.087
29	−0.321	61	+0.215	93	+0.035	125	+0.141
30	+0.386	62	−0.130	94	−0.370		
31	−0.112	63	−0.487	95	+0.534		
32	+0.091	64	+0.035	96	−0.413		

The maximum correction was 1".96 to the direction (No. 55) from Hugo to Carpenter. A larger correction than this occurred in but five out of fifty sections of primary triangulation in the United States.* This large correction will be discussed later in this appendix under the head of "A study of errors."

The probable error of an observed direction is

$$d=0.674\sqrt{\frac{\Sigma v^2}{c}}=\pm 0.45$$

in which Σv^2 is the sum of the squares of the corrections to directions and c is the number of conditions.

This places the section of triangulation between Lampasas and Seguin with Nos. 33 and 34 of the fifty sections of primary triangulation referred to in the preceding paragraph. The sections were numbered in order of accuracy, with the most accurate placed first. The Lampasas–Seguin section of triangulation, as measured by this standard, is of slightly greater accuracy than the eastern oblique arc and of practically the same grade of accuracy as the transcontinental triangulation.†

ACCURACY AS INDICATED BY CORRECTIONS TO ANGLES, CLOSURES OF TRIANGLES, AND ACCORD OF BASES.

The correction to each angle is the algebraic sum of the corrections to two directions. In order to make it possible to study the corrections to the separate angles, they are shown in the following table for every triangle in the primary scheme as far south as the line Lavernia–Thomas, at which the adjustment stops. The error of closure of the triangles, the corrected spherical angles, and the spherical excess are also shown. The plus sign prefixed to the error of closure of a triangle indicates that the sum of the angles is less than 180° plus the spherical excess. The spherical excess is a convenient indication of the size of the triangle, since it is proportional to the area.

Wherever no entry is made in the column headed, "Corrections to angles," the angle in question was not measured.

Lampasas base net to Seguin Base.

Stations	Corrections to angles	Error of closure of triangle	Corrected spherical angle			Spherical excess
	"	"	°	'	"	"
Buzzard	+0.55		84	56	57.26	
May	+1.74	+1.60	40	12	16.05	1.53
Gabriel	−0.69		54	50	48.22	
Post	−0.22		121	00	12.96	
May	−1.69	−1.89	35	54	48.66	0.52
Buzzard	+0.02		23	04	58.90	
Travis	−2.44		49	30	50.07	
Buzzard	−1.46	−3.57	93	54	52.51	0.95
Gabriel	+0.33		36	34	18.37	

* See Appendix 4, Report for 1903, pages 870–871.

† See Appendix 4, Report for 1903, page 855.

Lampasas base net to Seguin Base—Continued.

Stations	Corrections to angles	Error of closure of triangle	Corrected spherical angle			Spherical excess
	″	″	°	′	″	″
Shovel	+2.62		33	25	42.14	
Post	−0.05	+2.89	53	40	58.46	1.33
Buzzard	+0.32		92	53	20.73	
Shovel	−1.76		37	08	20.05	
Buzzard	+0.57	+0.66	65	09	50.60	1.10
Travis	+1.85		77	41	50.45	
Shingle	−0.50		66	09	19.01	
Shovel	−0.10	−1.14	65	02	24.64	1.26
Travis	−0.54		48	48	17.61	
Barton	−0.20		36	27	04.66	
Shovel	−0.12	−1.27	39	48	11.47	1.76
Travis	−0.95		103	44	45.63	
Barton	−0.23		57	56	43.47	
Shingle	+0.20	−0.43	67	06	49.97	1.47
Travis	−0.40		54	56	28.03	
Shingle	−0.30		133	16	08.98	
Shovel	+0.02	−0.30	25	14	13.17	0.97
Barton	−0.02		21	29	38.82	
Cedar	+0.53		87	52	29.53	
Shingle	+0.41	+0.82	43	10	48.67	0.80
Barton	−0.12		48	56	42.60	
Loneman	−0.64		47	33	21.59	
Shingle	−1.37	−2.44	45	30	49.30	0.85
Cedar	−0.43		86	55	49.96	
Carpenter	−0.91		41	46	22.85	
Cedar	−0.19	−1.57	109	22	39.79	0.50
Barton	−0.47		28	50	57.86	
Carpenter	−0.24		65	50	37.90	
Loneman	+0.05	−0.10	38	20	21.92	0.54
Cedar	+0.09		75	49	00.72	
Krueger	+0.84		69	32	02.65	
Loneman	−0.31	+0.68	54	42	53.28	0.67
Carpenter	+0.15		55	45	04.74	
Hugo	−3.31		35	40	07.44	
Loneman	−0.96	−3.97	115	00	14.06	0.71
Carpenter	+0.30		29	19	39.21	
Hugo	−0.90		62	16	37.05	
Loneman	−0.64	−2.20	60	17	20.79	0.60
Krueger	−0.66		57	26	02.76	
Krueger	+0.17		126	58	05.40	
Hugo	+2.42	+2.45	26	36	29.62	0.56
Carpenter	−0.14		26	25	25.54	
Gus	+0.39		53	40	07.57	
Hugo	−0.32	+0.53	80	01	11.96	0.62
Krueger	+0.46		46	18	41.09	
Tieken	+0.13		46	22	41.62	
Gus	−0.07	−0.27	103	24	18.68	0.70
Krueger	−0.33		30	13	00.40	

Lampasas base net to Seguin Base—Continued.

Stations	Corrections to angles	Error of closure of triangle	Corrected spherical angle			Spherical excess
	''	''	°	'	''	''
Bear	−0.24		53	16	25.52	
Hugo	−0.10	−0.62	40	26	39.50	0.45
Gus	−0.28		86	16	55.43	
Seguin West Base	−0.14		50	46	30.04	
Gus	−0.70	−1.38	30	03	36.21	0.32
Tieken	−0.54		99	09	54.07	
Seguin West Base	−0.21		34	53	32.01	
Bear	−0.05	+0.41	58	31	26.42	0.55
Gus	+0.67		86	35	02.12	
Seguin East Base	−0.88		105	07	12.41	
Seguin West Base	−0.71	−1.55	28	41	33.75	0.08
Tieken	+0.04		46	11	13.92	
Seguin East Base	−0.16		78	41	56.47	
Seguin West Base	−0.84	−1.36	79	28	03.80	0.30
Gus	−0.36		21	50	00.03	
Tieken	−0.50		145	21	07.99	
Seguin East Base	−0.73	−1.58	26	25	15.93	0.09
Gus	−0.35		8	13	36.17	
Seguin East Base	−0.32		51	02	43.22	
Seguin West Base	−1.06	−1.94	114	21	35.80	0.33
Bear	−0.56		14	35	41.31	
Mission	+0.80		63	34	52.74	
Bear	+0.74	+1.69	73	09	41.43	0.27
Gus	+0.15		43	15	26.10	
Mission	−0.08		56	46	37.71	
Gus	−0.18	−0.18	73	23	12.23	0.44
Tieken	+0.08		49	50	10.50	
Seguin East Base	+0.17		27	39	13.26	
Bear	+0.51	+0.99	43	55	45.11	0.52
Gus	+0.31		108	25	02.15	
Mission	−0.07		71	59	53.86	
Gus	+0.16	+0.88	65	09	36.05	0.53
Seguin East Base	+0.79		42	50	30.62	
Mission	−0.04		90	53	13.82	
Gus	+0.52	+0.67	43	19	36.02	0.40
Seguin West Base	+0.19		45	47	10.56	
Mission	+0.76		154	28	06.56	
Bear	+0.79	+1.95	14	38	15.01	0.12
Seguin West Base	+0.40		10	53	38.55	
Mission	+0.74		135	34	46.61	
Bear	+0.22	+1.58	29	13	56.31	0.28
Seguin East Base	+0.62		15	11	17.36	
Seguin West Base	+0.06		96	33	40.61	
Mission	+0.03	−0.53	34	06	36.10	0.28
Tieken	−0.62		49	19	43.57	
Seguin East Base	+0.06		69	15	46.55	
Mission	0.00	−0.52	15	13	16.14	0.18
Tieken	−0.58		95	30	57.49	

Lampasas base net to Seguin Base—Continued.

Stations	Corrections to angles	Error of closure of triangle	Corrected spherical angle			Spherical excess
	″	″	°	′	″	″
Seguin West Base	−0.65		125	15	14.36	
Mission	+0.02	−1.57	18	53	19.95	0.17
Seguin East Base	−0.94		35	51	25.86	
Herndon	−0.16		38	38	03.73	
Mission	−0.21	−0.62	42	29	16.81	0.41
Seguin West Base	−0.25		98	52	39.87	
Herndon	+0.71		53	13	25.56	
Mission	−0.19	+0.48	61	22	36.76	0.74
Seguin East Base	−0.04		65	23	58.42	
Herndon	−0.07		44	53	37.65	
Mission	−0.18	. . .	76	35	52.91	0.78
Tieken	. . .		58	30	30.22	
Mott	−0.40		42	36	07.11	
Mission	−0.07	−1.28	34	59	33.53	0.55
Tieken	−0.81		102	24	19.91	
Mott	−0.78		41	36	37.34	
Seguin West Base	−0.44	−1.42	85	18	46.58	0.25
Tieken	−0.20		53	04	36.33	
Mott	−0.55		38	13	13.24	
Seguin West Base	+0.27	+0.27	56	37	12.83	0.16
Seguin East Base	+0.55		85	09	34.09	
Mott	−0.17		39	12	43.01	
Mission	−0.08	−0.64	19	46	17.38	0.34
Seguin East Base	−0.39		121	00	59.95	
Mott	+0.17		56	04	54.54	
Herndon	−0.09	−0.03	82	18	46.84	0.76
Mission	−0.11		41	36	19.38	
Mott	+0.55		57	04	24.31	
Herndon	+0.07	+1.25	43	40	43.11	0.36
Seguin West Base	+0.63		79	14	52.94	
Mott	0.00		95	17	37.55	
Herndon	−0.80	−1.15	29	05	21.28	0.36
Seguin East Base	−0.35		55	37	01.53	
Mott	−0.23		98	41	01.65	
Herndon	−0.02	. . .	37	25	09.19	0.53
Tieken	. . .		43	53	49.69	
Seguin East Base	+0.02		134	39	44.97	
Herndon	+0.78	. . .	8	19	47.91	0.15
Tieken	. . .		37	00	27.27	
Seguin West Base	+0.19		164	33	39.52	
Tieken	. . .	. . .	9	10	46.64	0.08
Herndon	+0.09		6	15	33.92	
Seguin West Base	+0.38		178	07	32.81	
Mott	+0.38	+0.66	0	59	29.77	0.01
Mission	−0.10		0	52	57.43	
Seguin East Base	+0.33		169	43	13.50	
Tieken	−0.23	−0.13	6	53	22.42	0.02
Mott	−0.23		3	23	24.10	

Lampasas base net to Seguin Base—Concluded.

Stations	Corrections to angles	Error of closure of triangle	Corrected spherical angle			Spherical excess
	″	″	°	′	″	″
Seguin West Base	+0.90		135	52	05.77	
Seguin East Base	+0.90	+2.67	29	32	32.56	0.16
Herndon	+0.87		14	35	21.83	
Central	−0.22		111	07	35.59	
Herndon	−0.08	−0.47	40	43	22.63	0.20
Mott	−0.17		28	09	01.98	
Central	−0.35		63	34	52.28	
Herndon	−0.02	−0.24	84	24	05.73	0.27
Seguin West Base	+0.13		32	01	02.26	
Central	−0.46		85	29	08.26	
Herndon	−0.89	−1.75	69	48	43.90	0.35
Seguin East Base	−0.40		24	42	08.19	
Central	−0.10		21	54	15.99	
Seguin West Base	+0.77	+1.17	103	51	03.51	0.25
Seguin East Base	+0.50		54	14	40.75	
Central	+0.14		47	32	43.32	
Seguin West Base	+0.50	+1.03	47	13	50.68	0.30
Mott	+0.39		85	13	26.30	
Mott	−0.17		123	26	39.53	
Central	+0.24	+0.13	25	38	27.33	0.21
Seguin East Base	+0.06		30	54	53.35	
Thomas	−0.02		34	28	31.76	
Central	−0.11	+0.01	97	59	25.12	0.39
Mott	+0.14		47	32	03.51	
Lavernia	−0.03		17	49	15.15	
Herndon	+0.26	+0.38	76	48	25.27	0.50
Central	+0.15		85	22	20.08	
Lavernia	+0.23		33	58	05.85	
Central	+0.18	+0.63	65	30	39.21	0.82
Thomas	+0.22		80	31	15.76	

The maximum correction to any angle is $3''.31$ to the angle at Hugo, between Loneman and Carpenter. This angle involves the line Hugo–Carpenter already referred to and which will be discussed under the heading, "A study of errors."

The mean error of an angle, $a=\sqrt{\frac{\Sigma\Delta^2}{3n}}=\pm0''.82$ (in which $\Sigma\Delta^2$ is the sum of the squares of the closing errors of the triangles and n is the number of triangles).

Of the fifty sections of triangulation in the United States previously referred to there are sixteen for which a is greater than $\pm0''.82$.

Of the fifty-seven triangles in the preceding table, twenty-five have plus closures and thirty-two minus closures. The average triangle closure is $1''.13$ and the maximum $-3''.97$. The average closing error in the eastern oblique arc was $1''.19$ and in the transcontinental triangulation $1''.06$. Of the fifty sections of triangulation in the United States above referred to, twenty sections have average closures greater than 1.13 and thirteen sections have maximum closures greater than 3.97. The observers in 1903–4 were not attempting to secure the highest possible degree of accuracy, but on the contrary, had been directed to "proceed upon the assumption that the maximum speed consistent with the requirement that the closing error of a single triangle in the primary scheme shall seldom exceed 3″, and the average closing error shall be but little greater than 1″ is what is desired rather than a greater accuracy than that indicated." The average closing error of 1″.13, and the fact that but two closures out of fifty-seven exceeded 3″, shows that the observing corresponded with considerable accuracy to the specification laid down before commencing it. Each of the triangles with closures greater than 3″ involved a line of sight which was close to the ground or trees (see discussion under the heading, "A study of errors").

In solving the normal equations the length equation was, as usual, assigned to the last place so that the discrepancy in length, after all the conditions relating to closures of triangles and ratios of lengths had been satisfied, became known. The length of the Seguin Base, as thus computed from the Lampasas Base, was one part in 620 000 less than its measured length, corresponding to a discrepancy of −7 in the seventh decimal place of logarithms. This agreement within 11 millimeters on a base 6.8 kilometers long is exceedingly close. There are but two cases of closer agreement in the fifty sections of triangulation previously referred to.

A STUDY OF ERRORS.

The following comparison is interesting as showing how closely the two observers agreed in the rapidity and accuracy of their observations, or, in other words, how well the first observer succeeded in teaching the second at the two stations where they observed together.

Mr. Ferguson's primary observations were made at the rate of 2 minutes for each pointing on a distant signal, and Mr. Burger's at the rate of 2.1 minutes per pointing. During the season Mr. Ferguson observed seventy-two primary directions to which the average correction, without regard to sign, was found to be 0″.28 and the maximum 1″.30. The number of primary directions observed by Mr. Burger was fifty-three, to which the average correction was 0″.34 and the maximum 1″.96.

The progress of the work was much more rapid during the last half of the season than during the first half. The following comparison of the accuracy of the results in the two portions of the season is therefore interesting:

	Average correction to a direction	Maximum correction to a direction	Average closing error of a triangle	Maximum closing error of a triangle
	″	″	″	″
First half, to line Krueger–Hugo	0.44	1.96	1.65	3.97
Last half, line Krueger–Hugo and southward	0.21	0.67	0.92	2.67

During the first half of the season one of the observers was getting his first experience in this kind of work; the weather was more unfavorable than during the last half of the season, and more low lines, passing near the ground or trees, were encountered than during the last half of the season. It is difficult to ascertain whether these contrasts account for all of the difference in accuracy between the two halves of the season's work. The triangulation during the last half ranks with the best tenth of the primary triangulation by the Coast and Geodetic Survey.

The direction Hugo to Carpenter (No. 55) received the maximum correction in the adjustment, namely, $-1''.96$. The record books and field correspondence show that these two stations were not intervisible in daylight, though they were at night with the aid of the greater refraction which occurs then, and that the obstruction was at about one-third of the length of the line from Hugo. The nineteen observations at Hugo over this line showed an unusually large range, namely, $14.''3$, and three of the nineteen were rejected under the rule that all observations differing more than $5''$ from the mean are to be rejected. All these observations were made on December 10. At Carpenter sixteen observations were made on Hugo on the night of December 9 with a range of $8''.7$. The observer, knowing that Hugo was visible only with the aid of the extrarefraction at night, took sixteen more observations on December 10. On December 10 the range of the observations was $5''.1$ and the mean was $4.''85$ smaller than on December 9. In the final adjustment the mean of the thirty-two observations was used. The adjustment shows that this mean was close to the truth, as the correction which it received, No. 45, was only $+0.''07$. Apparently, according to all the observations, this line of sight was deflected to the northwestward on December 9, and in the opposite direction on December 10. In each case the wind blew across the line of sight from the side toward which the line was apparently deflected.

A comparative study of the corrections found necessary in making the adjustment and the records of observation and field correspondence shows a decided tendency for the larger corrections to be associated with low lines of sight. The records and correspondence show that thirty-seven out of one hundred and twenty-five directions were observed over lines which may be classed as low. The average correction to these thirty-seven directions is $0''.39$, whereas it was but $0''.28$ for the remaining 88 directions, for which the records and correspondence either show no notes as to the height of the line of sight, or else show it to be high throughout its whole length. Of the six corrections to directions which are greater than $1''$ four occurred on low lines. Eight of the eleven corrections to angles which are greater than $1''$ involved low lines. Each one of the seven triangles which have closing errors greater than $2''$ involves a low line.

COST.

The unit costs of this triangulation are as follows:

Cost per station occupied	\$300.00 (26 stations)
Cost per point determined	140.00 (58 points)
Cost per square mile in main scheme	5.30 (1 480 square miles)
Cost per square mile covered	5.10 (1 560 square miles)
Cost per linear mile of progress along the ninety-eighth meridian	71.00 (112 miles)

The total cost of the work of the season was \$7 900.

The cost per station occupied was the same as in 1902.* The cost per point determined was greater than in 1902 because a smaller percentage of points was determined by intersection. The remaining unit costs were larger than in 1902, even

* See Appendix 4, Report for 1903, page 872.

though the cost per station was the same, because the belt of triangulation was much narrower upon an average.

The cost, as given above, includes all salaries and wages chargeable to this field work, either in preparation or execution, and at the end of the field season the preparation of field reports and the putting of reports and computations in the final form in which they are submitted to the Computing Division in the Office. It includes even an addition of one-eleventh to the salaries actually paid to the members of the permanent force during this service, to take account of the fact that in general in such cases twelve months' salary is paid for each eleven months' work. It also includes all transportation of officers and men to and from the field and the cost of outfit and of material bought.

EXPLANATION OF POSITIONS, LENGTHS, AND AZIMUTHS, AND OF THE UNITED STATES STANDARD DATUM.

The lengths, as already fully explained in connection with the adjustment, all depend upon the Lampasas and Seguin bases. The lengths as given are all reduced to sea level. If the actual length of a line simply reduced to the horizontal is desired, it may be obtained with all the accuracy needed by adding to the sea-level length as given

$$\text{a correction} = (\text{length of line as given}) \left(\frac{\text{mean elevation of two ends of line in meters}}{6370000} \right).$$

The maximum value of this correction does not exceed $\frac{1}{13000}$ of the length for any portion of the triangulation here published. The maximum error made in the use of the above approximate formula for the correction does not exceed $\frac{1}{800000000}$ of the length for any portion of this triangulation.

The positions—that is, the latitudes, longitudes, and the azimuths—need a special explanation.

All of the positions and azimuths have been computed upon the Clarke spheroid of 1866, which has been in use in the Coast and Geodetic Survey for many years.

After a spheroid has been adopted and all the angles and lengths in a triangulation have been fully fixed it is still necessary, before the computation of latitudes, longitudes, and azimuths can be made, to adopt a standard latitude and longitude for a specified station and a standard azimuth of a line from that station. For convenience the adopted standard position (latitude and longitude) of a given station, together with the adopted standard azimuth of a line from that station, is called the *geodetic datum*.

The primary triangulation in the United States was commenced at various points and existed at first as a number of detached portions in each of which the geodetic datum was necessarily dependent only upon the astronomic stations connected with that particular portion. As examples of such detached portions of triangulation there may be mentioned the early triangulation in New England and along the Atlantic coast, a detached portion of the transcontinental triangulation centering on St. Louis and another portion of the same triangulation in the Rocky Mountain region, and three separate portions of triangulation in California in the latitude of San Francisco, in the vicinity of Santa Barbara Channel, and in the vicinity of San Diego. With the lapse of time these separate pieces have expanded until they have touched or overlapped.

The transcontinental triangulation, of which the Office computation was completed in 1899, joins all of the detached portions mentioned and makes them one continuous triangulation. As soon as this took place the logical necessity existed of discarding the old geodetic data used in these various pieces and substituting one datum for the whole country, or at least for as much of the country as is covered by continuous triangulation. To do this is a very heavy piece of work and involved much preliminary study to determine the best datum to be adopted. On March 13, 1901, the Superintendent adopted what is now known as the United States Standard Datum, and it was decided to reduce the positions to that datum as rapidly as possible. The datum adopted was that formerly in use in New England, and therefore its adoption did not affect the positions which had been used for geographic positions in New England * and along the Atlantic coast to North Carolina, nor those in the States of New York, Pennsylvania, New Jersey, and Delaware. The adopted datum does not agree, however, with that used in "The Transcontinental Triangulation" and in "The Eastern Oblique Arc of the United States," publications which deal primarily with the purely scientific problem of the determination of the figure of the earth and which were prepared for publication before the adoption of the new datum.

As the adoption of such a standard datum is a matter of considerable importance, it is in order here to explain the desirability of this step more fully.

The main objects to be attained by the geodetic operations of the Coast and Geodetic Survey are, first, the control of the charts published by the Survey; second, the furnishing of geographic positions (latitudes and longitudes), of accurately determined elevations, and of distances and azimuths, to officers connected with the Coast and Geodetic Survey and to other organizations; third, the determination of the figure of the earth. The first two of these objects are purely practical; the third is purely scientific. For the first and second objects it is not necessary that the reference spheroid should be accurately that which most closely fits the geoid within the area covered nor that the adopted geodetic datum should be absolutely the best that can be derived from the astronomic observations at hand. It is simply desirable that the reference spheroid and the geodetic datum adopted shall be, if possible, such a close approximation to the truth that any correction which may hereafter be derived from the observations which are now or may become available shall not greatly exceed the probable errors of such corrections. It is, however, desirable that one spheroid and one geodetic datum be used for the whole country. In fact this is absolutely necessary if a geodetic survey is to perform fully the function of accurately coordinating all surveys within the area which it covers. This is the most important function of a geodetic survey. To perform this function it is also highly desirable that when a certain spheroid and geodetic datum have been adopted for a country they should be rigidly adhered to without change for all time, unless shown to be largely in error.

In striving to attain the third object, the determination of the figure of the earth, the conditions are decidedly different. The problem concerns itself primarily with astronomic observations of latitude, longitude, and azimuth, and with the geodetic positions of the points at which the astronomic observations were made, but it is not

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* Many such positions had been published in Appendix No. 8, Report for 1885, Appendix No. 8 for 1888, and Appendix No. 10, 1894. Since the adoption of the United States Standard Datum many positions in Texas, Indian Territory, Oklahoma, Kansas, and Nebraska reduced to that datum have been published in Appendix 6, Report for 1901, Appendix 3, 1902, Appendix 4, 1903, and Appendix 9, 1904.

concerned with the geodetic positions of other points fixed by the triangulations. The geodetic positions (latitudes and longitudes) of comparatively few points are therefore concerned in this problem. However, in marked contrast to the statements made in preceding paragraphs, it is desirable in dealing with this problem that with each new important accession of data a new spheroid fitting the geoid with the greatest possible accuracy, and new values of the geodetic latitudes, longitudes, and azimuths of the highest degree of accuracy, should be derived.

The United States Standard Datum was adopted with reference to positions furnished for geographic purposes, but has no reference to the problem of the determination of the figure of the earth. It is adopted with reference to the engineer's problem of furnishing standard positions, and does not affect the scientist's problem of the determination of the figure of the earth.

The principles which guided in the selection of the datum to be adopted were: First, that the adopted datum should not differ widely from the ideal datum, for which the sum of the station errors in latitude, longitude, and azimuth should each be zero; second, it was desirable that the adopted datum should produce minimum changes in the publications of the Survey, including its charts; and, third, it was desirable, other things being equal, to adopt that datum which allowed the maximum number of positions already in the office registers to remain unchanged, and therefore necessitated a minimum amount of new computation. These considerations led to the adoption as the United States Standard of the datum which had been in use for many years in the northeastern group of States and along the Atlantic coast as far as North Carolina.

An examination of the station errors available in 1903, on the United States Standard Datum, at 246 latitude stations, 76 longitude stations, and 152 azimuth stations, scattered widely over the United States from Maine to Louisiana and to California, indicated that this datum approached closely to the ideal with which the algebraic sum of the station errors of each class would be zero.

The adopted United States Standard Datum, upon which the positions and azimuths given in this publication depend, may be defined in terms of the positions of the station Meades Ranch as follows:

$$\begin{array}{ll} & \quad {}^\circ \quad {}' \quad {}'' \\ \varphi & = 39\ 13\ 26.686 \\ \lambda & = 98\ 32\ 30.506 \\ \alpha \text{ to Waldo} & = 75\ 28\ 14.52 \end{array}$$

TABLE OF POSITIONS, AZIMUTHS, AND LENGTHS.

The following table gives the positions of all points and the azimuths and lengths of all lines fixed by the ninety-eighth meridian triangulation of 1903–4 in Texas, except the stations Serita and Stockdale and the points determined from them.

This table may be conveniently consulted by using as finders the two illustrations and the index at the end of this appendix. In the third column of the index will be found for each point a reference to the page on which its description is given, and in the fourth column the page on which its elevation above mean sea level may be found.

The azimuth and length of every line over which observations have been made in one or both directions are given in the list in connection with the position of one end only of the line.

The positions of all points for which the latitudes and longitudes are given to thousandths of seconds have been fixed by a complete adjustment of the triangulation concerned, so as to make all the triangles close and remove all discrepancies between lengths, azimuths, and positions. Such adjustments are of a very high degree of accuracy, as indicated in the preceding pages, for points on the main scheme, of a less degree of accuracy for supplementary points, and of a still more approximate character for points determined by intersections only. In each class all discrepancies are removed to the limit given by the decimal place shown. The above statements in regard to the various degrees of accuracy refer to the manner in which the discrepancies were removed.

If less than three decimal places are given in the latitudes and longitudes, the point in question has not been fixed by fully adjusted triangulation, or is fixed in such a way as to furnish no check on its position, and the accuracy with which its position is known is indicated in part by the number of decimal places given.

The seconds of latitude and longitude are also given in meters for the convenience of the draftsmen.

The azimuths, distances, and logarithms of distances are given to various numbers of decimal places, the intention being to indicate the accuracy to a certain extent, it being understood that in each quantity two doubtful figures are given. In some cases there is very little doubt of the correctness of the second figure from the right, and in a few cases some doubt may be cast upon the third figure.

The following tables give the positions of 23 primary stations and 35 subordinate stations, or 58 in all, which have not before been published.

The positions of May and Gabriel, which were published in Appendix 4 of the Report for 1903, are here repeated for the sake of completeness.

For the convenience of those who may wish to compare the lengths here given with others which are expressed in feet, or vice versa, the following conversion table is here inserted:

Meters	Feet	Feet	Meters
1	3.280833	1	0.3048006
2	6.561667	2	0.6096012
3	9.842500	3	0.9144018
4	13.123333	4	1.2192024
5	16.404167	5	1.5240030
6	19.685000	6	1.8288037
7	22.965833	7	2.1336043
8	26.246667	8	2.4384049
9	29.527500	9	2.7432055
10	32.808333	10	3.0480061

Station	Latitude and longitude	Seconds in meters	Azimuth	Back azimuth	To station	Distance	Logarithms
	° ′ ″		° ′ ″	° ′ ″		meters	
May	30 51 55.386	1705.5					
1902	98 13 50.442	1340.0					
Gabriel	30 45 41.644	1282.4	110 01 45.28	289 51 34.05	May	33741.12	4.5281595
1902	97 53 57.202	1521.3					
Buzzard	30 38 55.752	1716.8	150 08 15.55	330 03 50.10	May	27694.73	4.4423972
1903	98 05 11.383	303.1	235 05 12.81	55 10 57.06	Gabriel	21865.31	4.3397557
Post	30 45 06.259	192.7	185 58 13.36	5 58 38.76	May	12667.90	4.1027045
1903	98 14 40.039	1065.0	306 58 26.32	127 03 16.65	Buzzard	18952.32	4.2776623
Travis	30 30 58.822	1811.3	149 02 53.66	329 00 05.32	Buzzard	17129.38	4.2337416
1903	97 59 40.510	1080.1	198 33 43.73	18 36 38.69	Gabriel	28681.80	4.4576063
Shovel	30 26 30.557	941.0	180 39 17.27	0 39 24.78	Post	34359.21	4.5360432
1903	98 14 54.802	1462.3	214 04 59.41	34 09 55.92	Buzzard	27720.18	4.4427961
			251 13 19.46	71 21 03.21	Travis	25747.73	4.4107389
Shingle	30 18 13.223	407.2	136 20 21.22	316 15 44.10	Shovel	21182.44	4.3259761
1903	98 05 46.730	1248.7	202 29 40.23	22 32 45.60	Travis	25521.38	4.4069041
Barton	30 18 17.791	547.8	89 44 15.66	269 36 30.20	Shingle	24648.70	4.3917940
1903	97 50 24.268	648.4	111 13 54.47	291 01 30.93	Shovel	42095.17	4.6242322
			147 40 59.13	327 36 17.57	Travis	27741.76	4.4431341
Cedar	30 11 22.624	696.7	132 51 35.89	312 47 18.87	Shingle	18599.90	4.2695106
1903	97 57 10.479	440.8	220 44 05.42	40 47 33.06	Barton	16878.57	4.2273356
Loneman	30 04 36.193	1114.5	178 18 22.17	358 18 08.17	Shingle	25169.13	4.4008682
1903	98 05 18.887	505.8	225 51 43.76	45 55 45.93	Cedar	17981.88	4.2548351
Carpenter	30 05 38.351	1181.0	84 18 01.55	264 12 05.68	Loneman	19106.87	4.2811896
1903	97 53 28.982	776.1	150 08 39.45	330 06 45.21	Cedar	12224.99	4.0872485
			191 55 02.30	11 56 35.20	Barton	23901.07	4.3784174
Krueger	29 57 43.344	1334.5	138 58 25.67	318 54 58.96	Loneman	16857.85	4.2268022
1903	97 58 25.710	689.3	208 30 28.32	28 32 56.81	Carpenter	16647.47	4.2213482
Hugo	29 56 23.919	736.4	199 10 41.29	19 12 19.75	Loneman	16049.75	4.2054682
1903	98 08 35.755	958.9	234 50 48.73	54 58 22.34	Carpenter	29696.89	4.4727110
			261 27 18.34	81 32 22.91	Krueger	16540.40	4.2185460
Gus	29 48 46.694	1437.6	161 29 57.80	341 28 30.30	Hugo	14846.52	4.1716247
1903	98 05 40.091	1076.6	215 10 05.37	35 13 41.82	Krueger	20220.97	4.3058020
Tieken	29 43 04.229	130.2	138 37 15.86	318 34 24.05	Gus	14057.91	4.1479208
1903	97 59 54.022	1452.0	184 59 57.48	5 00 41.42	Krueger	27172.00	4.4341216
Mission or Mission Hill,	29 42 52.761	1624.4	211 55 30.74	31 57 36.29	Gus	12842.23	4.1086406
U. S. G. S.	98 09 52.996	1424.4	268 42 08.45	88 47 05.36	Tieken	16103.23	4.2069129
1903							
Bear	29 47 06.921	213.1	201 58 01.88	21 55 09.80	Hugo	18484.40	4.2668055
1903	98 12 52.654	1414.4	255 09 27.40	75 13 02.37	Gus	12016.27	4.0797698
			328 19 08.83	148 20 38.00	Mission	9194.68	3.9635368
Seguin West Base	29 39 16.232	499.8	122 51 54.79	302 48 44.55	Mission	12294.20	4.0897004
1901	98 03 28.807	774.8	133 45 33.35	313 40 53.82	Bear	20968.90	4.3215757
			168 39 05.36	348 38 00.25	Gus	17915.34	4.2532251
			219 25 35.40	39 27 21.79	Tieken	9089.96	3.9585620
Seguin East Base	29 40 38.416	1182.8	68 09 05.22	248 07 09.16	Seguin West Base	6794.59	3.8321633
1901	97 59 34.316	922.7	104 00 31.08	283 55 24.59	Mission	17139.01	4.2339858
			119 11 48.44	299 05 12.51	Bear	24564.08	4.3903005
			146 51 01.69	326 48 00.22	Gus	17961.76	4.2543488
			173 16 17.63	353 16 07.87	Tieken	4520.70	3.6552055
Mott	29 35 53.583	1649.8	123 47 37.42	303 41 41.95	Mission	23234.20	4.3661277
1903	97 57 54.631	1470.2	124 47 07.19	304 44 21.98	Seguin West Base	10943.10	4.0391403
			163 00 20.43	342 59 31 13	Seguin East Base	9170.66	3.9624004
			166 23 44.53	346 22 45.45	Tieken	13642.66	4.1348991
Herndon	29 32 41.524	1278.5	165 19 32.01	345 18 01.36	Mission	19455.37	4.2890395
1903	98 06 49.633	1336.3	203 57 35.74	23 59 14.92	Seguin West Base	13300.18	4.1238576
			210 13 09.66	30 16 35.14	Tieken	22194.44	4.3462442
			218 32 57.57	38 36 32.66	Seguin East Base	18782.56	4.2737549
			247 38 18.85	67 42 42.88	Mott	15567.30	4.1922133
Central	29 31 20.885	643.0	108 23 58.26	288 21 41.47	Herndon	7873.71	3.8961794
1903-4	98 02 12.139	326.9	171 58 50.54	351 58 12.68	Seguin West Base	14780.33	4.1696840
			193 53 06.52	13 54 24.47	Seguin East Base	17683.55	4.2475694
			219 31 33.85	39 33 40.90	Mott	10887.95	4.0369463

Station	Latitude and longitude	Seconds in meters	Azimuth	Back azimuth	To station	Distance	Logarithms
	° ′ ″		° ′ ″	° ′ ″		*meters*	
Thomas	29 25 40.885	1258.8	137 33 53.91	317 30 58.97	Central	14189.20	4.1519580
1904	97 56 16.612	447.8	172 02 25.67	352 01 37.38	Mott	19048.13	4.2798523
Lavernia	29 18 52.004	1601.1	185 09 24.68	5 10 06.74	Herndon	25643.72	4.4089810
1904	98 08 15.243	411.3	202 58 39.83	23 01 38.18	Central	25048.57	4.3987829
			236 56 45.68	57 02 38.14	Thomas	23110.74	4.3638139
Austin, Capitol dome, star in hand of Liberty	30 16 27.968	861.2	36 04 25.02	215 59 51.53	Carpenter	24736.33	4.3933353
	97 44 25.032	669.0	65 33 02.57	245 26 34.14	Cedar	22669.96	4.3554508
1903			109 25 48.76	289 22 47.57	Barton	10178.45	4.0076815
Bertram Methodist Church, spire*	30 44 27.33	841.6	261 22 23	81 27 14	Gabriel	15327.9	4.185483
1903	98 03 27.02	718.8	15 13 27	195 12 34	Buzzard	10581.8	4.024559
Bertram Railroad Windmill*	30 44 32.06	987.2	261 43 54	81 48 39	Gabriel	14971.7	4.175270
1903	98 03 14.29	380.1	16 45 14	196 44 15	Buzzard	10815.1	4.034032
Shingle Hill, U. S. G. S.	30 18 13.374	411.8	312 47 33.8	132 51 50.8	Cedar	18605.3	4.2696363
1903	98 05 46.843	1251.6	326 48 52.2	146 48 52.2	Shingle	5.552	0.744443
			136 20 11.3	316 15 34.3	Shovel	21177.0	4.3258642
Shovel Mountain, U. S. G. S.	30 26 30.559	941.0	316 16 18.4	136 20 55.3	Shingle Hill, U. S. G. S.	21172.8	4.3257773
1903	98 14 54.570	1456.1	89 25 44.4	269 25 44.3	Shovel	5.914	0.771878
Austin Colored Asylum, standpipe*	30 18 32.03	986.3	57 46 58	237 40 23	Cedar	24763.8	4.393817
1903	97 44 13.30	355.4	87 29 37	267 26 30	Barton	9921.8	3.996589
Austin Colored Asylum, dome at south end*	30 18 26.15	805.2	58 08 04	238 01 29	Cedar	24665.3	4.392086
1903	97 44 13.41	358.3	88 32 15	268 29 08	Barton	9912.5	3.996185
Austin Latitude Station	30 16 22.34	687.9					
1872	97 44 20.01	534.9					
Austin North Meridian	30 16 26.00	800.6	0 00 00	180 00 00	Austin Lat. Station	112.65	
1872	97 44 20.01	534.9					
Austin Longitude Station	30 16 26.15	805.2	0 00 00	180 00 00	Austin North Mer.	4.42	
1895	97 44 20.01	534.9					
Austin, University of Texas, main tower	30 17 07.21	222.0					
1895	97 44 21.63	578.1					
St. Edwards College, chapel, spire*	30 13 47.24	1454.7	40 57 33	220 53 28	Carpenter	19923.9	4.299374
1903	97 45 21.23	567.6	76 56 46	256 50 46	Cedar	19641.3	4.293171
Cedar Hill, U. S. G. S.	30 11 22.53	693.7	109 07 37.4	289 07 37.2	Cedar	8.517	0.930287
	97 57 16.18	432.8					
Kyle Cotton Gin, tank*	30 00 19.16	590.0	75 21 21	255 15 40	Krueger	18917.7	4.276868
1903	97 47 03.07	82.3	133 34 45	313 31 32	Carpenter	14264.4	4.154252
Hornbortel's (August) Gin, stack*	29 42 05.14	158.2	212 28 54	32 29 16	Tieken	2157.0	3.333850
1903	98 00 37.12	997.9	327 41 12	147 41 44	Seguin East Base	3159.2	3.499571
New Braunfels Catholic Church, spire	29 42 11.726	361.0	109 38 21.9	289 37 16.6	Mission	3760.9	3.575289
1903	98 07 41.216	1108.0	137 23 05.2	317 20 30.7	Bear	12354.9	4.091840
			194 58 21.9	14 59 22.1	Gus	12589.0	4.099991
			262 37 57.7	82 41 49.2	Tieken	12661.7	4.102491
			306 23 11.3	126 28 01.4	Mott	19607.6	4.292424
			308 30 29.0	128 32 34.0	Seguin West Base	8675.1	3.938276
New Braunfels Spire, massive base, slim cone	29 42 02.972	91.5	192 16 42.8	12 17 32.8	Gus	12722.0	4.104555
1903	98 07 20.846	560.3	261 02 40.7	81 06 22.2	Tieken	12157.9	4.084857
			281 41 38.3	101 45 29.4	Seguin East Base	12810.2	4.107557
New Braunfels Court-House, tower	29 42 11.70	360.2	193 35 25.3	13 36 19.6	Gus	12512.7	4.097352
1903	98 07 29.59	795.4	262 26 39.5	82 30 25.3	Tieken	12351.8	4.091731
			309 49 39.7	129 51 38.9	Seguin West Base	8432.2	3.925940
			108 10 07.0	288 08 56.0	Mission	4056.9	3.608198

* No check on this position.

Station	Latitude and longitude	Seconds in meters	Azimuth	Back azimuth	To station	Distance	Logarithms
	° ′ ″		° ′ ″	° ′ ″		*meters*	
New Braunfels Standpipe	29 41 48.677	1498.7	115 39 13.5	295 37 57.8	Mission	4559.4	3.658907
1903	98 07 20.089	540.0	137 39 28.0	317 36 43.0	Bear	13261.9	4.122605
			191 47 02.6	11 47 52.2	Gus	13148.2	4.118867
			258 59 23.7	79 03 04.7	Tieken	12214.1	4.086861
			279 46 08.7	99 49 59.3	Seguin East Base	12708.2	4.104085
			305 40 20.8	125 45 00.5	Mott	18730.7	4.272555
			307 01 39.3	127 03 33.8	Seguin West Base	7791.4	3.891617
Kingsbury, tall, heavy stack with cross*	29 38 54.74	1685.4	55 21 08	235 14 58	Central	24547.1	4.390000
1903	97 49 42.26	1136.7	67 11 55	247 07 52	Mott	14372.7	4.157538
Church, red spire†	29 36 01.46	45.0	271 30 34	91 33 21	Mott	9067.4	3.957484
1903	98 03 31.47	846.8	40 55 16	220 53 38	Herndon	8145.1	3.910897
Round Tank, light colored, east of Seguin†	29 34 29.32	902.7	115 44 55	295 43 16	Mott	5974.8	3.776324
1903	97 54 34.64	932.3	151 34 16	331 31 38	Tieken	18031.5	4.256031
Marion Lutheran Church, spire†	29 34 13.26	408.3	297 01 57	117 05 07	Central	11666.8	4.066951
1903	98 08 38.04	1023.9	314 03 24	134 04 17	Herndon	4061.3	3.608669
Marion, Schultz & Dreyer's cotton gin, stack†	29 34 20.58	633.6	299 15 54	119 18 54	Central	11309.1	4.053429
1903	98 08 18.49	497.7	321 53 15	141 53 58	Herndon	3876.1	3.588397
Seguin Oil Factory, water tower	29 34 57.364	1766.2	348 56 58.3	168 57 59.5	Thomas	17456.5	4.241958
1903	97 58 20.745	558.4	43 04 50.8	223 02 56.8	Central	9123.1	3.960144
			73 03 24.3	252 59 13.2	Herndon	14322.9	4.156030
			133 54 05.7	313 51 33.4	Seguin West Base	11498.8	4.060651
			202 05 40.1	22 05 53.0	Mott	1868.2	3.271416
Seguin Court-House, spire	29 34 05.779	177.9	54 11 35.9	234 09 27.1	Central	8674.0	3.938217
1903	97 57 50.920	1370.7	167 02 56.7	347 02 05.6	Seguin East Base	12405.0	4.093597
			168 42 49.3	348 41 48.4	Tieken	16906.1	4.228043
			178 16 35.5	358 16 33.7	Mott	3320.7	3.521232
Seguin Schoolhouse, short tower with two collars	29 34 28.577	879.9	51 01 12.1	230 59 01.4	Central	9183.1	3.962987
1903	97 57 47.056	1266.6	167 52 10.7	347 51 07.9	Tieken	16239.8	4.210581
			175 32 46.1	355 32 42.4	Mott	2625.2	3.419162
Seguin Standpipe	29 34 03.162	97.4	80 12 15.9	260 07 50.2	Herndon	14719.3	4.167887
1903	97 57 50.901	1370.1	134 55 31.0	314 48 04.7	Bear	34209.0	4.534140
			136 41 50.4	316 39 03.4	Seguin West Base	13250.5	4.122231
			167 07 46.2	347 06 55.2	Seguin East Base	12483.6	4.096341
			168 45 54.5	348 44 53.7	Tieken	16985.1	4.230069
			178 18 30.7	358 18 28.8	Mott	3401.2	3.531637
Seguin, Zanke's Gin, brick chimney	29 34 27.905	859.2	349 11 58.6	169 12 55.0	Thomas	16518.6	4.217972
1903	97 58 11.448	308.1	48 23 31.5	228 21 32.7	Central	8668.8	3.937957
			76 49 17.6	256 45 01.9	Herndon	14328.8	4.156210
			134 39 58.6	314 32 42.2	Bear	33279.7	4.522180
			136 08 10.8	316 05 33.9	Seguin West Base	12317.3	4.090516
			168 56 54.0	348 56 13.0	Seguin East Base	11623.6	4.065342
			170 09 42.3	350 08 51.5	Tieken	16135.0	4.207769
			189 44 04.7	9 44 12.9	Mott	2676.5	3.427565
Seguin Cotton Compress Building, top†	29 34 55.54	1710.0	73 52 16	253 47 55	Herndon	14820.6	4.170866
1903	97 58 00.84	22.6	132 18 50	312 16 08	Seguin West Base	11928.4	4.076582
Seguin Spire*	29 34 24.75	762.0	167 28 54	347 28 07	Seguin East Base	11785.6	4.071350
1903	97 57 59.31	1596.4	182 38 10	2 38 12	Mott	2738.1	3.437448
Seguin Milling and Power Co.'s tank	29 34 25.910	797.7	68 10 26.0	248 07 59.1	Herndon	8636.9	3.936358
1903	98 01 51.838	1395.3	163 44 08.6	343 43 20.7	Seguin West Base	9311.8	3.969034
			247 03 46.9	67 05 44.0	Mott	6931.1	3.840804
Seguin Catholic Church, spire†	29 33 58.61	1804.5	55 18 57	235 16 49	Central	8530.0	3.930950
1903	97 57 51.67	1390.9	178 42 41	358 42 40	Mott	3540.8	3.549102
Herndon Hill, U. S. G. S.	29 32 41.435	1275.7	129 30 08	309 30 08	Herndon	4.309	0.63438
1903	98 06 49.510	1333.0	165 19 05.7	345 17 34.9	Mission or Mission U. S. G. S.	19458.9	4.289118
Steins Church, spire	29 28 39.756	1224.2	30 08 43.1	210 05 32.0	Lavernia	20920.5	4.320572
1903	98 01 45.904	1236.6	171 53 42.4	351 53 29.5	Central	5011.0	3.699929
			301 48 07.0	121 50 48.8	Thomas	10443.8	4.018859
St. Hedwig Catholic Church†	29 24 55.70	1714.9	234 15 29	54 20 30	Central	20322.5	4.307985
1903	98 12 24.67	665.0	328 59 12	149 01 14	Lavernia	13063.1	4.116045

* No check on this position.

† Checked by vertical angles only.

DESCRIPTIONS OF STATIONS.

These descriptions may be conveniently consulted by reference to the illustrations at the end of this appendix and to the index.

In each description the tense used is appropriate to the date at which the description was written.

All directions in the descriptions are given in the form of azimuths reckoned continuously from the south around by west to 360°, west being 90°, north 180°, and east 270°. The azimuths are true, not magnetic, unless otherwise stated.

In general the surface and underground marks described are not in contact, so that a disturbance of the surface mark will not, in general, affect the underground mark. The underground mark should be resorted to only when there is evidence that the surface mark has been disturbed.

Any person who finds that one of the stations here described is disturbed, or that the description no longer fits the facts, is requested to send such information to

SUPERINTENDENT,
COAST AND GEODETIC SURVEY,
Washington, D. C.

GENERAL NOTES IN REGARD TO STATION MARKS.

Note 1.—A hole was dug 18 inches in diameter to a depth of 2 feet, then 1 foot in diameter to a depth of 4½ feet. In this, the lower or underground mark, a 2-inch iron pipe, 2 feet long, was set, flange down, and the hole filled, level with the top of the pipe, with concrete made of Portland cement, sand, and broken rock. The pipe was filled with concrete and a 60-penny steel wire nail set in the center of the top, the point, projecting one-fourth of an inch, marking the center of the station. Over this was placed 6 inches of sand. Then the surface mark, a similar piece of pipe, was plumbed directly over the lower mark and the hole and pipe filled with concrete level with the surface. A 60-penny nail was set in the top of the pipe as below to mark the center of the station. The top of the pipe was covered with cement about one-half inch, on which was marked "U. S. C. & G. S. 1903." The reference mark was an iron pipe, 2 feet long, set in a hole 1 foot in diameter, surrounded and filled with concrete, with a 60-penny wire nail projecting one-fourth of an inch, the top of the pipe being level with the surface.

Note 2.—The surface mark was the same as described in Note 1, except that sometimes the pipe was only 1 foot long. The subsurface mark was a 40-penny nail set in cement in the solid rock. The reference mark was the same as described in Note 1, unless otherwise stated.

Note 3.—The center of the station was marked as described in Note 2, unless stated otherwise, but the reference mark was a one-half or three-fourths inch drill hole, 1 to 2 inches deep, surrounded by a paneled triangle 3 to 5 inches on a side.

May (Burnet County, Tex., William Bowie, 1902; O. W. Ferguson, 1903).—See page 910, Appendix 4, Report for 1903. Additional azimuths and estimated distances to various points are as follows: To A. L. May's house, center of big stone chimney, distant about 90 meters; azimuth, 37° 09′ 39″; to U. S. Geological Survey △ mark on a cedar tree, distant about 50 meters; azimuth, 142° 49′ 48″; to Mr. Lastly's house, stovepipe (no chimney), distant about 180 meters; azimuth, 152° 15′ 24″.

Gabriel (Williamson County, Tex., O. W. Ferguson, 1902–3).—See page 910, Appendix 4, Report for 1903.

Buzzard (Burnet County, Tex., O. W. Ferguson, 1903).—About 9 miles by road and 7 miles direct southwest from Bertram, and 1½ miles southwest of Old Cedar Mills, about 1 mile east by north from "Buzzard Roost;" on Post Oak Ridge; at the north edge of the woods and the south edge of the cotton field; on land owned by William Rodgers, who lives a quarter mile northwest, on the edge of the same field; 6.83 meters north of the wire fence along the woods line. The reference mark is in the field ½ meter from the wire fence, and 67.603 meters from the station in azimuth about 325°. (Note 1, p. 269.)

Post (Burnet County, Tex., W. H. Burger, 1903).—About 1 mile west of Burnet, on Post Mountain, in a pasture belonging to Mr. James Cole, who lives at Burnet; near the south edge of a small open rocky space near the south edge of the mountain, 8 or 9 paces from the brow. The top of the mountain is covered with small brush and trees 10 to 20 feet high. Reference mark No. 1 is on the highest part of a large flat rock (rising about 8 inches above the ground), at the west edge of the open space at the south brow of the mountain, about 21 paces to the south brow, 29 paces to the brow westward, 55 paces to the brow eastward. Reference mark No. 2 is on a large flat rock rising about 5 inches above the ground at the north edge of the open space mentioned above. The witness tree is a blazed scrub oak about 15 feet high and 10 inches in diameter at the blaze; the blaze is about 2 feet from the ground and faces the station, and in it are 7 nails driven in the form of a pyramid. The azimuths and distances to certain points are: To reference mark No. 1, 21.992 meters, 150° 04′ 51″; to reference mark No. 2, 37.245 meters, 180° 55′ 55″; to witness tree, 8.380 meters, 138°; to high school, Burnet, 1 mile, 239°; to court-house, Burnet, 1 mile, 251° 32′ 39″; to center chimney, house of Mr. Paire, 1 mile, 111° 13′ 11″; to railroad water tank one-half mile south of Burnet, 285° 14′ 59″. (Note 3, p. 269.)

Travis (Travis County, Tex., O. W. Ferguson, 1903–4).—Three and one-half miles in a direct line from Travis; three-quarters of a mile in a direct line about N. 12° E. from a tank on the northeast side of Leander-Travis Peak wagon road, at a sharp turn in the road; in the Woolf pasture, upon the highest and gently rounding top of Post Oak Ridge, at its northeastern extremity. "Travis Peak," a high lone conical-shaped hill, about 3 miles distant, is in azimuth 119° 35′ 19″. A live oak tree, 4 inches in diameter, distant from the station 28.12 meters, in azimuth 280° 38′ 42″, is marked by an isosceles triangle, base 3 inches, sides 5 inches, cut deeply into the tree, facing the station, and 8 inches above the ground. A Spanish oak tree, 7 inches in diameter at the base and 8.10 meters distant, in azimuth 51° 06′ 27″, is marked 10 inches above ground, on the side facing the station, by a deeply cut equilateral triangle, 3½ inches on a side. A Spanish oak, 8 inches in diameter, distant 35.14 meters, in azimuth 83° 45′ 31″, is marked, 1 foot above ground, on the side facing the station, by a deeply cut equilateral triangle, 5 inches on a side. (Note 1, p. 269, except there was no reference mark.)

Shovel (Blanco County, Tex., William H. Burger, 1903).—On the west and highest part of Shovel Mountain, about 9 miles east of south from Marble Falls and 2½ miles east of south from Shovel Mount post-office; on land owned by Frank Ebeling, living about 3 miles north of the mountain. The mountain is very prominent and can be seen for quite a distance; its west edge is very abrupt. The station is about 38 paces from the brow to westward, 49 paces from the brow to southward, in about the center of the clearing on the top of the mountain, and just north of the south clump of bushes in the clearing. Distances and azimuths to various points are: To Frank Ebeling's, 2½ miles, 173° 18′ 09″; to top of small U. S. G. S. cairn, three-eighths of a mile, 226° 19′ 21″; to reference mark, 53.566 meters, 161°. (Note 2, p. 269. See also Shovel Mountain, U. S. G. S., p. 276.)

Shingle (near Travis and Hays County line, Texas, W. H .Burger, 1903).—Five miles northwest of Fitzhugh, on a prominent bald-topped hill, the north one of a series known for miles around as the "Shingle Hills"; 23 paces from the brow of hill on line to Shovel Mountain, 10 paces to the brow to eastward, 20 paces from the brow to westward, 40 paces to the brow to southward on line to Cedar △ (which passes just to the west of the house of Mr. Chisholm, 1 mile distant) and 39 paces eastward from the posts of an old fence line (county line?) at its highest point in crossing Shingle Hill. Distances and azimuths to various points are: To Mr. Wilkie's house, 1¼ miles, 152° 36′ 58″; to Mr. Chisholm's house, 1 mile, 312° 02′ 25″; to Albert Scott's house, one-half mile, 328° 10′ 59″; to reference mark, 14.148 meters, 128° 55′ 31″. The reference mark is in the top of a flat stone nearly level with the ground and 7 paces from the brow of the hill toward Shovel Mountain. (Note 3, p. 269. See also Shingle Hill, U. S. G. S., p. 276.)

Barton (Travis County, Tex., O. W. Ferguson, 1903–4).—Six miles direct from Austin, W. 19° N., and 8 miles by wagon road, on the north side of the Austin and Bee Caves road (wagon), upon a prominent rounded hill covered with small timber, abreast of and north of the 8-mile post; upon very rocky ground. The stone chimney on the north end of a stone house is in plain view on the slope, 3½ miles distant, in azimuth 42° 13′ 45″. (Note 1, p. 269, except the reference mark is the center of a ¾-inch drill hole, surrounded by a 5-inch triangle, on the most prominent large rock upon the very highest part of the hill, distant 16.193 meters from the △ in azimuth 54° 27′ 08″.)

Cedar (Hays County, Tex., O. W. Ferguson, 1903–4).—Two and one-half miles south of Cedar Valley, upon land owned by Fred Willie, a German, and one of the first settlers; about 1 mile east of his house; about 150 meters southwest from the line between Travis and Hays counties, which runs southeast; upon a rather high hill densely covered with cedar. The station was marked as described in note 2, page 269, the point of the nail of the underground mark being 27 inches below the surface. The reference mark, a deep triangle, 5 inches on a side, facing the station, cut into the base of a live oak tree, 1 foot in diameter, 0.55 of a meter above ground, is distant 6.191 meters from the station (straight measurement) and 7.380 meters (straight measurement) from Cedar Hill, U. S. G. S. △. The large stone chimney in the end of Fred Willie's house is distant about 1 mile, in azimuth 81° 36′ 05″; the center of the stone chimney on Friendship Church is 1¾ miles distant, in azimuth 247° 11′ 08″; the center of the stone chimney on the north end of Mr. Rissman's stone house is distant about 1½ miles, in azimuth 173° 19′ 14″.

Loneman (Hays County, Tex., William H. Burger, 1903).—Eighteen miles by road northwest of Kyle, on the International and Great Northern Railway, about 6 miles north of Wimberly; on the north side of the Blanco City and Kyle wagon road, which passes near the foot of the mountain, and three-fourths of a mile east of where the road to Dripping Springs leaves the Blanco and Kyle road; on the Everett ranch. Loneman Mountain is made up of a series of terraces of rock; the top is rather level and oval-shaped. The station is 51 paces from the north point of the oval which is almost in line to Shingle Hills, 7 paces to the brow of the oval eastward, 19 paces to the brow southward, and 7½ paces westward. The reference mark is on the edge of an outcropping ledge of rock in the terrace below the top of the oval, 7 paces east of extreme north edge of oval and 6 inches from outer edge of the rock, about 5 feet below the station, and 3 feet below the north point of the oval, and almost in line to Shingle △ from the station. The south point of the triangle points to the station. The distances and azimuths of various points are: To reference mark, 33.369 meters, 178° 16′ 31″; to church, Dripping Springs, 6 miles, 180° 17′ 38″; to east gable of Mr. Wood's house, 1½ miles, 326° 14′ 33″; to north gable of Mr. Brook's house, 2 miles, 17° 35′ 20″; to East Twin Peak, 5 miles, 19° 41′ 05″. (Note 3, p. 269.)

Carpenter (Hays County, Tex., O. W. Ferguson, 1903–4).—Four miles by road N. 75° W. from Buda, on what is known as "Carpenter Hill;" in a rocky pasture about 18 meters north of the Buda and Blanco City wagon road, on the land of Mrs. Harrison and her children, who live about 200 meters north by east from the station and upon the same hill. The reference mark is at the north side of the wagon road, 0.32 of a meter on the field side of the wire fence and distant 57.574 meters from the station in azimuth 276° 47′ 39″. The center of the stone chimney at the east end of Mrs. William Hancock's house is distant about 70 meters southwest, in azimuth 36° 47′ 45″; the end of the ridge of the south gable of the house of Capt. Fred Cocker is about 1½ miles north, in azimuth 172° 58′ 49″; the west stone chimney of Mr. S. H. Niven's house, distant about 1 mile, is in azimuth 239° 08′ 06″. (Note 1, p. 269, except the lower pipe is only 6 inches long.)

Krueger (Hays County, Tex., O. W. Ferguson, 1903–4).—Seven miles by road southwest of Kyle and 7 miles by road northwest of San Marcos, on the ranch of W. M. Krueger, on the highest part of a high, rocky, rounded hill partly covered with brush, oak, and cedar. The reference mark is on the highest and most prominent hard limestone rock and is distant 17.598 meters from the station in azimuth 145° 08′ 17″, and is a ¾-inch hole, 1¾ inches deep, surrounded by a triangle, 4 inches on a side, the apex toward the station. Distances and azimuths to various points are as follows: To W. M. Krueger's house, center of chimney, distant about 200 meters, in azimuth 170° 44′ 07″; a large windmill tower in a pasture three-fourths of a mile distant, in azimuth 59° 02′ 15″; Park's cabin, center of the stone chimney at the east end, a half mile distant, in azimuth 120° 14′ 47″. (Note 1, p. 269, except the lower pipe is only 6 inches long and the reference mark is as described above.)

Hugo (Hays County, Tex., William H. Burger, 1903).—Two miles by road northwest of Hugo, about 15 miles by road west of San Marcos, about a half mile north of the San Marcos, Hugo, and Blanco City wagon road, about 200 paces W. 25° S. (magnetic) from the place where the road from Wimberly to Hugo, on crossing the ridge, passes around the last "draw," which is very large and extends eastward; and about 300 paces W. 5° S. (magnetic) from where this road meets and follows closely the east property line fence on the top of the ridge; about a half mile to the northward of the house of Mr. Rolfe; in the Williamson pasture, on a hill covered with cedar and oak and plenty of rocks, known as the "Devil's Backbone;" near the southeast edge of a rather open, but exceedingly rocky, clearing. The station can probably always be found by the seven very large piles of rocks which were used as anchors to the legs of the tower. Three nails were driven into a blaze about 2 feet from the ground in the north half of a double spanish oak tree, which bears S. 44° W. (magnetic), and is 20.62 meters distant from the station. The reference mark is on the highest point of a large rock, whose top is from 6 to 8 inches above the neighboring rocks, and is 2.4 feet higher than the station. The reference mark is witnessed by three nails driven in a blaze, 1½ feet above ground, on a cedar tree (6 inches in diameter at the blaze), which is north 68° 30′ E. (magnetic), and 3.51 meters from the reference mark. Distances and azimuths to various points are: To the west chimney of Mr. Williamson's house, 1 mile, 296° 47′ 26″; to the west gable of old deserted house, three-fourths of a mile, 309° 32′ 15″; to the center of the tower of Mr. Rolfe's windmill, one-half mile, 327° 52′ 53″; to the reference mark, 29.751 meters, 113° 48′ 34″; to the East Twin Sister Peak, 198° 42′ 45″; to the west edge of the stone building, Wimberly post-office, 215° 42′ 59″. (Note 3, p. 269, the point of the nail of the underground mark being 14 inches below the surface of the ground.)

Gus (Comal County, Tex., O. W. Ferguson, 1903–4).—Nine miles by road from New Braunfels and about 3 miles in a straight line a little south of west from the village of Hunter on the International and Great Northern Railway; 1 mile east of the New Braunfels and Blanco City wagon road; upon the ranch owned by Gus Pfeuffer and about 380 meters from his house; upon a high, rocky, rounding timbered knoll, about 20 feet north of the crest. Distances and azimuths to various points are: To reference mark, at the south side of an old road, 53.348 meters, in azimuth 114° 46′ 13″; to windmill tower at farm, 2½ miles, in azimuth 310° 37′ 59″; to windmill tower at house in the woods, 2¾ miles, in azimuth 325° 31′ 18″; to the east gable of a large white house, about 3 miles, in azimuth 18° 21′ 58″. (Note 2, p. 269, the point of the nail of the underground mark being 27 inches below the surface of the ground.)

Tieken (Guadalupe County, Tex., O. W. Ferguson, 1903–4).—About 10½ miles N. 51° W. from Seguin, Tex., and about 8½ miles direct and 11 miles by road N. 80° E. from New Braunfels; upon the land of D. Tieken, upon high ground, in an open field. The reference mark is at a corner of the fence and at the south edge of the field and north edge of the brush, 0.6 of a meter north and 0.17 of a meter west of the corner post. Distances and azimuths to various points are: To reference mark, 114.112 meters, in azimuth 223° 26′ 50″; to the chimney of Christian Brown's house, about 1¼ miles, in azimuth 133° 51′ 46″; to the chimney of D. Tieken's house, about 700 meters, in azimuth 256° 19′ 15″. (Note 1, p. 269, except the lower pipe is only 6 inches long.)

Seguin West Base (Guadalupe County, Tex., S. Forney, 1899; A. L. Baldwin, 1900; William H. Burger, 1903).—About 6½ miles by road southeast of New Braunfels, about two-thirds of a mile south of the Seguin and New Braunfels road, on land owned by Mrs. Henry Steinmeier, living a half mile east; on a small rise in small mesquite brush about 250 meters S. 20° W. (magnetic) from the southwest corner of the cotton field of Mrs. Steinmeier, and 130 paces at right angles (east) from the fence line leading from above-mentioned corner southward to Guadalupe River which is about a fourth of a mile distant; the fence line meets the lane which runs to a small boat ferry across the river. Distances and azimuths to various points are as follows: To the reference mark, 23.80 meters south; to the flagstaff on the court-house at New Braunfels, 129° 51′ 47″; to the north gable of Peter Scheler's house, three-eighths of a mile, 222° 12′ 08″; to the south gable of Mrs. Steinmeier's house, a fourth of a mile, in azimuth 263° 58′ 44″; to the west gable of Frankfort school, a half of a mile, 269° 20′ 14″. The reference mark is 1 foot lower than the station and has no nail at the center. The station marks were put in position when the base was located. Below the surface a limestone block, 6 by 6 inches in cross section and 1 foot long, was set in concrete with its top 4 feet below the surface. Into the top surface of this post a copper bolt was secured, and the center of the station (underground) is a millimeter hole in this bolt. At the surface a hard limestone block, 23 by 23 inches and 16 inches high, weighing 700 pounds, set in a mass of concrete 4 feet square and 4 feet deep, carries at the center of its top surface a bronze station mark, the millimeter hole in the center of which marks the end of the base. These station marks are made of a composition of copper and brass and have a shank 76 millimeters long, with a slit in its lower end into which a brass wedge is inserted, so that when the bolt is driven home it bulges out at the bottom of the hole, which is made larger there than at the top, and in this manner is securely fastened in place. The top of the station mark is 80 millimeters in diameter, with an inner circle (countersunk) 37 millimeters in diameter. The letters "U. S. C. & G. S." are cast on the space between the inner and outer circles. Between the bottom of the surface monument and the bolt marking the point below the surface there is an earthenware drainpipe 7 inches in diameter and 25 inches long. This drainpipe is embedded in the upper mass of concrete and covered with a piece of galvanized iron to prevent anything from falling on the underground mark.

The reference mark is as described in note 1, page 269.

Mission (Comal County, Tex., William H. Burger, 1903).—On Mission Hill, 3 miles by road west of New Braunfels, on land owned by Frank Careth, about 40 paces N. 5° W. (magnetic) of the northwest corner of his house on the top of the same hill. It is identical with the U. S. G. S. △ Mission Hill, and is marked with their usual pipe which projects 0.85 feet above the ground. The tower is to be boarded up and used as a granary by Mr. Careth. The reference mark, about the same elevation as the station, is close to the fence line on the top of the hill, 2.2 feet west from the fence and 5.8 feet and 7.9 feet north and south, respectively, from two large trees near the tower to which the fence is nailed. Distances and azimuths to various points are as follows: To the reference mark, 6.493 meters, S. 22° 45′ E. (magnetic); to the south gable of Frank Careth's house, about 50 paces, 0° 40′ 33″; to the flag pole on the court-house at New Braunfels, 2½ miles, 288° 09′ 01″; to the standpipe of the city water tower, New Braunfels, 2½ miles, 295° 38′ 01″. The reference mark was like the mark described for the center in note 1, page 269, except the lower pipe was only 6 inches long.

Seguin East Base (Guadalupe County, Tex., S. Forney, 1899; A. L. Baldwin, 1900; O. W. Ferguson, 1903–4).—About 9 miles S. 77° E. from New Braunfels and about 9 miles N. 12° W. from Seguin, Tex.; three-fourths mile east of the New Braunfels and Beckman Gin road, upon the old Henry Loefge, sr., farm now owned by William Loefge, who lives 2 miles north; in a mesquite pasture, about 130 feet east of a cluster of large live oak trees and about 80 meters northwest of the "tank" or pond for watering stock. The reference mark is at the northwest corner of this pasture, 0.69

meter east of the west fence and 0.66 meter south of the north or lane fence. Distances and azimuths to various points are as follows: To the reference mark, 260.977 meters, in azimuth 113° 02′ 44″; to the chimney at the west end of H. Bading's house, about 1 400 meters, in azimuth 344° 50′ 1.1″; to the chimney of N. Braunholze's house, about 1 100 meters, in azimuth 16° 08′ 28″; to the chimney on the north side of H. Henze's house, about 300 meters, in azimuth 108° 42′ 17″. The station was marked in the same way as Seguin West Base, except the underground mark was a copper bolt cemented into the natural sandstone rock about 32 inches below the surface. The mass of concrete in which the capstone was set was kept clear of the bolt by means of a box 9 inches square.

Mott (Guadalupe County, Tex., O. W. Ferguson, 1903–4).—Two miles north of the court-house in Seguin and 1 mile north of the Southern Pacific Railroad depot, on the west side of the Seguin and Geronimo wagon road, 1.29 meters east of the wire fence on the west side of the road. The reference mark is at the wire fence on the east side of this road. Distances and azimuths to various points are as follows: To the reference mark, 17.842 meters, in azimuth 272° 03′ 12″; to the west tile chimney of Mrs. Schrom's house, about three-fourths mile, in azimuth 5° 02′ 55″; to Mrs. Wagner's windmill tower in a prominent cluster of live oak trees, about 300 meters, in azimuth 204° 18′ 15″; to the brick chimney of a house, about 450 meters, in azimuth 282° 51′ 48″. (Note 1, p. 269.)

Bear (Comal County, Tex., William H. Burger, 1903).—Ten miles by road northwest of New Braunfels, 1 mile south of Bear Creek, and one-fourth mile east of the New Braunfels, Bear Creek and Northwestern wagon road; on a hill covered with cedar, live oak, and plenty of rock, in a pasture belonging to the Borcher brothers, one of whom, Charles, lives about 3 miles southeast on the road to New Braunfels; about one-fourth mile east of the road from the top of the ridge where the gate gives entrance to the pasture. The lowest part of a large "basin" on the southeast side of the hill is about directly in line to Mission Hill. Almost due east on the opposite side of a large "draw" about a half mile distant is a large spot on the side of the hill, noticeable because of its being almost devoid of trees. The reference mark is on the highest point of a large stone projecting about 8 inches above the surrounding rock; it is 1.8 feet lower than the station and is witnessed by three nails driven into a blaze 2 feet from the ground on about the largest cedar tree at the south edge of the brow of the hill. This tree is S. 12° W. (magnetic) 7.97 meters from the reference mark. Distances and azimuths to various points are as follows: To the house of Charles Arnold, 4 miles, 354° 39′ 33″; to Mission Valley Church spire, 5 miles, 347° 19′ 50″; to the barn of Albert Hartwig, 5½ miles, in azimuth 340° 14′ 08″; to the reference mark, 22.864 meters, 339° 43′ 58″. (Note 3, p. 269.)

Herndon (Guadalupe County, Tex., William H. Burger, 1903–4).—About 2½ miles east of south of Marion, on the Southern Pacific Railroad; one-eighth mile south of the Marion and Seguin wagon road, in a pasture belonging to Mr. Krueger, who lives about 6 miles north of Marion; on top of the hill known as Herndon Hill, covered with trees 20–30 feet high; at the south side of a slightly cleared space, south of the old road to the top of the hill. The station was marked according to note 1, page 269, except that there was no reference mark. Trees were marked as follows: A 6-inch hickory 25 feet high, bearing S. 40° 15′ E. (magnetic), 14.02 meters distant, by 3 nails in a blaze, 2 feet from the ground; an 8-inch hickory about 18 feet high, bearing N. 66° W. (magnetic), 16.36 meters distant, and just a few feet north of the old road, by a nail in the center of a triangle, 3½ inches on a side, cut in a blaze, 2 feet from the ground; an 8-inch scrub oak about 12 feet high, north of the station and across the road, at the east side of the small clearing, bearing N. 5° 30′ W. (magnetic), and 30.92 meters distant, by 3 nails in blaze 2½ feet from the ground. Herndon Hill, U. S. G. S. △ (see p. 277), is 4.309 meters, S. 58° 30′ E. from the station.

Central (Guadalupe County, Tex., O. W. Ferguson, 1903).—About 6½ miles S. 50° W. from Seguin, about 125 meters north of the "South road" leading from Seguin to San Antonio; in a mesquite pasture, on land belonging to Mrs. Heinrich Beoker. The reference mark is between two large mesquite trees, 24.556 meters from the station, in azimuth 152° 23′ 11″. These trees were marked by triangles cut into them, one about 1 foot in diameter, distant from the reference mark 1.831 meters northeast; the other about 7 inches in diameter, distant 1.784 meters southwest from the reference mark. The chimney of a house about 800 meters distant is in azimuth 17° 11′ 22″. The chimney of Mrs. Beoker's house, 140 meters distant, is in azimuth 128° 22′ 06″. The east gable of Mrs. Beoker's new barn at the end of the ridge about 100 meters distant is in azimuth 141° 13′ 39″. (Note 1, p. 269.)

Thomas (Guadalupe County, Tex., William H. Burger, 1903–4).—Eleven miles by road S. 15° E. from Seguin, the nearest railroad town; 270 paces N. 62° E. (magnetic) from Thomas Springs (only a water hole), well known for miles around; just inside the pasture of William Brodt, of Seguin, near the gate giving entrance to the pasture and the road leading to the house of William Oliver, who lives about one-fourth mile east; 74 paces S. 65° E. (magnetic) from the northwest corner post of the pasture. The hill is cleared, except for large trees, to the north and the west pasture fences in the neighborhood of the station; fine white sand is in abundance. The reference mark, which has no nail to mark the point, is about 1½ feet north of the north fence line to the pasture; 82 paces east along fence line from the northwest corner near the gate, 50.873 meters N. 10° E. (magnetic) from the station and about one-half foot higher (in elevation) than the station. The west gable of James Pruitt's house is in azimuth 82° 18′ 20″; and the west gable of William Oliver's house, 273° 27′ 14″. (Note 1, p. 269.)

Lavernia (Wilson County, Tex., O. W. Ferguson, 1904).—About 3¾ miles southwest by road from Lavernia; on the southern end of a sand ridge covered with oak and hickory trees and brush; in the Howard pasture. Distances and azimuths of various objects are as follows: Three post-oak trees near the station, deeply marked with 6-inch triangles on the sides facing the station, one 11 inches in diameter, 16.33 meters, 292°; one 7 inches in diameter, 15.63 meters, 336°; one 16 inches in diameter, 5.02 meters, 92°; the reference mark, 30.071 meters, 158° 50′ 13″; a large stone chimney of a dwelling house beyond Lavernia, about 4 miles, 222° 38′ 39″; another stone chimney of a dwelling house, about 3 miles, 73° 37′ 22″. (Note 1, p. 269.)

Shingle Hill, U. S. G. S. (near Travis and Hays county line, Texas; U. S. Geological Survey; W. H. Burger, 1903).—Near Shingle △ (p. 271). Marked by a cross and the letters U. S. G. S. cut on a large flat rock.

Shovel Mountain, U. S. G. S. (Blanco County, Tex., U. S. Geological Survey; W. H. Burger, 1903).—Near Shovel △ (p. 270). Marked by a large cairn of loose rock about 10 feet high and 4½ feet in diameter. A smaller cairn placed also by the U. S. Geological Survey is on the east edge of the mountain about three-eighths mile distant.

Cedar Hill, U. S. G. S. (Hays County, Tex., U. S. Geological Survey; O. W. Ferguson, 1903).—Near Cedar △ (p. 271). Marked by a rough flat stone about 1 foot square, the top 2 inches below the average surface of the ground and marked with a cross and the letters U. S. G. S.

Herndon Hill, U. S. G. S. (Guadalupe County, Tex.; U. S. Geological Survey; W. H. Burger, 1903).—Southeast of Herndon △ (p. 275), and 2 feet west of an old dead tree. Marked by the usual iron pipe of the U. S. Geological Survey projecting 2 feet above the ground. Found in good condition in 1903.

Austin Latitude Station (Travis County, Tex.; William Eimbeck, 1872).—Near the northeast corner of the public reservation, bounded on the north by College avenue, on the west by Brazos street, on the south by Mulberry street, and the east by an alley, and occupied (1872) by the General Land Office of the State of Texas, but in 1895 reported as practically in New Brazos street. It was marked by a pier of cut-stone masonry, 16 by 22 inches, upon a rubble-masonry base extending 30 inches below the surface of the ground and resting on a solid layer of gravel. This pier forms the southern monument of the meridian line.

Austin North Meridian (Travis County, Tex., William Eimbeck, 1872; E. Smith, C. H. Sinclair, and G. R. Putnam, 1895; J. E. McGrath, 1899; G. C. Baldwin, 1903).—On Capitol Hill; a cross on the copper bolt in the center of the top of the square stone pillar marking the north end of the meridian line established in 1872.

Austin Longitude Station (Travis County, Tex., E. Smith, C. H. Sinclair, and G. R. Putnam, 1895; E. Smith and J. E. McGrath, 1899).—In the grounds on the east side of the Capitol; marked by a pier.

COMPUTATION, ADJUSTMENT, AND ACCURACY OF ELEVATIONS.

The zenith distances directly observed at each station were first computed and were corrected for height of object observed and of instrument, so as to refer them all to the station marks.

The difference of elevation of each pair of stations in the main scheme where zenith distances had been observed was then computed from the observations over the line joining them by the formula

$$h_2 - h_1 = s \tan \tfrac{1}{2} (\zeta_2 - \zeta_1) \left[1 + \frac{h_2 + h_1}{2\rho} + \frac{s^2}{12\rho^2} \right]$$

in which h_2 and h_1 are the elevations of the stations, ζ_2 and ζ_1 are the measured zenith distances, s is the horizontal distance between the stations, and ρ is the radius of curvature.

As there were always two or more lines to each new station, many rigid conditions existed between the observed differences of elevation, even if the connections with the precise leveling were ignored, and the least square adjustment furnishes the readiest accurate means of deriving the required elevations.

The elevations of the stations of the main scheme from Travis and Shovel, at the north, to Lavernia and Thomas, at the south, with the exception of Carpenter and Krueger, were obtained from a single adjustment, as shown in the tabulation below.

The elevations of Barton, Seguin West Base and Seguin East Base were held fixed at 315.70, 189.09, and 181.87 meters, respectively, these being the elevations as fixed by precise leveling.*

In the following tabulation the observed differences of elevation treated in the adjustment are shown, together with their adjusted values. The weight, p, assigned to each observed difference of elevation is inversely proportional to the square of the length, s, of the line between stations in meters and was conveniently computed by the formula $\log p = 9 - 2 \log s$. The observed difference of elevation is given the sign of the elevation of the second station named minus the elevation of the first. The quantity contained in the last column but one is the correction to be applied to an observed difference of elevation to obtain the adjusted difference of elevation.

Station 1	Station 2	Weight p	Observed diff. of elev. h_2-h_1	Adjusted diff. of elev. h_2-h_1	Adj.—Obs. v	pv^2
Travis	Shovel	1.51	+ 74.73	+ 74.39	−0.34	0.175
Shovel	Shingle	2.23	− 38.12	− 38.35	−0.23	0.118
Travis	Barton	1.30	− 80.33	− 79.93	+0.40	0.208
Barton	Cedar	3.51	+ 39.58	− 39.55	−0.03	0.004
Shingle	Loneman	1.58	+ 2.17	+ 1.59	−0.58	0.531
Cedar	Shingle	2.89	+ 76.55	+ 76.42	−0.13	0.049
Cedar	Loneman	3.09	+ 77.92	+ 78.01	+0.09	0.025
Loneman	Hugo	3.88	− 31.53	− 31.69	−0.16	0.101
Hugo	Bear	2.92	− 36.84	− 37.06	−0.22	0.140
Gus	Bear	6.92	+ 41.65	+ 41.63	−0.02	0.000
Gus	Tieken	5.06	−101.97	−101.97	0.00	0.000
Gus	Mission	6.07	− 27.03	− 27.06	−0.03	0.006
Gus	Seguin East Base	3.10	−141.12	−141.01	+0.11	0.037
Gus	Seguin West Base	3.12	−133.82	−133.79	+0.03	0.003
Bear	Mission	11.83	− 68.62	− 68.69	−0.07	0.059
Mission	Seguin West Base	6.62	−107.00	−106.73	+0.27	0.483
Tieken	Mission	3.86	+ 74.74	+ 74.91	+0.17	0.112
Tieken	Seguin West Base	12.11	− 31.69	− 31.82	−0.13	0.206
Tieken	Seguin East Base	48.87	− 39.04	− 39.04	0.00	0.000
Seguin West Base	Bear	2.28	+175.44	+175.42	−0.02	0.000
Tieken	Mott	5.37	− 43.73	− 43.61	+0.12	0.075
Seguin East Base	Mission	3.40	+113.30	+113.95	+0.65	1.435
Seguin East Base	Mott	11.89	− 4.47	− 4.57	−0.10	0.119
Seguin East Base	Herndon	2.83	+ 32.41	+ 32.48	+0.07	0.014
Seguin West Base	Herndon	5.65	+ 25.27	+ 25.26	−0.01	0.000
Seguin East Base	Central	3.20	+ 19.18	+ 19.40	+0.22	0.154
Mott	Seguin West Base	8.36	+ 11.78	+ 11.79	−0.01	0.000
Mott	Herndon	4.13	+ 37.14	+ 37.05	−0.09	0.033
Mott	Central	8.43	+ 24.01	+ 23.97	−0.04	0.017
Mott	Thomas	2.75	+ 50.11	+ 50.08	−0.03	0.003
Central	Herndon	16.14	+ 13.17	+ 13.08	−0.09	0.129
Central	Thomas	4.97	+ 25.94	+ 26.11	+0.17	0.144
Central	Lavernia	1.59	+ 35.90	+ 36.52	−0.62	0.611
Lavernia	Thomas	1.87	− 9.99	− 10.41	−0.42	0.329
Lavernia	Herndon	1.52	− 24.59	− 23.44	+1.15	2.009

*See Appendix 7, Report for 1904, pages 438–439.

The probable error of an observation of weight unity derived from the adjustment is ±0.41 meter. In other words, the reciprocal observations over a line 31.7 kilometers (19⅔ miles) long, this being the length of the line corresponding to unit weight, determined the difference of elevation of two points with such a degree of accuracy that it is an even chance whether the error is greater or less than 0.41 meter. The probable errors for lines of other lengths were assumed to be proportional to their lengths.

The probable errors of the elevations of the three stations fixed by precise leveling are about ±0.04 meter. The probable error approaches this value for stations adjacent to those fixed by precise leveling and is greatest for the most remote stations. Station Shovel was assumed to be the one least accurately determined, and its probable error was therefore computed as a limiting value and was found to be ±0.30 meter from the vertical angle measures alone, and when combined with the probable error of the elevations fixed by the spirit leveling, it was not changed.

In other words, for the least accurately determined station in this portion of the main scheme, there is an even chance that the elevation is correct within 0.30 meter, or 0.98 foot, and for most of the stations in the main scheme the accuracy is greater than this.

The elevations of the stations May and Gabriel had been fixed by the vertical angles measured in the Lampasas base net.* The elevations of the stations Post, Buzzard, Carpenter, and Krueger were fixed by observations in both directions over a single line only; hence, these stations do not appear in the adjustment.

TABLE OF ELEVATIONS.

The datum for all the elevations is mean sea level.

The stations are in three classes: First, those fixed directly by the spirit leveling, and of which the elevations are subject to a probable error of ±0.04 meter; second, the stations in the main scheme fixed by reciprocal measures of vertical angles and which are subject to probable errors varying from ±0.1 to ±0.3 meter, and third, the intersection stations, of which the elevations are fixed by measurements of vertical angles which are not reciprocal, the intersection stations not being occupied, and whose elevations are subject to probable errors which may be as great as ±2 meters in some cases.

The accuracy with which each elevation in the main scheme is determined depends mainly upon the remoteness of that station from the nearest one of which the elevation is fixed by spirit leveling, as indicated in Class I of the following table. Station Shovel is probably least accurately determined of all the stations in the main scheme.

For a table to be used in converting feet to meters, or vice versa, see page 265.

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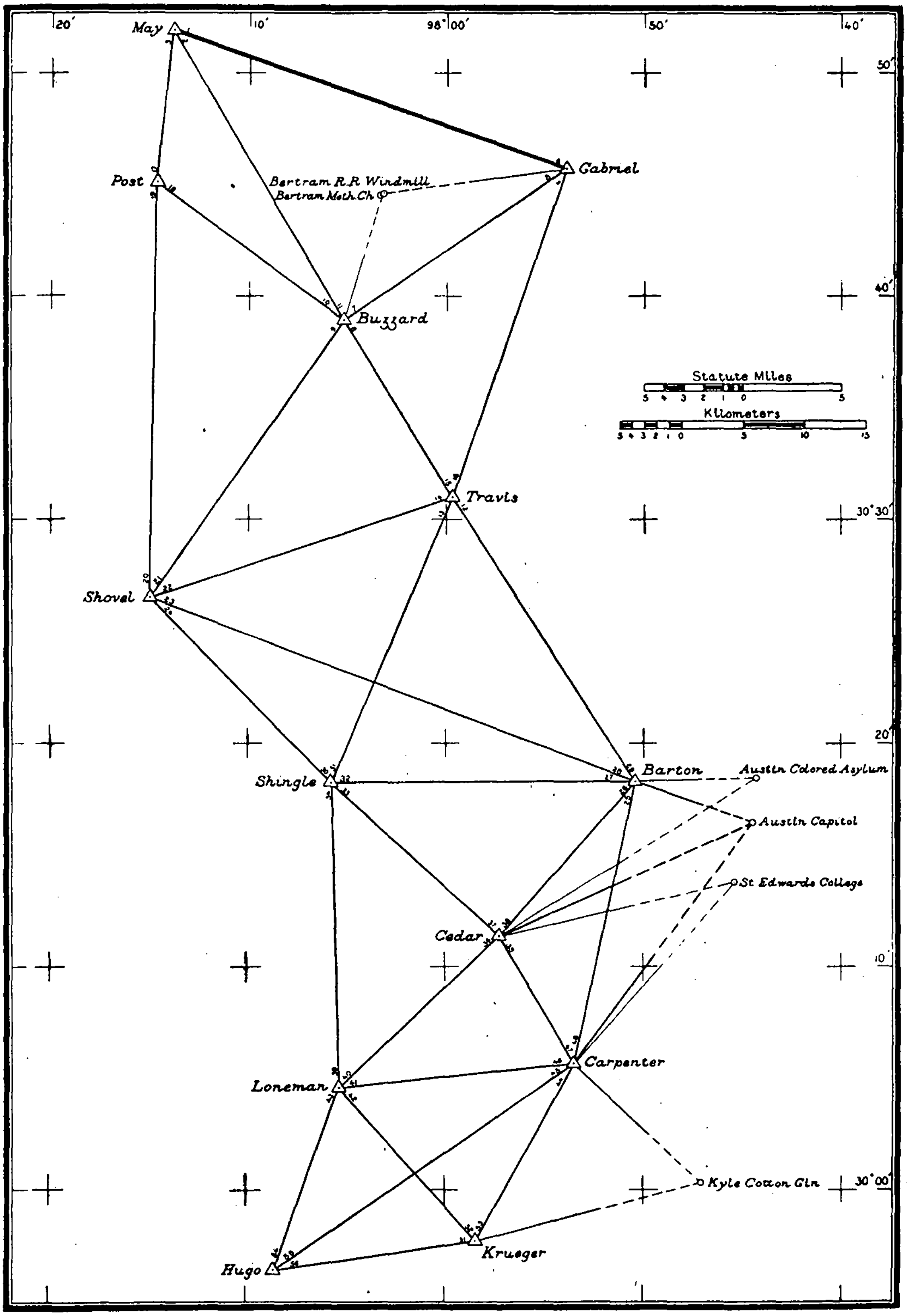
*See Appendix 4, Report for 1903, page 925.

Table of elevations.

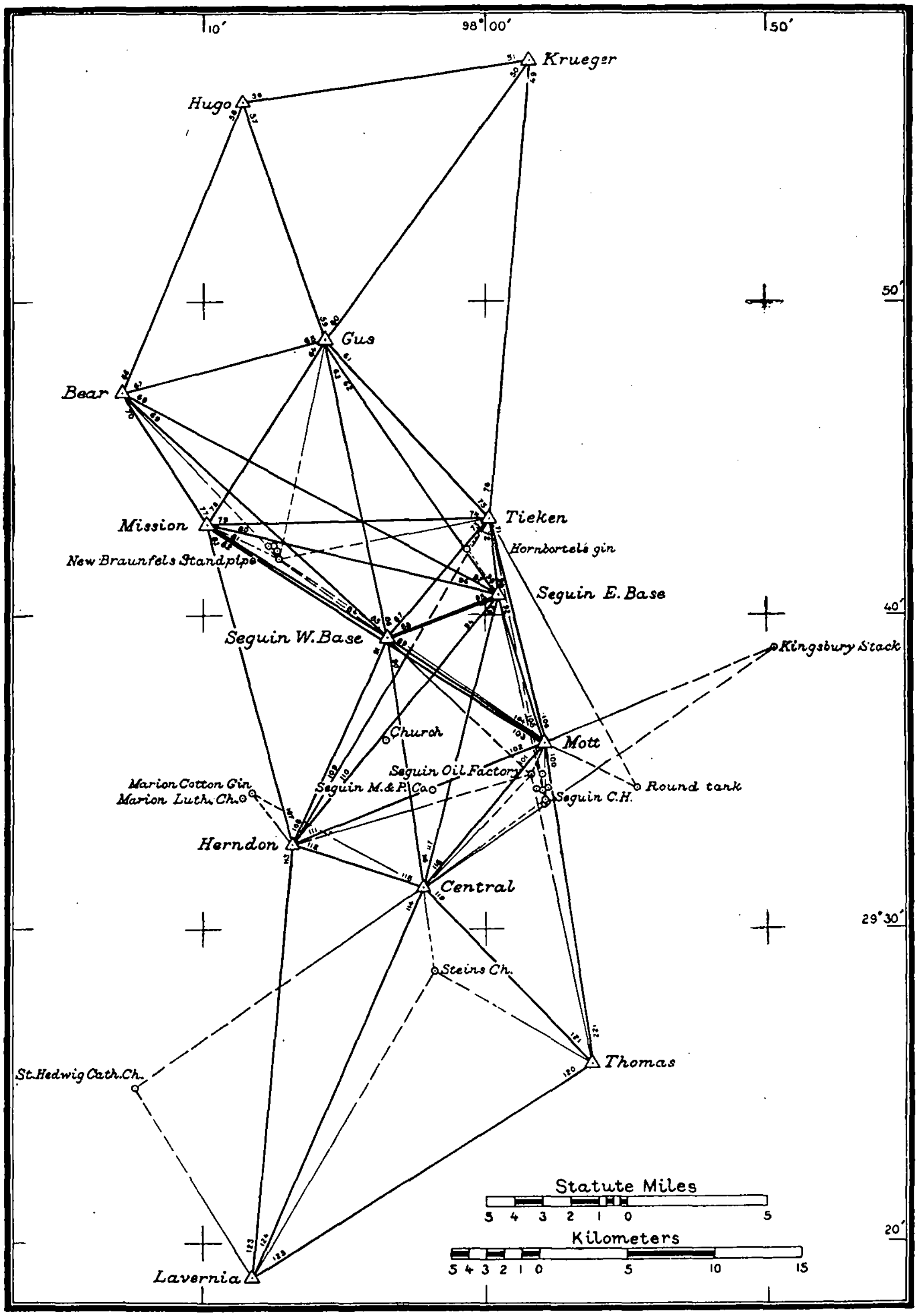
Stations	Point to which elevation refers	Elevations
Class 1		*meters*
Barton	Station mark	315.70
Seguin East Base	Station mark	181.87
Seguin West Base	Station mark	189.09
Class 2		
May	Station mark	466.7
Gabriel	Station mark	368.3
Travis	Station mark	395.6
Shovel	Station mark	470.0
Shingle	Station mark	431.7
Cedar	Station mark	355.2
Loneman	Station mark	433.3
Hugo	Station mark	401.6
Gus	Station mark	322.9
Bear	Station mark	364.5
Mission	Station mark	295.8
Tieken	Station mark	220.9
Mott	Station mark	177.3
Herndon	Station mark	214.4
Central	Station mark	201.3
Thomas	Station mark	227.4
Lavernia	Station mark	237.8
Post	Station mark	471.1
Buzzard	Station mark	432.0
Carpenter	Station mark	270.1
Krueger	Station mark	303.8
Class 3		
Austin, Capitol	Star in hand of Liberty	259.0
Bertram Railroad Windmill	Center of wheel	398.4
Bertram Methodist Church, spire	Top of cone	400.0
Austin Colored Asylum	Top of standpipe	221.4
Austin Colored Asylum	Dome at south end	215.3
Hornbortel's Gin	Top of stack	174.9
New Braunfels Catholic Church	Top of spire	230.0
New Braunfels Spire, square massive base, slim cone, silver ball on top		223.0
New Braunfels Court-House	Top of tower	216.9
New Braunfels Standpipe		224.1
Kingsbury, tall stack with cross *		202.5
Church, red spire, north end of building	Top of cone	187.5
Round Tank, light colored		174.9
Marion Lutheran Church	Top of spire	209.8
Marion, Schultz & Dreyer's Cotton Gin	Top of smokestack	211.3
Seguin Oil Factory	Top of tall water tower	193.7
Seguin Schoolhouse, quite high spire, short tower, two collars	Top of spire	182.9
Seguin Court-House	Spire	184.0
Seguin Standpipe		191.1
Seguin, Zanke's Cotton Gin	Top of tall brick smoke-stack	183.3
Seguin Cotton Compress Building	Top	183.1
Seguin Milling and Power Company	Top of water tank	183.6
Seguin Catholic Church, high, sharp spire	Point of cone	178.5
Steins Church	Spire	193.7
St. Hedwig Catholic Church	Top of heavy stone tower	202.7

* No check on this elevation.

Index to positions, descriptions, and elevations.



LAMPASAS BASE NET TO HUGO-KRUEGER.



HUGO-KRUEGER TO SEGUIN BASE.

APPENDIX 6

REPORT 1905

LONG WIRE SWEEP

By D. B. WAINWRIGHT
Assistant

LONG WIRE SWEEP.

By D. B. WAINWRIGHT, *Assistant.*

There are some areas along our coasts which have plenty of water for deep-draft vessels but which can not be pronounced absolutely safe for navigation owing to the fact that pinnacle rocks, coral rocks, or ledges of small area have been found there as a characteristic feature. No matter how closely these areas may have been surveyed with lead and line, there is still a possibility of the existence of hidden dangers which have not been charted. This uncertainty is an inherent defect in the method.

As a remedy a Harbor and Channel Sweep was devised and has proved highly satisfactory for channels and anchorages; but as it covers in a traverse a width of only 65 feet its employment for completely sweeping large areas, like Frenchmans Bay, Maine, could not be entertained. Some other construction which would accomplish the desired result within a reasonable time was needed.

The French Hydrographic Service has used a long rope sweep supported at intervals by buoys, but the most promising form for a sweep is one briefly described in the Report of the Chief of Engineers, U. S. Army, 1903.

Starting with the latter as a basis, the sweep used in Frenchmans Bay was developed.

The length of the horizontal dragging wire of the sweep is 1 000 feet, and it is supported at the desired depth by three large buoys, one at each end and one in the middle, and at intermediate points, at intervals of one hundred feet, by small buoys. The drag wire and the wires attaching the buoys were all of galvanized No. 12 American gauge.

The buoy wires were attached to the drag wire by swivels, and a swivel was also put in every 50 feet to overcome the tendency of the wire to twist into kinks. Shackled to the lower end of each of the large buoy wires were two cast-iron balls (deep-sea sinkers), each weighing 63 pounds. To the small buoy wires 9-pound sounding leads were attached by snap hooks.

The top cone of each of the small buoys was provided with a socket to carry a small flag stick with a flag. Around the top of the flag stick was wrapped a pound of sheet lead. This was for the purpose of capsizing the buoy when its wire was slackened by the drag wire striking an obstruction and thus giving notice of the presence of a danger to navigation.

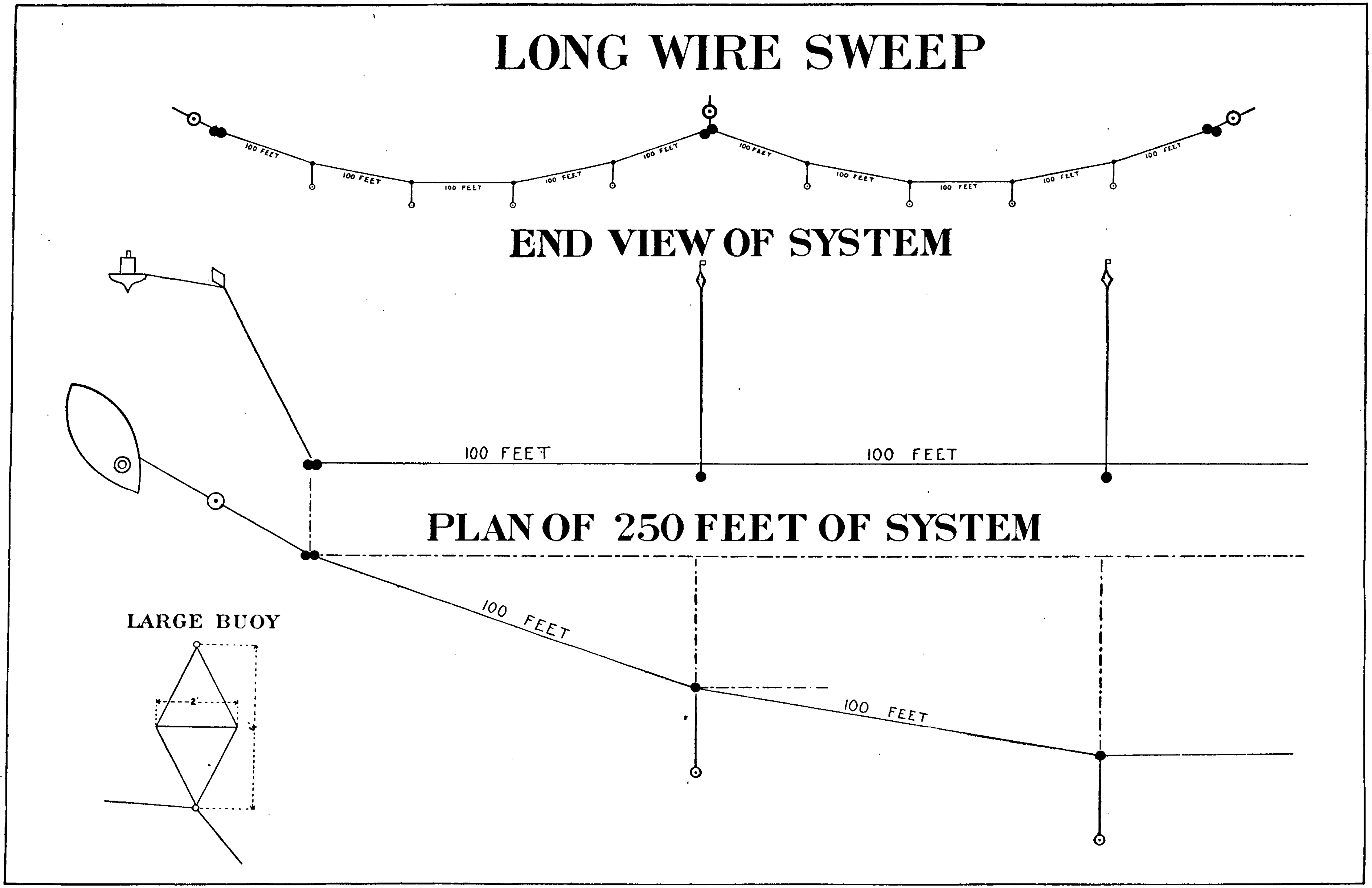
In operation three launches were used, and the one attached to the center buoy by a 50-foot line, towed straight ahead in the direction it was desired to drag over, and was kept on this course by observing sextant angles for position and plotting the same on a hydrographic boat sheet. The two other launches were attached to the ends of the drag by a 25-foot towline, and each directed its course so as to keep a specified strain on the towrope, as indicated on a spring balance attached to the latter, and at the same time make good a course that would be parallel to that of the middle launch. Position angles were observed with sextants on the end launches at regular intervals. These positions were plotted on the smooth hydrographic sheet and were used for drawing the path swept over by the drag. A sharp lookout for any unusual behavior of the buoys was kept up on the launches, and a patrol boat followed with spare buoy, anchor, and line to mark, for future development, any shoal spot indicated by the drag in the course of the day's work.

In Frenchmans Bay the rate of speed adopted was from 1½ to 2 nautical miles an hour, and the pull for each end launch 125 pounds. This pull represented the resultant of the tension necessary to keep a half of the system at a certain curve and carry it ahead through the water at the required speed. The angle of the towrope with the general direction of one-half of the system corresponded with that of a diagonal of a parallelogram of forces, the tension and speed through the water being taken as the components. This angle was computed in advance and, together with the pull indicated on the spring balance, served to determine the course to be steered by the launch.

When not in use the buoy wires were kept wound up on one reel and the drag wire on another. When the drag was set from a steamer or cutter, a buoy wire and one set of heavy weights were attached to the end of the drag wire and lowered slowly overboard until the upper end of the buoy wire was unreeled. One of the large buoys was then attached and lowered into the water, a small boat taking it in tow, carrying it away from the vessel. The drag wire was now paid out until the shackle for the first small buoy wire was reached. The latter and one of the 9-pound leads were snapped on to the shackle and the paying out continued until the upper end of the buoy wire was unreeled, when a small buoy was hooked on and dropped overboard.

The paying out was again continued, the weights and buoys, small and large, being attached in their proper sequence. The launches then took charge of the system and it was towed along endwise until the center launch reached the beginning of the line to be traversed, when the end launches took up their proper positions according to directions signaled from the center launch. The start was then made, and thereafter the end launches were maintained in their proper relative positions by a suitable code of signals given from the center launch.

To maintain the necessary transverse tension on the system and at the same time carry the system through the water at the required speed or its equivalent—maintain the tow rope at the proper angle while the spring balance indicated the specified pull—the end launches head out or away from the center launch. Should one of the ends of the sweep be observed to be in advance of its proper position, the launch having it in tow is given the proper signal, and it responds by heading still farther away from the center launch, thus slowing down that end. If, on the contrary, the end is falling behind, the launch heads in on a course more nearly parallel with the center launch, which has the effect of increasing the rate of speed of that portion of the system, at the expense of the transverse tension. This control of the end launches is a necessary feature, as the wind and tidal currents have more or less effect on the movements of the system.


LONG WIRE SWEEP
100 FEET
100 FEET
100 FEET
100 FEET
100 FEET
100 FEET
100 FEET
100 FEET
100 FEET
100 FEET
END VIEW OF SYSTEM
100 FEET
100 FEET
PLAN OF 250 FEET OF SYSTEM
LARGE BUOY
2'
100 FEET
100 FEET

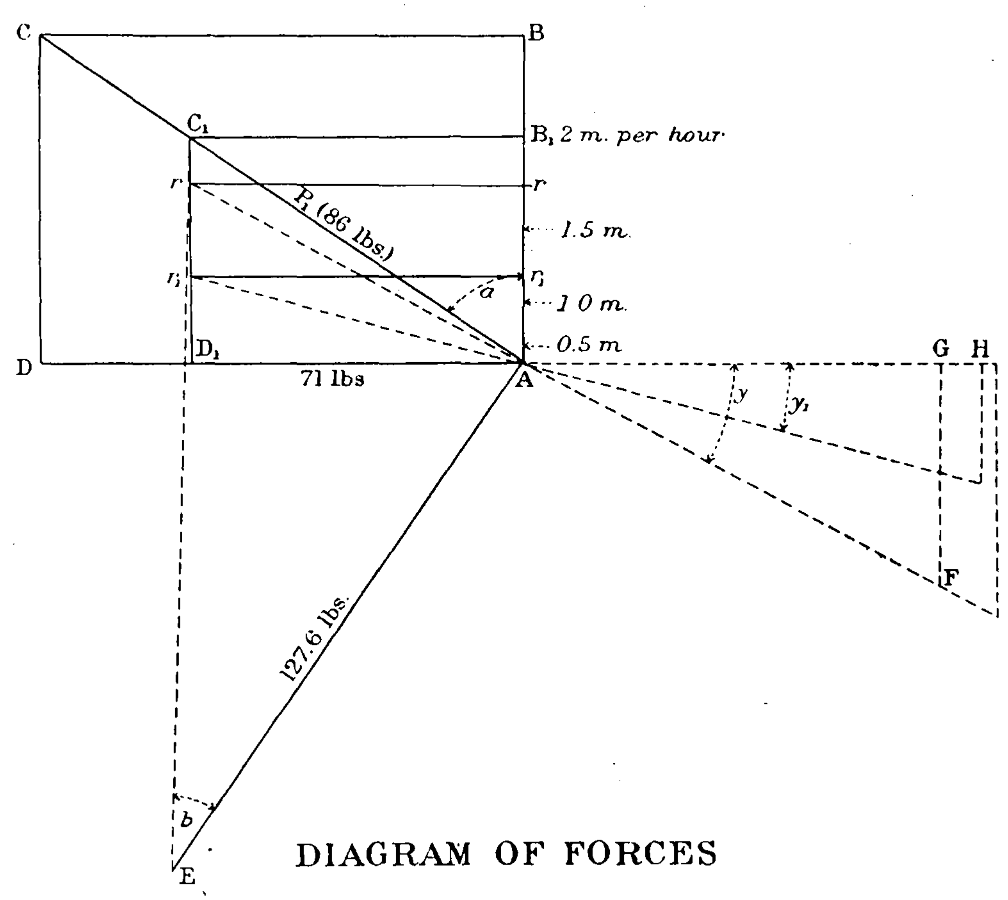


DIAGRAM OF FORCES

DESCRIPTION IN DETAIL.

Wire, galvanized No. 12, American gauge; diameter, 0.08 inch; weight per linear foot, 0.017 pound. The length used for buoy wires was 49 feet (0.83 pound). This length was determined, first, by the depth at mean low water it was desired to have absolute certainty as to hidden dangers, namely, 35 feet; second, the allowance for range of tide; third, the allowance for lift of weights due to pull of towrope. The total length of drag wire was 1 000 feet. This was divided into 50-foot sections, for, besides being connected by swivels to a shackle every 100 feet where the buoy wires were fastened, there was also an intermediate swivel, to avoid kinks.

End and center buoys.—Shape, double cone, each one 2 feet high and 2 feet in diameter at its base; weight, 30 pounds; volume, 4.19 cubic feet; displacement, 268.2 pounds in sea water; material, galvanized iron. They were strengthened by an inch flange at the junction of the two cones and a stay rod run through lengthwise. The latter was turned over at each end so as to form eyes.

Small buoys.—Double cone galvanized iron, 1 foot high and 1 foot in diameter; weight, 6.5 pounds; volume, 0.525 cubic foot; displacement, 33.5 pounds in sea water. Buoys strengthened by an inch flange at junction of cones. No stay rods. Socket soldered on at the upper end for a small flag stick. Eye soldered on at the lower end.

Weights.—For end buoys two 63-pound iron balls (deep-sea sounding sinkers) 8-inch diameter. For small buoys, 9-pound hexagonal sounding leads, 2 inches in diameter.

Weight supported by end buoys		Weight supported by small buoys	
	pounds		*pounds*
Weight of buoy	30.0	Weight of buoy	6.5
Weight of sinkers	126.0	Weight of sinker	9.0
50 feet drag wire, 49 feet buoy wire	1.7	100 feet drag wire, 49 feet buoy wire	2.5
		Swivels, shackles, etc.	2.0
Total	157.7	Total	20.0

With the above weights the buoys were submerged one-half. It may be stated that in case of emergency, and in a locality where the submerged rocks are not worn smooth, an effective drag could be constructed, if wire and swivels were on hand, by using oil barrels or boats for the larger buoys and 5-gallon kerosene oil or paint cans for the smaller ones.

APPENDIX 7

REPORT 1905

A PLANE TABLE MANUAL

By D. B. WAINWRIGHT
Assistant

CONTENTS.

PRELIMINARY STATEMENT.

INSTRUMENTS.

FIELD WORK.

ILLUSTRATIONS.

APPENDIX 7.

A PLANE TABLE MANUAL.

By D. B. WAINWRIGHT, *Assistant.*

PRELIMINARY STATEMENT.*

A topographic map is the delineation upon a plane surface, by means of conventional signs, of the natural and artificial features of a locality.

Every point of the drawing corresponds to some geographic position, according to some method adopted for representing the surface of the spheroid on a plane, which is called the *projection*.

Since it is a representation in miniature, the distance between any two points on the map is a certain definite fraction of the distance between the same points in nature. This ratio is called the *scale*.

Each point, besides being projected on a horizontal plane, has its elevation relative to a level surface, in some way indicated. The level surface adopted for the map is called the *datum plane*, and the representation of the variations in the vertical element, the modeling of the country, is called the *relief*.

CONTROL.

All topographic surveys of importance are based upon a system of triangulation.

A sufficient number of points, whose geographical positions have been determined by triangulation, properly distributed over the area to be surveyed, forms the framework for controlling the accurate location of the various details.

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* Advantage has been taken of the opportunity afforded by the preparation of a new edition of the Plane Table Manual to make a new arrangement of the "Three-point problem," with the intention of simplifying the description of the conditions found in practice and the several steps required for the graphic solution of the problem with the plane table according to Lehman's method. This method is the most rapid one, in the hands of an experienced topographer, but for those who may have only occasional use for a graphic solution Bessels's method or the tracing paper protractor method is recommended.

INSTRUMENTS AND ADJUSTMENTS.

THE PLANE TABLE.

The principal instrument in use by the Coast and Geodetic Survey for mapping details is the plane table. For this purpose it is a universal instrument. All the necessary operations for producing a map are executed with it in the field directly from the country as a model.

Other instruments are employed as auxiliaries to it under certain conditions, as will be seen later on under the head of "Field practice," but in general it fulfills all requirements alone.

Description (Illustration 1).—The plane table is composed of a well-seasoned drawing board* about 30 inches in length, 24 inches in width, and three-quarters of an inch thick, with beveled or rounded edges. It is commonly made of several pieces of white pine, tongued and grooved together, with the grain running in different directions to prevent warping. It is supported upon three strong brass arms, to which it is attached by screws passing through them and entering the underside of the board, the three holes for the reception of the screws being guarded by brass bushings and situated equidistant from each other and from the center of the table. By means of these screws the board can be removed at will.

The movements (Illustrations 1 and 2) of the tables in use by the Coast and Geodetic Survey are made from several different models, but as the principal features are the same in all designs the description of one type will suffice for all.

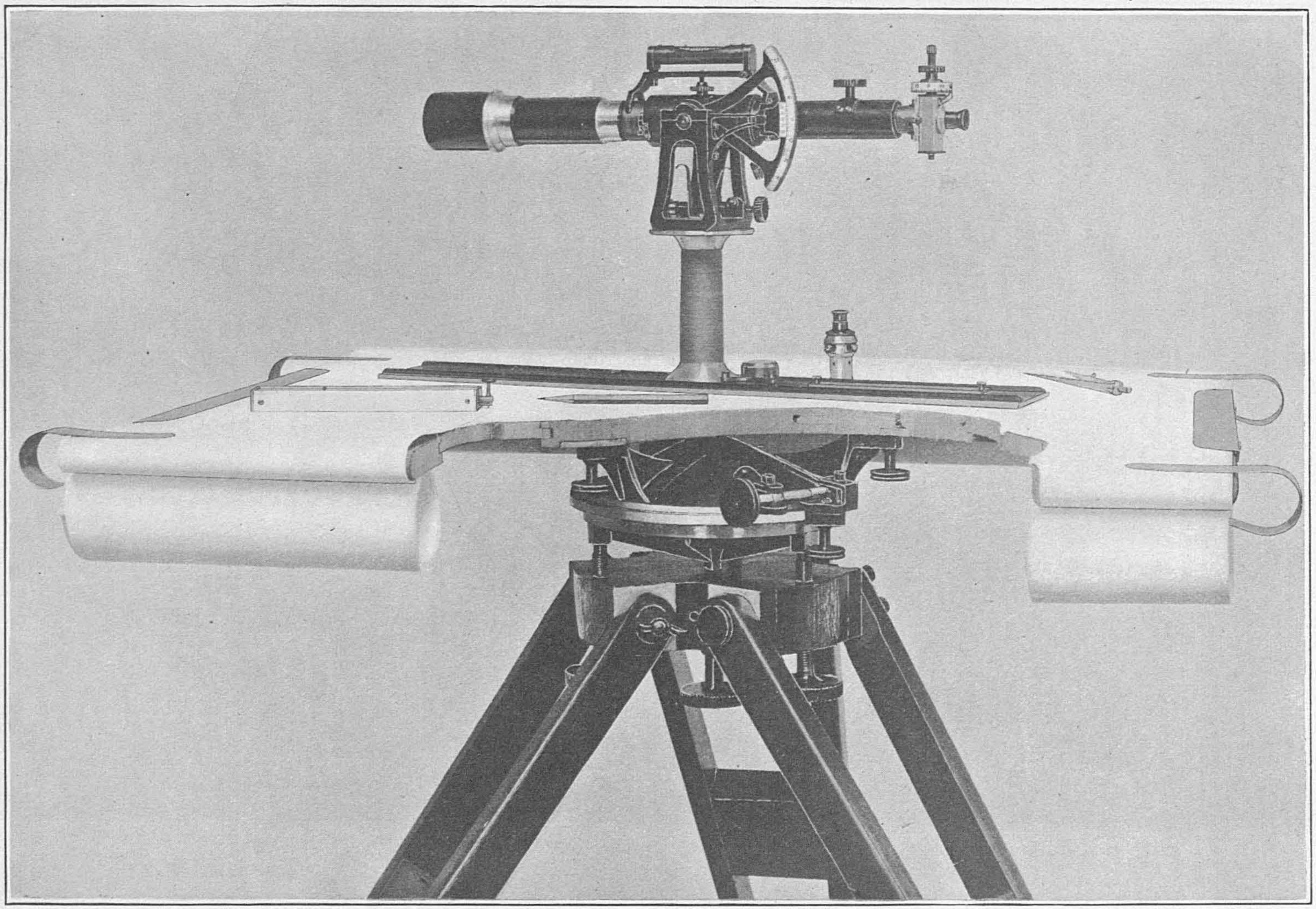
The arms to which the board is fastened rest upon the sloping upper face of a rather flat hollow cone of brass, to which they are permanently fixed. Upon its lower edge or periphery this cone is fashioned into a horizontally projecting rim, the inferior face of which is as nearly as possible a perfect plane, and this in its turn rests upon a corresponding rim of somewhat greater diameter projecting slightly beyond it. This second rim forms the upper and outer flange of a circular metal disk in the form of a very shallow cylinder. The inferior face or plane of the upper flange or rim has, at its contact with the superior face of the lower, a horizontal rotary movement about a common center which is also the center of the instrument, and the two are held together by means of a solid conical axis of brass extending upward from the center of the inner face of the lower disk. A socket of similar shape fits exactly over this axis, projecting downward from the inner side of the apex of the conical or upper disk. The two plates are held together by means of a screw with a milled head, capping the cone from the outside, and which can be loosened or removed at pleasure.

A tangent screw and clamp fastened to the edge of the upper rim permit, when loose, the revolution of the table about its center, and, when clamped to the lower limb, hold the table firm while the tangent screw gives a more delicate movement.

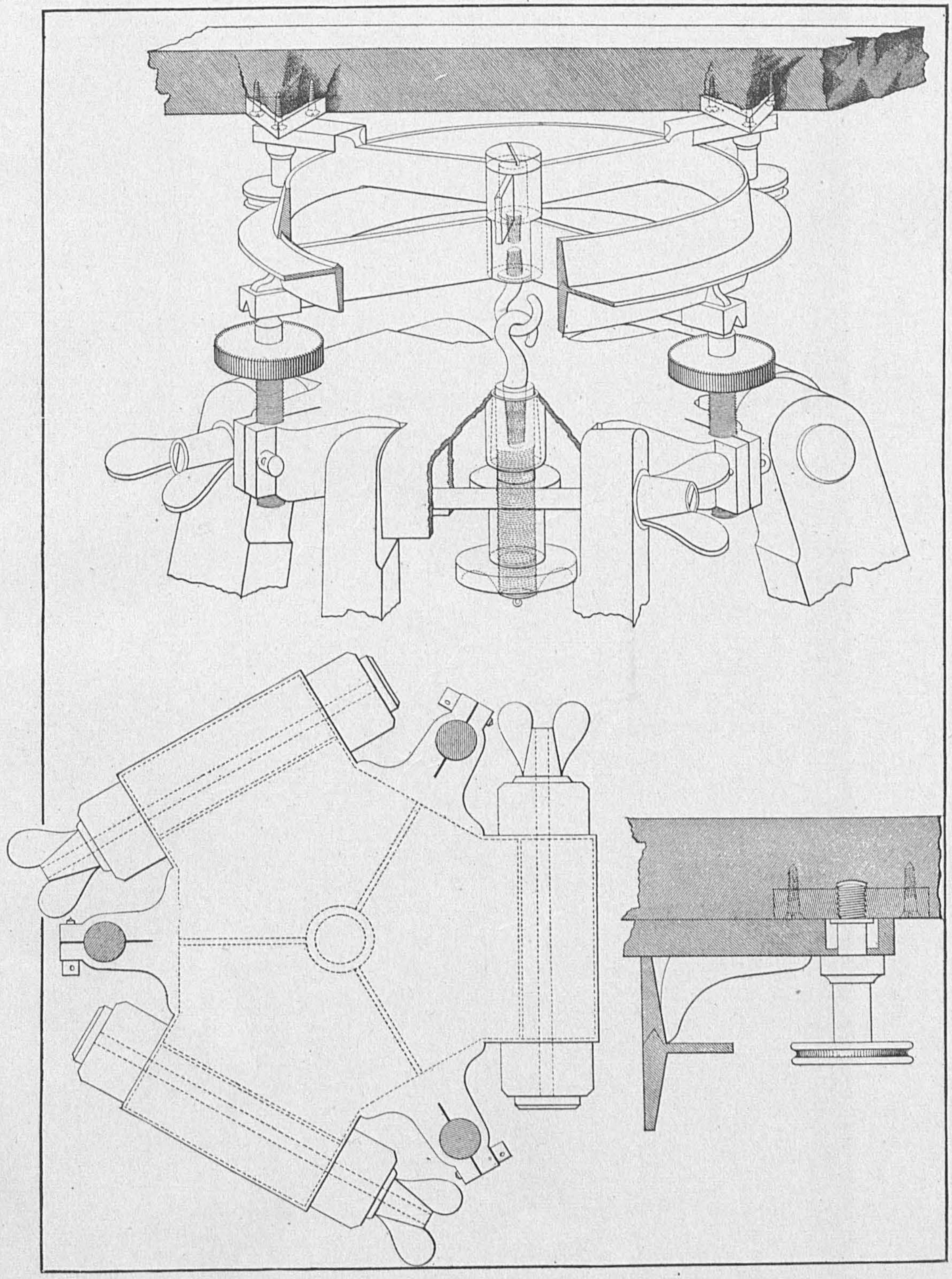
Three equidistant vertical projections of brass, grooved on the underside, and cast in one piece with the under face of the lower disk, extending from the periphery toward the center, rest upon the points of three large screws which come through a heavy wooden block below. This block, which is the top of the stand and is approximate in form to an equilateral triangle, is 2¼ inches thick when made of wood.

* It is contemplated having the board made of a special aluminum alloy.

NO. 1.

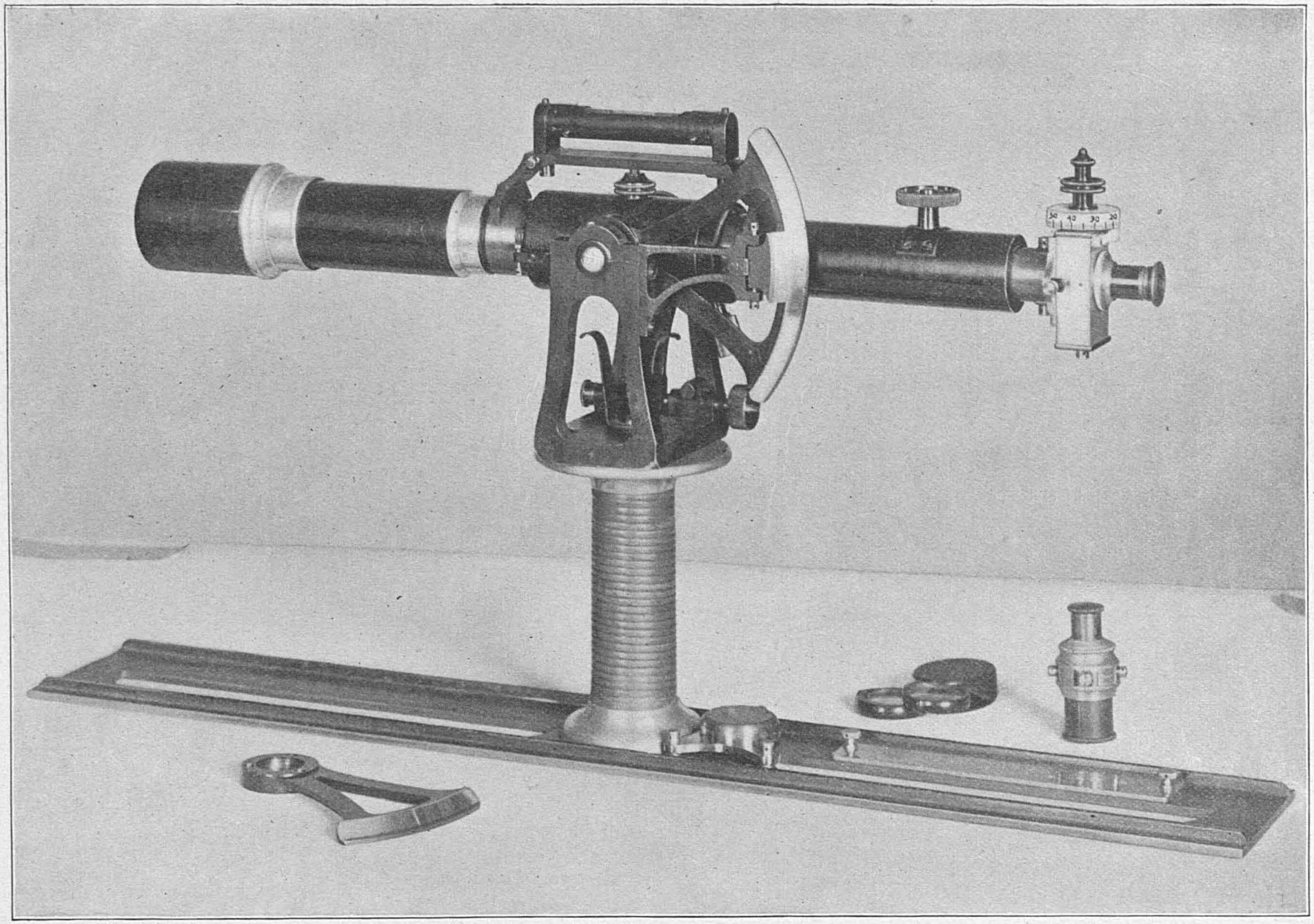


PLANE TABLE AND ALIDADE.



PLANE TABLE MOVEMENT.

56—05——20



ALIDADE.

The three screws last mentioned have large milled heads, are quite stout, and play through the block below by means of brass female screws let into it. They are the leveling screws of the instrument and are equidistant from its center.

Upon the underside and center of the metal lower disk is a socket containing a ball with a brass arm, which projects through the center of the block from beneath. The lower end of the arm is threaded, and upon it plays a female screw with a large milled head, which can be relaxed or tightened at pleasure. The screw clamps the whole upper part of the instrument to the stand; it is loosened only before leveling and kept securely clamped at all other times.

The block, made either of wood or brass,* is supported upon three legs, and with them forms the tripod or stand of the instrument, the legs being of such a length as to bring the table to a convenient height for working, and so arranged as to be taken off at will, or closed so that their brass-shod and pointed ends can be brought together or moved outward, as may be required. They are made on the open or skeleton pattern, and each is securely attached to a segment of the tripod head by a long brass bolt.

MOUNTAIN PLANE TABLE.

A small plane table, with a board measuring only 14 by 17 inches, is employed in reconnaissance, mountain work, or as an auxiliary to one of the standard size. All the various parts are reduced in size to correspond with the board, and the construction of the movement simplified.

THE ALIDADE.

The type of alidade in general use (Illustration 3) consists of a skeleton rule (12 inches long by 2½ inches wide) nickel-plated underneath, from and perpendicular to which rises a metal column (3 inches high), surmounted by Y's, receiving the transverse axis of the telescope, to one end of which axis is firmly attached a graduated arc of 30°, each side of a central 0°, an accompanying vernier being attached to the Y support. The arc moves with the telescope as it is raised or depressed, and it is used in the measurement of vertical angles to determine heights. A clamp and a tangent screw placed on the other side of the telescope, opposite the arc, controls its vertical movement.

The telescope is fitted accurately near its center of gravity within a closely fitting cylinder, to which is solidly attached the transverse axis. The telescope revolves within the cylinder 180°, stops being fitted for that range. This affords an easy mode of adjusting the cross lines to the axis of revolution, and for correcting with a striding level the errors of level and collimation and revolution of the telescope.

Upon the tube of the telescope are turned two shoulders, on which rest a striding spirit level, which can be readily reversed or removed at pleasure. The eyepiece carries the usual reticule with screws for the collimation adjustment, and to this is attached a glass diaphragm, having one vertical and three horizontal lines engraved upon it. One of the horizontal lines crosses the middle of the diaphragm, the other two are placed equidistant from it, one above and one below. The interval between them remains a constant chord for the measurement of distance upon a graduated staff or rod.

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* Now made of a special aluminum alloy.

In some cases short auxiliary lines have been added dividing the interval into still smaller chords.

Several of the alidades are furnished with a micrometer eyepiece so attached that the thread is horizontal, and has a vertical movement for measuring the angular distance of a fixed length on a rod which remains a constant chord.

To the rule of the alidade are attached two spirit levels, one in the longitudinal direction of the rule and the other at right angles to it.

A declinatoire (shown in Illustration 1) accompanies the alidade and is carried in the same packing box. It consists of a rectangular brass box 7 inches long by 2 wide, with an arc at each end graduated to 15° on each side of the 0°. It contains a needle long enough to extend from arc to arc, and resting on a pivot midway the box. The sides running lengthwise the box are parallel to a line connecting the zero marks of the two arcs.

The metal clamps, for holding the projection on the board, are of two kinds: U-shaped for the ends, and the side clamps, the latter being made of thin metal strips about 12 inches in length, with two or more springs attached to grip the underside of the board.

Adjustments.—From the nature of the service in some sections of the country the plane table is often necessarily subjected to rough usage, and there is a constant liability to a disturbance of the adjustments; still, in careful hands, a well-made instrument may be used under very unfavorable conditions for a long time without being perceptibly affected. One should not fail, however, to make occasional examinations, and while at work, if any difficulty be encountered which can not otherwise be accounted for, it should lead directly to an examination of the adjustments.

1. *The fiducial edge of the rule.*—This should be a true straight edge. Place the rule upon a smooth surface and draw a line along the edge, marking also the lines at the ends of the rule. Reverse the rule and place the opposite ends upon the marked points and again draw the line. If the two lines coincide no adjustment is necessary; if not, the edge must be made true.

There is one deviation from a straight line, which, by a very rare possibility, the edge of the ruler might assume, and yet not be shown by the above test; it is when a part is convex and a part similarly situated at the other end concave; in exactly the same degree and proportion. In this case, on reversal, a line drawn along the edge of the rule would be coincident with the other, though not a true right line; this can be tested by a true straight edge.

2. *The levels attached to the rule.*—Place the instrument in the middle of the table and bring the bubble of either level to the center by means of the leveling screws of the table; draw lines along the edge and ends of the rule upon the board to show its exact position, then reverse 180°. If the bubble remains central it is in adjustment; if not, correct it one-half by means of the leveling screws of the table, and the other half by the adjusting screws attached to the level. This should be repeated until the bubble keeps its central position whichever way the rule may be placed upon the table. This presupposes the plane of the board to be true. The other level should now be examined and adjusted in a like manner.

Great care should be exercised in manipulation lest the table be disturbed.

3. *Parallax.*—Move the eyeglass until the cross hairs are perfectly distinct, and then direct the telescope to some distant well-defined object. If the contact remains perfect when the position of the eye is changed in any way, there is no parallax; but if it does not, then the focus of the object glass must be changed until there is no displacement of the contact. When this is the case the cross hairs are in the common focus of the object and eyeglasses. It may occur that the true focus of the cross hairs is not obtained at first, in which case a readjustment is necessary, in order to see both them and the object with equal distinctness and without parallax.

4. *Axis of revolution.*—Since the bearings of the pivots are fixed, the axis of revolution is assumed to remain parallel to the plane of the rule.

5. *Vertical line of diaphragm.*—Point the intersection of the vertical and the middle horizontal lines of the diaphragm on some well-defined distant object; revolve the telescope in its collar 180° and again observe the object. If the intersection covers it, the adjustment is perfect; if not, one-half the error must be corrected by moving the diaphragm, by means of the adjusting screws, and the other half with the tangent screw of the table. This operation should be repeated until the adjustment is perfect.

6. *Middle horizontal line of diaphragm.*—(1) Adjust the striding level by reversing it end for end and correcting its error—half the difference by its own adjustment, half by the tangent screw of the telescope.

(2) Point the telescope to a target, and note the reading, or make a mark where the wire points, when the bubble is in the middle.

(3) Revolve the telescope in its collar 180°, and note the reading or mark the place where the wire points, when the bubble is in the middle.

(4) The mean of the two pointings is the true level line, upon which the wire is to be adjusted, which may be done in this way: Keep the bubble in the middle and by means of the adjusting screws bring the middle wire to bisect a point half way between the two readings or marks. The adjustment may be verified by revolving the telescope as in (2) and if the middle wire again bisects the point the adjustment is perfect.

(5) If it is now desired to make the vernier read *zero* on the vertical arc, the table must be carefully leveled; and in order to do this more perfectly than can be done with the levels on the ruler, it may be done by observing the striding level; the telescope remaining clamped, the striding level should read the same in every position of the alidate when the table is perfectly level. (In general, this will be found too delicate a test, as the table is not sufficiently *even* for so sensitive a level to be employed.) The table being leveled, move the telescope with the tangent screw until the bubble is in the middle, and then set the vernier to read zero; the screw holes in it are oblong, so that it admits of being pushed either way.

(6) It is easy to have the adjustments near enough to serve for running curves of equal elevation, but in determining the heights of stations it is best to make the observations complete, with reversals, both of level and of telescope, taking the mean of the observations, by which the errors of adjustment are eliminated. This, in fact, is always done with the theodolite, and should be done with the alidade when precision is required.

The following may serve as an example:

TELESCOPE DIRECT.

Reading of vernier, level direct with bubble in center	+ 0° 1′	
Reading of vernier, level reversed with bubble in center	0′	
Mean	+ 0° 0′.5	
Station, reading	+ 2° 17′	
Angle of elevation (difference)		2° 16′.5

TELESCOPE INVERTED.

Reading of vernier, level direct with bubble in center	− 0° 2′	
Reading of vernier, level reversed with bubble in center	− 1′	
Mean	− 0° 1′.5	
Station	+ 2° 12′	
Angle of elevation (difference)		2° 13′.5
Mean		2° 15′

It will be seen, from analyzing these observations, that the level was one-half minute out of adjustment, the horizontal wire one and one-half minutes, and that revolving the telescope in its collar 180° changed its relation to the index on the vernier by 1′. The mean is free from all errors of adjustment.

*The stadia rod** (Illustration 3), used in the Coast and Geodetic Survey, is simply a scale of equal parts painted upon a wooden rod about 10 feet long, 4 inches wide, and 1¼ inches thick, so graduated that the number of divisions upon it, as seen between the upper and lower horizontal wires of the telescope when the rod is held at right angles to the line of sight, is equal to the number of units in the distance between the instrument and the rod.

Graduation.—In all cases the rod should be graduated for the particular instrument, and, if the best results are to be obtained, to suit the convenience of the observer.

In practice the alidade is mounted on a stand, and its center is plumbed over one end of a hundred-meter base, measured on level ground. A line, representing the zero of the graduation, having been drawn about 5 inches from one end of the rod, the latter is held vertical at the other end of the base, zero mark upward. The observer at the alidade then makes the upper horizontal line of the diaphragm coincide with the zero and directs the rodsman by signals where to draw a line which coincides with the lower horizontal line. This intercepted space on the rod is subdivided to read meters and the graduation continued to within a short distance of the bottom.

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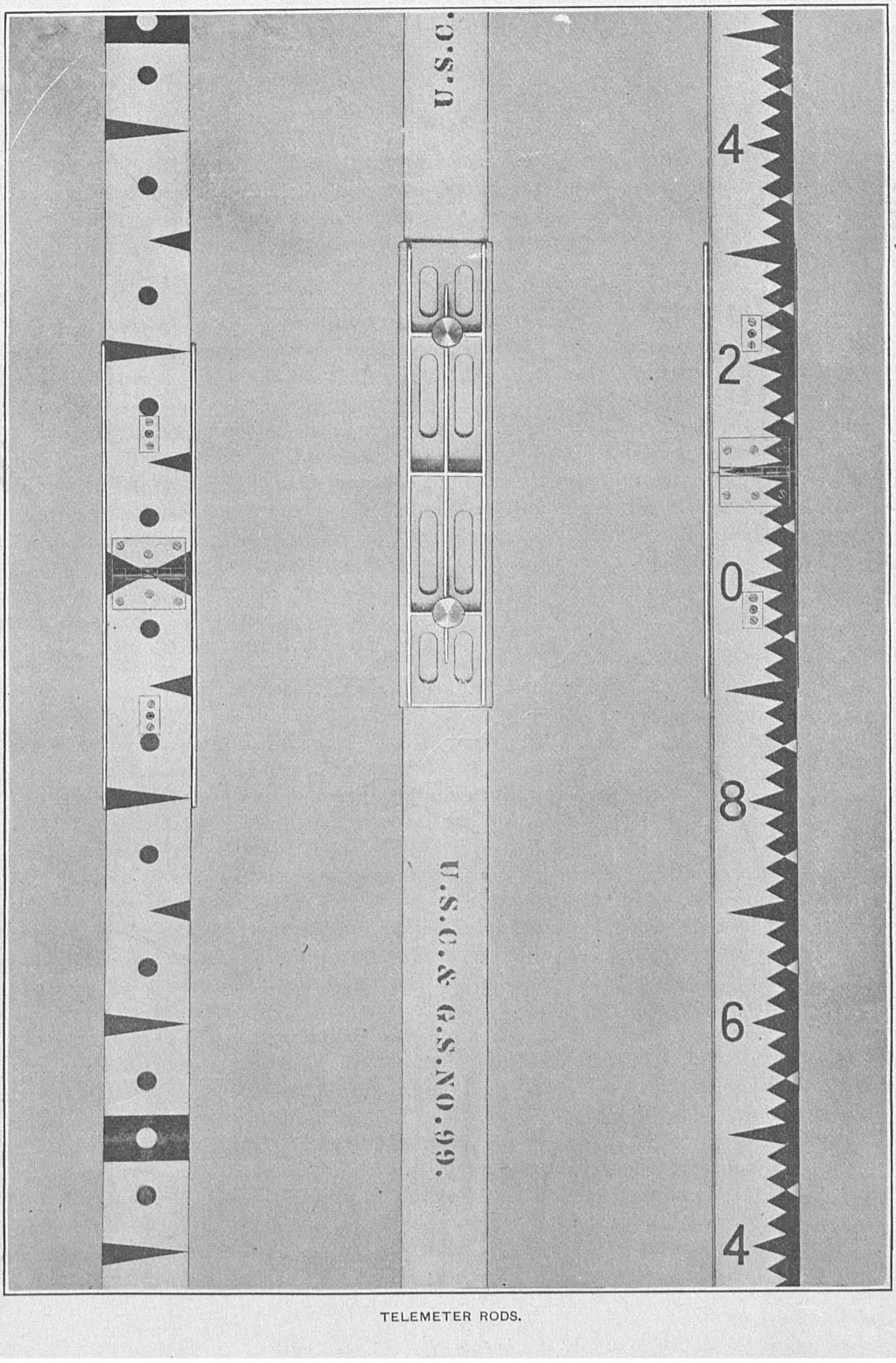
*For further details of the theory of stadia measurements see: Elemente der Vermessungs-Kunde, Bauernfeind, 1873, p. 322; Handbuch der Vermessungs-Kunde, Jordan, 1888, p. 554; Theory and Practice of Surveying, Johnson, 1898, p. 238; Gillespie's Higher Surveying, Staley, 1897, p. 311; Experimental Study of Field Methods, Smith, Bulletin of University of Wisconsin, Engineering series, Vol. I, No. 5.



TELEMETER RODS.

This graduation is represented by the equation

$$d=\frac{f}{i}s+(f+c),$$

where d=the distance from the center of instrument to rod (in this case 100 meters);
f=the focal length of the telescope (which is 35^{cm} for the average alidade);
i=the distance between the upper and lower wires of the diaphragm (4^{mm});
s=the length of the intercepted portion of the rod ($1^{m}.185$);
c=the distance from object glass to center of instrument $\left(=\frac{f}{2}\right)$.

As indicated in the preceding equation, the readings of a rod graduated in this manner are not quite true for distances above or below 100 meters, since the vertices of the constant and similar angles (one subtending the chord represented by the intercepted space on the rod and the other by the space between the upper and lower wires) do not lie at the center of the instrument, but at a distance beyond the object glass equal to the focal length of the telescope, and therefore the intercept on the rod will not be proportional for all distances from the center of the instrument. To have it so, the instrument should be mounted at a distance back from the end of the base equal to one and a half times the focal length of the telescope ($f+c$). To all readings of a rod graduated according to this last method the constant quantity $f+c$ must be added.

The correction for the first method is small and can be ignored for mapping on a scale of 1–10000 or smaller.

The formula for the correction is:

$$K=(C+F)\left(1-\frac{B}{B'}\right)$$

Where K=correction in meters,
B=distance read on rod in meters,
B'=length of base, in meters, for which the rod was graduated.

The corrections for 50, 200, 300, and 400 meters are +0.262, −0.525, −1.050, −1.575 meters, respectively.

Inclined sights.—When the rod is held at a point above or below the instrument, the line of sight is inclined at an angle with the horizon, and a correction has to be applied to the reading to obtain the horizontal distance. If the rod is held perpendicular to the line of sight the reduced distance is simply the product of the cosine of the angle of inclination into the rod reading. If the rod is held vertical, which is the usual and also the safest method, there is an additional correction on account of the oblique view of the rod. These corrections can be ignored in the ordinary work of the Survey; that is, on a scale of 1–10000 or smaller, since for short distances they are too small to plot, and when the distances are long enough for them to become appreciable they are still small as compared to the uncertainty of the rod reading.

For the convenience of the topographer engaged on large scale work, tables for reducing readings of inclined sights can be found at the end of the Manual.

Micrometer eyepiece.—When a micrometer eyepiece is used in place of the stadia lines, a rod about 3.7 meters in length is employed, attached to which are two targets. A base is measured on level ground and the instrument either plumbed over one end or back of it a distance equal to $f+c$, depending upon the manner the rod is to be held for an inclined sight. The rod is then taken to one of the subdivisions of the base, consisting of an even multiple of the unit adopted; say 100, 200, or 300 meters, and the upper target being fixed, the lower target is set and fixed so that the angular measure of the interval by the micrometer will consist of an even multiple of turns of the micrometer screw. The rod is now held at the other subdivisions of the base, and the readings tabulated. A distance table is then prepared, by interpolation, for the intermediate distances.

Plane-table sheet.—From the standpoint of efficiency the plane-table sheet is the least satisfactory portion of the plane-table equipment. Owing to its hygrometric nature it is very susceptible to atmospheric changes: expanding and contracting unceasingly. This would be but an insignificant source of error or annoyance if it were equal in all directions. The map or plan would then simply change its scale, for which an allowance could readily be made. But the objectionable feature arises from the unequal expansion and contraction which changes the relative distance and directions of the points. It has been determined by experiment that strips cut longitudinally from drawing paper varied from 10 to 25 per cent more than strips cut transversely from the same paper.

Various substitutes* have been tried, but none have proved entirely satisfactory. The United States Geological Survey, to eliminate this distortion, employs two sheets of paragon paper, the size of the plane-table board, mounted with the grain at right angles, and with cloth between them.

This method is applicable to small scale surveys where a sheet the size of the table board covers a large area of country, or, on the other hand, to large scale cadastral surveys where the great amount of detail makes the rate of progress slow. But for intermediate scales and an area containing a moderate amount of detail, a longer sheet is much more economical, because a smaller number of points are needed to keep the work within the control of the triangulation than would be required if it was limited to the size of the table. A certain amount of overlapping work, of which there is more or less at the junction of the two sheets, would also be avoided.

The plane-table sheet of the Coast and Geodetic Survey consists of a sheet of Whatman's cold-pressed, hand-made antiquarian paper, 52 by 30 inches. It is backed with muslin, which extends about 1 inch beyond the edge of the paper to protect it from fraying.

To reduce the distortion to a minimum a sheet should be thoroughly seasoned before it is taken to the field or a projection laid down on it. This is effected by exposing it alternately to a very damp and a very dry atmosphere. On testing a sheet after a week of such exposure it will be found to have much less tendency to expand or contract unequally.

Paper stored away, piled up in stacks, does not properly season.

Scale.—The selection of the scale to be employed depends so much on the character of the country to be surveyed, the amount of detail to be included, and the uses to which the completed map will be put, that no general rule can be given for guidance. It must be remembered, however, that nothing is gained, either in economy or rapidity, by the use of small scales when the details are shown to be plentiful. The minute drawing involved proves a tax on the topographer and is a great time consumer.

*Celluloid sheets are frequently used in Alaska. The pencil lines are neither washed out nor blurred by water accumulating on the sheet.

The scale adopted by the Coast and Geodetic Survey for the coast line from Maine to Delaware Bay is 1–10000; from Delaware Bay southward, 1–20000. Special surveys have been made on a scale as large as 1–1200.

PROJECTIONS FOR FIELD SHEETS.

It is presumed that determination has been made, by triangulation, of points most suitable for the use of the topographer who follows with the plane-table work, and that a sketch of the same is at hand, giving an approximate skeleton map of the area to be surveyed. The location or orientation (as it is frequently called) of the sheet is then based upon several important considerations.

It may be taken as a rule that the intervisibility of the points extends across valleys, from summit to summit, or across rivers, bays, and other bodies of water. So that generally the line of greatest depression of the valley (thalweg) should follow as nearly as practicable the middle of the sheet, regard being had for any abrupt change of direction or importance of lateral features; or, in other words, the areas to be surveyed should be divided as far as possible into water basins, extending from divide to divide, and not center upon a ridge forming portions of two basins. The reason for this being that from either slope of the basin points are visible on the opposite summits which will be common to the sheets which include the adjoining valleys, while from the middle of the valley points will be visible on both summits.

From the written descriptions of the points determined, discrimination should be made in regard to their temporary or permanent character. A flag in a tree is likely to have disappeared soon after its determination, and the usual cut of a triangle in its bark may have disappeared before the lumberman's ax, while a church spire, a light-house, a house chimney, a copper bolt in a rock, or a bottle buried beneath the surface of the ground is more likely to be recovered and to be of service to the topographer.

Two intervisible points, one of which may be occupied, or three inaccessible points, are all that are absolutely necessary upon a sheet for the commencement of work. for from, or upon these, all other points required may be determined, and it is oftener more important, from considerations of economy of time and facility for work, to have more regard for embracing the topographical subject in its entirety, where points may be determined at convenience, than to furnish a large number of determined points at the expense of the best orientation of the sheets in regard to topographical details.

In flat sections where the vertical question is scarcely a factor, the main question is generally a plan that will cover the area with the fewest sheets compatible with a sufficient overlap of common points; and where the object is a survey of one side of a river or other body of water, points on the opposite shore should be included when possible.

When it is possible, the sheet should be located by one familiar with the peculiar topography of the region to be surveyed, and with some knowledge from observation of the relative value of the points between which there may be any necessity for discrimination.

Where the surface is broken without any marked basins of large area, and when the sheet, on the scale determined upon, will cover several successive basins and dividing ridges, the consideration of reach from higher to higher summits should control as in the reach over one valley; thereby affording the best means for determining position and any desirable auxiliary points in the lower intermediate summits and in the valleys.

Points at the junction of confluent streams have usually large arcs of visibility, and are consequently of great value for purposes of orientation. If, therefore, such a point should be near but off the edge of a sheet of regular dimensions, and from the necessities at the opposite edge can not be included by it, it is often well to extend the length of the sheet so as to include the point, even though there may be no intention to complete topographic details upon the additional piece.

Light-houses are often of this character, the reasons governing the selection of their positions for light purposes having equal weight in the selection of such positions for survey signals.

The draftsman will be materially assisted in laying out the limits of the projection by drawing on a piece of tracing vellum a plan of the sheet, corresponding in size to the scale of the triangulation sketch. Take, for example, a sheet 52 inches in length by 30 in width, on which a projection on a scale of 1–10000 is to be drawn, the triangulation sketch being on a scale of 1–100000. The dimensions of the plan will then be one-tenth those of the sheet, viz. 5.2 by 3.0 inches. Placing the pattern over the sketch and shifting its position about over the locality to be surveyed, the limits which include the most favorable conditions for the projection will soon become apparent.

The Polyconic projection * has been adopted by the Coast and Geodetic Survey for mapping its work. The method of constructing one is as follows:

The limits of the sheet having been determined, the middle meridian A (see illustration 5) is located and drawn; then its intersection with the most central parallel is found, and the perpendicular B erected there.

Next turn to the page of the "Tables for a polyconic projection of maps" † in which is given the degree of latitude which includes the limits of the sheet. In this instance the latitude is 40°, to be found on page 223 of the tables. The number of minutes of latitude on the central meridian, above and below the central parallel, being known, take the corresponding distance from the column headed "Sums of minutes for middle latitude" and lay it off (C) above and below the central parallel, and with the same distance as radius, strike arcs D D D D above and below, from near the extremities of the perpendicular B. With a well-tested straightedge draw lines E E through the north and south minutes on the central meridian, and tangent to the two arcs D D to the right and left. This gives three parallel lines perpendicular to the central meridian. On the opposite page 222, from under the head of "Arcs of the parallel in meters," take out the value corresponding to the number of minutes of longitude east and west of the central meridian and lay off the whole distance F F′ F″ on each perpendicular, taking each distance from its appropriate latitude. Subdivide these into minutes G G′ G″.

For the areas usually covered by plane-table sheets the corrections X, for determining the abscissas from the arcs of parallels (Table VI, head "Coordinates of curv-

* See a Treatise on Projections, Craig, United States Coast and Geodetic Survey 1882. Chart and Chart Making, Pillsbury, No. 29, Proceedings United States Naval Institute.

† United States Coast and Geodetic Survey Special Publication No. 5, 1900.

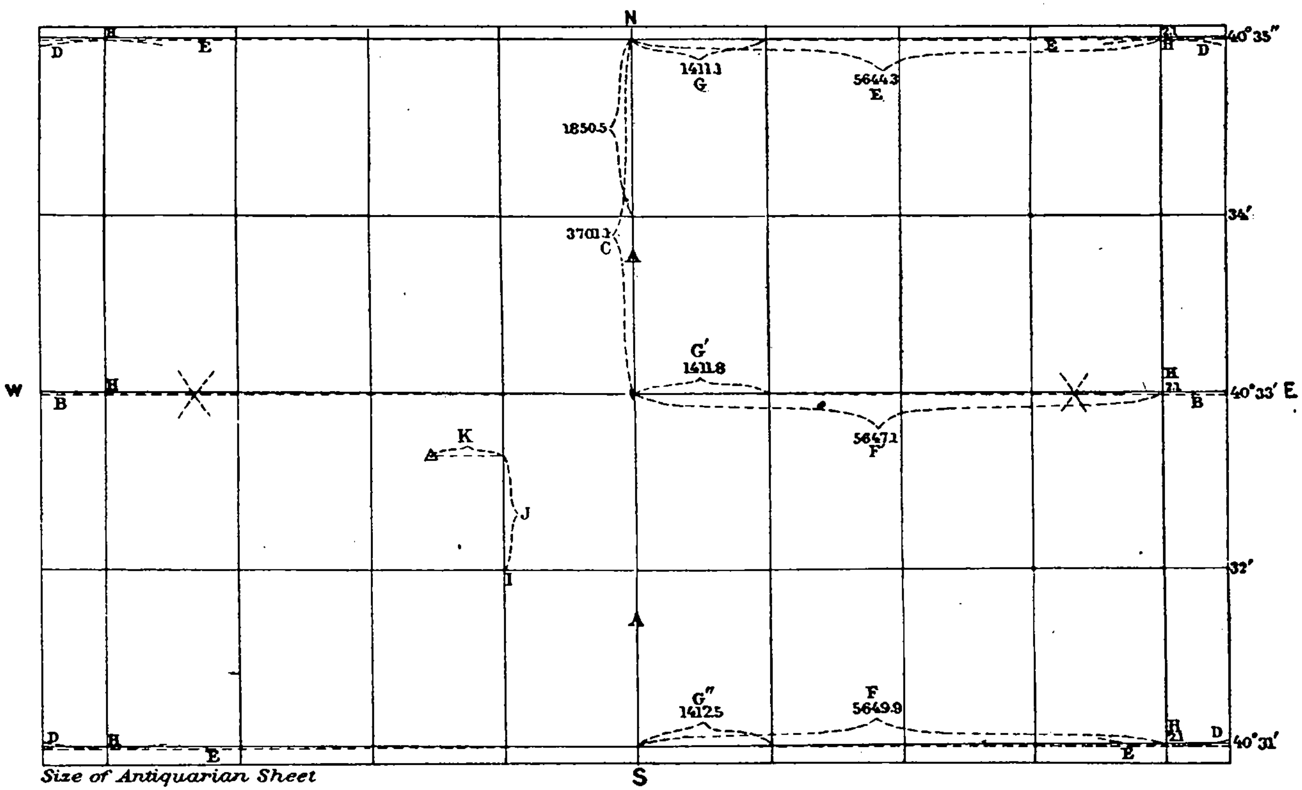


Diagram illustrating the mode of constructing the Polyconic Projection for Plane Table Work, Scale $\frac{1}{10000}$

Scale of Diagram, $\frac{1}{80000}$

ature"), are inappreciable and may be disregarded, the ordinates Y only being used. These give the distances to be set off from the lines B and E, perpendicularly toward the pole, for each minute of longitude counting from the central meridian. For ordinary field projections of scale 1–10000 the ordinate of the extreme minute only need be used, and the parallel drawn a right line from the point so found to the central meridian. This ordinate H being set off on each of the parallels, the meridians are all drawn in with a fine ruling pen, then subdivided into minutes, and the parallels carefully ruled in through the points of subdivision.

The projection is verified by applying the measure of a number of minutes of latitude and longitude, and by a comparison of diagonal measurements on different parts of the sheet.

All measurements should be carefully taken from the scale with a keenly pointed beam-compass, and the marks pricked in the paper should be as light as possible to be seen, so as to insure the greatest possible accuracy.

The draftsman is supplied with a list of triangulation points, which gives their relative distances, their latitudes and longitudes, and also the equivalents in meters of the *seconds* of latitude and longitude, according to which the points are now plotted on the sheet by measuring from the corresponding minutes. Thus in the diagram the distance J represents the seconds of latitude; K, the seconds of longitude of the trigonometric point.

The accuracy of the plotting is tested by a measurement of the respective distances between the points with a beam-compass, these distances being also given. The latitude and longitude are then plainly marked, usually on the north and east sides of the sheet, at one extremity of each parallel and meridian, and the pencil marks erased.

It sometimes becomes necessary to base topographic work upon a detached scheme of triangulation, before the usual astronomic observations have been made. In this case the only elements given are the distances from the points to two projected arcs of rectangular coordinates (which are assumed) and the distances between the points. The projection for plotting these consists simply of axes of ordinates and abscissas so laid on the sheet that it will embrace all the points required by the surveyor, and in the manner most convenient for his work; and the points are plotted from these by the intersection of two arcs with the distances of the points from the axes as radii, either north or south, east or west of the axes, as the plus or minus sign given may indicate. The only test is by the distances between the points, and there should be at least two from each. If the work be correctly done, a regular projection can be constructed on the sheet after it is finished and the required astronomic work is completed.

In case it so happens that for some special purpose it becomes urgent to undertake a piece of topography, when neither the data for projections nor coordinates are at hand, plotting by distances is the only resource left, and, of course, great care is necessary.

When a sheet has no projection—that is, no meridians and parallels, it is advisable to draw squares of 1 000 or any specified number of meters on it, by means of which the projection can ultimately be laid down correctly.

Accessories.—The usual accessories for plane-table work are: Large umbrella for shading table, binocular, pocket compass, 10 or 20 meter steel tape, Locke's level, clinometer, metal scale, dividers, pencils, rubber, block of emory or sand paper, table of heights, note, and sketch book.*

A metal chart case should always accompany the table to secure the sheet from sudden rain and other injury liable to occur in transportation of the sheet to and from the field and for its safe-keeping when not in use. Its diameter should not be less than 3 inches, for no sheet can be rolled to a less diameter without serious rupture of the fiber of the paper. It is also advisable to have a rubber cloth for covering the table when it is carried from station to station.

Approximate weights.—Plane-table movement, 18½ pounds, boxed, 34½ pounds; plane-table board, 8¼ pounds, boxed, 26½ pounds; plane-table alidade, 7 pounds, boxed, 21¼ pounds; plane-table tripod legs, 11 pounds; 2 stadia rods, 16½ pounds. Mountain plane table, set up complete with alidade, 19¾ pounds, boxed, 36 pounds; 2 stadia rods, 12¾ pounds.

FIELD WORK.

Organization of party.—In organizing a party for field work it is necessary to have one man to carry the table. His duty is to remain constantly with the instrument, never to leave it unguarded; and while the topographer is at work he holds the umbrella to shade the table from the sun and thus protect the observer's eyes from the glaring reflections from the paper and instruments. The table bearer should be taught at the beginning of the work the mode of setting the table over a point and taking it up from the same. In the first instance to grasp firmly two legs of the tripod and with the knee to extend the third one until it reaches the ground at the proper distance from the point, and then place the other two in position. The distances from the point will vary, as the ground may be level or sloping, in order to keep the tripod head vertically over the point and approximately horizontal, securing the latter condition by sighting over the head to the horizon. In taking up the table two legs should be grasped firmly and the table raised, resting upon the other leg, upon which the first two are closed, when the table is raised in place upon the shoulder.

Two rodsmen are needed, and the rapidity with which the work is executed largely depends upon their efficiency. When well trained they should be able to recognize the salient points of the features to be mapped, so that the topographer can draw in correctly the details from the least number of readings, in the absence of an aid to make a sketch of the intricate portions.

The amount of assistance an aid can give to his chief is limited only by his skill and experience. The logical inference being that he is in training to become a topographer himself, he takes charge of an increasing share of the work as he becomes more and more familiar with the methods employed. This enables his chief to turn his attention in other directions, which will expedite the survey and increase the output.

An outline, merely, of his duties can be suggested: Building signals, drawing plans of intricate details, sketching contours, selecting stations in advance, running traverse lines with auxiliary instruments, and finally in taking charge of the plane table in the absence of his chief, who is thus afforded the opportunity of inspecting some difficult area and formulating some plan to meet the conditions found there.

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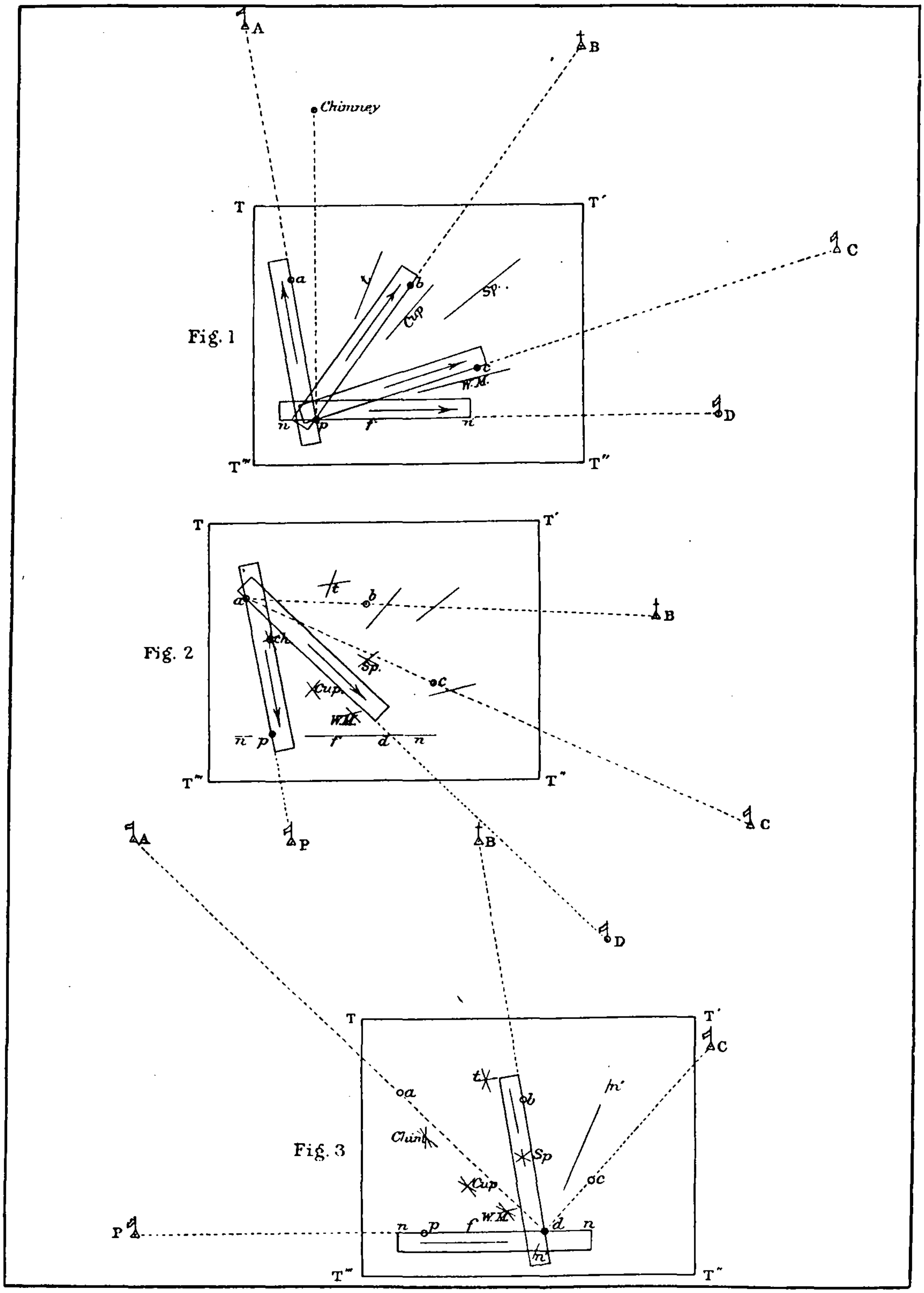
*For the Locke's level, clinometer, and pocket compass a Casella pocket alt-azimuth instrument may be substituted, as it combines all three in a very convenient form.



GRAPHIC TRIANGULATION.

The additional number of men required to complete the party will depend mainly on the means of transportation—wagon, horseback, or boat.

Preliminary reconnaissance.—Before commencing the instrumental work, a reconnaissance of the country should be made for the purpose of recovering triangulation stations and to locate signals at suitable points for subsequent determination and use. In the location of signals, either as permanent points or simply for temporary forward lines, a great deal depends upon the good judgment of the person placing them. Two purposes are to be subserved: First, the seeing of sufficient known points to give a good determination; and, second, to command a view of as great an area of country, and as many natural and artificial features for filling in the topography, as possible. It should be remarked, also, that in the course of prosecution of the regular work no favorable opportunity must be allowed to pass for locating a signal or determining a point which may at some future time be of service. Advantage should be taken of open places in the woods commanding roads or ravines. Piers or draws of bridges, or piles, giving lines up and down streams, which have precipitous and wooded banks; trees of unusual appearance in prominent positions, or bearing flags placed upon them for the purpose; points of rock, offshore or otherwise; lightning rods, cupolas, weathercocks, chimneys of factories, and other peculiar and marked objects come within this category. In fact, it may be set down as a rule that well-determined signals located at convenient distances over the sheet are more likely to be too few than too many.

Signal poles should be straight and perpendicular, and the flags upon them adapted in color to the background against which they will be seen when observed upon.

Graphic triangulation (Illustration 6).—Signals having been erected at each triangulation station, and also on all prominent hills within the area of the sheet, where they will be useful in providing additional control, the next proceeding will be to occupy one of the former points.

Care should be exercised in choosing a day for this portion of the work, as it is essential to have favorable weather for a satisfactory test of the plotted points in the field and for the determination of new ones.

On arrival at the station the table is set up approximately over the center mark, and the sheet secured to the table, so that it will be held firmly and evenly and not be disturbed in its position by the friction of the alidade, nor by ordinary winds. As the longest side of the board is usually made equal to the width of the sheet, and the sheet is usually longer than this width, the excess of length is rolled up inward, turned underneath the sides of the table and fastened with a metal spring clamp, biting from the top of the sheet on the table to the inside of the roll beneath. One clamp at each end of the roll serves to hold the roll ends securely. The sides of the sheet are sometimes held to the table by similar but shorter clamps, but it is preferable for the free movement of the alidade, and more secure against strong winds, that a metal strip, the length of the side between the end clamps, with spring clamps fastened to the outer edge, and biting the underside of the table, be used for holding down the edges of the paper.

The chief and controlling condition in work with the plane table, and without which no accurate work can be done, is that the table shall be oriented—that is, that all lines joining points on the sheet shall be parallel to the corresponding lines of nature.

Let T, T′, T″, T‴ (Fig. 1) represent the board of the plane table, upon which is spread the sheet; the plotted triangulation point *a* upon the sheet representing the signal A upon the ground; *b*, the spire B; *c*, the signal C; and *p*, the station P; the small letters on the sheet representing the centers of the signals on the ground, which are referred to by corresponding capital letters.

The table is placed approximately level over the station occupied, P, and oriented, also approximately, by the eye, so that the plotted points on the sheet are in approximate range with the station P and the signals or objects they represent in the field. Then plumb the point *p* over the station P, fixing the legs of the table firmly in the ground.

In maps of large scale it is important to plumb the plotted point exactly over the station, but on the usual field scales of the Coast and Geodetic Survey (1–10000 and 1–20000) an approximation with the eye is all that is requisite. To effect it more closely a small stone is held underneath the point and then dropped to test the position, or a plumb bob fastened to the table below the point serves the same purpose. Plumbing arms or forks are made and supplied by the instrument dealers.

The plotted point having been plumbed over the station as accurately as the scale of the work demands, place the alidade on the table so that the rule shall extend across and parallel with the line joining two of the leveling screws; loosen the large clamp screw under the tripod head, and with the leveling screws bring the bubbles of the two levels on the rule to the center; clamp the screw under the tripod head, and the table is level. Now, unclamp the revolving plate, place the edge of the rule upon the plotted points *p* and *b*, the telescope being directed toward the spire B, as shown by the arrow-head of the figure, and revolve the table until B is seen in the field of the telescope; clamp the revolving plate, and with the tangent screw of the movements bisect the top or center of the spire B with the vertical wire of the telescope. The table is now oriented, if the points have been correctly plotted and the proper objects sighted. To verify this, place the rule upon the point *p* again, and upon the points *a* and *c*, consecutively, and if the two signals A and C are bisected by the vertical wire of the telescope, the position is assured, and the lines connecting points of the sheet are parallel with the corresponding lines on the ground.

The failure to bisect A and C would indicate an error of plotting or an unequal change of the dimensions of the paper (distortion), which must be examined, and in case of the former, corrected, and in case of the latter, allowance made for, as indicated later on. (See distortion errors, page 316.)

The next proceeding is to draw the line to the next point which it is desirable to occupy or determine, either some natural object which can be occupied, or a temporary signal placed for that purpose, as the signal D.

The edge of the rule is placed upon the point *p*, and moved about that point as a center until the signal D is bisected by the vertical wire, and then a line, *f*, is drawn along the edge of the rule from *p* far enough to reach the estimated position on the sheet of the point *d*, and at each end of the rule the short check lines *n n* are drawn. These check lines can be used in reversing the alidade with the accuracy that is obtained by the greatest length of a range line. They may be indicated on the sheet, with names of objects, as in fig. 2—*ch.*, chimney; *t.*, tree; *cup.*, cupola; *sp.*, spire; *w. m.*, windmill; or numbered, and a record kept of the objects sighted, where details are complex.

In the same manner lines should be drawn to such objects as it is desired to determine. This determines only the one element of direction; it will be necessary to determine the distance from the point occupied either by measurement or by intersection from some other fixed point, at an angle not less than 30° nor more than 150°; all acute intersections should be verified by a direction from a third point.

The table is moved to the station A (Fig. 2) and placed over the point, oriented approximately, leveled, and the axis of revolution clamped as at station P. The rule is then set upon the line *a p*, the telescope directed toward the signal P, and the table put in position in the manner described. Then, keeping the edge of the rule upon *a*, direct the telescope to the signal D and draw the line *a d*, intersecting *f*, and determining the position of the point *d* upon the sheet, corresponding to D, and bearing the same relation in directions and distances from the points *p*, *a*, *b*, and *c* as the signal D does from P, A, B, and C. All lines to other objects which were drawn from *p*, and which objects can be seen from A, are intersected and determined in the same manner.

When a direction has been drawn from a station to any undetermined point that may be occupied, the position of the point may be determined by occupying it with the table, and orienting the table by the line drawn to it, and *resecting* upon a signal whose corresponding point is plotted upon the sheet.

The table is placed over the point D (Fig. 3), oriented approximately, leveled, etc., as at the previous stations. The edge of the rule is then placed upon the line *d p*, passing through the point *p*, so that the checks *n n* are just visible along the edge, and the telescope directed toward the signal P, and the table oriented. The rule is then placed with its edge bisecting one of the plotted points, such as *b*, which will give a good intersection (the nearer 90° the better) with the line *f*, and is moved about that point as a center until the spire B is bisected by the vertical web. A line is now drawn accurately along the edge of the rule through *b*, crossing the line *f*. If this line intersects the line *f* at the point *d*, the position of the latter is assured, and a delicate hole with the dividers should be pricked at the point, surrounded by a small circle in pencil.

Resection upon any other determined point will verify its position.

From this point, *d*, directions are observed and drawn to verify the previous intersections upon *chimney*, *tree*, *cupola*, *windmill*, etc.

There are occasions when occupying some station that several objects are seen whose position it is desirable to determine by prosection, but there is doubt of their being recognized from other stations. A new station is then occupied close by the first one and new lines drawn to the objects. The intersection thus obtained will necessarily be acute, but will materially assist in their identification from other localities.

All lines should be drawn lightly and carefully, close to the edge of the rule, with a hard, finely-sharpened pencil. If the table and alidade be in proper condition, the contact of the edge of the rule with the paper will be perfect throughout its length, and in drawing a line along the edge care must be taken to preserve the same inclination of the pencil and to keep it sharp. If the rule should be raised from the paper at any part, great care is to be observed that the pencil does not run under the edge and thus deviate from a straight line.

Amount of control.—There is no fixed ratio between the number of determined points and the number of square miles of the region to be surveyed or square inches of plane-table sheet.

The greater the number of points well distributed over the latter the less likelihood of error due to distortion of the paper.

A large number also makes it easy for the topographer to determine by resection subordinate stations for mapping the details, and in consequence fewer traverse lines need be run.

More than sufficient for these purposes are not necessary, and it is important when carrying on a graphic triangulation not to waste valuable time and favorable weather, but to advance this part of the work as rapidly as possible before the sheet becomes affected by exposure.

The three-point problem (Illustration 7).—A subordinate station is located at any desired place where a good view of the surrounding features can be obtained. If the position of this point has not been previously determined it is now effected by means of the resection of lines from three fixed points.

The special advantages of the plane table as a mapping instrument are due to the rapidity with which it obtains results by the method of graphic triangulation and to the facility it affords the topographer in determining his position at an unknown point by the graphic solution of the three-point problem.

When the latter method is applicable—that is, when the country is open and signals can be easily seen—its superiority over a system of traverse lines is manifest. The topographer is then at liberty to choose his ground without reference to his last station or to one succeeding. He is not tied down to a backsight nor restricted by the conditions imposed by a foresight. He need not set up his instrument on an area barren of detail nor cut his way through obstacles (bushes, hedges, trees) to establish a station at a commanding point of view.

The number and situation of the stations are governed solely by the amount and location of the information to be mapped. On the other hand, traverse stations are chosen on account of their visibility, and many of them are of no service whatever beyond carrying the line forward.

When the table is imperfectly oriented, the lines drawn from the three projected points, when sighting on the corresponding actual points, will not intersect at one point unless all four are on the circumference of a circle. (See Fig. 3, Indeterminate position.) Except in this case, two of the lines will be parallel, intersected by a third (see Fig. 4, Station on range line between two fixed points, and Fig. 2, Station on prolongation of range line), or they will form a small triangle called the *triangle of error.* (Figs. 1, 3, 5, and 6.) The solution of the three-point problem determines the location of the station occupied and orients the table simultaneously.

The relative positions of the three fixed points with reference to the new station have an important bearing on the strength of its determination.

In the following statement in regard to the different groupings of points met in practice, for the sake of brevity, the term "fixed points" will be understood to mean points already determined and plotted on the sheet; the "great triangle" referred to is one formed by the three fixed points, and the "great circle" is the circle passing through them.

When the new station is outside the great circle, the strength for determination of a position will be weak when the middle point as seen from the new station is the farthest of the three and the angles are small. (See Illustration 7, Fig. 3.) If the new station is located outside the circle, and some distance below it, the angles are small and the determination correspondingly weak.

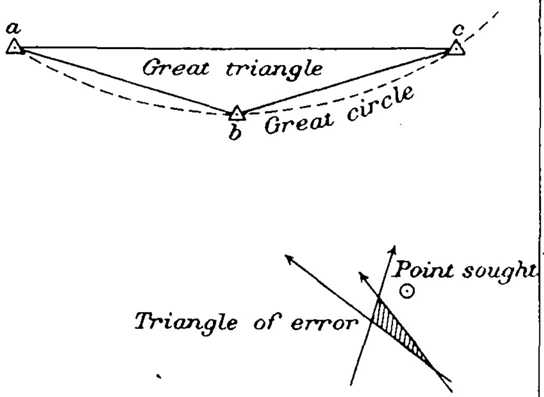


Fig. 1

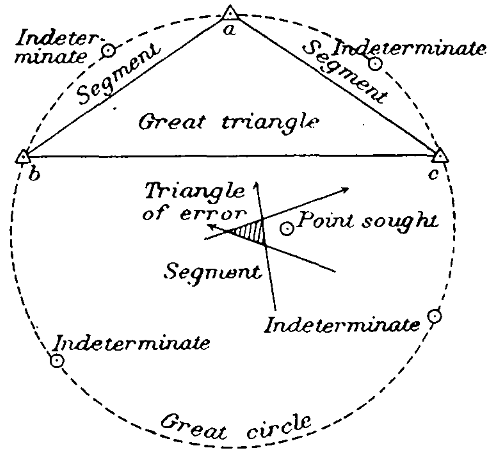


Fig. 3

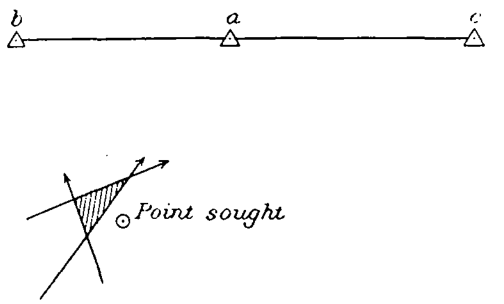


Fig. 6

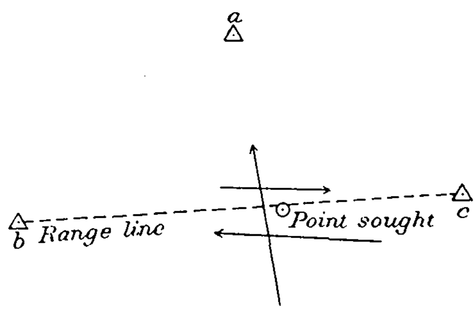


Fig. 4

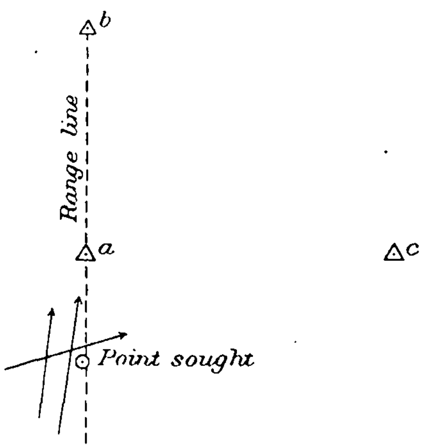


Fig. 2

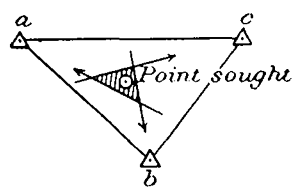


Fig. 5

THE THREE-POINT PROBLEM.

The determination increases in strength for given angles as the middle point approaches the new station. (Fig. 1.)

When one angle is small or 0° (points in range), the determination will be strong, provided the two points making the small angle or range are not too near each other when compared to the distances to the new station and to the third point; provided also the angle to the third point is not too small. (Fig. 2.)

When the new station lies on or near the great circle, its position is indeterminate. (See Illustration 7, Fig. 3.)

When the new station is within the great circle, the strength of its determination increases as it approaches the center of gravity of the great triangle. (Figs. 3, 4, 5.)

There are a number of graphic solutions, but all save three are better suited to the drafting room with its appliances than to the conditions which exist in the field.

Lehmann's method of solution is the simplest and most direct, and applies under all circumstances. The directions are stated in the form of rules.

The term "*point sought*" will be understood to mean the true position on the sheet of the projected point of the station occupied. The surveyor is assumed to be facing the signals, and the directions right and left are given accordingly.

Rule 1.—The point sought is always distant from each of the three lines drawn from the three fixed points in proportion to the distances of the corresponding actual points from the station occupied,* and it will always be found on the corresponding side of each of the lines drawn from the fixed points.†

The simplest case for the application of this rule occurs when the station to be determined is within the triangle formed by the three fixed points; the point sought must then be within the triangle of error to satisfy the conditions. (See Illustration 7, Fig. 5.)

Although Rule 1 is sufficient in itself for the solution of the problem, there are two subordinate rules which materially assist the topographer in reaching a decision as to the proper location of the point sought with reference to the lines from the fixed points.

Rule 2.—When the point sought is without the great circle it is always on the same side of the line from the most distant point as the intersection of the other two lines. (See Illustration 7, Fig. 1.)

Rule 3.—When the point sought falls within either of the three segments of the great circle formed by the sides of the great triangle the line drawn from the middle point lies between the point sought and the intersection of the other two lines. (See Illustration 7, Figs. 3, 4, 6.)

Application of rules.—In practice the topographer first decides the relation of the new station with reference to the fixed points, whether it is within the great triangle or in one of the segments or outside the great circle. He then determines the position of the

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* *Demonstration.*—A, B, C (Illustration 8, Fig. 1) are projections of the three signals from which it is desired to determine by resection the position of a fourth point, D. The table being out of position to the right, the triangle of error formed by the three lines from A, B, and C is ab, ac, bc. The true point occupied lies at D, being at the intersection of the circles AB ab, AC ac, BC bc. Now, if perpendiculars be drawn from D to the lines drawn from A, B, and C, we shall have

Da : Db :: DA : DB or Db : Dc :: DB : DC.

† That is, if it is on the right side of one line, it is on the right side of each one of the other two, and if on the left side of one, it is on the left side of each one of the other two.

point sought with reference to one line (if within one of the segments or without the great circle by Rule 2 or 3); it then follows from Rule 1 that it must be on the corresponding side of the other two lines. Finally, he estimates the relative distances of the three actual points from him and marks the position of the point sought a proportionate distance from the three lines.

EXAMPLES.

Illustration 7, Fig. 1: When the point sought is without the great circle, the intersection of the lines from B and C fall to the right of the line from A, the most distant point; therefore (Rule 2) the point sought must be on its right, and also (Rule 1) on the right of the line from B and C. Its exact position is then estimated according to Rule 1.

Illustration 7, Fig. 2: When the point sought is on or near the prolongation of a range line, it must be outside the parallel lines on the side of the line to the nearest fixed point of the range. In the figure it will be seen that the point sought must be outside the lines from A and B, and to their right to satisfy Rule 1, and also to the right of the line from C.

Illustration 7, Fig. 3: When the point sought is on the circle passing through the three fixed points, the position is indeterminate, as the three lines will intersect at one point, although the table is imperfectly oriented. Another selection of points must be made.

Illustration 7, Fig. 3: When the point sought falls within one of the segments of the great circle, the line drawn from A, the middle point is to the right of the intersection of the lines from B and C; therefore (Rule 3) the point sought must be on its right side, and also (Rule 1) to the right of the line from B and from C. Locate it exactly according to Rule 1.

Illustration 7, Fig. 4: When the point sought is on or near the range line between the fixed points, the point sought must be between the parallel lines to satisfy the conditions of Rule 1. Its position with reference to the intersecting line follows from the same rule. In the figure the point sought being between the lines from B and C, is to the right of each, therefore it is to the right of the line from A.

Illustration 7, Fig. 5: When the point sought falls within the great triangle, it must fall within the triangle of error. No other position would satisfy the conditions of Rule 1.

Illustration 7, Fig. 6: When the three fixed points are in a straight line. In this case the points are considered as being in the circumference of a circle of infinite diameter and the point sought always lying in one of the segments of the great circle. The treatment of this case is then identical with that of Illustration 7, Fig. 3.

The preceding cases are all examples of the conditions which may occur when the table is deflected to the right. By turning the printed side of the illustration to the light and looking at the figures through the paper, they will appear reversed, and they will then be examples of conditions which may occur when the table is deflected to the left.

Repetition.—When the true point has been estimated and marked on the sheet in accordance with the foregoing rules, a new orientation is made. If the lines from the three stations now intersect at that point, it proves the estimate to have been correct

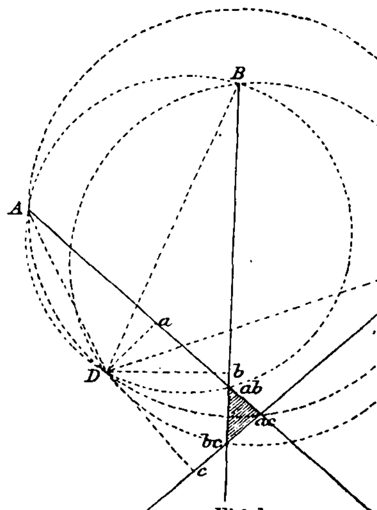


Fig. 1

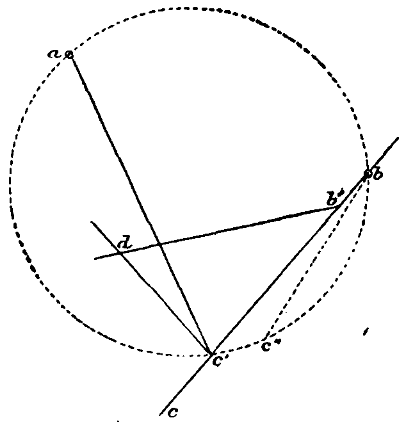


Fig. 6

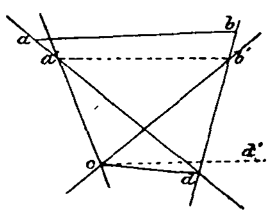


Fig. 2

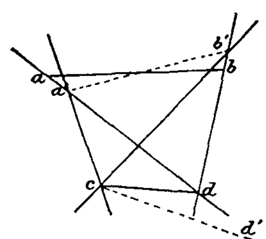


Fig. 3

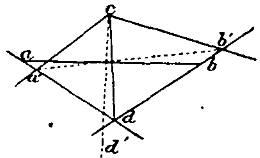


Fig. 4

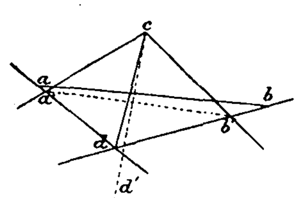


Fig. 5

THREE-POINT AND TWO-POINT PROBLEMS.

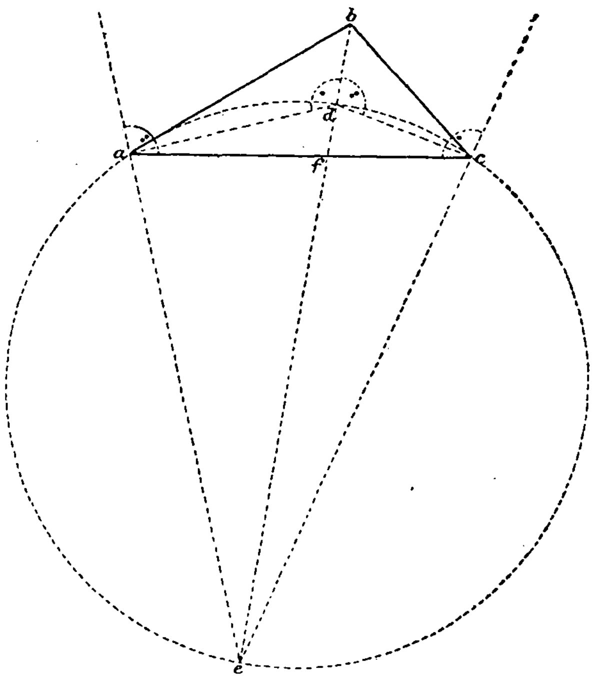


Fig. 1

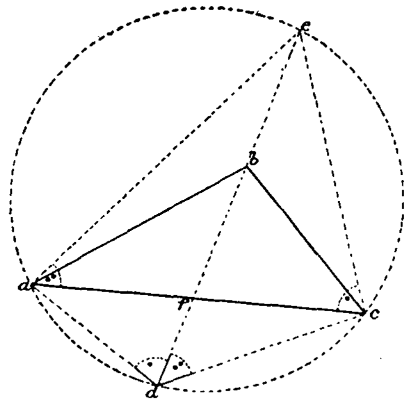


Fig. 2

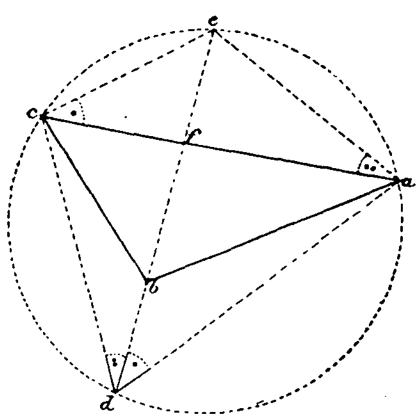


Fig. 3

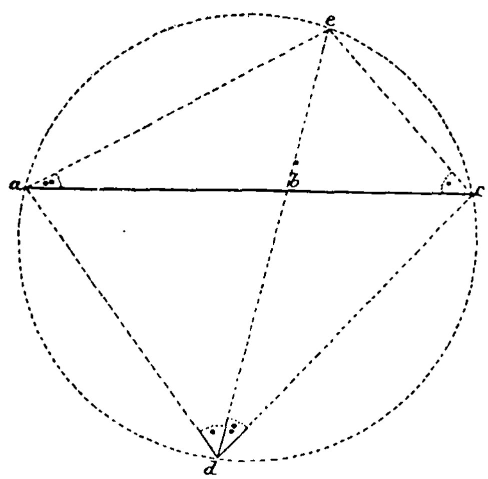


Fig. 4

BESSEL'S SOLUTION OF THREE-POINT PROBLEM.

and the position is determined. If a new triangle of error is formed, it indicates an erroneous estimate, and the operation must be repeated.

Orienting by estimation.—A small triangle of error is the result of a close orientation, which the topographer endeavors to accomplish at the first trial by taking advantage of any range that may exist either of signals or other details already plotted on the sheet. It will serve the same purpose if they are near enough in line to estimate a direction on the sheet to the farthest object, and then to orient by it.

The declinatoire may be used, but it is a slow and inaccurate method of orientation.

It is employed for this purpose by placing the straight edge of the box containing the needle upon a magnetic meridian, previously traced upon the map, and revolving the table until the needle points to 0°, or north, on the graduated arc at the end of the box. The magnetic meridian is roughly determined at any well-determined station, when the table is properly oriented by the use of the declinatoire itself, the meridian line being drawn upon the sheet along the straight edge of the box when the needle points to 0°. Or the table may be oriented by making the straight edge of the box coincide with one of the meridians of the projection and then turning the board until the needle points to the right or left of the zero, according to the amount and direction of the magnetic deviation.

Bessel's method by inscribed quadrilateral is the simplest method by construction. The objection to it arises from the fact that in practice the intersection of the construction lines often falls beyond the limit of the board.

By this method a quadrilateral is constructed with all the angles in the circumference of a circle, one diagonal of which passes through the middle one of the three fixed points and the point sought. On this line the alidade is set, the telescope directed to the middle point, and the table is *in position*. Resection upon the extreme points intersects in this line and determines the position of the point sought.

Illustration 9, Figs. 1, 2, 3, and 4. Let *a b c* be the points on the sheet representing the signals A B C on the ground. The table is set up at the point to be determined (*d*), and leveled. The alidade is set upon the line *ca*, and *a* directed, by revolving the table to its corresponding signal A, and the table clamped; then, with the alidade centering on *c*, the middle signal B is sighted with the telescope and the line *ce* drawn along the edge of the rule. The alidade is then set upon the line *ac* and the telescope directed to the signal C, by revolving the table, and the table clamped. Then, with the alidade centering on *a*, the telescope is directed to the middle signal, B, and the line *ae* is drawn along the edge of the rule. The point *e* (the intersection of these two lines) will be in the line passing through the middle point and the point sought. Set the alidade upon the line *bc*, direct *b* to the signal B by revolving the table, and the table will be *in position*. Clamp the table, center the alidade upon *a*, direct the telescope to the signal A, and draw along the rule the line *ad*. This will intersect the line *be* at the point sought. Resection upon C, centering the alidade on *c* in the same manner as upon A, will verify its position.

The opposite angles of the quadrilateral *adce* being supplementary,

$\angle ace$ and $\angle ade$ are subtended by the same chord *ac*, and $\angle cae$ and $\angle cde$ are subtended by the same chord *ce*; consequently, the intersection of *ae* and *ce* at *e* must fall on the line *db*; or, the segments of two intersecting chords in a circle being reciprocally proportional, the triangles *adf* and *cef* are similar, and the triangles *cdf* and *aef* are similar, and *d*, *f*, and *e* must be in a right line passing through *b*.

In using this method the triangle formed by the three fixed points can be contracted or extended, as may be desirable, by drawing a line parallel to the one joining the two extreme points, and terminated by those joining the extremes with the middle point. The graphic solution can then proceed in the same manner as that described for an original triangle.

Tracing-cloth protractor.—The third method consists in laying off the angles between the three known points on tracing cloth or paper, and using this as a protractor, determine the position of the unknown point.

Fasten a sheet of tracing cloth or paper to the board, marking upon it a point to represent the unknown point. Draw through it lines toward the three known points. Then shift the tracing cloth over the sheet until each of the three lines passes through the plotted point corresponding to the point toward which it is drawn. The position of the unknown point will be at the intersection of these lines.

This method is less exact and not so convenient as the other two previously described, and is impracticable when the wind blows.

TWO-POINT PROBLEM.

The occasion may arise where it is desirable to place the table in position at a given point, from which only two determined points are visible. This may be done by the following methods:

One method possesses the virtue of requiring no linear measurements, and demonstrates in a very satisfactory manner the effectiveness of the table in determining position by resection.

(Illustration 8, Figs. 2, 3, 4 and 5.): Two points, A and B, not conveniently accessible, being given, by their projections *a* and *b*, to put the plane table in position at a third point, C. (The capital letters refer to points on the ground, and the small ones to their corresponding projections.)

Select a fourth point, D, so that the intersections from C and D upon A and B make sufficiently large angles for good determinations. Put the table approximately in position at D, by estimation or by compass, and draw the lines A*a* and B*b*, intersecting at *d*; through *d* draw a line directed to C. Then set up at C, and assuming the point *c* on the line *d*C, at an estimated distance from *d*, and putting the table in a position parallel to that which is occupied at D, by means of the line *cd*, draw the lines from *c* to A and from *c* to B. These will intersect the lines *d*A and *d*B at points *a'* and *b'*, which form with *c* and *d* a quadrilateral *similar* to the true one, but erroneous in size and position.

The angles which the lines *ab* and *a'b'* make with each other is the error in position. By drawing through *c* a line *cd'* making the same angle with *cd* as that which *ab* makes with *a'b'*, and directing this line *cd'* to D, the table will be brought into position, and the true point *c* can be found by the intersections of *a*A and *b*B.

Instead of transferring the angle of error by construction, we may conveniently proceed as follows, observing that the angle which the line *a'b'* makes with *ab* is the error in the position of the table. As the table now stands, *a'b'* is parallel with AB, but we want to turn it so that *ab* shall be parallel to the same line. Place the alidade on *a'b'* and set up a mark in that direction, then place the alidade on *ab* and turn the table until it again points to the mark, then *ab* will be parallel to AB, and the table is in position.

Another method is as follows (Illustration 8, Fig. 6):

Two points, A and B, not conveniently accessible, being given by their projections *a* and *b*, to put the plane-table in position at a third (undetermined) point, C.

Set up the table at the point sought as closely oriented as can be done by estimation, and resect upon A and B, intersecting the line *bc* at *c'*. The angle *ac'b* is the true angle at the point occupied, subtended by AB, being the angle of nature actually drawn; therefore, the true point must be on the circumference of the circle passing through *abc'*. Construct this circle. Measure off a base, CD, at least half the length of CB, at right angles, or nearly so, to *bc*, in either direction most convenient. Set up a signal at D, and with the alidade draw the line *c'd*. Remove the table to D, and, by means of a signal at C (the point sought), and the line *dc'*, bring the table into a position parallel to that which it occupied at C. With the alidade centering on *d*, observe the signal B, and draw the line *db'* intersecting *cb* at *b'*. *c'b'* is the distance of the point C from B, and this distance laid off on the circle *ac'b* as a chord from *b* will give *c''*, the true position of the point C. A fourth point may then be occupied, and by resection upon A, B, and C the accuracy of the determination of C verified.

Where it is possible to get the two signals A and B in range, it is easy to determine the position of a third point by a method long practiced by topographers.

Set up the table anywhere on the range line, and orient by the latter. Resect on the unknown point, drawing the line anywhere on the sheet most convenient. Leave a signal at the occupied point on the range line and set up the instrument at the unknown point. Orient by the line drawn when at the station on the range line, sighting on the latter station. The table will now be in a parallel position to that when on the range line, which is the true position, and the unknown point may be determined by resection upon the two fixed points and their projections.

Deflection of long lines.—In adjusting lines of intersection upon a point or object from a series of stations, when these lines do not coincide in one point, as they are usually derived from signals at unequal distances, the error should not be divided equally among them, but in proportion to their lengths if the discrepancies are not eliminated by the rules for distortion errors given later.

It should be borne in mind that very short lines from a determined point—as, for instance, to the corners of a fenced road, where the table occupies the center of the intersection of two roads—may be taken with no apparent error when the table is deflected to some extent from its true azimuth, but that in this case a prolonged line will be considerably out at its further extremity.

A long line should never be obtained by the prolongation of a short one from a back station where there is no small check line, or some other point in that prolongation already fixed.

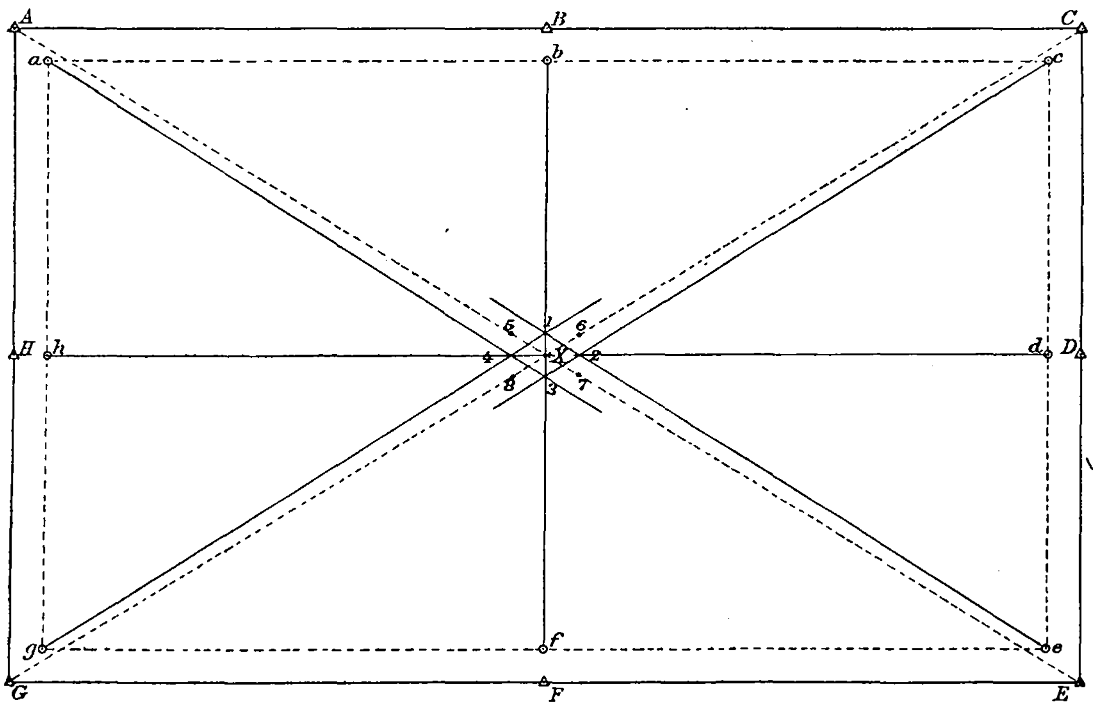
It will be apparent that the more nearly at right angles intersecting lines cross each other the more clearly the point will be defined; acute intersections, as far as possible, should be avoided, and, even when they are crossed by a third line at a satisfactory angle, a fourth line, or an accurate rod reading from a well-determined point, is advisable if within reach.

Sometimes a position is established by measuring along the estimated direction from a near-by fixed point and then orienting by this assumed position and a distant point. This method should be used with caution, but is generally reliable for rodding the detail in the vicinity.

*Distortion errors.**—The distortion of a plane-table sheet destroys the perfect proportions which exist between the fixed points and their plotted representatives on the sheet.

The diagram illustrates the effect distortion would have in the determination of a point.

NO. 10.



A, *B*, *C*, etc., are plotted in their true relations. After the sheet has contracted, *a*, *b*, *c*, etc., represent the relations those points have assumed. The paper contracts at a uniform but different rate in each direction.

The plane-table is supposed to be at *X*, the exact center of the figure, and it is required to determine the position by the distorted points *a*, *b*, *c*, etc. By reversing the telescope, we immediately ascertain that we are directly on the line *HD*. Reversal will also show that we are on the lines *AE*, *CG*, and *BF*. But the distortion is not apparent until the telescope is pointed at the signals, and the lines are drawn on the sheet. Then if we orient by the line *HD*, we shall produce the figure of the diagram, giving five determinations, 1, 2, 3, 4, and *X*, each made with four well-conditioned points. Any one of these conditions would be considered satisfactory if we had not the other points to show that something was wrong. To orient by the line *BF* will produce the same result. But if we take the diagonal *AE*, we shall have two positions at 5 and 7, formed by the intersection of the diagonal points, with the lines from the other points

* See Distortion of Plane Table Sheets, Ogden, Science, Vol. XI, No. 270.

running wild. Using the diagonal CG would give two points at 6 and 8, with the lines from the other points running wild as before.

Position by compromise.—There is no question that out of the nine positions developed by these settings, that at X is the only true compromise. When the sheet is distorted, all positions are compromises; and X is the true compromise in this case, for it is on the lines CG, AE, etc.: a below and e above, the line connecting A and E, by equal quantities. A line drawn through the distorted points a and e must pass through the middle point X. The positions 5, 6, 7, and 8 can not be true, because lines forming them will not pass through the opposite points when extended, which we know to be the condition that must be filled.

Rules:

(1) A station made with three points that are on the lines of contraction, the resecting lines forming nearly right angles at their intersection, will give the true position in relation to all points in the sheet (as h, b, d).

(2) A similar condition of right-angular intersection at the station, but the lines forming diagonals to the lines of contraction, will give the worst possible position for the station (as a, c, and e).

(3) A station made with three points on one of the lines of contraction will give the correct orientation of the table (a, h, and c) but not the correct position.

(4) In estimating errors of the point due to distortion, those situated on the lines of contraction require no allowance, however distant.

Application.—If the change in the sheet due to contraction or expansion gives the same percentage of the units of length, both lengthwise and transverse of the sheet, the points are still in their true relative position, and the projection is practically as good as when laid on the paper, but is on a slightly altered scale. When the percentage of change in the units of length is greater in one direction than the other, the sheet and projection are distorted; and to make a station by the three-point problem, the change of scale in each direction must be allowed for. The difficulty in making such allowances is not great, if the principal effects of distortion in the sheet are borne in mind. It would not be permissible, even were it practicable, to make new points on the sheet, as this would destroy the geographic position. It is necessary, therefore, to assume the new points by estimation, applying the percentage of change to the distances measured between the points on the lines of change—that is, on lines parallel to the edges of the sheet. If the point occupied and the point sighted to are on a line parallel, or nearly so, to one edge of the sheet, its movement from the distortion can only be along that line. When the position of the point sighted to is found situated to one side of the line parallel to the edge of the sheet, the distortion will also affect it in the direction at right angles to that edge, and the effect of the distortion will be most apparent when the angle of deflection is 45° and the position at as great a distance from the point occupied as the paper will permit. As the angle of deflection increases above 45° the effect becomes less and disappears at 90°, when the position will fall again in a line parallel to an edge of the sheet.

Referring to the diagram, Illustration 10, to make a station with the three points a, b, c: If the sheet were not distorted, the station would be at X; A, B, and C being the true positions plotted when the projection was drawn. But the sheet having contracted, a, b, and c show the relative positions of these points; therefore we make such allowance for the contraction derived from measuring the unit of length that we can place or imagine *a* and *c* to be where they belong, at *A* and *C*. *b* requires no change, as it is on a line parallel to the edge of the sheet. To locate *A* we must know the distances (approximately) *h* to *a* and *h* to *X*, which, multiplied by the percentages of contraction (in this case), will give the distance of *A* above and to the left of *a*. The same process locates *C*.

If the station were to be made with the points *a*, *c*, and *e*, all three points would have to be imagined in a new position by the same process that *A* has been located.

Stations made in this way will be good for all local sketching within an area that the contraction of the sheet is inappreciable; but to take cuts on distant objects from such a station the orientation of the table must be changed. If an object is somewhere near the direction of *a* and the table at the compromise station *X*, the table must be oriented by *a* and *X*, the imaginary position *A* being discarded.

The same processes apply to all positions on the sheet for the station occupied.

Height of instrument.—Having obtained the horizontal position on the sheet of the occupied point, the next proceeding in the logical sequence is the determination of the height of the instrument above some datum plane, in order to locate and draw the contours of the area surrounding the station. The angle read and the distance between the occupied point and the observed point measured from the map, the height is computed by means of the tables to be found at the end of the Manual, or the result can be obtained mechanically by using the hypsograph.

This instrument was designed by Assistant Fremont Morse for use in the Coast and Geodetic Survey and differs from the ordinary form of topographic slide-rule used by engineers in three particulars: First, it is circular instead of rectilinear; second. it does not give elevations in the same unit as the distances, but gives heights in feet when the distances are measured in meters; and third, the arguments used for determining the heights are the horizontal distance and angle of elevation instead of inclined distance and angle of elevation.

The instrument will indicate the difference of height (uncorrected for curvature and refraction) for any distances and angles encountered in ordinary topographic work, with an error much smaller than the probable error of observation of the plane-table alidade.

For complete description and directions for use, see Appendix 4, Report for 1902.

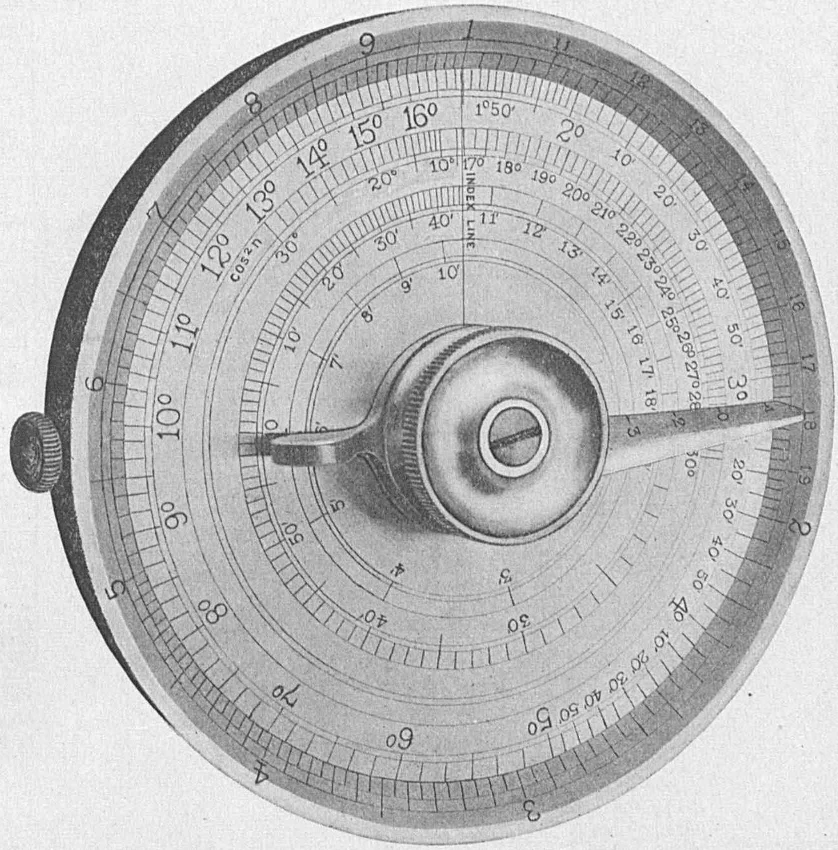
Relief.—There are two methods of representing it—by hill shading and by contours.

Hill shading is generally effected by a system of lines, called hachures, drawn in the direction of the slope. When it is steep, the hachures are thick and closely spaced. On the other hand, a gentle incline will be indicated by fine lines widely separated.

*Contours** or horizontal curves are the outlines of horizonal sections of ground at different elevations with designated equal intervals between their planes, delineated in their true positions relatively to each other and to the rest of the map, and conforming to the scale of the map itself; or, briefly, a contour is a curve produced by the intersection of the horizontal plane with the surface of the ground. They may also be described

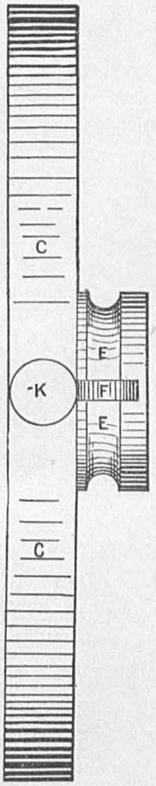
*For interesting articles on the diagrammatic properties of the contour line see: On Contour and Slope Lines, Cayley, London & Ed. Mag., 1859, pp. 264-268; On Hills and Dales, Clerk Maxwell, ibid, 1870, pp. 421-426; Properties of Matter, Tait, 1890, pp. 70-81.

NO. 11.

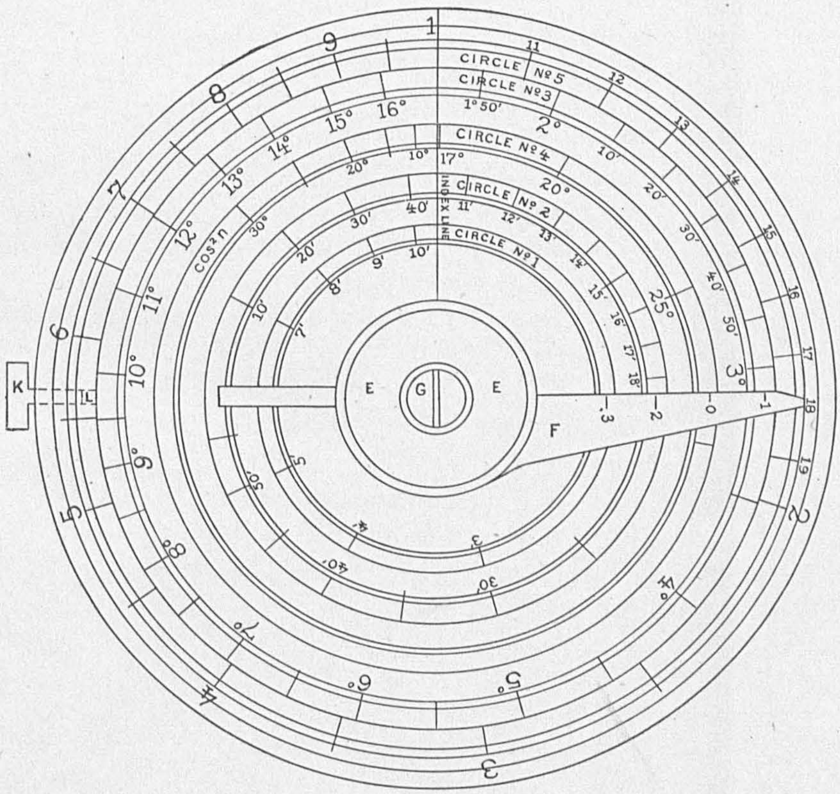


HYPSOGRAPH.

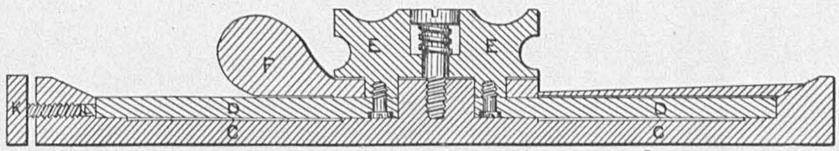
NO. 12.



SIDE VIEW



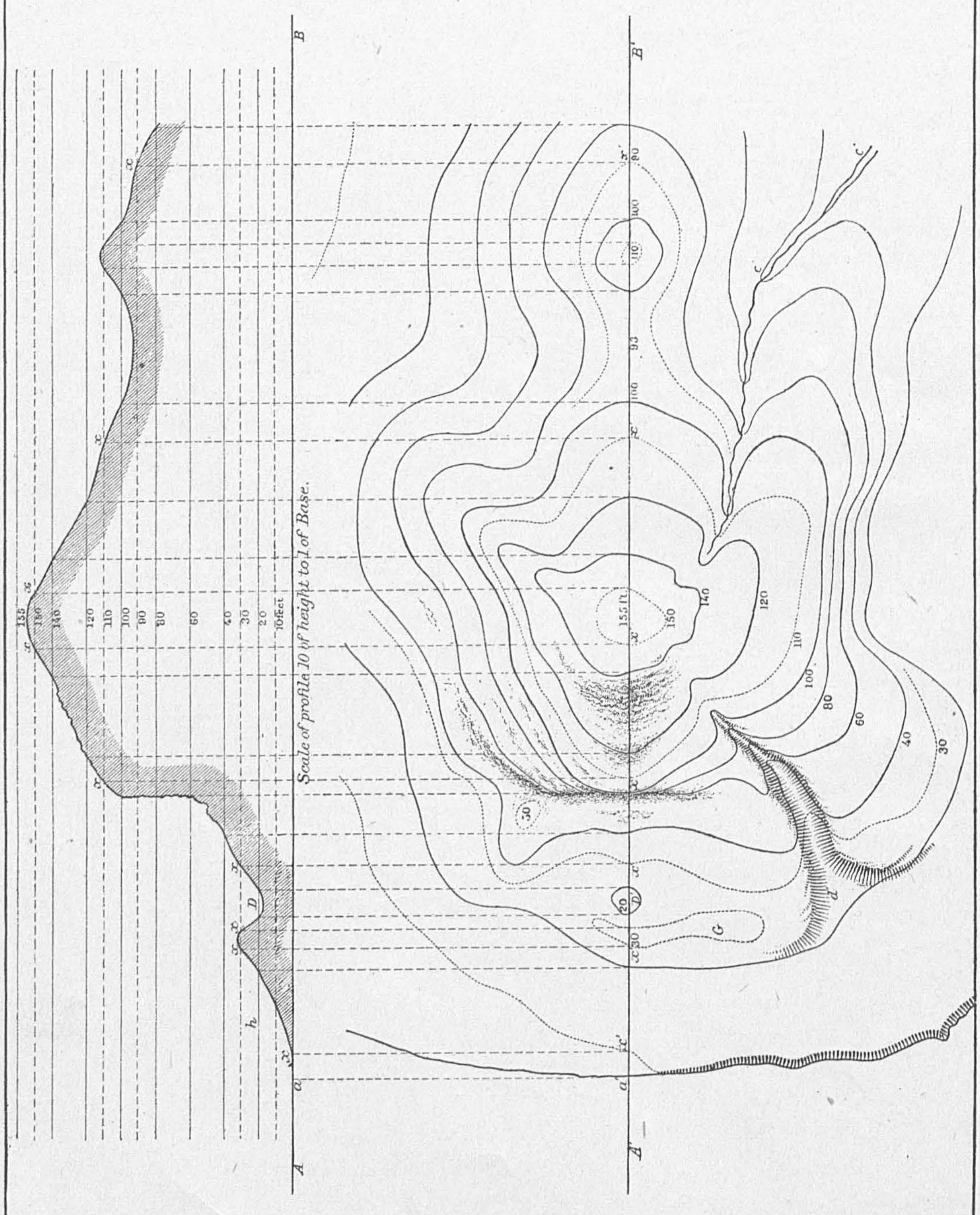
TOP VIEW

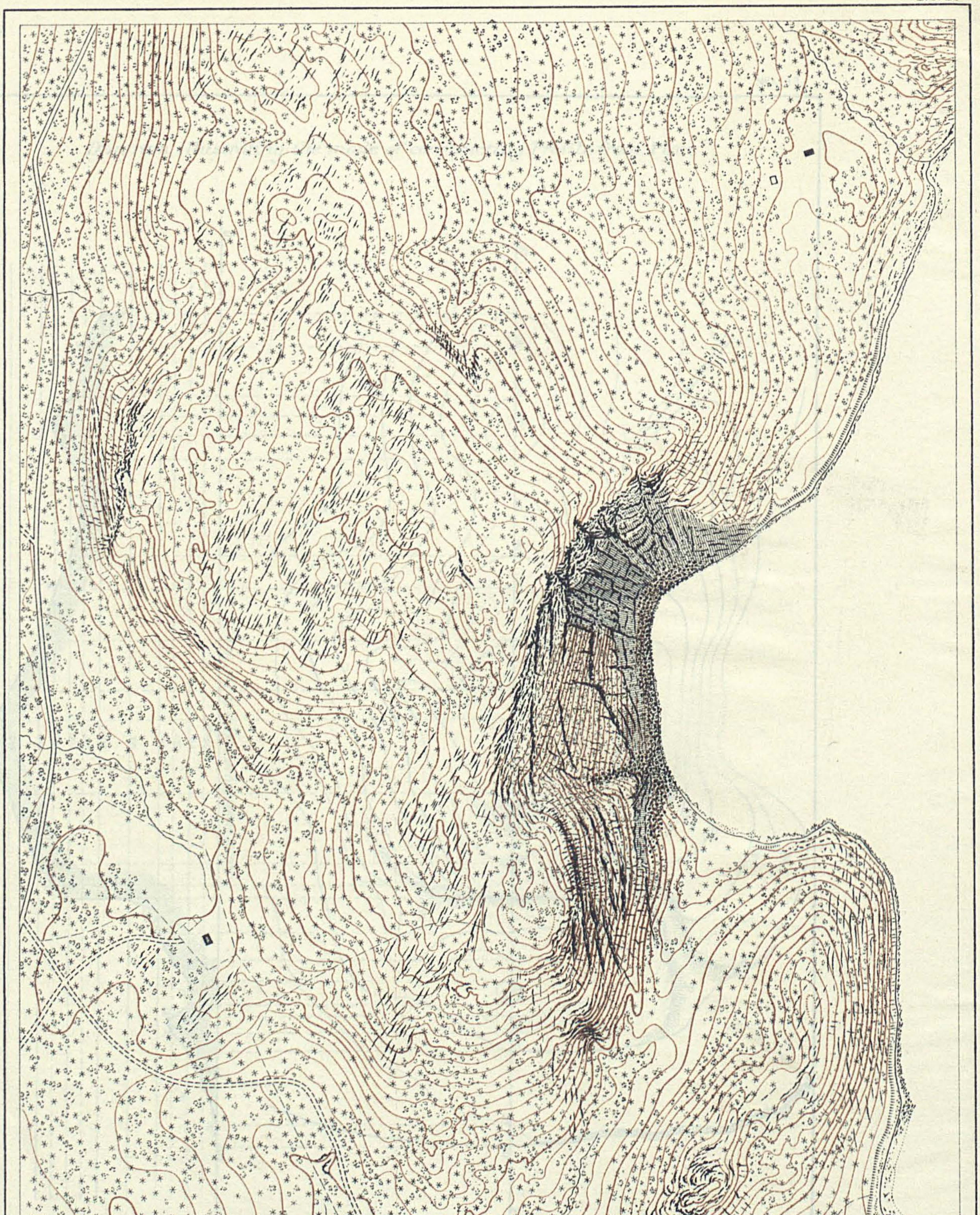


SECTION

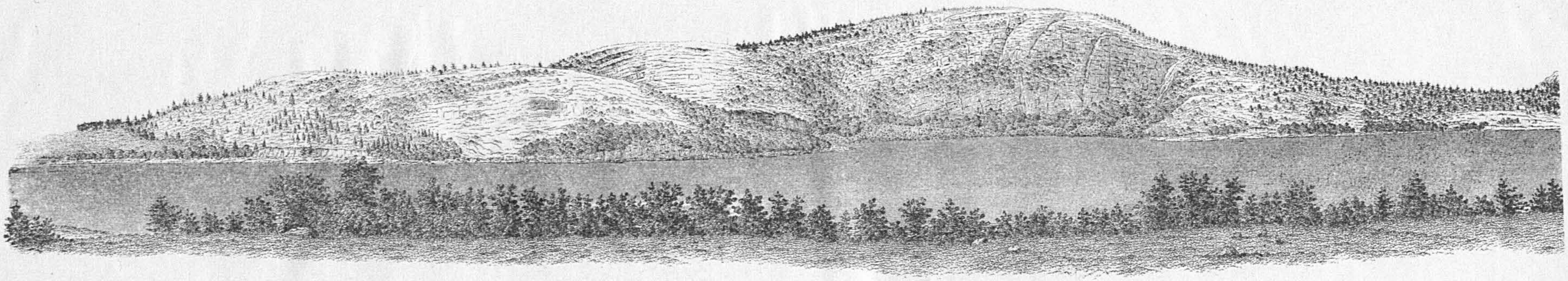
HYSOGRAPH.

Diagram illustrating the mode of constructing Profile from Plan





Crest, Face and Talus of a Granite Cliff (Eagle Cliff, Mt. Desert Id.)



Eagle Cliff, Mt. Desert Id. (Looking West.)

as imaginary shore lines formed at stated or regular elevations, by water which is supposed to rise successively to these elevations over the face of the country.

Profile.—As each curve has equal vertical ordinates at all points, the elevation or profile of a hill, as well as a model in relief, can be constructed from the map, when it is accurately executed on a large scale, without further field measurements.

A profile of a hill is the outline or trace formed with its surface by a vertical plane cutting the hill in any direction.

Illustration No. 13 shows the profile through the line A' B' of the hill h, as represented on a topographic map. The full parallel lines upon the profile represent the successive heights or sections of the hill of 20 feet, and the broken or intermediate lines x . x x those of 10 feet. A reference to the letters of the diagram is all that is necessary to a full understanding of the subject: a is the shore line or high-water line upon the map, x x x are the auxiliary 10-foot curves; f' the coincidence of curves upon the chart at the perpendicular face of the hill f, upon the section. This is the only case where contours of different heights run into each other upon a topographic plan. D' is a depression in the face of the hill, represented on the profile by D. d' is a barranca or dry broken gully, and c' c' a water course.

It will be plain that if we were to suppose the water to rise to a height of 20 feet above the high-water line, to h on the profile, the 20-foot curve upon the map would become the shore line and the depression D' would fill up and become a pond of water; and if the water were to rise to a height of 30 feet, the dotted broken line would form a shore line, and the knoll G would become an island.

Advantages and disadvantages of hill shading and contours.—In a mountainous country the method of hill shading presents a picture which expresses more forcibly to the eye the configuration of the country than a system of contours. But the objection to its sole use arises from the fact that, although one ridge is perceived to be higher than another, there is no guide for stating in terms of some linear unit this difference in elevation. It also obscures the symbols representing other details on the surface.

A system of contours furnishes a convenient means for obtaining the heights on any part of a map, but does not adapt itself to the representation of the small but important accidents of the ground, such as gullies, ledges, rocks, etc.; nor does it satisfactorily delineate such features as cliffs, bluffs, quarries, railroad cuts, and embankments.

For these reasons the Coast and Geodetic Survey has adopted both methods, employing hachures for the smaller features and where the steepness of the slope would make the contour lines approach together so closely that individual lines would become indistinguishable, and relying on the contours to delineate less precipitous ground.

The two systems can be seen combined when it is necessary to indicate a rocky and broken mountain face. (Illustrations 14 and 15.)

The contour interval customarily used on the Coast and Geodetic Survey field sheets is 20 feet. When, however, the contour runs very near to some remarkable accident of ground, as a prominent spur or indentation, a slight deviation above or below its true plane is admissible to include this feature, although it is preferable to avoid doing so, if possible, by the introduction of an auxiliary curve.

In abruptly mountainous and comparatively inaccessible regions, where sketching must be relied upon, 100-foot curves may suffice to develop all necessary features.

Datum plane.—Probably the best plane of reference for heights of points on the earth's surface is the mean level of the sea, since the mean of the rise and fall of the tides is approximately this level. In practice, however, mean high water is usually taken, as it includes all land not covered by the tide range, and is the line dividing land and water.

Reference signal.—It is advisable in commencing the survey of a region bordering on tide water to locate one or more signals at the assumed high-water line, carefully noting the height of the top of the flag above the same, to be used in measuring angles of depression for heights from points occupied during the progress of the graphic triangulation. As the heights of other points are determined in the course of the survey and verified from observations from two or three other points, these in turn may be used for the same purpose.

The following are the methods of surveying curves of equal elevation:

First. The determination of the position and heights of a number of characteristic points of the terrene, and with these as guides tracing the contour lines.

This is the method generally used in surveys embracing such areas as the sheets of the Coast and Geodetic Survey on scales of 1-10000 and 1-20000.

It has the merit that the development of the terrene proceeds with the survey of the skeleton, and does not necessitate a return to a station when once occupied. In connection with the determination of position by resection it works harmoniously and economically, since points that would be selected for position as having the best outlook are likely to be the characteristic ones of the terrene.

Second. Surveying and leveling the skeleton and its traverses.

Third. Surveying and leveling the profile lines.

The profile is a traverse line on which are determined the heights of the points at which the surface changes slope. The points where this line is intersected by the successive contour interval are easily determinable with the level and rod.

Fourth. Surveying and leveling the base of each level section.

To determine the base of each level section the table is set up in position where this level intersects the profile, and using the alidade as a leveling instrument, with a target fixed on the rod at the height of the optical axis of the telescope, the line is traced by locating the rod in successive positions at characteristic points of the terrene, when the target comes in the horizontal plane of the optical axis, direction and distance of the rod being determined and drawn in each case. A line drawn through these points, recognizing features between the stations, locates the curve. In this operation allowance should be made for curvature and refraction, when the distance becomes sufficiently great to make it a factor.

Fifth. Surveying and leveling the parts of several level sections from one station.

When parts of several level sections are run from one station, set up the table at a point on a contour, and observe on a staff the height of the optical axis of the alidade. Set a target on the staff above this height as many contour intervals as its length will include. The aid carries the staff below the instrument and is signaled to stop when the target comes in the horizontal plane of the optical axis, and at successive steps traverses the lower curve. The target is then lowered on the staff one contour interval and the next curve above is traced in the same manner, continuing the proceeding until the level of the instrument is reached, when the table is moved to an upper station

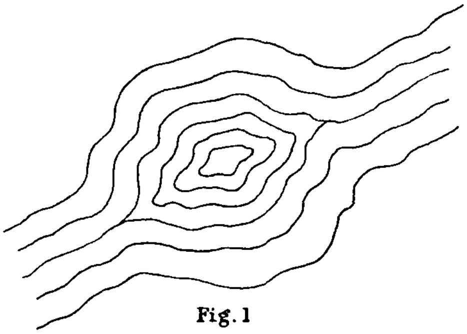


Fig. 1

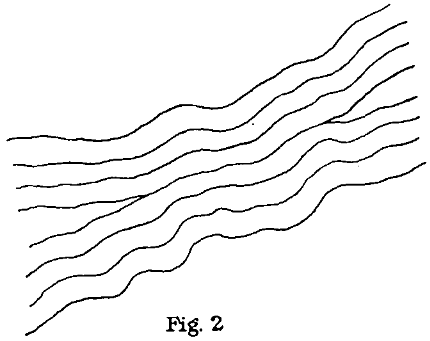


Fig. 2

Fig. 3

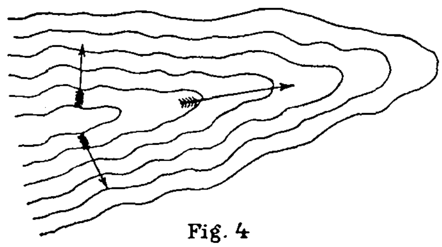


Fig. 4

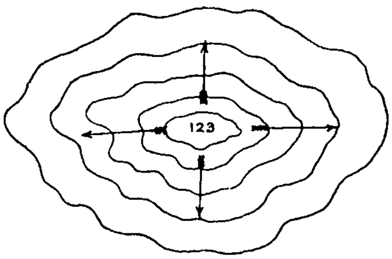


Fig. 5

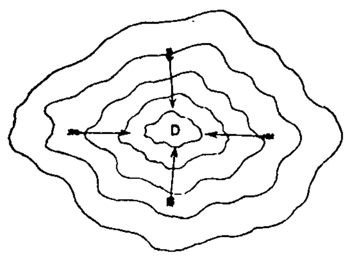


Fig. 6

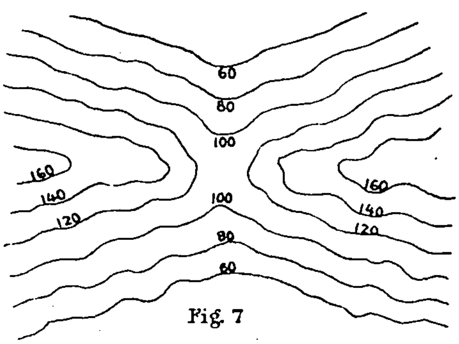


Fig. 7

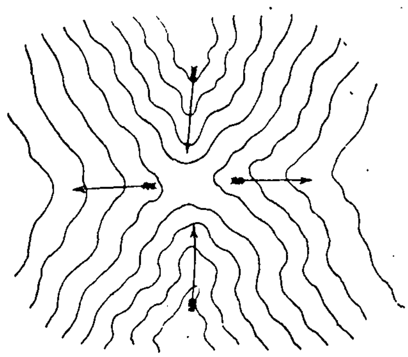


Fig. 8

TYPICAL CONTOUR GROUPS.

and the proceeding continued until the summit is reached. (Applies only to very small contour intervals.)

Sixth. The division of the terrene into squares, triangles, or parallelograms.

By the mode of regular division of the surface into squares, triangles, or parallelograms, pegs are driven at regular intervals, and their heights determined by level in the way that may be most convenient, a spirit-leveling instrument being the most accurate.

Station routine.—The topographer having determined his position on the sheet, and also the height of the instrument, proceeds to map the natural and artificial details of the area surrounding the station. For this purpose the direction of each detail is obtained by pointing the telescope upon it, the edge of the rule cutting the station point; its distance is determined by reading the stadia rod held there for the purpose. This distance is then taken off the metal scale with a pair of dividers and plotted along the edge of the rule.

While this is in progress the alidade is used both as a level for the observation of objects of the same height as the instrument and for measuring angles of elevation and depression to such of the plotted details whose position at critical points of the contours would materially assist the topographer in tracing them.

Number of elevations to be determined.—No rule can be laid down as to the number of elevations that should be determined from each plane-table station or for a given area. It will depend on the skill of the topographer and the modeling of the ground. The number will be adequate when he is confident of tracing, by their aid, the contours with an accuracy sufficient for the scale and the purpose of the survey.

It would indicate careless and slovenly work if the contours were found on examination to deviate frequently from their true position on the sheet by more than half an interval for a slope of less than 5° in an open country. When the slope is steeper, or in wooded regions, a greater latitude is permissible, but even here, in representing the crests of ridges, prominent hill tops, and valley floors, this limit of half an interval should not be departed from for good work.*

Contour sketching.—The topographer will be assisted in sketching contours, where the modeling is intricate, by lightly drawing a skeleton composed of the ridge lines and thalweg lines (lowest lines of valleys) in their proper positions around the station. On the ridge lines will be found the extreme outward or convex bends of the contours, and on the thalweg lines the extreme inward or concave bends.

It can be readily imagined that if each spur and each small depression was represented by its appropriate line, and on each of them were located, either by observation or estimation, points having elevations equal to some multiple of the contour interval, it would be only necessary to connect those points having the same elevation with a smooth curve to have a correct plan of the contours.

It will simplify the sketching at a station to draw the highest, lowest, and middle contours first, as they will then serve as guides for estimating the position of the others.

Typical contour groups (Illustration 16).—It should be remembered that a contour never splits, as shown in Fig. 1; nor do two contours run into one, as shown in

* For some pertinent remarks on this subject see Bulletin of the University of Wisconsin, Eng. Series, Vol. 1, No. 10, Topographical Surveys; their methods and values. J. F. Van Ornum, pp. 360–361.

Fig. 2; nor cross each other, except in the rare instance of an overhanging cliff, as shown in Fig 3.

When an auxiliary contour is introduced, no more of it is drawn than is sufficient to delineate the special feature which makes it necessary. A principal contour, on the other hand, can not have an end within the map; if it commences at one edge it must terminate at another.

A closed contour encircled by one or more closed contours is either a hill, as shown in Fig. 5, or a depression, as shown in Fig. 6; the arrows showing the direction in which water would run. The summits of all the hills of importance should have their elevations determined and marked on the map. All depressions without an outlet and which do not contain a pond or lake should be marked with a D at their lowest point.

A series of contours, as shown in Fig 4, is either a croupe (the end of a ridge or promontory) or a valley. If a croupe, the contours will have their concave sides toward the higher ground; if a valley, the contours will have their concave sides toward the lower ground.

A combination of four sets, like Fig. 7, with convex sides turned toward each other, represents a dip in a ridge, or the junction of two ridges, and is called a saddle.

A pass in a mountain range generally takes the form shown in Fig. 8.

Order of development of contours.—As the progress of topographic work is usually from the shore line inward, this affords the most favorable direction for drawing the curves of equal elevation, and as it is desirable that all work at a station shall be completed when it is first occupied to avoid the necessity of returning to it, the curves should be drawn by estimation from the shore line to the points sighted and determined for position and height, to be checked by drawing from those points when in turn occupied. The heights of a sufficient number of points must be determined to guard against any wide range of estimate of height by the eye.

In abrupt slopes of considerable extent the use of a pocket clinometer is valuable in determining the degree of slope, and in order to draw the curves by the widths of their zones (the cosines of angles of slope) from a paper scale prepared for the purpose. (See Illustration 32.)

Filling in.—Having completed the work at a given station, the topographer proceeds with his party and instruments to an adjoining locality, where he selects a new station from which he can gather the details of an area bordering upon the one last surveyed. In this manner the skeleton map is filled in by successively occupying stations over the whole expanse of the sheet.

Traverse lines.—In a wooded country, where it is impossible to find open space with range sufficient to see enough points for determination of position by resection, it is necessary to run traverses along the roads, with offsets to such lateral features as it may be practicable to reach without the expenditure of excessive labor and time in opening lines of sight. The levels, when necessary, are carried along with the line by observing vertical angles with the alidade upon some mark on the rod, taking back and fore sights at alternate stations.

Main traverse.—The standard table is used on main roads and whenever the details are important and numerous.

The traverse line is started by occupying some point previously determined and sending the telemeter rod ahead to a place selected for its advantageous position, in reference either to the surrounding features or facility in obtaining a new section of the traverse.

Having sighted to this point, read and plotted the distance, short guide lines should be drawn along the edge of the ruler at both ends and numbered or lettered, so they may be identified from others of like character. The table is then moved to the forward station, approximately oriented by estimation, and the plotted point carefully plumbed over the one on the ground.

The alidade is now placed on the table, and the table oriented by bringing the edge of the ruler close up to the guide lines; then revolving the table until the vertical wire bisects the rod or signal left for that purpose at the last station.

The same processes which were employed at the initial station are now repeated; the detail is mapped and the new station in advance occupied in turn, the line progressing in this manner by successive steps.

In running traverses, great care should be taken to sight as low as possible upon the fore and back signals, so as to avoid any error of deflection which might arise from the inclination of the signal poles.

Subordinate traverse.—When the line is unimportant and few features present themselves to be noted, an auxiliary plane table oriented by a declinatoire or a transit, fitted with stadia wires, may be employed.

When this method is pursued with a second table the forward rod station is not occupied, but another is chosen in advance of it, from which it can be seen where the instrument is set up and oriented with the declinatoire. Sighting the alidade to what is now the back station, the distance is read and plotted along the edge of the ruler, and the point so determined represents the one occupied by the table.

The pivot on which the declinatoire needle rests should be examined frequently as the least roughness will cause the needle to drag and introduces serious deflections in azimuth.

All traverse lines should start and end at well-determined points. This will serve to check the accuracy of the work. If the closing error is not too large, the line should be adjusted by distributing it throughout its length. The line is run on a spare sheet when an auxiliary table is used; then traced, "swung in," and adjusted between the two fixed points.

Determinations for hydrography.—Where the topography surveyed includes the shore line of a body of water, the hydrographic survey of which is intended to follow the topographic work, as in the Coast and Geodetic Survey, it is the duty of the topographer to locate and determine the shore signals, and it is only necessary to state that they should be so placed as to furnish the hydrographic party with as many points as is desirable for the determination of positions on the water.

Natural or artificial objects along the shore, or in plain sight from the water, such as fence ends, rocks, prominent houses, etc., should be determined and marked upon the sheet.

Lines to buoys and other permanent floating objects at anchor should be, as far as practicable, taken at the same stage of the tide, or direction of current.

The mean low-water mark should be delineated, and when it is beyond the reach of the plane-table and presents no marked points for determination, or is of a character that will not permit the use of the instrument—as along the swampy shores in the

South, where the muddy shoals extend far seaward, and among the shifting quicksands of our great estuaries and bays—it may be left to be traced by the work of the hydrographic parties. The channels through mud flats of this character should be indicated, however, if only approximately, by cuts and tangents, or the determination of stakes at the turning points. Where the fall of the tide exposes rocks and ledges, shingle beaches, etc., their character and extent should be delineated and distinguished from the sandy beaches, as these features are most difficult and laborious for the hydrographic survey to represent.

High-water and storm-water line.—In tracing the shore line on an exposed sandy coast care should be taken to discriminate between the average high-water line and the storm-water line.

Determination of inaccessible points.—On a precipitous coast, where the shore line is inaccessible and can not be determined by ordinary methods, the salient features are located, when occupying commanding stations, by observing the vertical angles upon them, and drawing direction lines to them. Then using the elevation of each station as a base the distance to each feature is computed and platted.

The same method applies to outlying rocks, and is often employed where there is any doubt of their being identified from different places.

Large-scale surveys.—As has been previously stated, 1–10000 and 1–20000 are the scales customarily used in the execution of the topographic work of the Coast and Geodetic Survey, as they are the ones best suited for the charting of the coast line and harbors of the United States.

Other surveys for special purposes have been made from time to time on scales both larger and smaller, and the field practice has been modified according to the requirements of the scale used.

A topographic survey of the District of Columbia outside the thickly populated limits of the city of Washington was made between the years of 1880 and 1891 on a scale of 1–4800.

The methods pursued are here described, as they are typical of other surveys on a large scale.

Based on a sufficiently minute triangulation, the plane-table and stadia, wye level, and rod were used for all determinations of details. The relief was elaborately indicated by contour intervals of 5 feet. The datum plane is the same as used by the engineer department of the District, on which is based all the levels used for grades of streets and sewers in the city of Washington, the survey being made for the purpose of extending streets and avenues beyond the city limits.

From this datum, along all roads, avenues, and railroads, and where roads were infrequent, across country, lines of level were run, and after careful checking in the usual manner bench marks were placed in position convenient to all parts of the region.

The plane-table stations were established so as to easily overlook every part of the field and so close together that each was surrounded by the others within the range of a single reading of the stadia rod.

The mode of procedure was as follows:

The plane-table was placed in position by a graphic solution of three-point problem. At the same time the height of the level was determined above some near bench mark and the target of the level rod fixed, so that when it was in the line of sight of the level the bottom of the rod would rest on the ground where the elevation corresponded to that of some contour. The level rodsman then began his journey along this imaginary horizontal line, holding the rod for the observation of the levelman at each noticeable change in the configuration of the ground. The levelman directed the rodsman by signals at each point until the rod was in position on the contour line, when the stadia rod was substituted and its distance read and plotted on the plane-table sheet. The rodmen followed the contour line in both directions from the table as far as the stadia rod could be conveniently read. Generally two and sometimes three contours were run from one level station, and on their completion a turning point was fixed and the level shifted to higher or lower ground, as the circumstances required.

A survey of Craney Island, Virginia, was made in the same manner on a scale of 1–1200.

RAPID SURVEYS.

Military reconnaissance.—In almost every field of operations, from the commencement of the civil war to its close, the plane-table was used.

Until this time very little was known, save in theory, of the value of the plane-table as a reconnoitering instrument, and all the officers engaged in the work testify that, for rapidity and accuracy in the execution of military reconnaissance, it is more effective than any other instrument.

The system usually adopted, in default of triangulation, was to measure a base with an ordinary chain and to do triangulation with the plane-table.

In detailed surveys for the Army, where a topographer averages from 1 to 3 square miles a day, on large scales a chained base of from one-half to three-quarters of a mile for the survey of an area of 25 square miles is found sufficient.

At Chattanooga, from two different bases of about half a mile each, plotted on separate sheets, and carefully measured once with a common 20-meter chain, the same chain being used to measure both bases, after considerable intermediate plane table triangulation carried on by two officers, two objects were determined 2½ miles apart, common to both sheets, which were on a scale of 1–10000, and the discrepancy was but about 15 meters. Many other points of junction indicated this to be the maximum error. In this case the leaves were mostly off the trees and the hills afforded good points. The sheets covered about 20 square miles each. At Nashville there was a discrepancy of about 10 meters in 2 miles.

At other times, when the character of the country or the pressure of time did not admit of the measurement of a preliminary base and plane-table triangulation, the work was commenced by starting from a single point and extended by linear measurement with the chain or stadia, intersections from the ends of the chained lines being taken to determine objects, which, as the work progressed, could also be used as checks upon the chaining. Where circumstances permitted, an occasional return with the chain to a back point, either to close a series of lines upon it or to start afresh, was resorted to. This work was generally carried on over roads and the interior filled in by sketching and intersections as far as practicable. Some of the tests of this latter work, where the operations of two officers joined, were remarkably close.

A very efficient topographic officer estimates that with the usual number of hands and a good sketcher to aid, in a country of average variety of detail, in which all the houses, prominent barns and outbuildings, streams, roads, general outline of woods, and approximate curves are to be shown, on a scale of 1–10000, an area of between 2 and 3 square miles can be filled in daily, with sufficient accuracy for military purposes.

This rapidity of work, however, could not be expected in or near towns or populous districts. It is doubtful if, under average conditions, the work would be more than one-half this amount.

In some thickly wooded sections and where time is limited, it has been found advisable to run the main roads with the plane table and fill in with the compass, which is more rapid but less accurate than where the entire work is done with the plane table alone. The usual method employed where these methods were combined, was as follows: Where the army was stationary, or moving leisurely, one main road was run with the plane table, the operator being accompanied by assistants well practiced in the use of the compass. Upon arriving at any important road or water course an assistant was sent to the right and left, starting from a plane-table point, determined by the chaining, and running as far as was requisite and then returning to the main road again to repeat the operation, the compass notes, of course, being kept in a book prepared for the purpose. Prominent points determined by the plane table were used as checks in the compass work. The intervening topography, where no compass or plane-table work had been done, was sketched in by the chief of the party, in which accurate pacing became of great value.

With compass and notebook.—Plane-table methods can be utilized to advantage when compass, pencil, notebook, and ruler are the substitutes for an instrumental outfit. The book serves as the sheet and board combined, and the ruler, as it was in the early days of the art, becomes the alidade.*

Photogrammetry.†—In the topographic reconnaissance made for the Alaska Boundary Survey by the Coast and Geodetic Survey, the camera with constant focal length has been used as an adjunct to the small mountain plane table. The latter was used to plot the shore line and adjacent topography, also to determine as many peaks of the interior country as possible by the intersection of lines of direction. All camera stations were determined geographically and hypsometrically, and plotted upon the plane-table sheet. The topographic details beyond the reach of the plane-table were added to the map in the Office by the photogrammetric methods.

The rugged mountains of southeast Alaska appear particularly well adapted for this mode of procedure, as identical points can be readily picked out from different panorama views, owing to the characteristic shapes of the mountain peaks, snow fields, glaciers, etc.

Periods of fair weather are also very short and of rare occurrence in that locality, and a great deal of topographic material can be gathered photographically in a short time, which when plotted will cover a large territory if a sufficient number of reference points on the views have been located instrumentally.

The plotting proper can be carried out to any degree of minuteness and detail; the only requirement is that a sufficient number of camera stations shall have been occupied

*See "Sketching without instruments," in Topography, Drawing, and Sketching, by Lieut. Henry A. Reed, U. S. Army, 1886.

†See United States Coast and Geodetic Survey Report, 1893, Appendix 3, and Report for 1897, Appendix 10.

to fully cover the territory in question, so that every topographic feature of prominence has been seen or photographed from at least two stations.

By this application of photogrammetry the plane-table methods of determining topographic details are extended to the Office, inasmuch as the same features are selected from the panorama views and plotted geographically which would have been located by the plane-table. But the actual time spent in the field is reduced at the expense of the time needed for office work.

Survey in advance of triangulation.—Where it is necessary to make a topographic survey in advance of the determination of points by triangulation, a reconnaissance is first made for the location of a base line and selection of points to be determined with the plane table.

The base is measured with sufficient accuracy and conveniently, with a steel tape which has been compared with a standard at a fixed tension, and to one end of which is attached a spring balance to secure the same tension during measurement. The successive lengths are marked by lines cut on copper tacks driven in wooden stubs firmly set in the ground. The temperature is noted at frequent intervals as the work progresses, and the corrections are applied to the length of the base when completed.

The base is then properly located on the sheet in reference to the area to be embraced and its length carefully set off. It is well at the same time to mark in three or four different parts of the sheet lengths of 1 000 meters for the purpose of determining at any time the true scale of the sheet, variable by the different hygrometric conditions of the atmosphere.

Signals having been erected at the selected points, the extremes of the base are occupied with the table and the points, as far as may be reached with good intersections, determined from them and lines of direction drawn to all the points visible, to serve as checks upon their determination from other points furnishing directions for good intersections. The survey then proceeds as usual.

It is well at the beginning of work to draw (using the declinatoire) the magnetic meridian, at some determined point near the middle of the sheet for the purpose of putting the table in approximate position at any station with the declinatoire. The manner of doing this is described elsewhere.

Before finishing the field work it is important, when the sheet has no projection, to provide data for drawing a true north and south line. This is done by drawing from a point upon the sheet, when the table is in position, a line in the vertical plane through Polaris and the point occupied and recording the time of observation. The azimuth of the star at that time being known, a true north and south line can accordingly be set off.

If a small transit instrument is at hand and carefully adjusted for movement in vertical plane, an assistant with a lantern can be located where the vertical plane through Polaris and the point occupied intersects the ground, at as great a distance from the point as the ground will admit within the limit of communication by light signals. When such a position is marked the direction from the point occupied may be determined by daylight.

If, in the absence of a transit, the alidade has not vertical range sufficient to observe Polaris, an illuminated plumb line may be used for the alignment.

OFFICE WORK.

All the topographic features of a survey should be drawn in pencil upon the sheet in the field, while they can be seen. Sketching and plotting in the office from notes, unless the country be near at hand for ready reference in case of doubt or defective data, is objectionable. When this is unavoidable, the sketches should be transferred to the sheet as soon as possible after being made, while fresh in the mind of the person by whom they were made, and by whom they should be plotted. Days which, from inclemency of the weather, are unfavorable for out-of-door work should be allotted to this purpose, and advantage should be taken of them, also, for retouching any details of the sheet which may have become indistinct, as it is very important that they should not be left indefinite or become obliterated; for when the inking is done, as it generally is, at a distance from the field of operations, the necessity for this care is obvious. Nos. 4 and 5 pencils are good for this purpose, for which very hard or very soft and black pencils are equally unsuited.

In the inking of a topographic sheet three requisites to its proper appearance when finished should be borne in mind—clearness, neatness, and uniformity.

The lines and objects should be clear and sharply defined, nothing being left obscure or doubtful; the paper should be kept unsoiled, and erasures avoided as far as possible, and the style and strength of the drawing should be the same throughout. It is an important matter that an easy and natural appearance should be given to the sheet, for, as before remarked, a mere rigid adherence to conventional signs is not all that is necessary; while there should be no deviation in this respect, at the same time the draftsman should strive to *represent the country*. There is a great difference with regard to this among topographers. Two correct sheets of the same section of ground, executed by different persons, may be inked, and while one will have a stiff and ungraceful look, the other will appear artistic and natural, giving at once the impression of a true representation of the country surveyed.

Office work should not be commenced until the topography is entirely completed, as no inked or partially inked sheet should ever be used in the field. Sometimes, for the special examination of old work, or for the insertion of some recent artificial or natural changes, this becomes necessary, but there is always a risk of injuring an inked sheet by exposure to the weather or by using it upon a plane table.

The inking should begin with the high and low water lines. The high-water line or shore line proper should, in all cases, be full and black, the heaviest line on the sheet, and in this, as in all the rest of the ink work, the lines of the surveyor should be strictly adhered to.

The topography as drawn in the field is supposed to be correet when the sheet is finished, and no office amendments or changes are admissible. The low-water line is drawn, not so full as the former, but clear, black, and uniform, consisting of a dotted line for sand and mud and the conventional sign where it is formed by shells, rocks, or coral reefs.

Neither the inner border of a marsh nor a shoal covered at high tide has a distinct continuous line to mark its limits, each being represented in its proper form and within its area by its conventional sign only, but the shape should be well and correctly defined. All objects between high and low water, covered at full tide, should be represented less boldly than the other features on the sheet, but not faintly or indefinitely.

The roads should be inked plainly and evenly, with their sides parallel, except where the survey shows a deviation from the general width. Main thoroughfares when fenced are drawn with a full line, subordinate roads where fenced should be shown by the usual sign, and where there is no inclosure a line of dashes should indicate the roadside, and then should follow the fences and houses. In drawing the latter, care must be taken that the corners and angles exhibit a sharp, clear outline, which adds much to the appearance of the sheet.

The general skeleton of the survey being now completed, the contours are drawn with a bold, uniform, plain red line, without break, over all the other work, following accurately the full range of level of each of the contours on the sheet.

After this comes the general filling in, by conventional signs, of sand, marsh, grass, cultivation, orchards, rocks, hachures, etc. Some practice is needed to execute the sand work regularly and neatly. It should never be done hurriedly, though of course rapidity in this respect follows practice. The lines representing marsh, and the delineation of grass on the fast ground, should always run in the same direction over the whole sheet and be parallel to the top of the sheet and the title. The appended drawings (Illustratious 17, 18, 19, 20, and 21) give the conventional signs as adopted by and now used by the Coast and Geodetic Survey.

The most difficult part of the inking for a beginner is the lettering, which now follows, and for which samples are given (Illustration 22). It is expected that every topographer shall have learned to draw sufficiently well to ink his sheet in a clear and distinct manner and letter it with some regard to neatness and graphic effect, as the appearance of an otherwise well-inked sheet is marred by careless or indifferent lettering.

The location of the names upon the sheet should be such as not to cover or obliterate any detail or feature of the survey, and the letters should be put on neatly and gracefully, and in point of size and form according to the specimens furnished. The title should follow, with such notes as may be necessary to explain any peculiarity of the sheet or survey.* This title and lettering should, as far as practicable, be so placed that when the sheet is held with the top (the north end of the map) from you it can be easily read; in other words, as nearly parallel to the top or upper end of the sheet as the nature of the work will admit. All names well established and recognized in a neighborhood, both general and local, should be collected during the survey, and their correct orthography ascertained, and in case of any doubtful or disputed orthography a report should be made giving any traditions or authorities which bear upon the subject. No illuminated or German text, old English, or what is known as "fancy printing," should be indulged in, a strict adherence to simplicity being required.

The minutes of the parallels of latitude and meridians of longitude should be marked in figures at the upper and right-hand ends, respectively, the degrees on the center parallel and center meridian only.

When buoys are determined by the topographer, and their names, colors, numbers, or kind are known, they should be placed on the sheet and so marked.

* The topographers in the Coast and Geodetic Survey are required to write the title and notes on a separate sheet of paper and attach it to the plane table sheet. This portion of the lettering is done at the Office.

The triangulation points should be surrounded by a small red triangle. Barns, houses, prominent trees, and other objects determined by the plane table that may be used as points of reference in making additions to the sheet subsequent to the survey should be indicated by a small blue circle.

TABLES AND FORMULÆ.

Table for reducing readings of inclined sights on a rod held perpendicular to the line of sight.

Angle	Hypothenuse				
	100 meters	200 meters	300 meters	400 meters	500 meters
5°	99.62	199.24	298.86	398.48	498.10
10°	98.48	196.96	295.44	393.92	492.40
15°	96.59	193.19	289.78	386.37	482.96
20°	93.97	187.94	281.91	375.88	469.85
25°	90.63	181.26	271.89	362.52	453.15
30°	86.60	173.21	259.81	346.41	433.01
35°	81.92	163.83	245.75	327.66	409.58
40°	76.60	153.21	229.81	306.42	383.02
45°	70.71	141.42	212.13	282.84	353.55

When it is desired to use the preceding table, a sight must be attached to the rod or the proper position of the rod left to the judgment of the rodsman. The usual and safer way is to have the rod held vertical for all readings. There are then two corrections to be applied, one to reduce the inclined distance to a horizontal one and one for the oblique view of the rod.

The equation for reducing the readings is:

$$\text{Horizontal distance} = r \cos^2 v + (c+f) \cos v$$

Where r=reading of vertical rod;

v=angle of elevation or depression;

c=distance of object glass to center of instrument;

f=focal length of telescope.

The following table gives the coefficient of reduction by which the rod reading is to be multiplied. It is based on the assumption that $c+f$ is to be added to the result to obtain the distance to the center of the instrument.

Example: Given an angle of elevation or depression 8° 10′ and the reading of the inclined sight on vertical rod=173.1 meters.

From the table:

Factor for 1 meter for 8° 10′ multiplied by 100	=97.98	meters.
" " 7 " " " " " " , 10	=68.59	"
" " 3 " " " "	= 2.94	"
" " 0.1 " " " "	= .09	"
Horizontal distance	169.60	"

To which $c+f$ is to be added.

*Table of coefficients for reducing readings of inclined sights on a vertical rod to horizontal distance.**

Angle of inclination	Horizontal projection of 1 m.	2 m.	3 m.	4 m.	5 m.	6 m.	7 m.	8 m.	9 m.
0° 10′	.99999	1.99998	2.99997	3.99997	4.99996	5.99994	6.99994	7.99993	8.99993
20′	.99997	1.99993	2.99990	3.99986	4.99983	5.99980	6.99977	7.99973	8.99970
30′	.99992	1.99984	2.99977	3.99969	4.99962	5.99954	6.99946	7.99939	8.99932
40′	.99986	1.99973	2.99959	3.99946	4.99932	5.99919	6.99905	7.99892	8.99878
50′	.99979	1.99957	2.99936	3.99915	4.99894	5.99873	6.99852	7.99831	8.99810
1° 00′	.99970	1.99939	2.99909	3.99878	4.99848	5.99817	6.99787	7.99757	8.99726
10′	.99959	1.99917	2.99875	3.99834	4.99793	5.99752	6.99711	7.99669	8.99628
20′	.99946	1.99891	2.99838	3.99783	4.99729	5.99676	6.99622	7.99568	8.99514
30′	.99932	1.99863	2.99794	3.99725	4.99657	5.99589	6.99520	7.99452	8.99384
40′	.99915	1.99831	2.99746	3.99659	4.99572	5.99489	6.99406	7.99323	8.99239
50′	.99908	1.99801	2.99693	3.99590	4.99488	5.99386	6.99284	7.99182	8.99080
2° 00′	.99878	1.99756	2.99635	3.99513	4.99391	5.99269	6.99147	7.99025	8.98904
10′	.99857	1.99714	2.99571	3.99428	4.99285	5.99142	6.99000	7.98857	8.98714
20′	.99834	1.99669	2.99503	3.99337	4.99171	5.99006	6.98840	7.98675	8.98509
30′	.99810	1.99620	2.99429	3.99239	4.99049	5.98859	6.98669	7.98479	8.98289
40′	.99784	1.99568	2.99351	3.99135	4.98918	5.98702	6.98485	7.98268	8.98053
50′	.99756	1.99511	2.99267	3.99023	4.98778	5.98534	6.98290	7.98046	8.97802
3° 00′	.99726	1.99452	2.99178	3.98904	4.98630	5.98357	6.98083	7.97809	8.97635
10′	.99695	1.99390	2.99085	3.98780	4.98474	5.98169	6.97865	7.97560	8.97255
20′	.99662	1.99324	2.98986	3.98648	4.98309	5.97972	6.97634	7.97296	8.96958
30′	.99627	1.99255	2.98882	3.98509	4.98136	5.97764	6.97391	7.97019	8.96646
40′	.99591	1.99182	2.98773	3.98364	4.97955	5.97546	6.97137	7.96728	8.96319
50′	.99553	1.99106	2.98659	3.98212	4.97765	5.97318	6.96871	7.96424	8.95978
4° 00′	.99513	1.99027	2.98540	3.98054	4.97567	5.97081	6.96595	7.96108	8.95621
10′	.99472	1.98944	2.98416	3.97888	4.97360	5.96832	6.96304	7.95776	8.95249
20′	.99429	1.98858	2.98287	3.97716	4.97145	5.96574	6.96003	7.95432	8.94862
30′	.99384	1.98769	2.98153	3.97537	4.96922	5.96306	6.95691	7.95075	8.94460
40′	.99338	1.98676	2.98014	3.97352	4.96690	5.96028	6.95366	7.94704	8.94043
50′	.99290	1.98580	2.97870	3.97160	4.96450	5.95740	6.95030	7.94320	8.93611
5° 00′	.99240	1.98481	2.97721	3.96961	4.96202	5.95443	6.94683	7.93923	8.93164
10′	.99189	1.98378	2.97567	3.96756	4.95945	5.95134	6.94323	7.93512	8.92702
20′	.99136	1.98272	2.97408	3.96544	4.95680	5.94816	6.93952	7.93088	8.92224
30′	.99081	1.98163	2.97244	3.96326	4.95407	5.94489	6.93570	7.92652	8.91733
40′	.99025	1.98050	2.97075	3.96100	4.95125	5.94150	6.93175	7.92200	8.91225
50′	.98967	1.97934	2.96901	3.95868	4.94835	5.93802	6.92769	7.91736	8.90703
6° 00′	.98907	1.97814	2.96722	3.95630	4.94537	5.93445	6.92358	7.91260	8.90167
10′	.98846	1.97692	2.96538	3.95384	4.94230	5.93077	6.91923	7.90769	8.89615
20′	.98783	1.97566	2.96349	3.95132	4.93915	5.92698	6.91481	7.90264	8.89048
30′	.98718	1.97436	2.96155	3.94873	4.93591	5.92310	6.91029	7.89748	8.88467
40′	.98652	1.97304	2.95956	3.94609	4.93261	5.91913	6.90566	7.89218	8.87870
50′	.98584	1.97169	2.95753	3.94337	4.92921	5.91506	6.90090	7.88674	8.87259
7° 00′	.98515	1.97030	2.95544	3.94059	4.92574	5.91089	6.89604	7.88119	8.86634

*Computed by J. A. Flemer, Assistant, Coast and Geodetic Survey.

Table of coefficients for reducing readings of inclined sights on a vertical rod to horizontal distance—Continued.

Angle of inclination	Horizontal projection of 1 m.	2 m.	3 m.	4 m.	5 m.	6 m.	7 m.	8 m.	9 m.
10′	.98444	1.96888	2.95331	3.93775	4.92218	5.90662	6.89105	7.87549	8.85993
20′	.98371	1.96742	2.95112	3.93483	4.91854	5.90225	6.88596	7.86967	8.85337
30′	.98296	1.96592	2.94889	3.93185	4.91481	5.89777	6.88073	7.86370	8.84667
40′	.98220	1.96441	2.94661	3.92881	4.91101	5.89322	6.87542	7.85762	8.83982
50′	.98142	1.96285	2.94427	3.92570	4.90712	5.88855	6.86997	7.85140	8.83282
8° 00′	.98063	1.96126	2.94189	3.92252	4.90315	5.88378	6.86441	7.84504	8.82568
10′	.97982	1.95964	2 93946	3.91928	4.89910	5.87892	6.85874	7.83856	8.81839
20′	.97899	1.95798	2.93698	3.91598	4.89497	5.87396	6.85296	7.83196	8.81096
30′	.97815	1.95630	2.93446	3.91261	4.89076	5.86891	6.84707	7.82522	8.80337
40′	.97729	1.95459	2.93188	3.90918	4.88647	5.86377	6.84106	7.81836	8.79565
50′	.97642	1.95284	2.92926	3.90568	4.88209	5.85851	6.83493	7.81134	8.78777
9° 00′	.97553	1.95106	2.92658	3.90211	4.87764	5.85317	6.82870	7.80423	8.77975
10′	.97462	1.94924	2.92386	3.89848	4.87310	5.84772	6.82234	7.79696	8.77159
20′	.97370	1.94740	2.92110	3.89480	4.86849	5.84219	6.81589	7.78959	8.76328
30′	.97276	1.94552	2.91828	3.89104	4.86379	5.83655	6.80931	7.78207	8.75483
40′	.97180	1.94361	2.91542	3.88722	4.85902	5.83083	6.80263	7.77444	8.74624
50′	.97083	1.94166	2.91250	3.88333	4.85416	5.82499	6.79583	7.76667	8.73750
10° 00′	.96985	1.93970	2.90954	3.87938	4.84923	5.81907	6.78892	7.75876	8.72861
10′	.96884	1.93769	2.90653	3.87537	4.84421	5.81306	6.78190	7.75074	8.71959
20′	.96782	1.93565	2.90347	3.87129	4.83912	5.80695	6.77477	7.74259	8.71042
30′	.96679	1.93358	2.90037	3.86716	4.83395	5.80074	6.76753	7.73432	8.70111
40′	.96574	1.93148	2.89721	3.86295	4.82869	5.79443	6.76017	7.72591	8.69165
50′	.96467	1.92934	2.89402	3.85869	4.82336	5.78803	6.75271	7.71738	8.68206
11° 00′	.96359	1.92718	2.89077	3.85436	4.81795	5.78154	6.74513	7.70872	8.67232
10′	.96249	1.92498	2.88748	3.84997	4.81247	5.77496	6.73746	7.69995	8.66245
20′	.96138	1.92276	2.88414	3.84552	4.80690	5.76828	6.72966	7.69104	8.65242
30′	.96025	1.92051	2.88076	3.84101	4.80126	5.76152	6.72177	7.68202	8.64227
40′	.95911	1.91822	2.87732	3.83643	4.79553	5.75464	6.71375	7.67286	8.63196
50′	.95795	1.91590	2.87385	3.83180	4.78974	5.74769	6.70564	7.66358	8.62153
12° 00′	.95677	1.91355	2.87032	3.82709	4.78386	5.74063	6.69741	7.65418	8.61095
10′	.95558	1.91116	2.86674	3.82232	4.77790	5.73348	6.68906	7.64464	8.60023
20′	.95438	1.90876	2.86313	3.81750	4.77187	5.72625	6.68062	7.63500	8.58938
30′	.95315	1.90631	2.85946	3.81261	4.76576	5.71892	6.67207	7.62522	8.57838
40′	.95192	1.90384	2.85575	3.80766	4.75958	5.71150	6.66341	7.61533	8.56724
50′	.95066	1.90132	2.85199	3.80265	4.75332	5.70399	6.65465	7.60532	8.55598
13° 00′	.94940	1.89880	2.84820	3.79759	4.74698	5.69638	6.64577	7.59516	8.54456
10′	.94811	1.89623	2.84434	3.79245	4.74056	5.68868	6.63679	7.58491	8.53302
20′	.94682	1.89364	2.84045	3.78726	4.73407	5.68088	6.62770	7.57452	8.52133
30′	.94550	1.89101	2.83651	3.78201	4.72751	5.67301	6.61852	7.56402	8.50952
40′	.94417	1.88835	2.83252	3.77669	4.72087	5.66505	6.60922	7.55339	8.49757
50′	.94283	1.88566	2.82849	3.77132	4.71415	5.65698	6.59981	7.54264	8.48548
14° 00′	.94147	1.88295	2.82442	3.76589	4.70736	5.64884	6.59031	7.53179	8.47326

Table of coefficients for reducing readings of inclined sights on a vertical rod to horizontal distance—Concluded.

Angle of inclination	Horizontal projection of								
	1 m.	2 m.	3 m.	4 m.	5 m.	6 m.	7 m.	8 m.	9 m.
10′	.94010	1.88020	2.82030	3.76040	4.70050	5.64060	6.58070	7.52080	8.46090
20′	.93871	1.87742	2.81613	3.75484	4.69355	5.63226	6.67097	7.50968	8.44840
30′	.93731	1.87462	2.81192	3.74923	4.68654	5.62385	6.56115	7.49846	8.43578
40′	.93589	1.87178	2.80767	3.74356	4.67945	5.61534	6.55123	7.48712	8.42302
50′	.93446	1.86892	2.80338	3.73784	4.67229	5.60675	6.54121	7.47567	8.41013
15° 00′	.93301	1.86602	2.79903	3.73204	4.66505	5.59806	6.53107	7.46408	8.39710
16° 00′	.92402	1.84805	2.77208	3.69610	4.62011	5.54414	6.46816	7.39218	8.31620
17° 00′	.91452	1.82904	2.74355	3.65806	4.57258	5.48710	6.40161	7.31613	8.23065
18° 00′	.90451	1.80902	2.71352	3.61803	4.52253	5.42704	6.33154	7.23605	8.14056
19° 00′	.89400	1.78800	2.68201	3.57600	4.47001	5.36402	6.25802	7.15203	8.04603
20° 00′	.88302	1.76604	2.64906	3.53208	4.41510	5.29812	6.18114	7.06416	7.94718

TABLE I.—*Table showing the height in feet corresponding to a given angle of elevation and a given distance in meters.**

Meters	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
Angle	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
1′	0.3	0.4	0.6	0.6	0.8	0.9	1.0	1.2	1.3	1.5	1.7	1.8	2.0	2.2	2.3	2.5	2.7	2.8
2	0.6	0.8	1.0	1.2	1.5	1.7	1.9	2.1	2.4	2.6	2.9	3.1	3.4	3.7	3.9	4.2	4.5	4.7
3	0.9	1.2	1.5	1.8	2.2	2.5	2.8	3.1	3.4	3.8	4.2	4.4	4.8	5.3	5.6	5.9	6.3	6.6
4	1.2	1.5	2.0	2.4	2.8	3.2	3.6	4.1	4.5	4.9	5.4	5.8	6.3	6.8	7.2	7.6	8.1	8.6
5	1.5	1.9	2.4	2.9	3.5	4.0	4.5	5.0	5.5	6.1	6.6	7.1	7.7	8.3	8.8	9.4	9.9	10.5
6	1.8	2.3	2.9	3.5	4.2	4.8	5.3	5.9	6.6	7.2	7.9	8.5	9.1	9.8	10.4	11.1	11.7	12.4
7	2.1	2.7	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.4	9.1	9.8	10.6	11.4	12.1	12.8	13.5	14.3
8	2.4	3.1	3.9	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.1	12.0	12.9	13.7	14.5	15.3	16.2
9	2.7	3.5	4.4	5.2	6.2	7.0	7.9	8.8	9.7	10.7	11.6	12.5	13.4	14.4	15.3	16.2	17.2	18.1
10	2.9	3.8	4.9	5.8	6.8	7.8	8.8	9.8	10.8	11.8	12.8	13.8	14.9	15.9	16.9	17.9	19.0	20.0
11	3.2	4.2	5.3	6.4	7.5	8.6	9.6	10.7	11.8	13.0	14.1	15.1	16.3	17.5	18.6	19.7	20.8	21.9
12	3.5	4.6	5.8	6.9	8.2	9.3	10.5	11.7	12.9	14.1	15.3	16.5	17.7	19.0	20.2	21.4	22.6	23.8
13	3.8	5.0	6.3	7.5	8.8	10.1	11.4	12.6	13.9	15.2	16.6	17.8	19.2	20.5	21.8	23.1	24.4	25.7
14	4.1	5.4	6.8	8.1	9.5	10.9	12.2	13.6	15.0	16.4	17.8	19.1	20.6	22.0	23.4	24.8	26.2	27.6
15	4.4	5.7	7.2	8.6	10.2	11.6	13.1	14.5	16.0	17.5	19.0	20.5	22.0	23.6	25.0	26.5	28.0	29.5
16	4.7	6.1	7.7	9.2	10.8	12.4	13.9	15.5	17.1	18.7	20.3	21.8	23.5	25.1	26.7	28.2	29.9	31.4
17	4.9	6.5	8.2	9.8	11.5	13.1	14.8	16.5	18.1	19.8	21.5	23.1	24.9	26.6	28.3	30.0	31.7	33.4
18	5.2	6.9	8.7	10.4	12.2	13.9	15.7	17.4	19.2	21.0	22.8	24.5	26.3	28.2	29.9	31.7	33.5	35.3
19	5.5	7.3	9.1	10.9	12.8	14.7	16.5	18.4	20.2	22.1	24.0	25.8	27.7	29.7	31.5	33.4	35.3	37.2
20	5.8	7.7	9.6	11.5	13.5	15.4	17.4	19.3	21.3	23.3	25.2	27.2	29.2	31.2	33.2	35.1	37.1	39.1
21	6.1	8.0	10.1	12.1	14.2	16.2	18.2	20.3	22.3	24.4	26.5	28.5	30.6	32.7	34.8	36.8	38.9	41.0
22	6.4	8.4	10.6	12.6	14.9	17.0	19.1	21.2	23.4	25.5	27.7	29.8	32.0	34.3	36.4	38.5	40.7	42.9
23	6.7	8.8	11.1	13.2	15.5	17.7	20.0	22.2	24.4	26.7	29.0	31.2	33.5	35.8	38.0	40.3	42.5	44.8
24	6.9	9.2	11.5	13.8	16.2	18.5	20.8	23.1	25.5	27.8	30.2	32.5	34.9	37.3	39.6	42.0	44.3	46.7
25	7.2	9.6	12.0	14.4	16.9	19.3	21.7	24.1	26.5	29.0	31.4	33.8	36.3	38.8	41.3	43.7	46.2	48.6
26	7.5	9.9	12.5	14.9	17.5	20.0	22.5	25.0	27.6	30.1	32.7	35.2	37.8	40.4	42.9	45.4	48.0	50.5
27	7.8	10.3	13.0	15.5	18.2	20.8	23.4	26.0	28.6	31.3	33.9	36.5	39.2	41.9	44.5	47.1	49.8	52.4
28	8.1	10.7	13.4	16.1	18.9	21.5	24.2	26.9	29.7	32.4	35.2	37.8	40.6	43.4	46.1	48.8	51.6	54.3
29	8.4	11.1	13.9	16.7	19.5	22.3	25.1	27.9	30.7	33.6	36.4	39.2	42.1	45.0	47.8	50.6	53.4	56.2
30	8.7	11.5	14.4	17.2	20.2	23.1	26.0	28.9	31.8	34.7	37.6	40.5	43.5	46.5	49.4	52.3	55.2	58.2
40	11.5	15.3	19.2	22.9	26.9	30.7	34.6	38.4	42.3	46.1	50.0	53.9	57.8	61.7	65.6	69.4	73.3	77.3
50	14.4	19.1	23.9	28.7	33.5	38.3	43.2	47.9	52.7	57.6	62.4	67.2	72.1	77.0	81.8	86.6	91.5	96.3
1° 00	17.2	22.9	28.7	34.4	40.2	46.0	51.7	57.5	63.3	69.0	74.8	80.6	86.4	92.3	98.0	104	110	115
1 10	20.1	26.7	33.5	40.1	46.9	53.6	60.3	67.0	73.8	80.5	87.2	93.9	100.7	107.5	114.3	121	128	134
1 20	23.0	30.5	38.3	45.8	53.6	61.2	69.0	76.6	84.2	91.9	99.6	107.3	115.1	123	131	138	146	154
1 30	25.8	34.4	43.0	51.6	60.3	69.0	77.7	86.1	94.7	103.4	112.0	120.7	130	138	147	155	164	173
1 40	28.7	38.2	47.8	57.3	66.9	76.6	86.3	95.6	105.2	115	124	134	144	153	163	173	182	192
1 50	31.6	42.0	52.6	63.0	73.6	84.2	94.9	105.2	115.7	126	137	147	158	169	179	190	200	211
2 00	34.4	45.8	57.4	68.9	80	92	103	115	126	138	149	161	172	184	195	207	218	230
2 30	43.0	57.3	71.7	86.0	100	115	129	144	158	172	186	201	215	230	244	259	273	287
3 00	51.6	68.8	86.2	103.2	120	138	155	172	190	207	224	241	259	276	293	310	328	345
3 30	60.2	80.4	100.5	120.5	141	161	181	201	221	241	261	281	302	322	342	362	382	402
4 00	68.9	91.8	114.8	137.7	161	184	207	230	253	276	299	322	345	368	391	414	437	460

*Curvature and refraction taken into account for angles of elevation. This table should not be used for angles of depression.

Example of use of table of heights.

[Angle of elevation from point A to point B, distant from each other 1756 meters=1° 56′.]

	Meters.	Feet.
1° 50′......	1700	179.00
1° 50′......	50	5.26
1° 50′......	6	.63
0° 06′......	1700	10.40
0° 06′......	50	.29
0° 06′......	6	.04
		195.62

Point B is 195.62 feet above point A.

Formula for determining heights by a vertical angle and distance.—The difference of level consists of two parts—that which arises from the angle of elevation above the horizontal plane of the station and that which is due to the curvature of the earth. The former depends upon the angle and distance, the latter upon the distance and the earth's radius. If a' be the angle of elevation in minutes of arc, d the distance, h the height, then, as the tangent of 1′ is $\frac{1}{3437}$, we have for the first part $h=\frac{1}{3437}a'd$, if h and d are both expressed in the same units of length, but if d is expressed in meters and h in feet, one meter being 3.28 feet, we get $h=\frac{1}{1048}a'd$. For the fraction $\frac{1}{1048}$ we may conveniently and with sufficient accuracy put $\frac{1}{1000}$ less $\frac{1}{20}$ of $\frac{1}{1000}$, and thus find the rule: *Multiply the distance in meters by the number of minutes of arc, point off the thousandth part, and subtract the twentieth part of the number thus obtained.* This will give the first portion of difference of height, whether elevation or depression.

The second term, depending on the curvature, varies as the square of the distance, and amounts to 0.22 foot in 1000 meters, including the effect of ordinary refraction. As with the instruments under consideration extreme accuracy is not attainable, it is plain that for distances under 1000 meters this term may be neglected. When the distance is greater, we have the following rule: *Take the thousandth part of the distance in meters, square the same, having regard to the first decimal figure, and multiply by* 0.22. This term is always positive. If the first term be an elevation, it is increased; if a depression, it it diminished by the second term.

Example.—Distance=5500 meters; angle of elevation, 36′.

$\frac{1}{1000}d \times a'$	=198.000	$\frac{1}{1000}d$	= 5.5
subtract $\frac{1}{20}$	9.9	square	=30.2
		multiply by	0.22
first term	188.1		
second term	6.6	second term	6.64
sum	194.7=difference of elevation in feet.		

TABLE II.—*Table showing the height, in meters, corre-*

(Curvature and refraction

	100	200	300	400	500	600	700	800	900	1000	1100	1200
0° 1′	0.03	0.06	0.09	0.13	0.16	0.20	0.24	0.28	0.32	0.36	0.40	0.45
2	0.06	0.12	0.18	0.24	0.31	0.37	0.44	0.51	0.58	0.65	0.72	0.79
3	0.09	0.18	0.27	0.36	0.45	0.55	0.64	0.74	0.84	0.94	1.04	1.14
4	0.12	0.24	0.36	0.48	0.60	0.72	0.85	0.97	1.10	1.23	1.36	1.39
5	0.15	0.29	0.44	0.59	0.74	0.90	1.05	1.21	1.36	1.52	1.68	1.84
0° 6′	0.18	0.35	0.53	0.70	0.89	1.07	1.26	1.44	1.62	1.81	2.00	2.19
7	0.20	0.41	0.62	0.82	1.04	1.24	1.46	1.67	1.89	2.10	2.32	2.44
8	0.23	0.47	0.70	0.94	1.18	1.42	1.66	1.90	2.16	2.39	2.64	2.89
9	0.26	0.53	0.79	1.06	1.33	1.59	1.87	2.14	2.41	2.68	2.96	3.24
10	0.29	0.58	0.88	1.18	1.47	1.77	2.07	2.37	2.68	2.98	3.28	3.59
0° 11′	0.32	0.64	0.97	1.29	1.62	1.94	2.27	2.60	2.93	3.27	3.60	3.74
12	0.35	0.70	1.05	1.41	1.76	2.12	2.48	2.84	3.20	3.56	3.92	4.29
13	0.38	0.76	1.14	1.52	1.91	2.29	2.68	3.07	3.46	3.85	4.24	4.63
14	0.41	0.82	1.23	1.64	2.05	2.47	2.88	3.30	3.72	4.14	4.56	4.98
15	0.44	0.88	1.32	1.76	2.20	2.64	3.08	3.53	3.98	4.43	4.88	5.33
0° 16′	0.47	0.93	1.40	1.87	2.34	2.82	3.29	3.77	4.24	4.72	5.20	5.68
17	0.50	0.99	1.49	1.99	2.49	2.99	3.49	3.90	4.50	5.01	5.52	6.03
18	0.52	1.05	1.58	2.10	2.64	3.17	3.70	4.23	4.77	5.30	5.84	6.38
19	0.55	1.11	1.66	2.22	2.78	3.34	3.90	4.46	5.03	5.59	6.16	6.63
20	0.58	1.17	1.75	2.34	2.93	3.51	4.11	4.70	5.29	5.88	6.48	7.08
0° 21′	0.61	1.23	1.84	2.45	3.07	3.69	4.31	4.93	5.55	6.17	6.80	7.43
22	0.64	1.28	1.93	2.57	3.22	3.86	4.51	5.16	5.81	6.47	7.12	7.78
23	0.67	1.34	2.01	2.69	3.36	4.04	4.72	5.40	6.08	6.76	7.44	8.12
24	0.70	1.40	2.10	2.80	3.50	4.21	4.92	5.63	6.34	7.05	7.76	8.47
25	0.73	1.46	2.19	2.92	3.65	4.39	5.12	5.88	6.60	7.34	8.08	8.82
0° 26′	0.76	1.52	2.28	3.04	3.80	4.56	5.33	6.09	6.86	7.63	8.40	9.17
27	0.79	1.57	2.36	3.15	3.95	4.74	5.53	6.33	7.12	7.92	8.72	9.52
28	0.82	1.63	2.45	3.27	4.09	4.91	5.74	6.56	7.38	8.21	9.04	9.87
29	0.84	1.69	2.54	3.38	4.24	5.08	5.94	6.79	7.65	8.50	9.36	10.22
30	0.87	1.75	2.62	3.50	4.38	5.26	6.14	7.02	7.91	8.79	9.68	10.57
0° 40′	1.16	2.33	3.50	4.66	5.84	7.00	8.18	9.35	10.53	11.70	12.88	14.06
50	1.45	2.91	4.37	5.83	7.29	8.75	10.22	11.68	13.14	14.62	16.08	17.55
1 00	1.75	3.49	5.24	6.99	8.74	10.50	12.25	14.01	15.76	17.52	19.28	21.04
1 10	2.04	4.08	6.12	8.16	10.20	12.24	14.29	16.33	18.38	20.43	22.48	24.53
1 20	2.33	4.66	6.99	9.32	11.66	13.99	16.33	18.66	21.00	23.34	25.68	28.03
1° 30′	2.62	5.24	7.86	10.48	13.11	15.73	18.36	20.99	23.62	26.25	28.88	31.52
1 40	2.91	5.82	8.74	11.65	14.56	17.48	20.40	23.32	26.24	29.16	32.09	35.01
1 50	3.20	6.40	9.61	12.82	16.02	19.23	22.44	25.65	28.86	32.08	35.29	38.51
2 00	3.49	6.99	10.48	13.98	17.49	20.98	24.48	27.98	31.48	34.99	38.49	42.00
2° 30′	4.37	8.74	13.11	17.28	21.85	26.22	30.60	34.97	39.35	43.73	48.11	52.49
3 00	5.24	10.48	15.73	20.97	26.22	31.47	36.72	41.97	47.22	52.47	57.73	62.99
3 30	6.12	12.24	18.36	24.48	30.60	36.72	42.85	44.97	55.10	61.23	67.36	73.49
4 00	6.99	13.99	20.98	27.98	34.98	41.98	48.98	55.98	62.99	69.99	77.00	84.01
	100	200	300	400	500	600	700	800	900	1000	1100	1200

* Curvature and refraction taken into account for angles of

*sponding to given angles of elevation and distances in meters.**

taken into account.)

1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	
0.49	0.54	0.59	0.64	0.69	0.74	0.80	0.85	0.90	0.96	1.02	1.08	1.14	0° 1′
0.87	0.95	1.02	1.10	1.18	1.26	1.35	1.43	1.52	1.60	1.69	1.78	1.87	2
1.25	1.35	1.46	1.57	1.68	1.79	1.90	2.01	2.13	2.24	2.36	2.48	2.60	3
1.63	1.76	1.90	2.03	2.17	2.31	2.45	2.59	2.74	2.88	3.03	3.18	3.33	4
2.00	2.17	2.33	2.50	2.67	2.83	3.00	3.18	3.35	3.52	3.70	3.88	4.05	5
2.38	2.57	2.77	2.96	3.16	3.35	3.56	3.76	3.96	4.16	4.37	4.57	4.78	0° 6′
2.76	2.98	3.20	3.43	3.66	3.88	4.11	4.34	4.57	4.80	5.04	5.27	5.51	7
3.14	3.39	3.64	3.89	4.15	4.50	4.66	4.92	5.18	5.44	5.70	5.97	6.24	8
3.52	3.80	4.08	4.36	4.64	4.93	5.22	5.50	5.79	6.08	6.37	6.67	6.96	9
3.90	4.20	4.51	4.82	5.14	5 45	5.77	6.08	6.40	6.72	7.04	7.36	7.69	10
4.27	4.61	4.95	5.29	5.63	5.98	6.32	6.67	7.01	7.36	7.71	8.06	8.42	0° 11′
4.65	5.02	5.39	5.76	6.13	6.50	6.87	7.25	7.62	8.00	8.38	8.76	9.14	12
5.03	5.42	5.82	6.22	6.62	7.02	7.43	7.83	8.24	8.64	9.05	9.46	9.87	13
5.41	5.83	6.26	6.69	7.12	7.55	7.98	8.41	8.85	9.28	9.72	10.16	10.60	14
5.78	6.24	6.70	7.15	7.62	8.07	8.53	8.99	9.46	9.92	10.39	10.86	11.32	15
6.16	6.65	7.13	7.62	8.11	8.59	9.08	9.58	10.07	10.56	11.06	11.55	12.05	0° 16′
6.54	7.05	7.56	8.08	8.60	9.12	9.64	10.16	10.68	11.20	11.73	12.25	12.78	17
6.92	7.46	8.00	8.55	9.09	9.64	10.19	10.74	11.29	11.84	12.40	12.95	13.51	18
7.30	7.87	8.44	9.01	9.59	10.16	10.74	11.32	11.90	12.48	13.06	13.65	14.23	19
7.68	8.28	8.88	9.48	10.08	10.69	11.30	11.90	12.51	13.12	13.73	14.35	14.96	20
8.05	8.68	9.31	9.94	10.58	11.21	11.85	12.48	13.12	13.76	14.40	15.04	15.69	0° 21′
8.43	9.09	9.75	10.41	11.07	11.74	12.40	13.07	13.73	14.40	15.07	15.74	16.42	22
8.81	9.50	10.19	10.88	11.57	12.26	12.95	13.65	14.34	15.04	15.74	16.44	17.14	23
9.19	9.90	10.62	11.34	12.06	12.78	13.51	14.23	14.96	15.68	16.41	17.14	17.87	24
9.57	10.31	11.06	11.81	12.56	13.31	14.06	14.81	15.57	16.32	17.08	17.84	18.60	25
9.94	10.72	11.50	12.27	13.05	13.83	14.61	15.39	16.18	16.96	17.75	18.54	19.32	0° 26′
10.32	11.13	11.93	12.74	13.55	14.35	15.16	15.98	16.79	17.60	18.42	19.23	20.05	27
10.70	11.53	12.37	13.20	14.04	14.88	15.72	16.56	17.40	18.24	19.09	19.93	20.78	28
11.08	11.94	12.80	13.67	14.53	15.40	16.27	17.14	18.01	18.88	19.76	20.63	21.51	29
11.46	12.35	13.24	14.13	15.03	15.92	16.82	17.72	18.62	19.52	20.42	21.33	22.23	30
15.24	16.42	17.60	18.79	19.97	21.16	22.35	23.54	24.73	25.82	27.12	28.31	29.50	0° 40′
19.02	20.49	21.97	23.44	24.92	26.40	27.88	29.36	30.84	32.32	33.81	35.29	36.78	50
22.81	24.57	26.33	28.10	29.87	31.64	33.41	35.18	36.95	38.72	40.50	42.28	44.06	1 00
26.59	28.64	30.70	32.75	34.81	36.87	38.94	41.00	43.06	45.13	47.19	49.26	51.33	1 10
30.37	32.72	35.06	37.41	39.76	42.10	44.46	46.82	49.17	51.53	53.89	56.25	58.61	1 20
34.16	36.79	39.43	42.07	44.71	47.35	49.99	52.64	55.28	57.93	60.58	63.23	65.88	1° 30′
37.94	40.87	43.80	46.73	49.66	52.59	55.52	58.46	61.40	64.34	67.28	70.22	73.16	1 40
41.72	44.94	48.16	51.38	54.61	57.83	61.06	64.28	67.51	70.74	73.97	77.21	80.44	1 50
45.50	49.02	52.53	56.04	59.56	63.07	66.59	70.10	73.63	77.15	80.67	84.20	87.72	2 00
56.87	61.26	65.64	70.03	74.42	78.81	83.20	87.59	91.98	96.38	100.78	105.17	109.57	2° 30′
68.24	73.51	78.76	84.02	89.29	94.55	99.82	105.10	110.35	115.62	120.89	126.16	131.44	3 00
79.63	85.76	91.89	98.03	104.18	110.31	116.45	122.59	128.74	134.88	141.03	147.18	153.33	3 30
91.02	98.03	105.04	112.06	117.07	126.09	133.10	140.12	147.14	154.18	161.19	168.21	175.24	4 00
1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	

elevation. This table should not be used for angles of depression.

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Illustration 34 is a diagram showing the method of constructing a scale for taking off the heights corresponding to a given angle and distance.

*Table of factors for computing differences in elevation.**

To obtain the difference in elevation in feet multiply the horizontal distance in meters by the factor in this table corresponding to the observed angle of elevation or depression. The factors are given for each ten minutes, but the value for the nearest minute may be interpolated, using the column of differences for one minute. The result is still to be corrected where necessary for the effect of curvature and refraction.

TABLE III.

Angle	0′	10′	20′	30′	40′	50′	60′	Difference for 1 minute (fourth decimal place)
°								
0	0.0000	0.0095	0.0191	0.0286	0.0382	0.0477	0.0573	9.5
1	0.0573	0.0668	0.0764	0.0859	0.0955	0.1050	0.1146	9.6
2	0.1146	0.1241	0.1337	0.1432	0.1528	0.1624	0.1719	9.6
3	0.1719	0.1815	0.1911	0.2007	0.2102	0.2198	0.2294	9.6
4	0.2294	0.2390	0.2486	0.2582	0.2678	0.2774	0.2870	9.6
5	0.2870	0.2967	0.3063	0.3159	0.3255	0.3352	0.3448	9.6
6	0.3448	0.3545	0.3641	0.3738	0.3835	0.3932	0.4028	9.7
7	0.4028	0.4125	0.4222	0.4319	0.4416	0.4514	0.4611	9.7
8	0.4611	0.4708	0.4806	0.4903	0.5001	0.5098	0.5196	9.8
9	0.5196	0.5294	0.5392	0.5490	0.5588	0.5687	0.5785	9.8
10	0.5785	0.5884	0.5982	0.6081	0.6179	0.6278	0.6377	9.9
11	0.6377	0.6476	0.6576	0.6675	0.6774	0.6874	0.6974	9.9
12	0.6974	0.7073	0.7173	0.7273	0.7374	0.7474	0.7574	10.0
13	0.7574	0.7675	0.7776	0.7877	0.7978	0.8079	0.8180	10.1
14	0.8180	0.8282	0.8383	0.8485	0.8587	0.8689	0.8791	10.2
15	0.8791	0.8893	0.8996	0.9099	0.9201	0.9304	0.9408	10.3
16	0.9408	0.9511	0.9615	0.9718	0.9822	0.9926	1.0031	10.4
17	1.0031	1.0135	1.0240	1.0344	1.0449	1.0555	1.0660	10.5
18	1.0660	1.0766	1.0872	1.0978	1.1084	1.1190	1.1297	10.6
19	1.1297	1.1404	1.1511	1.1618	1.1726	1.1833	1.1941	10.7
20	1.1941	1.2050	1.2158	1.2266	1.2375	1.2485	1.2594	10.9
21	1.2594	1.2704	1.2813	1.2924	1.3034	1.3144	1.3255	11.0
22	1.3255	1.3367	1.3478	1.3590	1.3702	1.3814	1.3926	11.2
23	1.3926	1.4039	1.4152	1.4266	1.4379	1.4493	1.4607	11.4
24	1.4607	1.4722	1.4836	1.4952	1.5067	1.5183	1.5299	11.5
25	1.5299	1.5415	1.5532	1.5649	1.5766	1.5884	1.6002	11.7
26	1.6002	1.6120	1.6239	1.6358	1.6477	1.6597	1.6717	11.9
27	1.6717	1.6837	1.6958	1.7079	1.7200	1.7322	1.7444	12.1
28	1.7444	1.7567	1.7690	1.7814	1.7937	1.8061	1.8186	12.4
29	1.8186	1.8311	1.8436	1.8562	1.8688	1.8815	1.8942	12.6
30	1.8942	1.9069	1.9197	1.9326	1.9454	1.9584	1.9713	12.9
31	1.9713	1.9843	1.9974	2.0105	2.0236	2.0368	2.0501	13.1
32	2.0501	2.0634	2.0767	2.0901	2.1036	2.1171	2.1306	13.4
33	2.1306	2.1442	2.1578	2.1715	2.1853	2.1991	2.2130	13.7
34	2.2130	2.2269	2.2408	2.2548	2.2689	2.2831	2.2973	14.0
35	2.2973	2.3115	2.3258	2.3402	2.3546	2.3691	2.3837	14.4
36	2.3837	2.3983	2.4130	2.4277	2.4425	2.4574	2.4723	14.8
37	2.4723	2.4873	2.5023	2.5175	2.5327	2.5479	2.5633	15.2
38	2.5633	2.5787	2.5942	2.6097	2.6253	2.6410	2.6568	15.6
39	2.6568	2.6726	2.6885	2.7045	2.7206	2.7367	2.7530	16.0
40	2.7530	2.7692	2.7856	2.8021	2.8186	2.8353	2.8520	16.5
41	2.8520	2.8688	2.8857	2.9026	2.9197	2.9368	2.9541	17.0
42	2.9541	2.9714	2.9888	3.0063	3.0239	3.0416	3.0594	17.6
43	3.0594	3.0773	3.0953	3.1134	3.1316	3.1499	3.1683	18.1
44	3.1683	3.1868	3.2054	3.2241	3.2429	3.2618	3.2808	18.8

*Computed by G. R. Putnam, Assistant, Coast and Geodetic Survey.

*Table of corrections for curvature and refraction.**

The correction in feet for the combined effect of curvature and refraction is given for each 100 meters' distance, the thousands of meters being given in the column to the left and the hundreds in the upper line. The correction is to be added to the *difference* of elevation for angles of *elevation* and *subtracted* for angles of *depression*, or it is always to be added to the uncorrected *elevation* of the point to be determined from point of observation.

Example: At a station whose elevation is 1000 feet (at telescope), angle to signal=3° elevation, horizontal distance=5000 meters. From Table III factor is 0.1719, which multiplied by 5000=859.5 feet. From Table IV correction is 5.5 feet. Corrected difference of elevation=859.5+5.5=865 feet, which added to 1000=1865 feet for elevation of signal. If the above angle to signal be 3° depression, then corrected difference of elevation=859.5−5.5=854 feet, which makes height of signal= 1000—854=146 feet.

TABLE IV.

Distance in meters	0	100	200	300	400	500	600	700	800	900	1000
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2
1000	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.9
2000	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.0
3000	2.0	2.1	2.3	2.4	2.6	2.7	2.9	3.0	3.2	3.4	3.5
4000	3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.5
5000	5.5	5.8	6.0	6.2	6.5	6.7	7.0	7.2	7.4	7.7	8.0
6000	8.0	8.2	8.5	8.8	9.1	9.4	9.7	10.0	10.2	10.6	10.9
7000	10.9	11.2	11.5	11.8	12.1	12.5	12.8	13.1	13.5	13.8	14.2
8000	14.2	14.5	14.9	15.3	15.6	16.0	16.4	16.8	17.2	17.6	18.0
9000	18.0	18.4	18.8	19.2	19.6	20.0	20.4	20.8	21.3	21.7	22.2
10000	22.2	22.6	23.0	23.5	24.0	24.4	24.9	25.4	25.8	26.3	26.8
11000	26.8	27.3	27.8	28.3	28.8	29.3	29.8	30.3	30.8	31.4	31.9
12000	31.9	32.4	33.0	33.5	34.1	34.6	35.2	35.7	36.3	36.9	37.4
13000	37.4	38.0	38.6	39.2	39.8	40.4	41.0	41.6	42.2	42.8	43.4
14000	43.4	44.1	44.7	45.3	46.0	46.6	47.2	47.9	48.5	49.2	49.8
15000	49.8	50.5	51.2	51.9	52.5	53.2	53.9	54.6	55.3	56.0	56.7
16000	56.7	57.4	58.2	58.9	59.6	60.3	61.0	61.8	62.5	63.3	64.0
17000	64.0	64.8	65.6	66.3	67.1	67.9	68.6	69.4	70.2	71.0	71.8
18000	71.8	72.6	73.4	74.2	75.0	75.8	76.7	77.5	78.3	79.1	80.0
19000	80.0	80.8	81.7	82.5	83.4	84.2	85.1	86.0	86.9	87.7	88.6

* Computed by G. R. Putnam, Assistant, Coast and Geodetic Survey.

Table of factors for computing differences in elevation.

To obtain the difference in elevation in *meters*, multiply the horizontal distance in meters by the factor in this table corresponding to the observed angle of elevation or depression. The factors are given for each ten minutes, but the value of the nearest minute may be interpolated, using the column of differences for one minute. The result is still to be corrected where necessary for the effect of curvature and refraction.

TABLE V.

Angle	0′	10′	20′	30′	40′	50′	60′	Difference for 1 minute (4th dec. place)
°								
0	0.0000	0.0029	0.0058	0.0087	0.0116	0.0145	0.0175	2.9
1	.0175	.0204	.0233	.0262	.0291	.0320	.0349	2.9
2	.0349	.0378	.0407	.0437	.0466	.0495	.0524	2.9
3	.0524	.0553	.0582	.0612	.0641	.0670	.0699	2.9
4	.0699	.0729	.0758	.0787	.0816	.0846	.0875	2.9
5	.0875	.0904	.0934	.0963	.0992	.1022	.1051	2.9
6	.1051	.1080	.1110	.1139	.1169	.1198	.1228	2.9
7	.1228	.1257	.1287	.1317	.1346	.1376	.1405	2.9
8	.1405	.1435	.1465	.1495	.1524	.1554	.1584	3.0
9	.1584	.1614	.1644	.1673	.1703	.1733	.1763	3.0
10	.1763	.1793	.1823	.1853	.1883	.1914	.1944	3.0
11	.1944	.1974	.2004	.2035	.2065	.2095	.2126	3.0
12	.2126	.2156	.2186	.2217	.2247	.2278	.2309	3.0
13	.2309	.2339	.2370	.2401	.2432	.2462	.2493	3.1
14	.2493	.2524	.2555	.2586	.2617	.2648	.2679	3.1
15	.2679	.2711	.2742	.2773	.2805	.2836	.2867	3.1
16	.2867	.2899	.2931	.2962	.2994	.3026	.3057	3.2
17	.3057	.3089	.3121	.3153	.3185	.3217	.3249	3.2
18	.3249	.3281	.3314	.3346	.3378	.3411	.3443	3.2
19	.3443	.3476	.3508	.3541	.3574	.3607	.3640	3.3
20	.3640	.3673	.3706	.3739	.3772	.3805	.3839	3.3
21	.3839	.3872	.3906	.3939	.3973	.4006	.4040	3.3
22	.4040	.4074	.4108	.4142	.4176	.4210	.4245	3.4
23	.4245	.4279	.4314	.4348	.4383	.4417	.4452	3.4
24	.4452	.4487	.4522	.4557	.4592	.4628	.4663	3.5
25	.4663	.4699	.4734	.4770	.4806	.4841	.4877	3.5
26	.4877	.4913	.4950	.4986	.5022	.5059	.5095	3.6
27	.5095	.5132	.5169	.5206	.5243	.5280	.5317	3.7
28	.5317	.5354	.5392	.5430	.5467	.5505	.5543	3.8
29	.5543	.5581	.5619	.5658	.5696	.5735	.5774	3.8
30	.5774	.5812	.5851	.5890	.5930	.5969	.6009	3.9
31	.6009	.6048	.6088	.6128	.6168	.6208	.6249	4.0
32	.6249	.6289	.6330	.6371	.6412	.6453	.6494	4.1
33	.6494	.6536	.6577	.6619	.6661	.6703	.6745	4.2
34	.6745	.6787	.6830	.6873	.6916	.6959	.7002	4.3
35	.7002	.7046	.7089	.7133	.7177	.7221	.7265	4.4
36	.7265	.7310	.7355	.7400	.7445	.7490	.7536	4.5
37	.7536	.7581	.7627	.7673	.7720	.7766	.7813	4.6
38	.7813	.7860	.7907	.7954	.8002	.8050	.8098	4.7
39	.8098	.8146	.8195	.8243	.8292	.8342	.8391	4.9
40	.8391	.8441	.8491	.8541	.8591	.8642	.8693	5.0
41	.8693	.8744	.8796	.8847	.8899	.8952	.9004	5.2
42	.9004	.9057	.9110	.9163	.9217	.9271	.9325	5.4
43	.9325	.9380	.9435	.9490	.9545	.9601	.9657	5.6
44	.9657	.9713	.9770	.9827	.9884	.9942	1.0000	5.7

Table of corrections for curvature and refraction.

The correction in *meters* for the combined effect of curvature and refraction is given for each 100 meters distance, the thousands of meters being given in the column to the left and the hundreds in the upper line. The correction is to be added to the *difference* of elevation for angles of *elevation* and subtracted for angles of *depression*, or it is always to be added to the uncorrected *elevation* of the point to be determined from point of observation.

Example: At a station whose elevation is 304.80 meters (at telescope), angle to signal 3° elevation, horizontal distance 5000 meters. From Table V factor is 0.0524, which multiplied by 5 000= 262.00. From Table VI correction is 1.67 meters. Corrected difference of elevation=262.00+1.67=263.67 meters, which added to 304.80=568.47 meters for elevation of signal. If the above angle to signal be 3° depression, then corrected difference of elevation 262.00−1.67=260.33 meters, which makes height of signal=304.80−260.33=44.47 meters.

TABLE VI.

Distance in meters	0	100	200	300	400	500	600	700	800	900	1000
0	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.07
1000	0.07	0.08	0.10	0.11	0.13	0.15	0.17	0.19	0.22	0.24	0.27
2000	0.27	0.29	0.32	0.35	0.38	0.42	0.45	0.49	0.52	0.56	0.60
3000	0.60	0.64	0.68	0.73	0.77	0.82	0.86	0.91	0.96	1.01	1.07
4000	1.07	1.12	1.18	1.23	1.29	1.35	1.41	1.47	1.54	1.60	1.67
5000	1.67	1.74	1.80	1.87	1.94	2.02	2.09	2.17	2.24	2.32	2.40
6000	2.40	2.48	2.56	2.65	2.73	2.82	2.91	3.00	3.09	3.18	3.27
7000	3.27	3.36	3.46	3.55	3.65	3.75	3.85	3.96	4.06	4.16	4.27
8000	4.27	4.38	4.49	4.60	4.71	4.82	4.93	5.05	5.16	5.28	5.40
9000	5.40	5.52	5.65	5.77	5.89	6.02	6.15	6.28	6.41	6.54	6.67
10000	6.67	6.80	6.94	7.08	7.22	7.36	7.50	7.64	7.78	7.93	8.07
11000	8.07	8.22	8.37	8.52	8.67	8.82	8.98	9.13	9.29	9.45	9.61
12000	9.61	9.77	9.93	10.09	10.26	10.42	10.59	10.76	10.92	11.10	11.27
13000	11.27	11.45	11.62	11.80	11.98	12.16	12.34	12.52	12.71	12.89	13.08
14000	13.08	13.26	13.45	13.64	13.83	14.03	14.22	14.42	14.61	14.81	15.01
15000	15.01	15.21	15.41	15.62	15.82	16.03	16.24	16.44	16.65	16.87	17.08
16000	17.08	17.30	17.51	17.73	17.95	18.17	18.39	18.61	18.83	19.05	19.28
17000	19.28	19.51	19.73	19.96	20.19	20.43	20.66	20.89	21.13	21.37	21.61
18000	21.61	21.86	22.10	22.34	22.58	22.83	23.08	23.33	23.58	23.83	24.08
19000	24.08	24.34	24.60	24.85	25.11	25.37	25.63	25.89	26.15	26.42	26.68

Comparison of feet and meters.

[1 meter=3.280869 feet.]

Meters.	Feet.	Feet.	Meters.
1.............	3.2808	1.............	0.3048
2.............	6.5617	2.............	0.6096
3.............	9.8425	3.............	0.9144
4.............	13.1233	4.............	1.2192
5.............	16.4042	5.............	1.5240
6.............	19.6850	6.............	1.8288
7.............	22.9658	7.............	2.1336
8.............	26.2467	8.............	2.4384
9.............	29.5275	9.............	2.7432

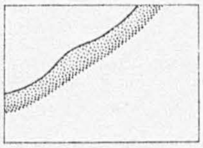
NOTE.

Illustrations 22 to 31 were selected from a collection prepared by the late Assistant E. Hergesheimer to illustrate the topographic features in various portions of the United States. The full collection is to be found in Appendix 14, United States Coast and Geodetic Survey Report, 1883.

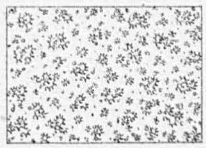
Topographic Signs

No. 17

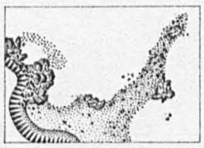
Shoreline Low Water



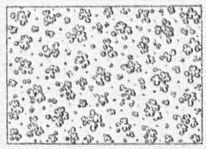
Oak



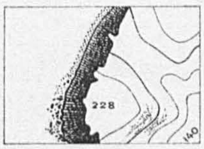
Rocky Ledges



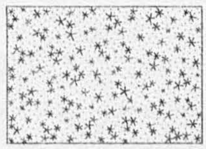
Deciduous and Undergrowth



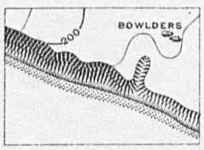
Rocky Bluff



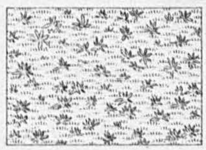
Pine



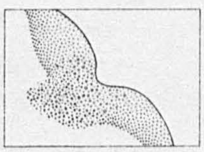
Eroded Bank



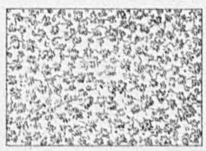
Palmetto



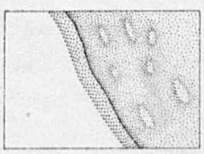
Sand and Shingle



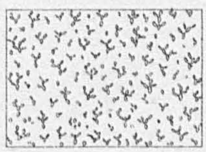
Mangroves



Sand Dunes

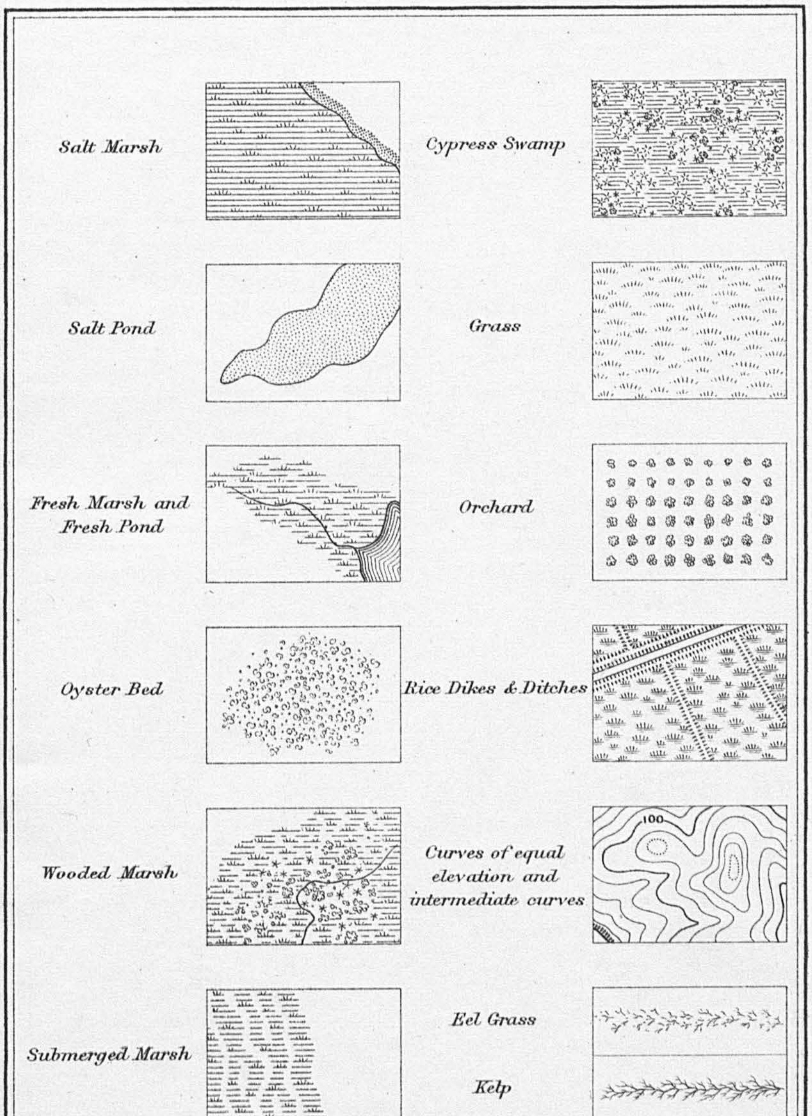


Cacti



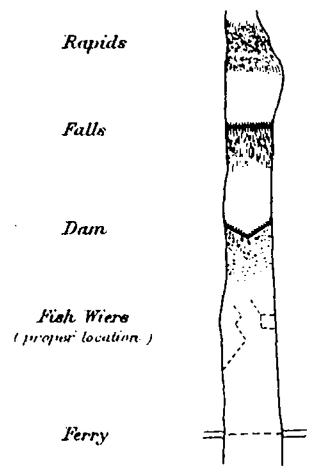
Topographic Signs

No. 18



Topographic Signs

No. 19



Topographical Station ....

Triangulation Point ....

Dwelling House ....

Barn ....

Shed and Pen ....

Ruins ....

Windmill ....

Church ....

Cemetery ....

Fence ....

Public Road ....

Road fenced on one side ....

Telegraph Road ....

Hydrographic Signs

No. 20

Lighthouse .... ✡

Lighthouse on small scale chart • *Old light tower* .... ●

Beacon, lighted .... ☆ *Beacon, not lighted* .... ▲

Spindle (or stake) .... *add word Spindle if space allows*

Lightship .... *Wreck* ....

Anchorage .... ⚓ *Covering and uncovering rock* .... ●

Rock awash at low water ...... ✱ *Sunken rock* .... +

Life Saving Station .... ✦ L.S.S. (T) .... *signifies connection with telegraphic system.*

Kelp ....

No bottom at 20 fathoms .... $\overset{\circ}{20}$ *etc.*

Red buoy ♀ *or add word white or yellow as required.*

Black buoy ....

Horizontally striped buoy ....

Perpendicularly striped buoy ....

Buoys with perch and square ....

Buoys with perch and ball ....

Lighted buoy .... ✱ , *in place of* • , *as* .... *etc.*

Mooring buoy ....

Landmark, as Cupola, Standpipe, etc .... ○

Whirlpool ....

Tide rip ....

Current, not tidal, drift in knots as .... ⋙—— 2.0 ——→

" *flood, first quarter, drift in knots, as* .... —— 0.4 ——→

" , " *, second* " " " " " .... —— 1.0 ——→

" , " *, third* " " " " " .... —— 0.3 ——→

" *, ebb,* .... ————→ , *otherwise like flood.*

Topographic Signs

No. 21

Railroad (each track) ....

Railroad (large Scale) ....

Road not fenced ....

Path or Trail ....

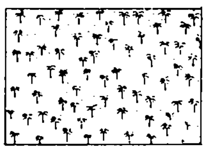
Stone Wall ....

Hedge ....

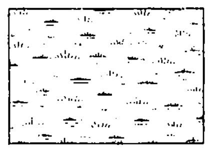
Embankment ....

Canal and Lock ....

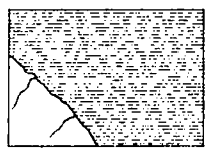
Palms



Tundra



Mud



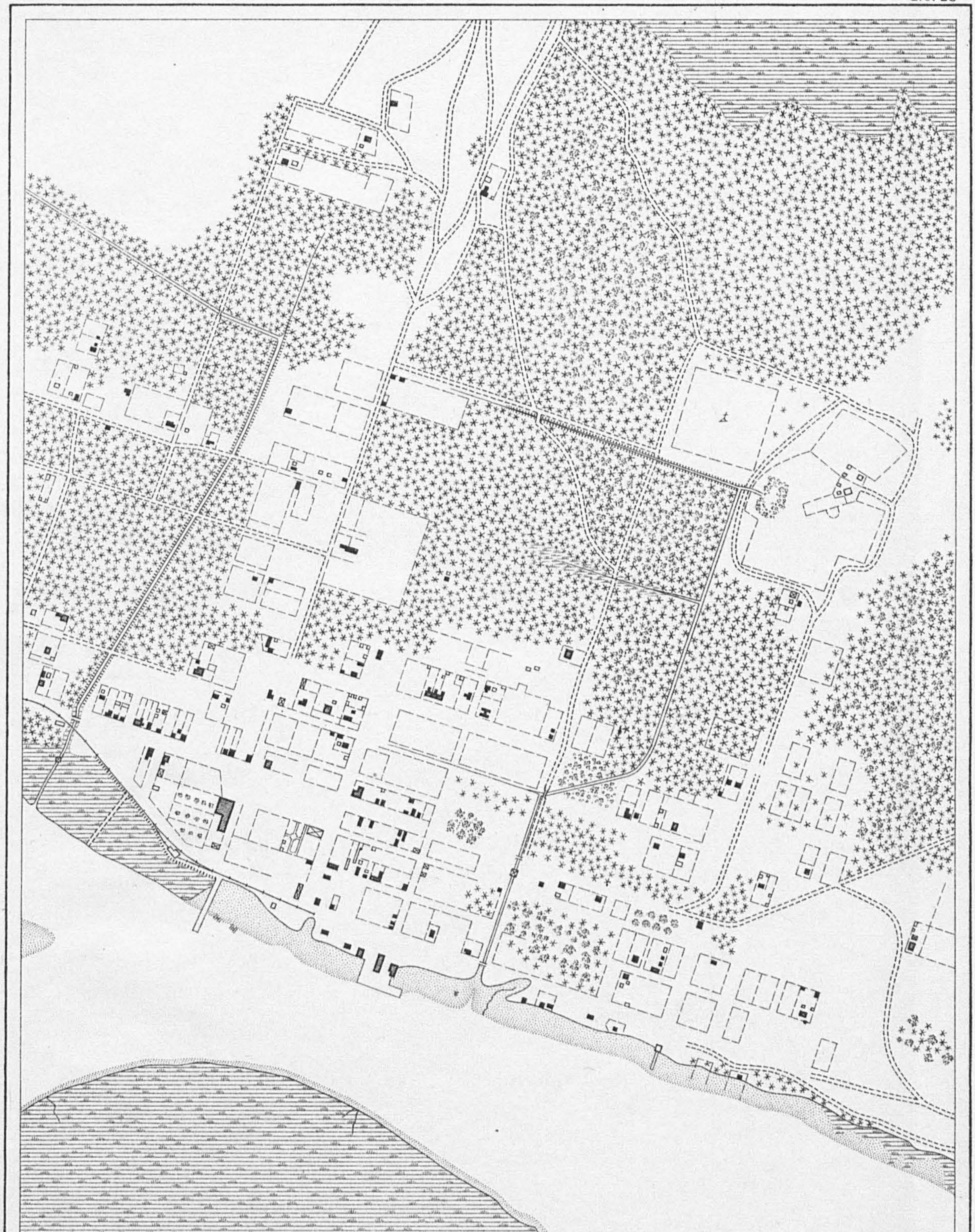
DECIMILLIMETRES						
60	ENGRAVING			*ENGRAVING*		
55	DIVISION			*DIVISION*		
50	CAPITOL			*CAPITOL*		
45	HARBOR			*HARBOR*		
40	ISLANDS			*ISLANDS*		
35	RIVERS			*RIVERS*		
30	SOUNDINGS			*SOUNDINGS*		
25	DIRECTIONS			*DIRECTIONS*		
20	POINTS	*POINTS*	Points	*Points*	POINTS	*POINTS*
15	CREEKS	*CREEKS*	Creeks	*Creeks*	CREEKS	*CREEKS*
12	CHANNELS	*CHANNELS*	Channels	*Channels*	CHANNELS	*CHANNELS*
10	SHOALS	*SHOALS*	Shoals	*Shoals*	SHOALS	*SHOALS*

ABCDEFGHIJKLMNOPQRSTUVWXYZ

ABCDEFGHIJKLMNOPQRSTUVWXYZ

Specimens of Lettering

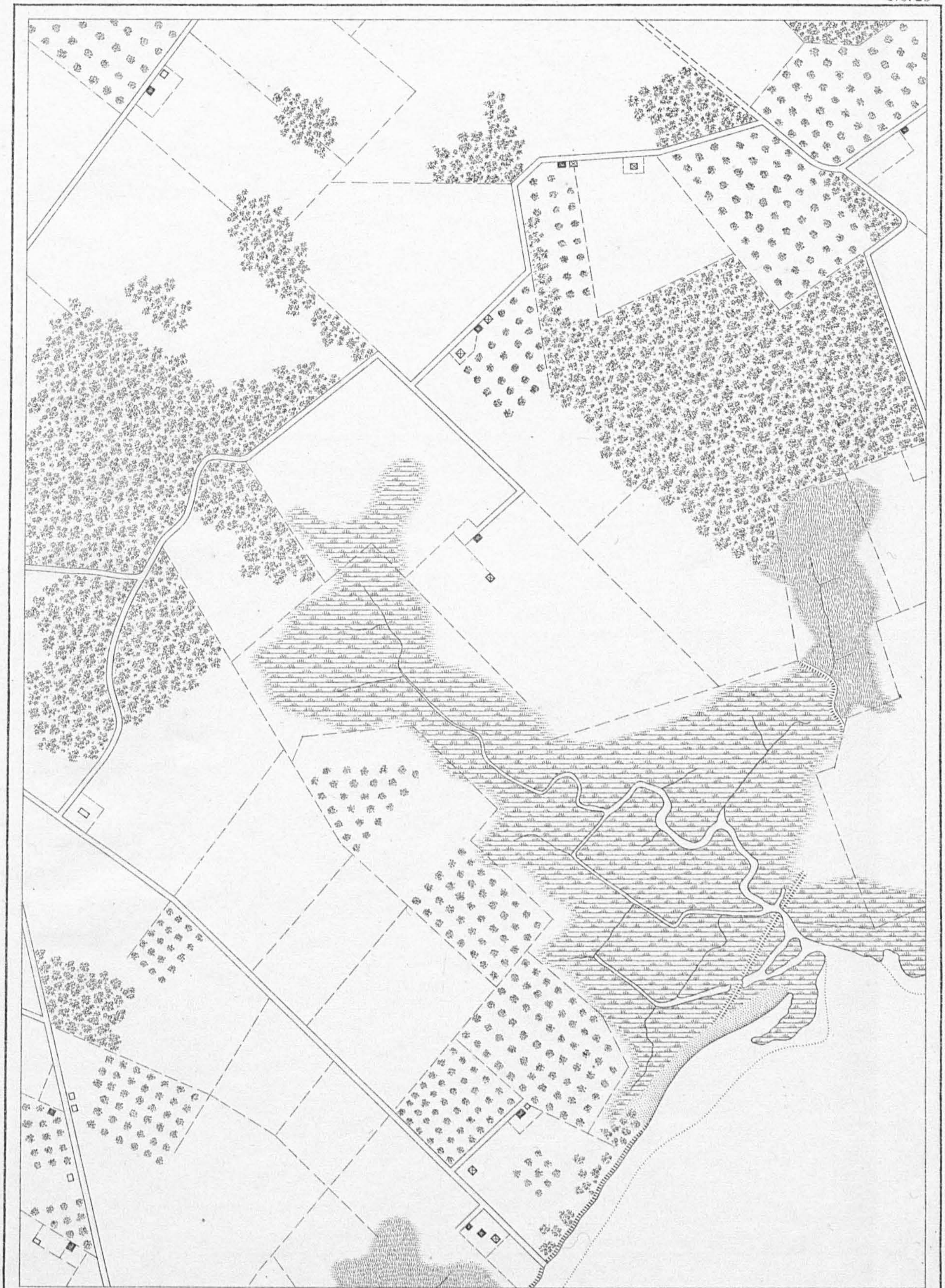
30



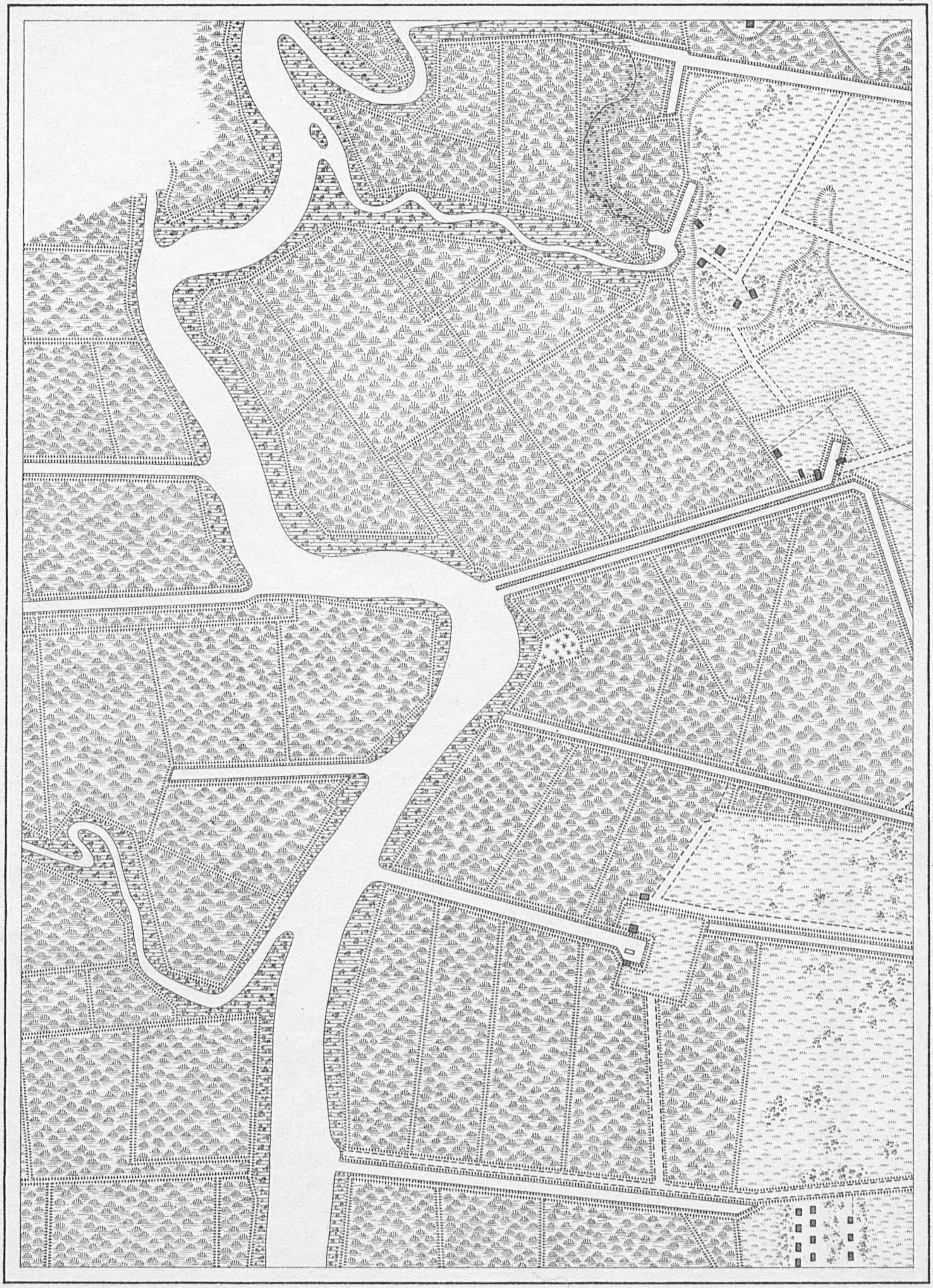
Sparsely settled Town, Salt Marsh, Pine Woods, Ditches, Fences, and Undefined Roads

31

Railroads, Canals, Iron Bridges, Rocky-cliffs, Mid-river drift, Water-worn Rocks, Mixed Woods over hill curves (Harper's Ferry)



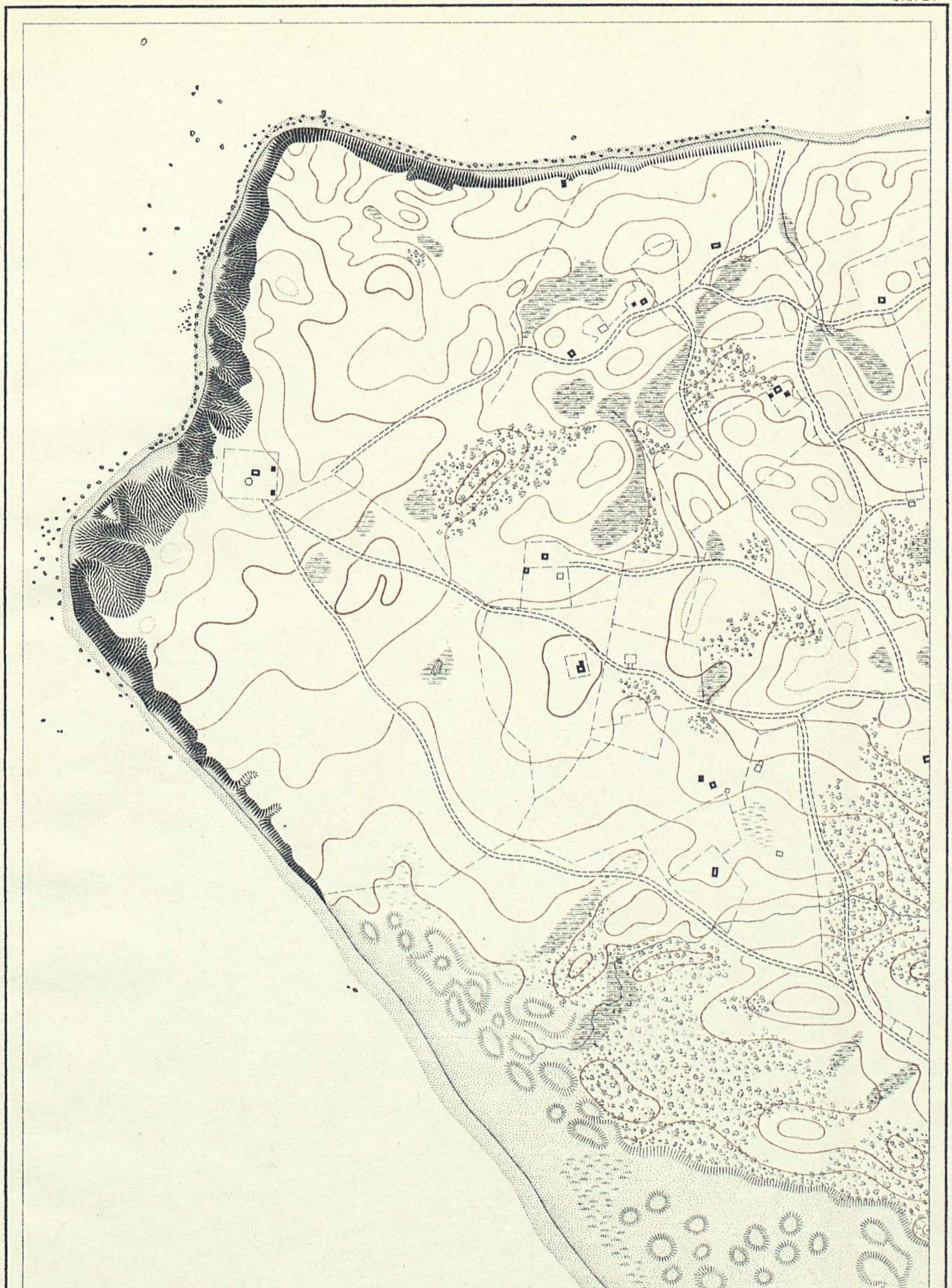
Heavy Oak Woods, Reclaimed Marsh and Orchards (Delaware River)



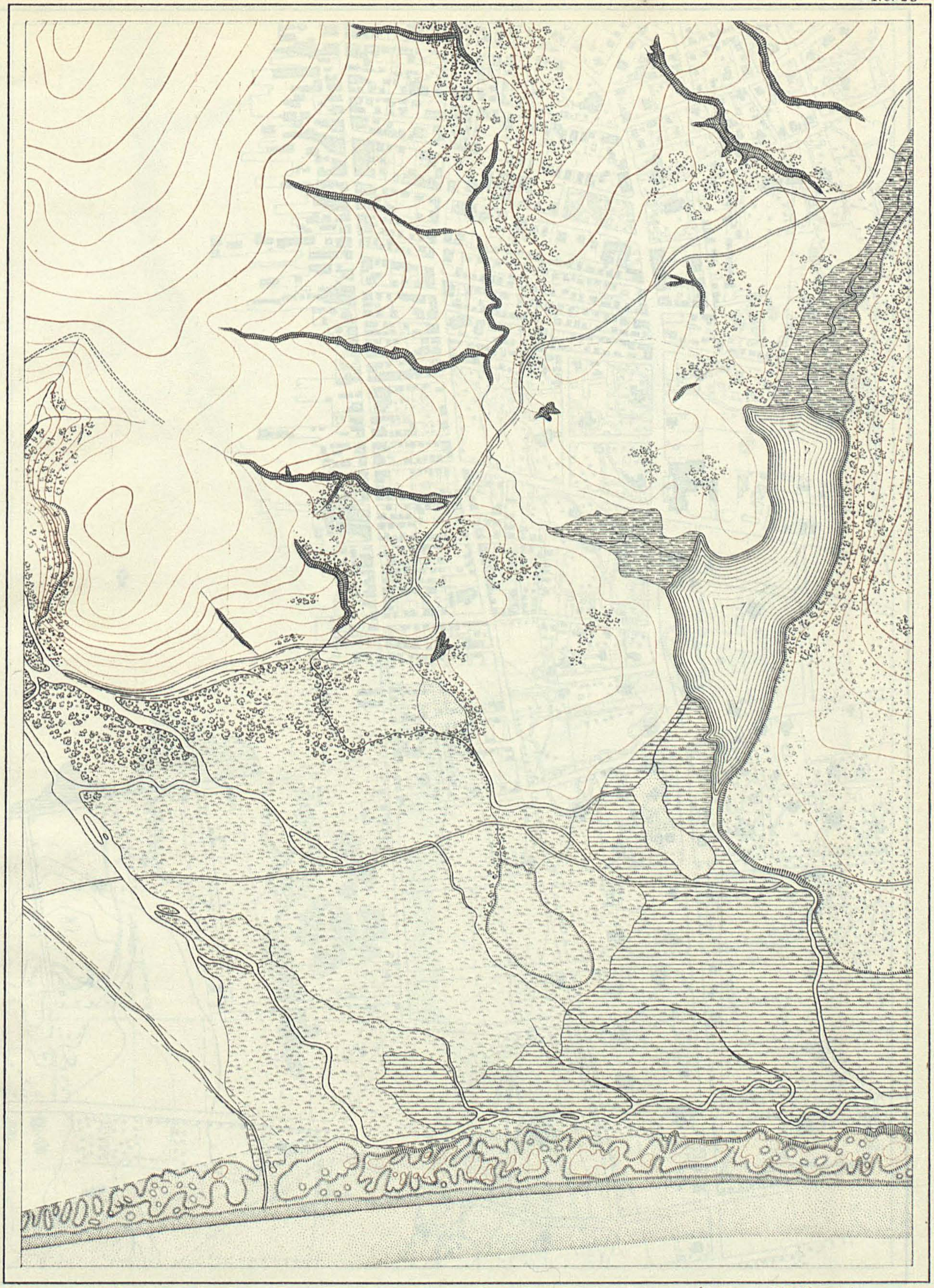
Rice, Dykes and Ditches (Santee River)

32

No. 27



Eroded drift banks, with boulders set free; and scrub deciduous woods (Gay Head)

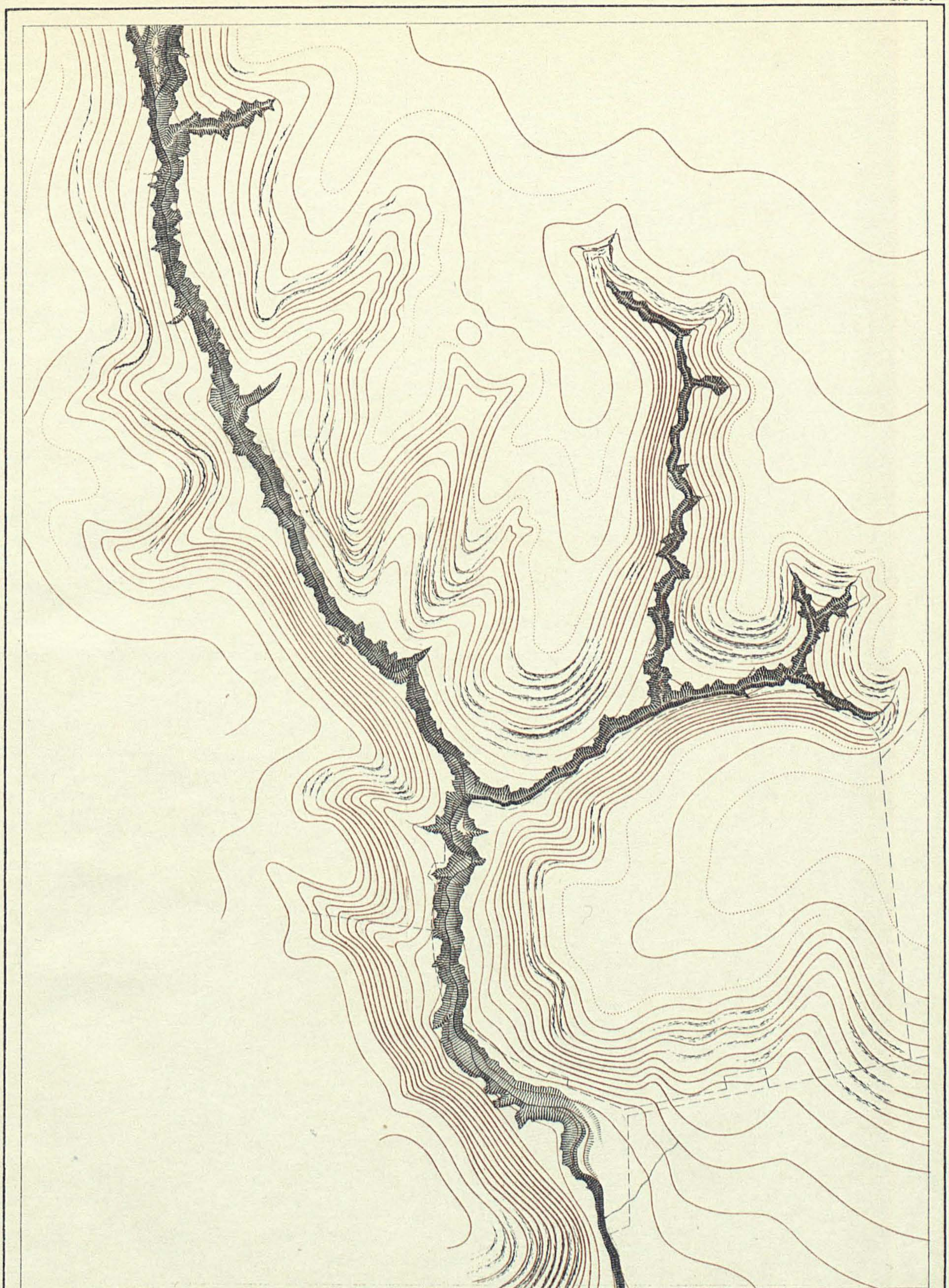


Sand Beach with Low Dunes, Fresh Water Pond, Meadow Grass, Sage Brush and Arroyos (S. Coast of California)

Blocking of Cities, Large Buildings, Suburban Villas and Grounds, Fresh Marsh

34

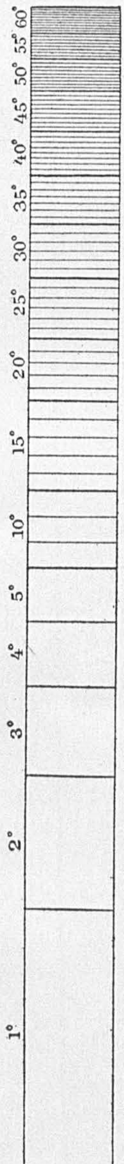
No. 30



Erosion of Soft Stratified Rock and Gulch, (Santa Cruz, California)

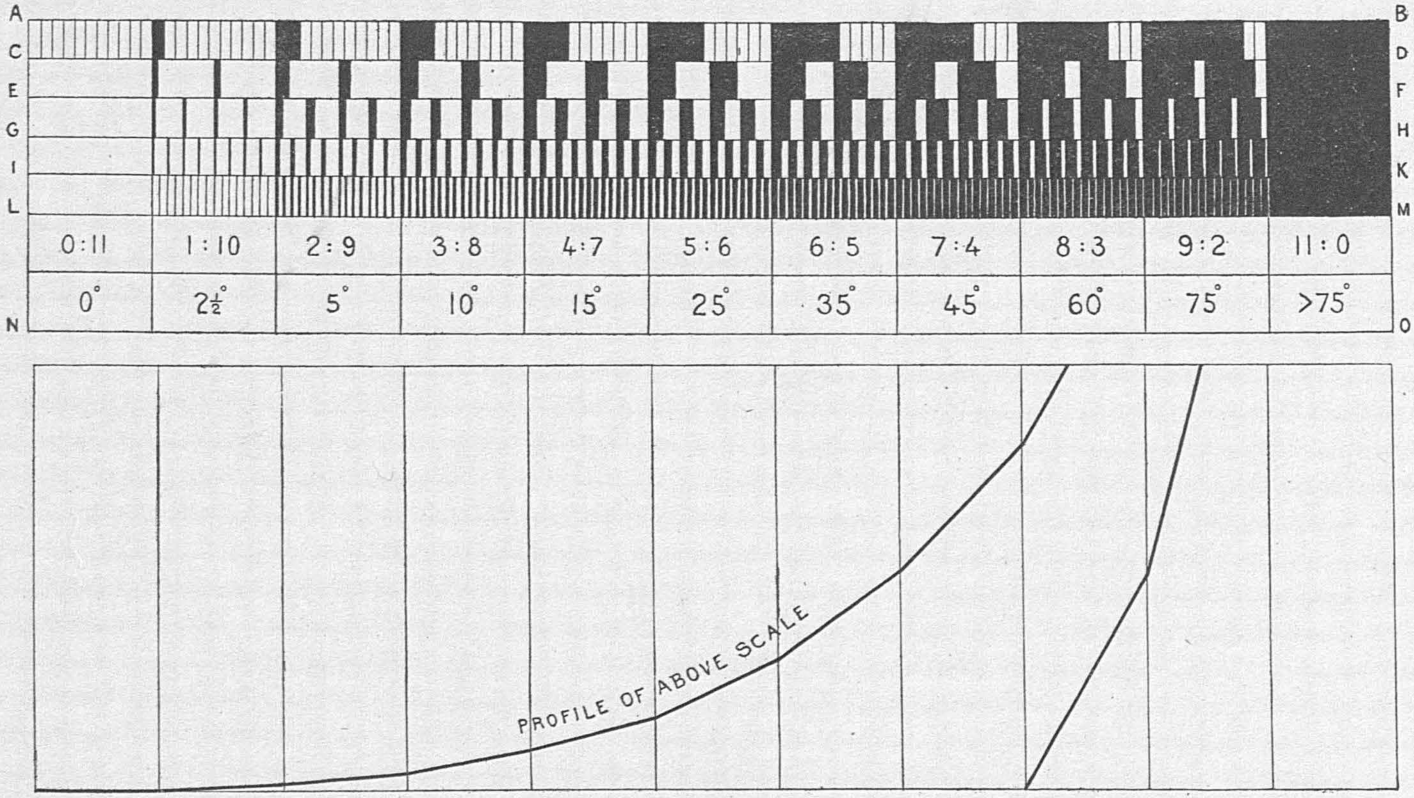
35

Hill Curves for every 20 feet difference of level. Scale $\frac{1}{10,000}$



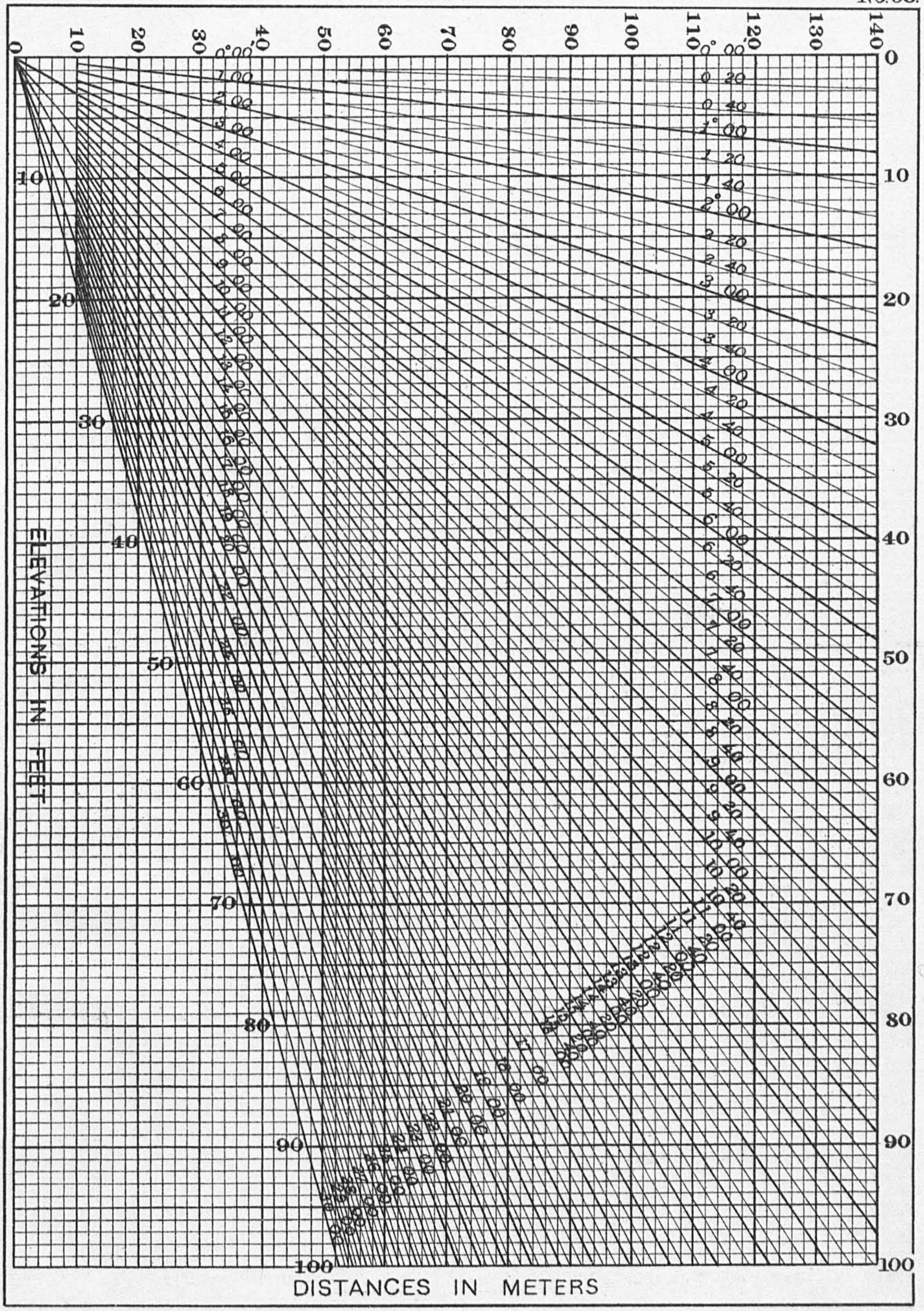
Slope.	Proportion of Height to Base.	Length of Base to 1 foot of Height (in feet.)	Length of Base to 20 feet of Height (in feet.)	Length of Base to 20 feet of Height (in meters.)
1°	1 to 57	57 . 29	1145 . 8	349 . 1
2°	1 to 29	28 . 64	572 . 8	174 . 5
3°	1 to 19	19 . 08	381 . 6	116 . 3
4°	1 to 14	14 . 30	286 . 0	87 . 1
5°	1 to 11	11 . 43	228 . 6	69 . 7
10°	1 to 6	5 . 67	113 . 4	34 . 6
15°	1 to 4	3 . 73	74 . 6	22 . 7
20°	1 to 3	2 . 75	55 . 0	16 . 7
25°	1 to 2	2 . 14	42 . 8	13 . 1
30°	1 to 1.7	1 . 73	34 . 6	10 . 5
35°	1 to 1.4	1 . 43	28 . 6	8 . 7
40°	1 to 1.2	1 . 19	23 . 8	7 . 2
45°	1 to 1	1 . 00	20 . 0	6 . 1
50°	1 to 0.8	0 . 84	16 . 8	5 . 1
55°	1 to 0.7	0 . 70	14 . 0	4 . 3
60°	1 to 0.6	0 . 58	11 . 6	3 . 6

U. S. C. AND G. SURVEY SCALE OF SHADE.



37

No. 33.



ALPHABETICAL INDEX.

[Exclusive of Appendices 3 to 7.]

D.

E.

F.

G.

H.

I.

J.

K.

L.

M.

N.

O.

FOR LIBRARY CATALOGUE CARDS.

U. S. *Coast and geodetic survey.*

. . . Report of the superintendent of the Coast and geodetic survey, showing the progress of the work from July 1, 1904 to June 30, 1905. Washington, Gov't print. off., 1905.

347 p. 6 illus. 4 maps. 31 diags. 4 prog. sketches in pocket. 30cm.

At head of title: Department of Commerce and labor.

7 appendices; nos. 3-7 also issued separately.

Contents of appendices: 1. Details of field operations. 2. Details of office operations. 3. Results of magnetic observations made by the Coast and geodetic survey between July 1, 1904, and June 30, 1905. By L. A. Bauer. 4. Precise leveling from Red Desert, Wyoming, to Seattle, Washington. By John F. Hayford. 5. Triangulation along the ninety-eighth meridian, Lampasas to Seguin, Texas. By John F. Hayford. 6. Long wire sweep. By D. B. Wainwright. 7. A plane table manual. By D. B. Wainwright.

SLIPS FOR LIST AND CATALOGUE.

LIST ENTRY.

1905.

Report of the superintendent of the Coast and geodetic survey, showing the progress of the work from July 1, 1904, to June 30, 1905. Washington, Gov't print. off., 1905.

347 p. 6 illus. 4 maps. 31 diags. 4 prog. sketches in pocket. 30cm.
At head of title: Department of commerce and labor.
7 appendices; nos. 3-7 also issued separately.

APPENDICES.

1. Details of field operations. p. 25-86.
2. Details of office operations. p. 87-103.
3. Results of magnetic observations made by the Coast and geodetic survey between July 1, 1904, and June 30, 1905. By L. A. Bauer. p. 105-192.
4. Precise leveling from Red Desert, Wyoming, to Seattle, Washington, 1903-1904. By John F. Hayford. p. 193-241.
5. Triangulation along the ninety-eighth meridian, Lampasas to Seguin, Texas. By John F. Hayford. p. 243-282.
   2 diags.
6. Long wire sweep. By D. B. Wainwright. p. 283-287.
   2 diags.
7. A plane table manual. By D. B. Wainwright. p. 289-342.
   6 illus. 27 diags.

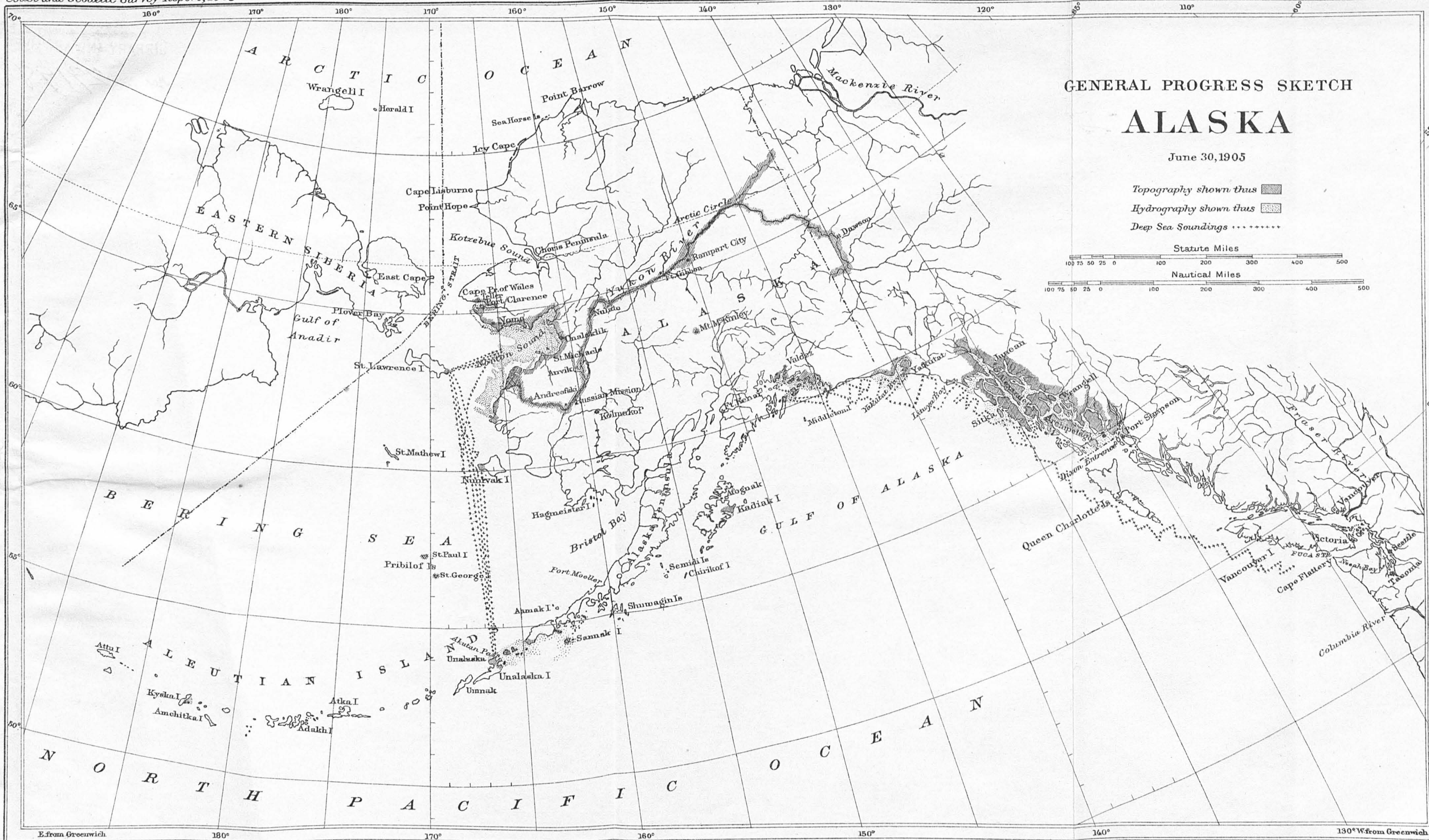
PLATE No. 1654

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

PLATE No. 1655

PLATE No.1655

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



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

Coast and Geodetic Survey Report, 1905.

GENERAL PROGRESS SKETCH

D.