

REPORT OF THE SUPERINTENDENT
OF THE
U. S. COAST AND GEODETIC SURVEY

SHOWING
THE PROGRESS OF THE WORK

DURING THE
FISCAL YEAR ENDING WITH

JUNE, 1891.

IN TWO PARTS.

PART I.

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National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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LETTER
FROM
THE ACTING SECRETARY OF THE TREASURY,

TRANSMITTING

*The Report of the Superintendent of the United States Coast and Geodetic Survey
for the fiscal year 1891.*

TREASURY DEPARTMENT, *December 15, 1891.*

SIR: In compliance with the requirements of section 4690, Revised Statutes, I have the honor to transmit herewith, for the information of Congress, a report addressed to this Department by T. C. Mendenhall, Superintendent of the Coast and Geodetic Survey, showing the progress made in that work during the fiscal year ended June 30, 1891, and accompanied by maps illustrating the general advance in the operations of the Survey up to that date.

Respectfully yours,

O. L. SPAULDING,
Acting Secretary.

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF TRANSMISSION.

UNITED STATES COAST AND GEODETIC SURVEY,
Washington, D. C., December 14, 1891.

SIR: In conformity with law, and with the regulations of the Treasury Department, I have the honor of submitting herewith for transmission to Congress, the Annual Report of the Coast and Geodetic Survey, showing the progress of the work during the fiscal year ended June 30, 1891, and accompanied by maps illustrating the general advance in the operations of the Survey up to that date.

Very respectfully yours,

T. C. MENDENHALL,
Superintendent.

HON. CHARLES FOSTER,
Secretary of the Treasury.

REPORT OF THE SUPERINTENDENT
OF THE
U. S. COAST AND GEODETIC SURVEY

FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

IN TWO PARTS.

PART I.

RECORDS OF PROGRESS IN FIELD AND OFFICE WORK.
ESTIMATES FOR FUTURE PROGRESS.
REPORT OF EXPENDITURES.

PREFATORY NOTE.

The Report for the fiscal year 1891, is the first one in which the text has been arranged for publication in two parts. Part I, in quarto form, contains the historical portion. It states progress in field and office work, gives estimates for future progress, and a report of expenditures during the fiscal year, and is accompanied by maps of general progress and by progress sketches more in detail.

In Part II, in octavo, are published the Appendices, which relate to the methods, discussions, and results of the Survey, with such illustrations as are required.

The octavo form is more convenient and suitable for the scientific and professional papers, while the quarto form appears to be demanded for the statistical matter and the progress sketches. Since the latter are of less general interest than the former, in the future distribution of the Report, Part II only will be sent, as it is believed that this will include all that is generally desired and in a much more compact and convenient form than that of the old quarto.

In special cases, where both parts are desirable they will be sent.

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ERRATA.

COAST AND GEODETIC SURVEY REPORT FOR 1891.

- Page 28, line 5 from bottom, for *Blake* put *Bache*.
Page 59, line 13 from bottom, for *Edward W.* put *Edward M.*
Page 63, line 18 from top, for *Sierra Blanco* put *Sierra Blanca*.
Page 67, line 5 from top, for *Mansfield Cove* put *Mansfield, Cone*.
Page 69, line 14 from top, for *Fremont* put *Fremont*.
Page 69, line 4 from bottom, for *squals* put *squalls*.
Page 70, line 20 from top, for *verticle* put *vertical*.
Page 78, line 14 from bottom, for *California* put *California*.
Page 79, line 15 from top, for *sureeys* put *surveys*.
Page 107, line 4, under "Base Lines," for *sudordinate* put *subordinate*.
Page 107, magnetic parties, number of, insert the number 6 in middle column of table.
Page 108, line 2 from bottom, for *hydrograyhic* put *hydrographic*.
Page 109, line 13 from bottom, for *circulacion* put *circulation*.
Page 119, line 18 from top, for *udersigned* put *undersigned*.
Page 132, line 2 from top, for *Crinage* put *Grinage*.
Pages 148 and 149, in lists of Naval officers, Lieut. E. J. *Donn* should be E. J. *Dorn*.
Page 149, line 10 from top, for *Kemmell* put *Kimmell*.
Page 183, line 10 from bottom, for *Reveue* put *Revenue*.
Page 186, line 30 from top, for *Propretors* put *Proprietors*.

REPORT.

PART I.

INTRODUCTORY STATEMENT.

During the fiscal year 1891 the several branches of the work of the Survey made satisfactory progress in nearly every State and Territory bordering on the Atlantic and Pacific coasts, and in eleven States and Territories of the interior.

Among the operations referred to in this report, the following may be named as of special importance:

Surveys relating to the location of part of the Northeastern Boundary Line between the United States and the Dominion of Canada; re-survey of Nantucket Shoals; observations of tides, currents, densities, and temperatures in Long Island Sound and to the south of Marthas Vineyard in coöperation with the work of the United States Fish Commission; completion of the detailed topographical survey of the District of Columbia; observations begun at Rockville, Md., and at San Francisco, Cal., for investigating the variations of latitude in coöperation with the work of the International Geodetic Association; survey for the site of a lighthouse on Cape Hatteras Shoals; continuation of the investigation in the Gulf Stream and preparation for publication of a volume relating to the methods of the investigation and the results of the research; connection of the primary triangulation on or near the 39th parallel advancing to the westward in the State of Indiana with that advancing to the eastward in the same State; extension to Kansas City of the transcontinental line of the geodetic leveling; reconnaissance along the boundary line on the Rio Grande between the United States and Mexico; establishment off the coast of California, at the request of the Navy Department, of a trial course for the new naval cruiser *San Francisco*; advance of the primary triangulation in California by the occupation of Mount Conness; special surveys of harbors in Puget Sound for the Harbor Line Commission of the State of Washington, and continuation of the preliminary operations relating to the location of the boundary line between Alaska and the British possessions in North America.

Advantage was taken by the Superintendent of opportunities afforded by his visit of inspection to the Pacific coast to determine gravity with new and approved apparatus at a number of stations in California, Washington, and Alaska. In compliance with a request from the International Geodetic Association, and with the sanction of the Secretary of the Treasury, an officer of the Survey was instructed to proceed to the Hawaiian Islands and aid an officer detailed by that Association in observations relating to the variations of latitude. He was further directed to determine simultaneously with latitude the force of gravity at sea-level, and also, when practicable, near the summit of Mauna Kea.

OFFICE OF STANDARD WEIGHTS AND MEASURES.

The work of constructing sets of Standard Weights and Measures for the States that have not yet received them was continued in the Office of Weights and Measures. Comparisons of thermometers were made for the Internal Revenue Bureau; comparisons of coin weights for the United States Mint at San Francisco, and of series of test weights for the United States Mint at Carson, Nev.

At the request of the Secretary of the Treasury an examination was undertaken of the standards in use in the sugar laboratories of the appraiser's offices in Boston, New York, and Philadelphia, and carried to a successful conclusion. Subsequently, at the request of the Commissioner of Internal Revenue, a commission was organized, composed of one expert from the Agricultural Department, one from the Internal Revenue Bureau, and one from this office, for the purpose of recommending methods for the polarization of sugars on which bounty is paid.

Owing to the exigencies of the case the time of the office was largely given to coöperating with the Internal Revenue Bureau in verifying for it the standards to be used in the sugar determinations.

In my last annual report, referring to the facts that the use of the metric system of weights and measures in this country was legalized by act of Congress in 1866; that since that date it has been adopted by the majority of civilized and progressive nations; and that the International American Conference has recommended its adoption in the three Americas, I suggested that it would be advisable to ask Congress to take steps to insure its introduction in the Customs Service. This suggestion was favorably considered by the Secretary of the Treasury, and in his report for the fiscal year 1890, he recommended that the metric system should be made obligatory in transactions at United States Custom Houses from and after the first day of the calendar year 1895. The reasons for this recommendation having lost none of their force, I would urge its renewal.

The recent acquisition by the United States of the National Prototypes of the Metre and Kilogramme, and their deposit in the Office of Weights and Measures has called attention to the need of regulations prescribing the manner of safely keeping these standards, the relation of which to the International Standards is known. That statutory authority for this purpose should be conferred upon the Executive, as recommended by the Secretary in his last annual report, is too obvious to need argument.

The arrangement of Part I of this Annual Report is as follows: (1), General statements of progress under the heads of Field Work, Office Work, Hydrographic Discoveries and Developments, as embodied in Notices to Mariners, Bulletins, and Special Scientific Work, followed by a Notice of the Topographical Conference; (2), Explanation of Estimates for the fiscal year 1893, and Estimates in detail; (3), Abstracts of reports from chiefs of field parties and notices of special operations; (4), abstracts of annual reports showing progress in Office work; (5), notices of the Sub-Offices at Philadelphia and at San Francisco; (6), reference to officers specially employed under the direction of the Superintendent; (7), tabular statements showing the distribution of the parties of the Survey, the statistics of field and office work, and information furnished in response to requests, official or personal; (8), the annual reports of the Assistant in charge of the Office, the Hydrographic Inspector, the Disbursing Agent, and the Assistant in charge of the Office of Standard Weights and Measures.

The maps of general progress (Nos. 1 and 2) and the map (No. 3) showing progress in Alaska, represent graphically the progress of the Survey, afield and afloat, throughout the entire territory of the United States to the close of the fiscal year.

The Appendices, which constitute Part II of this Annual Report, relate to the methods, discussions, and results of the Survey.

GEOGRAPHICAL ORDER OF THE LOCALITIES OF FIELD WORK.

In this report, the localities of field operations are arranged in a geographical order under four divisions, namely:

- I. The Eastern Division, including the States east of the Mississippi River.
- II. The Middle Division, comprising the States and Territories between the Mississippi River and the Rocky Mountains.
- III. The Western Division, including the States and Territories between the Rocky Mountains and the Pacific Coast.
- IV. The Division of Alaska.

The reasons which were for many years operative in retaining the early classification by sections are so no longer, the work of the Survey being now continuous along the entire Atlantic and Gulf coast; nearly continuous on the Pacific; and tending to become continuous throughout the interior, so that all purposes of reference to localities of field operations can be readily met by divisions including a few large areas.

GENERAL STATEMENT OF PROGRESS.

I. FIELD WORK.

EASTERN DIVISION.—*States east of Mississippi River.*—Field work within the limits and upon or off the coasts of the States east of the Mississippi River during the fiscal year 1891 included the following-named operations:

Triangulation of the Schoodic Lakes, forming part of the Northeastern Boundary between the United States and the Dominion of Canada; topographical survey of these lakes to the northward of Vanceboro; continuation of the topographic and hydrographic survey of the St. Croix River from the vicinity of Vanceboro to the southward; completion of the hydrographic survey of Eastport Harbor, Me.; magnetic observations at stations in Maine, New Hampshire, Massachusetts, Connecticut, Vermont, New York, New Jersey, and Pennsylvania; observations relating to changes in river beds, coast of Maine; hydrographic examinations for the Coast Pilot on the coasts of the New England States; topographic and hydrographic survey of the Kennebec River, Me., from Gardiner to Augusta; continuation of the determinations of town boundaries in the State of Massachusetts; physical hydrographic survey begun of the coast of Nantucket Island; hydrographic resurvey of Nantucket Shoals continued; additional soundings and revision of hydrography on Handkerchief Shoal and its vicinity; topographic resurveys and triangulation preparatory thereto on the shores of Buzzards Bay and Nantucket Sound; establishment of an automatic tide-gauge at Bristol, R. I.; observations of temperatures, densities, and currents to the south of Marthas Vineyard and Long Island Sound in connection with the work of the U. S. Fish Commission; hydrographic survey of Shelter Island Sound, L. I.; topographical and hydrographical survey of the Connecticut River from Lyme Ferry to above Middletown; hydrographic resurveys of Shinnecock, Quantuck, and Moriches Bays, south coast of Long Island; hydrographic examination off Rye Beach, New York; determination of the longitude of Cape May, N. J., by exchange of telegraphic signals with Albany, N. Y., and observations for the latitude of Cape May station; continuation of the topographical survey of the Hudson River; tidal observations continued with an automatic tide-gauge at Sandy Hook, N. J.; reconnaissance and signal building in connection with geodetic operations in southeastern New Jersey; continuation of the detailed survey for the revision of the maps of the water-front of the city of Philadelphia and tidal observations at Chestnut Street wharf; topographic and hydrographic survey of Sparrow Point, Patapsco River, Md., and of the waters in the vicinity; observations for latitude of a station at Rockville, Md., in coöperation with researches on the variations of latitude under the general direction of the International Geodetic Association; determinations of relative gravity at the Smithsonian Institution, Washington, D. C.; completion of the detailed topographical survey of the District of Columbia; experimental work conducted with a view to the use of metallic tapes in measurement of bases; examination of locality of a shoal reported near Smith's Point Light, and hydrography of Horseshoe Shoal and vicinity, Chesapeake Bay; hydrographic work upon Cape Hatteras Shoals in connection with the proposed site for a lighthouse on the western part of the Northern Outer Shoal; determinations of the magnetic elements at stations in North and South Carolina; determination of the position of Martin's Industry Light Vessel off Port Royal Entrance, S. C., and hydrographic examination for shoal reported off Hetzel Shoal, Cape Canaveral, Fla.; tidal observations continued at the automatic tidal station on Tybee Island, Savannah River Entrance, Ga.; surveys for the preparation of detailed maps of the grounds included in the Chickamauga and Chattanooga National Military Park;

determinations of the longitude of Augusta, Ga., Gainesville, Fla., and Jacksonville, Texas, by exchanges of telegraphic signals with Washington, D. C., and observations for the latitude of those three stations; continuation of Gulf Stream explorations; topographical reconnaissance of the west coast of Florida between Cape Sable and Cape Romano; survey of the tributaries of Pensacola Bay continued and that of Perdido Bay and its tributaries completed; continuation of the reconnaissance and occupation of stations for the extension of the primary triangulation in Alabama towards the Gulf of Mexico; connection of Memphis, Tenn., and Corinth, Miss., by lines of geodetic leveling; reconnaissance between Lakes Huron and Erie on the Detroit and St. Clair Rivers for a scheme of triangulation connecting with the work of the Lake Survey; continuation of geodetic operations in the State of Wisconsin; continuation of the primary triangulation advancing to the westward near the 39th parallel in Indiana to a connection with that advancing to the eastward in the same State; reconnaissance for a base of verification; connection of the primary triangulation near the 39th parallel advancing to the eastward in the State of Indiana with that advancing to the westward in that State, and preparation for the measurement of a base of verification at Holton, Ind.; reconnaissance for a site of a base-line in West Virginia, and occupation of stations in continuation of the triangulation of the State of Tennessee and for its connection with the triangulation of the State of Kentucky.

MIDDLE DIVISION.—*States and Territories between the Mississippi River and the Rocky Mountains.*—Field work within the limits of the States and Territories just named has included the following operations:

Reconnaissance and occupation of stations in continuation of the triangulation of the State of Minnesota; determinations of longitude by telegraphic exchanges at stations in Minnesota and North Dakota, and in Utah and Montana, with observations for latitude also; determinations of longitude by exchanges of telegraphic signals at stations in Missouri, and observations for latitude of these stations; transcontinental line of geodetic leveling extended from Jefferson City to Kansas City, Mo.; occupation of stations continued and reconnaissance extended for carrying to the westward in Kansas the transcontinental triangulation near the 39th parallel, and extension of this triangulation to the westward and eastward from Fort Wallace, Kansas; hydrographic surveys on the coast of Louisiana between Barataria Bay and Last Island; reconnaissance for the connection of the triangulation of the Mississippi River in the vicinity of Donaldsonville with that of the Gulf of Mexico by way of the Atchafalaya River; observations of the magnetic elements, absolute and differential, continued at the automatic registry station, San Antonio, Texas, and reconnaissance for triangulation along the boundary line between the United States and Mexico on the Rio Grande from El Paso, Texas, to the southward and southwestward.

WESTERN DIVISION.—*States and Territories between the Rocky Mountains and the Pacific.*—The following-named field operations have been in progress or completed in the States and Territories between the Rocky Mountains and the Pacific.

Establishment of a trial course off the coast of California for the speed trials of the new naval cruiser, *San Francisco*; completion of the hydrography of the coast of California in the vicinity of Piedras Blancas and Point Sur Lights; determination of the position of Von Helm Rock in the vicinity of San Simeon; triangulation and topography of the coast of California between Cape San Martin and Point Sur; determinations of gravity at stations in California and Washington; occupation of the primary station, Mount Conness in the Sierra Nevada; moon culminations observed at the astronomical station, San Francisco, in connection with those observed in Alaska; magnetic observations at the Presidio of San Francisco; observations for latitude at San Francisco in coöperation with the work of the International Geodetic Association; tidal record continued at the automatic tidal station, Sausalito, Bay of San Francisco; completion of resurveys and examinations of soundings in Suisun Bay, Karquines Strait and vicinity; primary triangulation north of San Francisco Bay; topographic and hydrographic surveys in Coos Bay, Oregon, and coast topography south of Cape Gregory; continuation of the survey of the Columbia River from Vancouver, Washington, towards the Dalles; hydro-

graphic survey of Willapa Bay, Washington; topographical resurvey of the water front of Port Townsend; hydrographic surveys in Skagit Bay, Drayton Harbor, Boundary Bay, and the Gulf of Georgia; surveys of the water fronts of Whatcom, New Whatcom, and Fairhaven, for the Harbor Line Commission of the State of Washington; exchanges of telegraphic signals for longitude between Salt Lake City, Utah, and Helena, Montana, and occupation of stations in continuation of the transcontinental triangulation along or near the 39th parallel in Utah.

ALASKA.

In the Division of Alaska, which includes the coast, inlets, sounds, bays, rivers, and the Aleutian Islands, the following-named field operations were in progress or completed:

Determinations of gravity with improved apparatus at a station in British Columbia near the Alaska boundary line, at six stations in southeastern Alaska, and at a station on St. Paul Island, Bering Sea; triangulation, topography, and hydrography of Taku Inlet, Stephens Passage from Douglass Island northward, Gastineau Channel, Lynn Canal and Behm Canal; continuation during part of the year of the tidal record at the automatic tidal station, Saint Paul, Kadiak Island, Gulf of Alaska, and occupation of stations near the junction of the one hundred and forty-first meridian with the Yukon and Porcupine Rivers, Alaska, in connection with a preliminary survey of the boundary line between Alaska and the British Possessions in North America.

SPECIAL OPERATIONS.

Field operations of a special character are referred to in some detail following the abstracts of reports from chiefs of field parties.

II.—OFFICE WORK.

The annual reports of the Assistant in charge of the Office and of the Hydrographic Inspector, which are published at the close of this volume, present full statements of office operations carried on under their direction during the fiscal year, and the abstracts of those reports which follow the notices of field operations make reference to their leading topics.

It is a subject of much gratification that the new presses and increased working room soon to become available will probably enable the office to meet the largely increased and increasing demand for the charts of the survey.

During the fiscal year 1891 there were issued 52 959 copies of charts, 3 153 of which were for the use of Congress, 2 651 for the Executive Departments, and 31 465 to sale agents. Although this total issue, owing to various causes, was considerably less than that for the previous fiscal year, it exceeded by upwards of 16 000 copies the average issue of the five years from 1885 to 1889, inclusive.

Of Notices to Mariners, issued monthly, or oftener, should occasion demand it, 139 000 copies were printed for free distribution. The publication of Coast Pilots and Tide Tables was continued. Of the Coast Pilots for the Atlantic and the Pacific coasts, 1 052 copies were issued. The manuscripts of the Tide Tables predicting times and heights of high and low waters on the Atlantic and Pacific coasts for 1892 were sent to press before the end of the fiscal year; 19 154 copies were printed of the six Bulletins issued; and there were received from the Public Printer 13 570 extra copies of Appendices to the Annual Reports. The distribution, domestic and foreign, made of these reports to individuals and institutions was 2 746 copies.

III.—HYDROGRAPHIC DISCOVERIES AND DEVELOPMENTS AS ANNOUNCED IN NOTICES TO MARINERS.

The monthly issue of a Notice to Mariners was continued throughout the fiscal year. These notices are primarily intended to inform navigators of changes in aids to navigation, discoveries of dangers, and changes in depths on the coasts and approaches to the coasts of

the United States and adjacent territories. They contain also lists of new charts, chart agencies and new publications, and each notice is accompanied by a circular which can be used by any person desiring to communicate information concerning charts or data for the use of mariners to the Superintendent.

Of the 13 numbers published during the year, one of them being an index to chart corrections made from January 1 to December 31, 1890, 139 000 copies were printed for free distribution. Copies are furnished to all who may apply for them at the agencies of the Survey in the principal ports of the United States; at the United States Custom Houses; at the Branch Hydrographic Offices of the Navy Department in the principal seaport cities; at United States Consulates in foreign ports; at the Office of the Survey in Washington, D. C., and at the Sub-Offices in Philadelphia and San Francisco.

Following is an abstract of contents of the notices issued during the fiscal year:

No. 130 (July, 1890). Chart corrections during the month. New publications.

No. 131 (August, 1890). Chart corrections during the month. New chart. New editions. Exhausted charts. Cancelled charts. New publication.

No. 132 (September, 1890). Chart corrections during the month. New charts. New edition.

No. 133 (October, 1890). Chart corrections during the month. New charts. New edition. New publication.

No. 134 (November, 1890). Chart corrections during the month. New charts. New edition.

No. 135 (December, 1890). Chart corrections during the month. Lights. Beacons. New editions. New publications.

No. 136 (January 1 to December 31, 1890). Index to chart corrections.

No. 137 (January, 1891). Chart corrections during the month. New chart. New editions. Cancelled chart. New publications.

No. 138 (February, 1891). Chart corrections during the month. New publications.

No. 139 (March, 1891). Chart corrections during the month. New charts. New editions. Cancelled charts. New publication.

No. 140 (April, 1891). Chart corrections during the month. New charts. New edition. Cancelled charts.

No. 141 (May, 1891). Chart corrections during the month. New chart. New edition. Cancelled chart. New publications.

No. 142 (June, 1891). Chart corrections during the month. New charts. Cancelled chart. New publications.

Among the hydrographic discoveries or developments to which the attention of mariners was specially called in the notices above named, the following were the more important:

In No. 132, announcement of the discovery of a pinnacle rock, with but one foot of water over it, in Eastport Harbor, Me.; existence of a dangerous ledge in Long Island Sound, off Parsonage Point. In No. 133, discovery of a sunken rock, over which the sea breaks at very low water, NW. from Cape Blanco Light, coast of Oregon. In No. 138, changes in depth resulting from improvements in New York Harbor and Entrance Channels. In No. 140, general changes in the aids to navigation in the approaches to New York Harbor; discovery of a rock, with but ten feet of water over it, in Twin Peak Bay, coast of California. And in No. 142, correct location of the dangerous sunken rock known as Von Helm Rock, off San Simeon, California.

IV.—BULLETINS.

The Bulletins published during the year embodied results derived from the work of the Survey relating to gravity research, terrestrial magnetism, astronomical azimuth, and physical hydrography. These papers not unfrequently anticipate in the form of abstracts the more elaborate presentation of methods, discussions, and results given in the Annual Reports. They are supplied free of charge to applicants. Of the six Bulletins, the titles, etc., of which are given in the following list, an edition of 19 154 copies was printed.

TITLE.	When approved or submitted for publication.	Date of publication.
No. 19. On the Sounds and Estuaries of Georgia with reference to Oyster Culture. A report by J. C. Drake, Ensign U. S. Navy, Assistant U. S. Coast and Geodetic Survey, Commanding Schooner <i>Ready</i> , 1889-1890.	Mar. 15, 1890	Feb. 26, 1891
No. 20. The Magnetic Observations made on Bering's first voyage to the coasts of Kamchatka and Eastern Asia in the years 1725 to 1730. Discussion by C. A. Schott, Assistant.	Dec. 12, 1890	Feb. 26, 1891
No. 21. Determination of an Azimuth from Micrometric Observations of a close Circumpolar Star near elongation by means of a Meridian or Transit and Equal Altitude Instrument, or by means of a Theodolite with Eye-Piece Micrometer. Report on method by C. A. Schott, Assistant. Observations by A. T. Mosman, Assistant.	Dec. 12, 1890	Feb. 26, 1891
No. 22. Results of Observations made to determine Gravity and the Magnetic Elements at stations on the West Coast of Africa, and on some Islands in the North and South Atlantic, 1889-1890. By E. D. Preston, Assistant.	Feb. 20, 1891	June 4, 1891
No. 23. The Secular Variation and Annual Change of the Magnetic Force at stations occupied by E. D. Preston, Assistant U. S. Coast and Geodetic Survey, in connection with the U. S. Eclipse Expedition to the West Coast of Africa in 1889-1890, in charge of Prof. D. P. Todd. Abstract of the result of a discussion by C. A. Schott, Assistant.	Mar. 16, 1891	June 1, 1891
No. 24. Changes in the Shore Lines and Anchorage Areas of Cape Cod (or Provincetown) Harbor, as shown by a comparison of Surveys made between 1867 and 1890. Abstract of a report by Henry L. Marindin, Assistant.	Mar. 28, 1891	June 30, 1891

V.—SPECIAL SCIENTIFIC WORK.

DETERMINATIONS OF GRAVITY WITH NEW AND IMPROVED APPARATUS AT STATIONS ON THE PACIFIC COAST.

The study of a method of determining relative gravity by apparatus more portable, capable of quicker manipulation, simpler in the processes of observation, and giving results of even greater accuracy than had hitherto been attained in the Coast and Geodetic Survey, had for some time engaged the attention of the Superintendent. Under his direction, experiments were begun early in the autumn of 1890 in the Office of the Survey to determine the best form of pendulum and the best method of getting the times of oscillation.

These experiments resulted ultimately in the adoption of a half seconds pendulum, as first used by Von Sternek, and a method of observing coincidences similar in some respects to that devised by him. The times of vibration of this free pendulum were noted by coincidences with the beats of a whole second chronometer. These coincidences were observed optically, the chronometer being made to open every second a relay armature carrying an upright metallic disk with a thin slit cut in it. As the armature moved, this disk passed before a fixed slit a short distance in front of it, so that a light, suitably disposed, flashed at every break of the electric circuit by the chronometer. This apparatus was placed about two metres from the pendulum and so adjusted that the beam of light from the slit fell upon two mirrors, one on the pendulum and one on its support, one therefore movable and one stationary. From these mirrors the beam of light was reflected back into the observer's telescope. Now, the time of oscillation of the pendulum being slightly different from half a second, the flashes from the opening of the electric circuit and those from the pendulum mirror do not generally coincide, but when they do, the coincidence is noted, the point of reference to which the motion of the movable image is referred being furnished by the flash reflected back from the stationary mirror.

A full description of this apparatus, with illustrations, and a report of results obtained with it, is given by the Superintendent in Appendix No. 15, Part II, of this Report.

In the spring and summer of 1891 he made with it determinations of relative gravity at two stations in California, one in Washington, six in southeastern Alaska, one station in British Columbia near the Alaska boundary line, and one station on St. Paul Island, Pribilof Group, Bering Sea, these results being referred to the base stations, which are the Smithsonian Institution at Washington, D. C., and the Stevens Institute at Hoboken, New Jersey.

DETERMINATIONS OF GRAVITY IN CONNECTION WITH OBSERVATIONS FOR INVESTIGATING THE VARIATIONS OF LATITUDE AT STATIONS IN THE HAWAIIAN ISLANDS.

It being well known that the changes which have been found to exist in terrestrial latitudes are closely connected with variations in the force of gravity, Assistant E. D. Preston, the officer detailed to make latitude determinations in the Hawaiian Islands in co-operation with the work of the International Geodetic Association, was instructed to determine also the force of gravity at Honolulu and at one or two stations on the Island of Hawaii, preferably at the sea level, and near the summit of Mauna Kea, if this mountain should be found accessible.

For the gravity work, Mr. Preston was provided with one of the sets of new and improved pendulum apparatus made in the office under the direction of the Superintendent, and partly described under the preceding heading.

Observations for latitude and gravity were begun by Mr. Preston, and by his colleague, Dr. Marcuse, representing the International Geodetic Association, at a station near Honolulu early in June, 1891, and will be continued at this and other stations for probably a year.

In his report of progress, bearing date of June 30, of which an abstract is given in Part II, Appendix No. 13, Mr. Preston outlines the plan of nightly work at Waikiki, near Honolulu, as follows:

Latitude observations are made in connection with Dr. Marcuse. Time is determined for gravity work in the intervals between pairs of stars, and the pendulum is swung during the entire evening, coincidences being noted at the beginning and end of the night's work and whenever opportunity offers during the latitude and time observations.

OBSERVATIONS FOR INVESTIGATING THE VARIATIONS OF LATITUDE IN CO-OPERATION WITH THE WORK OF THE INTERNATIONAL GEODETIC ASSOCIATION.

Observations for latitude made in 1889 and 1890 at Berlin, Potsdam, and Prague in Europe having shown a progressive yearly change in the results, the International Geodetic Association asked the co-operation of the Coast and Geodetic Survey in pursuing further investigation of the laws of this change, so that by a comparison of observations at stations differing largely in longitude, taken in connection with simultaneous determinations of gravity, it might be decided whether it was due to an actual shifting of the axis of the earth, or to transfers of large masses of matter under its surface.

In compliance with this request, observations of latitude of a high degree of precision were begun by the Survey in 1891 at a station in Rockville, Md; at the Lafayette Park station, San Francisco, Cal., and at a station in the Hawaiian Islands, the Hawaiian Government Survey having signified its desire to co-operate in the work.

Reports of results arrived at by the officers charged with these important investigations, Assistant Edwin Smith at Rockville, Assistant George Davidson at San Francisco, and Assistant E. D. Preston at Honolulu, will be prepared at as early a date as practicable.

THE TRANSIT OF MERCURY, MAY 9, 1891, AS OBSERVED NEAR HONOLULU, OAHU, HAWAIIAN ISLANDS.

As it seemed probable that the arrival of Assistant E. D. Preston in the Hawaiian Islands in May, 1891, would be a few days before the time of the transit of Mercury, May 9, instructions were given to Mr. Preston to observe that transit in addition to the special duty assigned to him as observer of the variations of latitude in co-operation with the work of the International Geodetic Association.

By the kind co-operation of Professor Alexander, Director of the Hawaiian Government Survey, the observations of the transit by Mr. Preston, and by his colleague, Dr. Marcuse of the International Geodetic Association, were made possible, the mail steamer from San Francisco, on which these officers had taken passage, not having arrived at Honolulu until one o'clock in the afternoon of May 8. They landed immediately, and in the afternoon of that

day selected a point at Waikiki, about 3 miles southeast of Honolulu, where the conditions of observation would be best fulfilled for a transit, the last contact of which would occur only a few minutes before sundown.

Clouds interfered with the work on the 9th, so that the first contact was lost, but the second was very satisfactorily observed, and a fairly good observation of the third secured.

Mr. Preston's report is given in full in Appendix No. 12, Part II.

RESULTS OF MAGNETIC OBSERVATIONS AT LOS ANGELES, CALIFORNIA. PART III.
DIFFERENTIAL MEASURES OF THE HORIZONTAL INTENSITY.

The exposition of the results obtained during the period 1882 to 1889 at the Magnetic Observatory at Los Angeles, Cal., is resumed by Assistant Schott in Appendix No. 4, Part II, of this Annual Report. This paper is wholly occupied by a discussion of the several variations of the horizontal component of the earth's magnetic force, namely:—those depending on solar and those depending on lunar action. As a necessary preliminary step, the effect of changes of temperature is investigated, and the whole differential hourly record of the horizontal force as tabulated is reduced to a uniform condition and appended to the paper for any further use that may suggest itself.

The connection of the differential series with the absolute measures having been made, and the results of the annual and the diurnal variations of the solar deflecting forces having been presented, there follows a discussion of the disturbances and their variations of short and long period, treated with respect to number and amount. The lunar diurnal-variation is next analyzed, and the effects of the variations in the moon's declination, in her distance and in her phases are developed. The paper concludes with a determination of the period of the sun's rotation about its axis, deduced from the observed changes in the indications of the horizontal force magnetograph. These variations are compared with similar results obtained at other stations. Ten diagrams (illustrations Nos. 1 to 10 inclusive) present graphically the leading facts elicited by the discussion.

OBSERVATIONS OF CURRENTS WITH THE DIRECTION CURRENT METER IN THE STRAITS OF
FLORIDA AND IN THE GULF OF MEXICO.

A report of much interest in continuation of the investigation of deep-sea currents is published as Appendix No. 10, Part II of this Annual Report. Opportunity was taken of the cruise of the steamer *Blake*, Lieut. C. E. Vreeland, U. S. N., Assistant Coast and Geodetic Survey, commanding, to make trial of the recent invention of the direction current meter in the course of the occupation of a series of current stations in the Straits of Florida and in the Gulf of Mexico. Mr. E. E. Haskell, Assistant, and co-inventor of this meter with Mr. E. S. Ritchie, of Boston, was on board the *Blake* as hydrographer, and has presented in his paper some of the results of his observations with a description and photograph of the apparatus. The construction of the meter is such that an observation of the velocity and an observation of the direction of the current are taken simultaneously, and are registered electrically, and can be repeated at will in any depth of water to which it is possible to lower it.

TOPOGRAPHICAL CONFERENCE.

In order to promote a better understanding among topographers of the Survey with regard to methods of executing field and office work; to formulate rules for governing topographic work on specified scales for typical regions; to consider the question of improvements in the plane-table; what other instruments might be valuable as auxiliaries, and how far photogrammetry would be a useful auxiliary; to discuss the subject of conventional signs as now adopted for topographic sheets; to review the present state of the science and art of topography in our own and foreign countries, and also the more recent advances in methods or improvements in instruments in other countries, and to discuss methods by which field topography may be executed more rapidly, and at less cost without material loss of accuracy, the Superintendent, in December, 1891, made arrangements for the assembling of a Topographical Conference at the Coast and Geodetic Survey Office in Washington.

The members of the Conference were Assistants Henry L. Whiting (Chairman), R. Meade Bache, Augustus F. Rodgers, William H. Dennis, Cleveland Rockwell, John W. Donn, C. T. Iardella, Herbert G. Ogden, D. B. Wainwright, W. C. Hodgkins, and J. A. Flemer.

Through answers to a circular letter of invitation from the Conference to contribute views on topographical matters, the following named officers of the Survey became to that extent its co-adjutors; Assistants George Davidson, Henry L. Marindin, J. J. Gilbert, F. W. Perkins, W. I. Vinal, and Fremont Morse. Also, by answers to the same circular, Messrs. Charles Junken, A. Lindenkohl, and F. C. Donn, draughtsmen in the Office of the Survey.

The members of the Conference have, through their chairman, submitted a report of their proceedings, accompanied by a series of papers embodying the facts and reasons which governed them in forming opinions and coming to conclusions on the subjects referred to them by the Superintendent or suggested in the course of their deliberations.

This paper is published as Appendix No. 16, in Part II, of this Report.

EXPLANATION OF ESTIMATES.

The estimates submitted to the Secretary of the Treasury for the fiscal year ending June 30, 1893, were accompanied by the following statement:

UNITED STATES COAST AND GEODETIC SURVEY,
Washington, D. C., October 1, 1891.

SIR: I forward herewith, in response to your circular of July 15th, my estimates for the expenditures of the Coast and Geodetic Survey for the year ending June 30, 1893. These estimates differ very little from those submitted a year ago, or from the appropriations made in the Sundry Civil Act of March 3, 1861.

The changes made are confined almost exclusively to estimates under the head of "Party Expenses," the items for which must, in the nature of things, change from year to year. The total under that head is apparently greater than that of last year, but in reality it is less. The apparent increase is due to the placing of the item for repair of vessels under the head of "Party Expenses" where it more properly belongs. The amount hitherto appropriated for "Repairs of Vessels" has proved inadequate to maintain the fleet of the Survey in good condition, as the majority of the vessels are now quite old, and the cost of repairing grows larger each year. I have, therefore, increased the amount in the estimates herewith, by \$3 000, but a saving to the same extent under other items, leaves the total the same as for last year. The total sum under the heading "Pay of Office Force," is the same as the amount appropriated by the last Congress, but is apparently greater on account of the distribution, under the appropriate classes, of the new force for chart printing, provided for in the Act of March 3, 1891. The items under "Office Expenses" remain unchanged, except in paragraph three, in which an increase of \$1 500 is asked. This is absolutely demanded on account of the addition of the new buildings, and extension of the printing facilities.

I am glad to say that as a result of a close supervision over the expenditures for the fiscal year ending June 30, 1891, we shall have no deficiency to be covered by the next Congress.

The estimates herewith submitted have been prepared with great care. The sum asked for is somewhat less than that appropriated at any session of Congress during the past four or five years. Any further reduction would be incompatible with the interests of the public service, the amount called for being, in my judgment, both necessary and sufficient for the proper discharge of the duties devolving upon this Bureau.

Respectfully, yours,

T. C. MENDENHALL,
Superintendent.

THE HONORABLE THE SECRETARY OF THE TREASURY,
Washington, D. C.

ESTIMATES—COAST AND GEODETIC SURVEY.

For every expenditure requisite for and incident to the survey of the Atlantic, Gulf, and Pacific coasts of the United States and the coast of the Territory of Alaska, including the survey of rivers to the head of tide water or ship navigation; deep sea soundings, temperature and current observations along the coast and throughout the Gulf Stream and Japan Stream flowing off the said coasts; tidal observations; the necessary re-surveys; the preparation of the Coast Pilot; continuing researches and other work relating to terrestrial magnetism and the magnetic maps of the United States and adjacent waters, and the tables of magnetic declination, dip and intensity usually accompanying them; and including compensation not otherwise appropriated for of persons employed on the field work, in conformity with the regulations for the government of the Coast and Geodetic Survey adopted by the Secretary of the Treasury; for special examinations that may be required by the Light House Board or other proper authority, and including traveling expenses of officers and men of the Navy on duty; for commutation to officers of the field force while on field duty, at a rate to be fixed by the Secretary of the Treasury, not exceeding \$2.50 per day each; outfit, equipment and care of vessels used in the Survey, and also the repairs and maintenance of the complement of vessels, to be expended in accordance with the regulations relating to the Coast and Geodetic Survey from time to time prescribed by the Secretary of the Treasury, and under the following heads: *Provided*, That no advance of money to chiefs of field parties under this appropriation shall be made unless to a commissioned officer, or to a civilian officer who shall give bond in such sum as the Secretary of the Treasury may direct.

FOR PARTY EXPENSES:

For triangulation, topography, and hydrography of the coast of Maine and to the International boundary monument; the vicinity of the east end of Long Island; Nantucket Shoals and approaches including Vineyard Sound, the coasts of Massachusetts (including re-survey of Boston Harbor) and New Hampshire; the Connecticut River to Hartford; the Hudson River to Troy; and to continue to date corrections of former surveys of the Delaware River from the vicinity of Philadelphia to Trenton	\$18 000
For completing unfinished surveys of parts of the Atlantic coast from Maryland to Florida, and for necessary re-surveys	3 000
To continue the primary triangulation from the vicinity of Montgomery toward Mobile	3 500
For triangulation, topography, and hydrography of unfinished portions of the Gulf coast, including Lake Pontchartrain and the resurvey of Mobile Bay entrance	12 000
To make off-shore soundings along the Atlantic coast and current and temperature observations in the Gulf Stream	8 000
For continuing the triangulation west of the 110th meridian and connecting the same with the transcontinental arc	10 000
For continuing the survey of the coasts of California, Oregon, and Washington, including off-shore hydrography, and to continue the survey of the Columbia River from the mouth of the Willamette towards the Cascades, triangulation, topography, and hydrography	28 000
For continuing explorations in the waters of Alaska and making hydrographic surveys in the same, and for the establishment of astronomical, longitude, and magnetic stations	10 000
For continuing the researches in physical hydrography relating to bars and harbors, including computations and plottings	8 000
For examination into reported dangers on the Atlantic, Gulf, and Pacific coasts	500
To continue magnetic observations, including the maintenance of the magnetic observatory	3 000

FOR PARTY EXPENSES—Continued.

For continuing the lines of exact levels westward and southward from the vicinity of Kansas City; westward from Old Point Comfort, Va.; eastward from San Francisco; eastward from Vicksburg, Miss., between Fernandina and Cedar Keys, Fla., and from the vicinity of Chicago, Ill., to Lake Erie .	\$5 000
For continuing tidal observations on the Atlantic, Gulf, and Pacific coasts	5 000
To continue gravity experiments, at a cost not exceeding \$500 per station, except for special investigations and experiments authorized by the Superintendent at one or more stations	2 500
For furnishing points to State surveys, to be applied as far as practicable in States where points have not been furnished	10 000
For determination of geographical positions	3 000
For continuing the transcontinental geodetic work on the line between the Atlantic and Pacific Oceans, including a primary base in the vicinity of Salt Lake and the necessary check bases	22 000
To continue the compilation of the Coast Pilot and to make special hydrographic examinations for the same	3 000
For traveling expenses of officers and men of the Navy on duty, and for any special surveys that may be required by the Light House Board or other proper authority, and contingent expenses incident thereto	3 500
For objects not hereinbefore named that may be deemed urgent; including the actual necessary expenses of officers of the field force temporarily ordered to the office at Washington for consultation with the Superintendent, to be paid as directed by the Superintendent in accordance with the Treasury regulations	7 000
For contribution to the International Geodetic Association for the measurement of the earth, \$450, or so much thereof as may be necessary, to be expended through the office of the American Legation at Berlin, and for expenses of the attendance of the American delegate at the general conference of said association, or so much thereof as may be necessary	550
[Provided, That such contribution and expenses of attendance shall be payable out of the item "For objects not hereinbefore named."]	
For repairs and maintenance of the complement of vessels used in the Coast and Geodetic Survey	28 000
[And 20 per centum of the foregoing amounts shall be available interchangeably for expenditure on the objects named.]	
Total party expenses	\$193 000

ALASKA BOUNDARY SURVEY: .

For expenses of carrying on a preliminary survey of the frontier line between Alaska and British Columbia and the Northwest Territory, in accordance with plans or projects approved by the Secretary of State, including expenses of drawing and publication of map or maps, \$10,000, said sum to continue available for expenditure until the same is exhausted	\$10 000
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PAY OF FIELD OFFICERS:

For Superintendent	\$6 000
For two assistants, at \$4 000 each	8 000
For one assistant	3 600
For one assistant	3 200
For four assistants, at \$3 000 each	12 000
For two assistants, at \$2 800 each	5 600

PAY OF FIELD OFFICERS—Continued.

For two assistants, at \$2 600 each	\$5 200
For six assistants, at \$2 400 each	14 400
For four assistants, at \$2 200 each	8 800
For seven assistants, at \$2 000 each	14 000
For nine assistants, at \$1 800 each	16 200
For six assistants, at \$1 600 each	9 600
For five sub-assistants, at \$1 400 each	7 000
For two sub-assistants, at \$1 200 each	2 400
For aids temporarily employed at a salary not greater than \$900 per annum each	3 600

Total pay in the field \$119 600

PAY OF OFFICE FORCE:

For one disbursing agent	\$2 200
For one general office assistant	2 200
For one chief of division of library and archives	1 800
For one clerk to Superintendent	1 200
For one clerk to the assistant in charge of office and topography	1 000
For clerical force, namely:	
For two, at \$1 650 each	3 300
For three, at \$1 400 each	4 200
For five, at \$1 200 each	6 000
For three, at \$1 000 each	3 000
Chart correctors, buoy colorists, stenographers, writers, typewriters, and copyists, namely:	
For two, at \$1 200 each	2 400
For three, at \$900 each	2 700
For one	800
For ten, at \$720 each	7 200
For one	600
Topographic and hydrographic draughtsmen, namely:	
For one	2 400
For one	2 200
For two, at \$2 000 each	4 000
For three, at \$1 800 each	5 400
For two, at \$1 400 each	2 800
For two, at \$1 200 each	2 400
For two, at \$1 000 each	2 000
For three, at \$900 each	2 700
Astronomical, geodetic, tidal, and miscellaneous computers, namely:	
For three, at \$2 000 each	6 000
For two, at \$1 600 each	3 200
For two, at \$1 400 each	2 800
For three, at \$1 200 each	3 600
For two, at \$1 000 each	2 000
Copper plate engravers, namely:	
For three, at \$2 000 each	6 000
For three, at \$1 800 each	5 400
For two, at \$1 600 each	3 200
For one	1 200
For one	1 000
Additional engravers, at not to exceed \$900 per annum each	4 000

PAY OF OFFICE FORCE—Continued.

Electrotypers and photographers, plate printers and their helpers, instrument makers, carpenters, engineer, janitor, and other skilled laborers, namely:	
For two, at \$1 800 each	\$3 600
For two, at \$1 600 each	3 200
For one	1 200
For eleven, at \$1 000 each	11 000
For three, at \$900 each	2 700
For seven, at \$700 each	4 900
Watchman, fireman, messengers and laborers, packers and folders, and miscellaneous work, namely:	
For three, at \$880 each	2 600
For six, at \$820 each	4 920
For two, at \$700 each	1 400
For three, at \$640 each	1 920
For four, at \$630 each	2 520
For four, at \$550 each	2 200
For two, at \$365 each	730
Total pay of office force	<u>\$143 830</u>

PUBLISHING OBSERVATIONS:

For the discussion and publication of observations	\$1 000
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OFFICE EXPENSES:

For the purchase of new instruments, for materials and supplies required in the instrument shop, carpenter shop, and drawing division, and for books, maps, charts and subscriptions	9 000
For copper plates, chart paper, printer's ink, copper, zinc and chemicals for electrotyping and photographing; engraving, printing, photographing and electrotyping supplies; for extra engraving and drawing; and for photolithographing charts and printing from stone and copper for immediate use	20 000
For stationery for the office and field parties, transportation of instruments and supplies, when not charged to party expenses, office wagon and horses, fuel, gas, telegrams, ice, and washing	7 500
For miscellaneous expenses, contingencies of all kinds, office furniture, repairs, and extra labor, and for traveling expenses of assistants and others employed in the office sent on special duty in the service of the office	4 500
Total general expenses of office	<u>\$41 000</u>

That no part of the money herein appropriated for the Coast and Geodetic Survey shall be available for allowance to civilians or other officers for subsistence while on duty at Washington (except as hereinbefore provided for officers of the field force ordered to Washington for short periods for consultation with the Superintendent), or to officers of the Navy attached to the Survey, except as now provided by law.

PRINTING AND BINDING, COAST AND GEODETIC SURVEY:

For all printing and lithographing, photo-lithographing, photo-engraving, and all forms of illustration done by the Public Printer, on requisition by the Treasury Department, for the Coast and Geodetic Survey, namely:	
For tide tables, coast pilots, appendices to the Superintendent's annual reports, published separately, notices to mariners, circulars, blank books, blank forms, and miscellaneous printing (including the cost of all binding and covering), the necessary stock and materials and binding for the library and archives	\$20 935

PRINTING AND BINDING, COAST AND GEODETIC SURVEY—Continued.

Note.—No engraving is done by the Public Printer for the Coast and Geodetic Survey.

Total Coast and Geodetic Survey (exclusive of printing and binding) for the fiscal year ending June 30, 1893.....	\$508 43 ⁰
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OFFICE OF CONSTRUCTION OF STANDARD WEIGHTS AND MEASURES:

<i>Salaries, Office of Standard Weights and Measures.</i> —For construction and verification of standard weights and measures, including metric standards, for the custom houses, other offices of the United States, and for the several States, and mural standards of length at Washington, District of Columbia: one adjuster, at \$1 500; one mechanician, at \$1 250; one assistant messenger; and one watchman, in all.....	\$4 190
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<i>Contingent Expenses, Office of Standard Weights and Measures.</i> —For the purchase of materials and apparatus and incidental expenses	500
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For expenses of the attendance of the American member of the International Committee on Weights and Measures at the general conference provided for in the convention signed May 20th, 1875, the sum of \$600, or so much thereof as may be necessary.....	600
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Total.....	\$1 100
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RECORDS OF PROGRESS IN FIELD WORK.

Abstracts of reports from chiefs of field parties begin this portion of the Report. They are arranged in a geographical order under the heads of the general divisions of the country which, during the fiscal year 1891, have replaced the smaller areas of sections of the coast and interior.

Thus for sections consisting of one or more States, and numbered 1, 2, 3, 4, 5, 6, 7, 8, 13, and 14, has been substituted the Eastern Division, including the States east of the Mississippi River; for sections 9 and 15, the Middle Division, including the States and Territories between the Mississippi River and the Rocky Mountains; for sections 10, 11, 16, and 17, the Western Division, including the States and Territories between the Rocky Mountains and the Pacific Coast, and for section 12, the Division of Alaska.

Following the summarized reports of field work and of special operations, will be found abstracts from the annual reports of the Assistant in charge of the Office, of the Hydrographic Inspector, of the Disbursing Agent, and of the Assistant in charge of the Office of Standard Weights and Measures, followed by notices of the Sub-Offices at Philadelphia and at San Francisco.

These annual reports form the concluding portion of Part I. They are preceded by three tabular statements: No. 1 showing the distribution of field parties on the Atlantic, Gulf, and Pacific coasts, and in the interior of the United States; No. 2, the statistics of the field and office work of the Survey to the close of the fiscal year, and No. 3, a list of information furnished by the Survey in response to requests, official and personal.

ABSTRACTS OF REPORTS FROM FIELD PARTIES, FISCAL YEAR 1891.

EASTERN DIVISION.

STATES EAST OF THE MISSISSIPPI RIVER.

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

Progress Sketches No. 1, Nos. 4 to 9, inclusive, and Nos. 14, 15, and 16, show the localities of field work in the Eastern Division. A list of Progress Sketches is given at the close of this volume.

Triangulation of the Schoodic Lakes, forming part of the Northeastern Boundary between the United States and Canada.—At the beginning of the fiscal year, the party in charge of Assistant Joseph Hergesheimer had been in the field about two weeks, engaged in a reconnaissance for the location of stations and opening of lines needed to carry forward a tertiary triangulation from Vanceboro, Me., to the northward and northwestward over the Schoodic Lakes. These third order points are needed for the prospective topographic and hydrographic survey of the lakes, the situation of which, as forming part of the northeastern boundary between the United States and Canada, makes it desirable that they should be carefully surveyed.

By the close of the season, October 10, Mr. Hergesheimer had occupied twenty-eight stations and determined forty-one points in geographical position. Lake Chiputadicook, from Vanceboro to Forest City, he found to be without settlements on its shores, and the surrounding country is rough and wooded. About Grand Lake, the country is more open, and there are farms and roads on both the east and west sides of the lake. Four bridges connect the territory of the United States with that of Canada in this region; two between the Northeastern Boundary Monument and Vanceboro, and two at Vanceboro for the Canadian Pacific Railroad.

Mr. Hergesheimer has stated in his report the locations of springs and camping grounds; also the names of places at which board and transportation can be obtained. He recommends a scale of 1-10 000 for the topographic and hydrographic work, except at the bridges where a 1-1200 scale would be desirable.

Mr. J. S. Siebert rendered effective service as recorder throughout the season.

During the winter of 1890-1891 Mr. Hergesheimer was on duty on the west coast of Florida. This service is referred to under a subsequent heading in this volume.

Topographical Survey of the Schoodic Lakes to the northward of Vanceboro.—At the close of the fiscal year the party of Sub-assistant J. A. Flemer had been in the field in the vicinity of the Northeastern Boundary since June 11, under instructions to make a topographical survey of the Schoodic Lakes from Vanceboro northward.

Mr. Flemer arrived at Vanceboro, June 10, and began the topography of the northern portions of Vanceboro, Maine, and of St. Croix, New Brunswick, June 13. The survey was then carried up the lower lake to a point known as The Lower Cutting-off Place. On June 19, so many "booms" had arrived from the upper lakes that navigation on the lower lake was impossible, and as soon as the weather permitted, the party was moved to a point known as "Cold Water Tavern" on the south border of Chiputneticook Lake and about six miles from Vanceboro. While camping at this point between June 22 and 30, Mr. Flemer took advantage of the almost continual rainy weather to have the two canoes upon which the party depended for transportation pitched and painted in the dry shed of a lumber mill. Unfortunately the mill, and with it, the larger of the two canoes, was destroyed by fire on the night of June 24-25, and the means of transportation of the party somewhat crippled.

The further progress of this work will be stated in the next annual report.

Up to June 30, 1891, the statistics are:

Topography:

Area surveyed in square statute miles	0.5
Length of general coast line in statute miles	4
Length of roads in statute miles	3
Scale of plane-table sheet	1-10 000

Continuation of the topographic and hydrographic survey of the St. Croix River, from the vicinity of Vanceboro, Maine, to the southward.—Reference was made in the last annual report to the survey of the St. Croix River begun in May, 1890, by Sub-Assistant J. A. Flemer, who proceeded to Vanceboro, Maine, under instructions to take up the topography of the head waters of the St. Croix, and to locate as accurately as possible the thread of the stream, bearing in mind its importance as an International Boundary Line.

At the beginning of the fiscal year, field operations had been in progress since June 3, and

the party had reached its second camping station, Duck Point, about 6 miles below Vanceboro. As the party moved down the river, camps were established at intervals of from two to five miles until October 23, when a connection was made at Ryan's Ripps, about 35 miles below Vanceboro, with the work of Mr. E. Ellicott (formerly an Assistant in the Survey.) Work was then closed for the season.

Mr. Flemer has submitted a full report of his survey, accompanied by a sketch showing the course of the river, the distances between the several camps and "ripps," and the heights in feet of the water levels at seventy-three different stations between McPhail's Rolling Tier, where the work was begun, and Ryan's Ripps.

He observes that the topography of the section of the river referred to in his report is rolling; in some places hilly and well wooded. From McPhail's Rolling Tier to Duck Point are numerous bowlders. These, when of large size and sufficiently close together, cause the "ripps" or rapids, which are the main obstacle to boating on the river, and prevent its possible use as a public waterway. Other ripps are caused by ledges, of a calcareous nature, stretching across the river; Rocky, Canoose, Dog Island, Pike Island, and Kindric Ripps, with others that might be named, are due to such ledges, which are not unfrequently traceable on the land. The large bowlders which form serious obstructions to the "drives" of logs down stream are almost every year reduced in size by blasting with dynamite, this work being carried on under the auspices of the corporation of lumber merchants who own the forests along the river's course, and also the sawmills below Baring Boom. The logs which are cut during the winter months, after the driving season is over, are hauled to the nearest water courses and piled up into "rolling tiers" for convenience of measurement and marking. During the driving season, which lasts from April or May to June or July, all of the rolling tiers are rolled into the river and floated down stream to Baring Boom, where they are assorted according to the marks of ownership and thence conveyed to the mills at Milltown near Calais and St. Stephens.

On the American side of the St. Croix River valley the only roads are the bark and logging roads of the lumbermen, but they are not passable, except in winter when heavy snows prevail, as stumps, bowlders, and water courses without bridges prevent their being used in summer.

The traverse (scale 1-40 000) follows, as far as practicable, a trail, certain stretches of which are used as paths by the station men of the river-drivers' camps during the driving season, and by utilizing these trails, the cutting of lines of sight was reduced to a minimum. There are, however, certain sections of wooded country near the river which had neither trails nor wood roads, and then cutting became imperative.

All distances between the stations of the traverse line were read twice by the aid of the telemeter, and the orientation was carefully guarded against errors, although some unavoidably short lines (15 metres) may affect the final closing error.

The series of plane table stations on the topographical sheets (scale 1-10 000) forms a secondary traverse line, all distances between stations having been carefully read and frequently checked by resecting and double readings.

The hydrography has value only as far as it served to locate the thread of the river (International Boundary), the water level having been irregular owing to the outflow from the Spednic Lakes above Vanceboro, which is regulated according to the needs of the driving season. Efforts were made however to fix the level of the water at the date of the soundings by referring it to the plane of reference of the contours, and by means of the inscribed soundings and the interpolated value of the water level deduced from the two nearest water level determinations, the elevation of the river bottom above high tide at St. Andrews can be obtained.

From McPhail's Rolling Tier to Ryan's Ripps (about 32 miles by water) the river has a fall of 202.7 feet, or about 6.3 feet per mile, disregarding the intervening falls and ripps.

The Little Falls have a drop of	5.1 feet.
The Spednic Falls have a drop of	13 feet.
The Grand Falls upper pitch have a drop of	13.1 feet.
The Grand Falls lower pitch have a drop of	12.8 feet.

Only a few scattering soundings were plotted in addition to those taken along the thread of the stream, since the holding of the sounding boat in the current was a difficult matter, requiring both strength and skill on the part of the boatman. Nor was it deemed advisable to attempt a regular hydrographic survey, since this part of the river cannot be navigated in its present condition, and the blasting of rocks in its bed which is carried on almost every autumn causes numberless changes in its hydrographic characteristics.

Mr. Flemer refers to the hardship and exposure which were incidental to work in an almost unsettled country, and commends the industry, promptness, and great interest in the advancement of the survey manifested by his acting aids, Messrs. S. P. Bradley and W. B. Paca.

Since the close of field operations he has completed the inking and lettering of the four plane table sheets, scale 1-10 000. Upon these sheets the hydrographic data have been plotted.

The statistics are:

Topography and hydrography:

Area surveyed in square statute miles	9
Miles of shore line surveyed	66
Number of miles of sounding lines run.....	23
Whole number of soundings	462

Later in the year Mr. Flemer took up and completed the remaining portion of the topographical survey of the District of Columbia which had been assigned to him, and towards the end of May, 1891, he was directed to organize a party for the topographical survey of the Schoodic Lakes. Mention of the beginning of this work has been made under the heading immediately preceding.

Completion of the hydrographic survey of Eastport Harbor, Maine.—In addition to making certain verifications of hydrography for the use of the Coast Pilot, Lieut. Commander S. M. Ackley, U. S. N., Assistant Coast Survey, commanding the steamer *Endeavor*, was instructed to complete a part of the hydrographic survey of the harbor of Eastport, Maine, which had been omitted in former seasons. This unfinished portion extended to the westward of a line from Estes Head to Treat Island and south of a line from Shackford Head to Seward's Neck, including Broad Cove, the best anchorage near the city of Eastport, and covering an area of a little over two square miles.

Upon the arrival of the party on board the *Endeavor* at Eastport, July 22, 1890, the erection and location of signals was begun, and followed immediately by the work of sounding which was carried on until finished, August 1.

One series of sounding lines was run normal to the shore, as nearly as its irregular outline would permit; this series was crossed by another set of lines so as to leave as little area uncovered as possible. For depths over 10 fathoms the distance between the lines is about 200 metres, and for less depths 100 metres, except where ledges or shoals are found; the lines were then run much closer to develop carefully their contour.

The shore line is rocky; the depth of water variable, and the tidal currents are very strong. Advantage had to be taken of slack water to enable the whale boat to make satisfactory progress.

Two prominent dangers near the track of navigation were discovered and located; one, an unnamed pinnacle rock with but 1 foot of water over it at mean low water and showing bare at extreme low tides. This rock lies to the northward of Treat Island, its position being half a mile S. $\frac{1}{2}$ W. from Estes Head, and quarter of a mile E. by N. from the west end of Burial Island. The attention of navigators was called to this rock in Notice to Mariners No. 132, published September 30, 1890.

The other danger was an 8½-foot ledge about 350 metres (1 148 feet) from the shore of Seward's Neck, and 490 metres (1 608 feet) to the southward of first hydrographic station. Residents in this locality state that this ledge, known locally as Comstock Ledge, was formerly marked by a buoy. Lieut. Commander Ackley recommends that both this ledge and the pinnacle rock should be buoyed.

Following are the statistics of the survey:

Hydrography:

Number of miles run in sounding.....	45
Number of angles measured.....	921
Number of soundings.....	2 239

Hydrographic verifications and examinations made by Lieut. Commander Ackley on the New England coast and to the southward during his cruise in the *Endeavor* are duly noticed in this report.

Magnetic Observations at stations in the New England and Middle States.—The magnetic tour planned for Assistant Jas. B. Baylor during the summer and autumn of 1890 involved the occupation of a number of stations at which the magnetic elements had been determined in previous years, the object being to obtain additional data for the discussion of the secular variations of the magnetic declination, dip and intensity. These stations were as follows:

At Bangor, Maine, August 19, 20, and 21, 1890, Mr. Baylor re-occupied his station of 1879 on Thomas's Hill, determining time and azimuth on the first day, and the magnetic elements on the two last days.

At Kittery Point, Maine, the station occupied in 1863, and again occupied by Mr. Baylor in 1879 was re-occupied. Azimuth and time were determined August 26 and 28, and the magnetic elements on the 28 and 29.

At Provincetown, Mass., a station was selected as near as possible to the point occupied by Assistant Schott in 1860. Azimuth, time and the magnetic elements were determined on September 1, 2 and 3.

A station was occupied at Boston, Mass., on the Common near the north meridian stone, and the magnetic elements determined September 8 and 9.

At Factory Village, near Chesterfield, New Hampshire, the Bache Fund station of 1874, occupied by Dr. T. C. Hilgard, was re-occupied, and the magnetic elements determined September 14 to 18.

At Hanover, New Hampshire, between September 20 and 23, Mr. Baylor re-occupied his station of 1879, three-fourths of a mile west of Observatory Hill.

At Burlington, Vermont, a station was selected as near as practicable to the station east of the south end of the campus of the State University which had been occupied by Dr. T. C. Hilgard in 1873. The magnetic elements were determined September 25 to 27.

The stations which had been occupied in 1859, 1873, and 1879 at Rutland, Vermont, having been built upon, a station was selected in the City Park, about one square east of Assistant Schott's station of 1859, and the magnetic elements were determined between September 30 and October 2.

At Albany, N. Y., a point in the grounds of the Dudley Observatory was occupied, fifteen feet west of the station of 1879, which could not again be used on account of local obstructions. Observations were made here between October 7 and 9.

At Hartford, Conn., Mr. Baylor re-occupied his station of 1879 in the Capitol Park, observing on October 12, 13 and 14.

A station at Sandy Hook, N. J., was occupied as near as possible to the station of 1879, the point having to be shifted slightly so as to be well removed from all telegraph wires, etc. Observations were made October 18 to 20.

A new station had to be selected at Ithaca, New York, the one occupied by Dr. Hilgard in 1847 not being available. The point occupied by Mr. Baylor was in the grounds of Cornell University; the magnetic elements were determined by observations made between October 25 and 28.

The last station occupied by Mr. Baylor for the season was at Girard College, Philadelphia, in the large open space near the southern and western wall, this being the only space now available for magnetic observations. This point was occupied between October 31 and November 3.

Mr. Baylor then proceeded to his home under instructions to complete the computations of his work of this and previous seasons. In this duty he was engaged until the middle of April, 1891, when instructions to resume field service having reached him he proceeded to Washington, D. C., and thence to North and South Carolina. Reference to the stations in these States at which the magnetic elements were determined will be found under a subsequent heading.

Examinations on the coast of Maine with reference to Changes in the River Beds.—During the summer of 1890, Lieut. Commander S. M. Ackley, U. S. N., Assistant Coast Survey, commanding the steamer *Endeavor*, made some examinations on the coast of Maine which led him to call the attention of the Superintendent to the changes which are constantly going on in the river beds of that locality; changes which not unfrequently affect materially the correctness of the charts and sailing directions published by the Survey. These changes are due, not to natural deposits brought down by the streams, these deposits being very slight except during freshets, but chiefly to the large quantities of sawdust, bark and other mill refuse thrown into the rivers near their head waters by the owners of the saw-mills. This material soon becomes saturated and sinks to the bottom, and as this goes on mostly at a time when the river current is not strong enough to carry it into deep water, shoals are formed that soon become a serious obstruction to navigation.

Lieut. Commander Ackley observes that while some of this deposit is carried away during freshets when the scour is sufficient also to deepen the water in which deposits have taken place during a previous stage of low water, yet by far the larger portion is so mixed with sand and mud that it remains until removed artificially, the General Government being called upon to free the channel ways from the obstructions thus created.

This is markedly the case in the St. Croix, Machias, Narraguagus, Union, and Penobscot rivers. The argument that this fault will correct itself because the supply of timber is being rapidly exhausted is fallacious, for while it is true that there has been a marked diminution in the supply of the largest class of timber from which the heavier lumber is cut, there is still a large quantity for the shingle and lath mills, and these are the ones that make the greatest percentage of sawdust.

With regard to the St. Croix River, Lieut. Commander Ackley remarks that the combined action that would be required on the part of the United States and the Dominion Government to prevent accumulations of sawdust in the river has not yet been taken, the result being that some parts of it are almost closed by these deposits. He found that the depths of water between Oak Point and the Ledge had materially decreased since the survey made three years ago by Lieut. Crosby.

The navigation of Union River to the town of Ellsworth, Hancock county, Me., was improved between 1869 and 1872 by the removal of about 80 000 cubic yards of mill refuse from its bed, an appropriation for this purpose having been made by the United States. This opened a channel about 160 feet wide with a least depth of from 3 to 5 feet at low water and from 13 to 15 feet at high water, and together with the removal of a number of bowlders and ledges, proved of great benefit to navigation. Nevertheless the practice of throwing in sawdust and refuse lumber has been continued, so that the channel had lost both in width and depth at the time of the survey made in 1879.

Between Bucksport and Winterport, the Penobscot River had naturally a wider channel than at almost any other point, but it has become gradually contracted by the deposit of sawdust and other material on Frankfort Flats, so that there is now much less water and a narrower channel than that given by the surveys used as a basis for the charts.

Lieut. Commander Ackley cites these cases as examples of what is going on in the rivers referred to in his report, and urges the need of national legislation to prevent practices so injurious to the interests of commerce and navigation.

Hydrographic examinations for the Coast Pilot, and special inquiries and examinations relative to hydrography on the coast of the New England States and off Rye Beach, New York.—Having organized a hydrographic party on board the steamer *Endeavor* in pursuance of instructions received in

June, 1890, Lieut. Commander S. M. Ackley, U. S. N., Assistant Coast Survey, left Washington towards the end of that month for the locality of the hydrographic examinations assigned to him to be made for the use of the Coast Pilot between Eastport, Me., and Cape Ann, Mass.

On June 27, at New Haven, he made inquiries in reference to the grounding of the schooner *Robert Morgan* off the harbor, and after some needed repairs to the *Endeavor* had been completed at New Bedford, he proceeded on July 17 to Wood's Holl, and there took up inquiries and observations relating to the currents setting through that passage.

On July 18, he sailed for the Gulf of Maine, and on the 21st and 22d, he ran all the off shore lines required for the use of the Coast Pilot between Eastport and Portland. The hydrographic work executed in Eastport Harbor and vicinity has been referred to under a previous heading. Coast Pilot examinations were prosecuted, with occasional interruptions from bad weather, from August 2 till September 8, at which date, at Portsmouth, N. H., these examinations were finished.

In a number of localities which had been from time to time reported to the Office as needing examination, Lieut. Commander Ackley made personal inquiry and investigation, or executed such hydrography as the circumstances of each case seemed to require. These he has enumerated in a special report as follows:

August 7, determined position of rocks in Mistake Harbor, Me.; August 10 and 11, executed hydrography in Frenchman's Bay; August 19, determined position of Light-house on Great Duck Island; August 20, made examination for reported rock off north side of Greening's Island, near South West Harbor; August 25, determined position of rock off Birch Island in Fox Island Thoroughfare; August 26, made examination for reported rocks in Fisherman's Island Passage; September 3, took soundings off the west side of Long Island near Portland, Me., to develop a reported ledge; September 11, examined ledges in Hingham Bay, Boston Harbor, and September 16, took soundings on rocks reported off Rye Beach, N. Y.

In all cases in which the result of the examination involved a chart correction, detailed reports were sent to the Office as soon as practicable. The examination in Hingham Bay showed that a hydrographic resurvey in that locality would be very desirable.

On September 1, Ensign E. A. Anderson, having received orders preparatory for sea service, left the party on leave of absence. On September 26, Lieut. Commander Ackley was detached from the *Endeavor* and turned her over to Lieut. A. L. Hall, U. S. N., at the Navy Yard, Washington, D. C. He then resumed the charge of the Coast Pilot Division, and continued therein until March 18, 1891, when he was instructed to report for duty as Hydrographic Inspector, relieving Commander Charles M. Thomas, U. S. N.

Topographic and hydrographic survey of the Kennebec River, Maine, from Gardiner to Augusta.—The survey of the Kennebec River, Maine, from Gardiner to Augusta, having been assigned to Assistant Stehman Forney, he arrived at Gardiner August 13, organized his party and chartered a steam launch. After completing the shore line survey, which involved the determination in position of ice houses, wharves, log booms, boom piers, and other topographical details, up to the dam above Augusta, he took up the hydrography at Gardiner, and carried it to the road bridge at Augusta, which is the head of tide water navigation on the Kennebec.

The main ship channel from Gardiner to Augusta, Mr. Forney observes, is narrow and crooked; at high water 10 feet can be carried up it with a mean rise and fall of $4\frac{1}{2}$ feet. The old bridge piers at Hallowell form a dangerous obstruction to navigation, and their removal is recommended. Off Oil Cloth Point, on the west side of the river where the channel is narrow, there is a sunken rock that is dangerous to navigation.

From the road bridge at Augusta to the dam the river was found to be shallow and filled with rocks and flats. There was not water enough to use the launch in sounding, and the current being too strong for such row boats as could be obtained on the upper Kennebec, no soundings were taken above the road bridge.

The current from Augusta to Gardiner is very swift, running about 4 miles an hour. Both currents and tides are greatly affected by the winds, northerly winds making strong ebb currents and very low tides, and southerly winds strong flood currents and very high water.

Tide gauges were established at Gardiner, Hallowell and Augusta; at Hallowell the tidal observations were kept up for two months, and at the other two stations during the times of sounding in the vicinity of the gauges. The zeros of the staff gauges were referred by leveling to bench marks. At Hallowell the zero of staff was connected by a line of levels with the bench mark established there by the U. S. Engineers.

Mr. Forney reports that the navigation of the Kennebec between Gardiner and Augusta is very much interfered with by the log booms and piers of the logging men, the entire river from Augusta to Hallowell being filled with logs between July 1 and November 15. He thinks that if the logs were assorted above the dam and run with booms constructed above the road bridge, rafts could then be made up and floated down the river without interfering with navigation. There are large shipping interests on the Kennebec; from May to October 30, 1890, eleven hundred and fourteen vessels, none of them less than 500 tons capacity, passed through the drawbridge at Gardiner, and upwards of 500 000 tons of ice alone were shipped from the ice-houses and stacks north of Gardiner bridge.

To complete the survey there remains to be delineated the topography of the country immediately back from the shores of the river, the character of which is broken and the contouring intricate. Field operations were closed October 31.

The statistics are:

Topography, scale 1-10 000:	
Length of shore line in statute miles	19
Hydrography, scale 1-10 000:	
Area sounded in square geographical miles	6
Number of miles (geographical) run while sounding	44
Number of angles measured	640
Number of soundings	5 080

In November, Mr. Forney was assigned to duty involving a reconnaissance for primary triangulation along the boundary line between the United States and Mexico in the State of Texas.

Continuation of the work of determining town boundaries in the State of Massachusetts.—Re-surveys of Marthas Vineyard.—Service as a member of the Mississippi River Commission.—Under the general direction of Assistant Henry L. Whiting, as one of the Commissioners of the Topographical Survey of the State of Massachusetts, Assistant C. H. Van Orden, in pursuance of instructions issued in May, 1890, was in the field at the beginning of the fiscal year, having organized a double party, May 20, for continuing the work of marking the town boundaries of the State. This was done by connecting the monuments of the signals fixing the position of the town corners with the stations of the triangulation of the Coast and Geodetic Survey, for the most part, or with such points of the Borden triangulation as could be identified.

On July 1, 1890, the headquarters of the two field parties were at Taunton, Bristol County, and at Middleboro, Plymouth County, a foreman being in immediate charge of each.

The work was executed in the same manner as has been described in previous reports, the chief improvement being in the character of the instruments used, one of which belonged to the Survey, two to the State, and one to the Massachusetts Institute of Technology. The Coast Survey theodolite was an eight inch repeating instrument, of fine design and construction, made in the Office of the Survey. It gave excellent results. The smaller theodolites, 7 and 4 inch, were made by Buff & Berger, of Boston, and were very satisfactory, giving results but little inferior to the 8-inch by increasing the number of repetitions.

Early in September the parties were moved from the southeastern to the eastern and northeastern portions of the State, one party being established in headquarters at Waltham, Middlesex County, and the other at Georgetown, Essex County. From these localities the work was pushed forward until October 30, soon after which field operations were closed for the season, with the exception of the determination early in November of a new corner in the town of Whitman, Plymouth County.

Upon the completion of the field work, Mr. Van Orden transferred his parties to the office of the Commissioners of the Topographical Survey in Boston, and took up the duplication of the records and computations of the results. Two independent sets of computations were made, and where differences occurred they were examined by recomputation. This office work was finished by the middle of April, 1891, 350 triangle sides having been computed, 51 eccentric stations reduced to the center, and 257 latitude longitude and azimuth computations made.

Mr. Van Orden then began preparations for resuming field work, and on May 3 had both of his parties in the field with the same headquarters as at the close of the preceding season.

Up to June 30, 1891, the town boundaries, the marking of which was finished, were those of Attleboro, Norton, Taunton, Raynham, Rehoboth, Dighton, Seekonk, Swansea, Berkley, Carver, Lakeville, Freetown, Brockton, Middleboro, Watertown, Belmont, Arlington, Groveland, and Georgetown, and those partly marked were Waltham, Lexington, Weston, Winchester, Cambridge, Bradford, Boxford, Avon, and Stoughton.

Mr. Van Orden acknowledges the untiring industry and interest in the work shown by his foreman, Mr. J. B. Tolley, who has been connected with it from the beginning. To Assistant Whiting he expresses his thanks for unfailing kindness and approval of his suggestions.

The statistics for the fiscal year are:

Triangulation:

Area of, in square statute miles	80
Signal poles erected, number of	185
Number of stations occupied for horizontal measures	189
Number of geographical positions determined	397

In June 1891, Mr. Whiting took up, under instructions, two re-surveys on Marthas Vineyard. The first of these, executed between June 5 and 12, was undertaken in continuation of the study of the changes on the south shore of the island with special reference to the condition of the openings or inlets of Edgartown Harbor through Katama Beach. Since his re-survey of June 1889, the results of which are published in Appendix No. 14 to the report for that year, he found that a decided waste or reduction from the mass of material above high water mark had taken place, so that what remains of the beach is of less value than at that time as a barrier and breakwater between the ocean and the harbor.

The re-survey of 1891 shows that the beach had broken up into three openings, and at high tide it was observed that heavy rollers broke over the entire line of beach between the east and middle openings and also along other portions.

Mr. Whiting furnishes the following measurements, taken by him from the several surveys:

	Feet wide.
1846, one opening at the southeast corner of bay	1 800
1856, two openings, one near middle and one at southeast corner, total width	1 650
1870, beach closed	
1886, one opening near middle of bay	1 200
1887, one opening working eastward	1 650
1889, one opening working eastward	2 000
1891, three openings working eastward between middle and southeast corner of the bay, total width	1 700

Remarking upon the importance of this beach in maintaining the quality of the waters within its shelter as a harbor of refuge, Mr. Whiting observes that new beaches may be thrown up by ocean forces in the alignment of the present or former ones, but the topographical indications seem to point to the filling up of Mattakessett Bay and the southern part of Katama Bay, and that the outside sands are being driven into these former water spaces.

The re-survey of West Chop, Marthas Vineyard, executed by Mr. Whiting between June 15 and 26, was undertaken in order to mark upon the plane table sheet of that locality finished

in 1887, the details of improvements that would affect the charts. Chief in importance among these is the wharf which has been built upon the Sound side of the Chop, not far from its northeasterly point. This is a substantial structure, and although seemingly in an exposed position is really not so, as the shoal known as the Middle Ground forms a shelter from heavy seas and renders the wharf a good landing place. At the time of the re-survey the building of a jetty by the U. S. Engineers was in progress on the northeast face of the Chop, near the Light-house. The effect of this structure in arresting the erosion of the point, Mr. Whiting regards as doubtful from his observation of the action of similar solid structures on sandy shores. As compared with Mr. Vinal's survey of 1887, his survey indicated a waste of the shore and bluffs of from ten to fifteen feet.

During the fiscal year Mr. Whiting continued to serve as a member of the Mississippi River Commission.

Physical hydrography.—Coast of the Island of Nantucket from Great Point to Siasconset, and thence to the Surf-side Hotel.—Reference was made in the last Annual Report to the arrangements begun at the end of June, 1890, by Assistant Henry L. Marindin, for the transfer of his party, engaged in a physical survey of the coast of Massachusetts, from Provincetown to the island of Nantucket.

These arrangements were completed on July 3, the party and its equipment reaching Nantucket Harbor in a light draught schooner on July 6, and the physical survey being begun at Great Point July 10. This survey involved the establishment of a self-registering tide-gauge with siphon attachment* at the "Haulover," nearly midway between Great Point and Siasconset; the running of a transit line along the beach to locate the points from which the measurements of the cross-sections were to be made, and the location, measurement, and sounding out of the one hundred and ten cross-sections established between Great Point and Siasconset. By means of these stations, each of which averaged 500 linear feet of shore line, a determination was obtained of the character of the bluff and beach, and of the submerged shore as far as a depth of 36 feet.

There were but occasional breaks in the tidal record, and these were due to the exposed nature of the coast. A current station was undertaken about half a mile off shore opposite the camp ground, but could not be carried satisfactorily to completion, owing to the difficulty of landing with a boat in the heavy surf.

By the middle of September the field work had been completed from Great Point to Siasconset, a distance of eleven miles; all of the cross-sections had been connected by two lines of spirit leveling, and bench-marks had been established on Great Point Light-house and at Squam Head. The top of the siphon pipe of the automatic tide-gauge had been referred also to the bench-mark established by Assistant Henry Mitchell, at Siasconset in 1855.

At this stage of the work it was deemed advisable to move the party from the camp near the "Haulover," and put up a second camp at Forked Ponds, twelve miles distant on the south shore of the island. The self-registering siphon gauge was also moved to a location near Humane House No. 54, about midway between the limits of the work yet remaining. Here the tides were observed from September 25 to October 8, occasional interruptions in the record being due to the breaking of the connection with the anchor sieve by storm waves. This gauge was connected with the Siasconset bench-mark of 1855, and was referred also to another bench-mark established on the foundation of Humane House No. 54.

Between Siasconset and the Surf-side Hotel, a distance of seven and a half miles, eighty cross sections were measured, leveled, and sounded out to a depth of 36 feet. This fringe of hydrography from Great Point around the elbow at Siasconset, and as far as the Surf-side Hotel, will serve as a basis for connecting with the hydrographic re-surveys of Nantucket shoals and vicinity by the parties on the Coast Survey steamers *Bache* and *Daisy*, and will relieve these parties from the necessity of executing the hydrography close inshore, which always consumes much time.

* Described and illustrated by Mr. Marindin in Bulletin No. 12, U. S. Coast and Geodetic Survey.

The results of the work accomplished during the season, which closed October 23, are shown on two double hydrographic sheets on a scale of 1-10 000. No. 1, from Great Point to Sankaty Head; No. 2, from Sankaty Head to Weweeder.

Mr. Marindin has accompanied his report by a progress sketch showing the location of the cross-sections and the lines of levels run to connect these with the bench-marks and tide-gauges. He acknowledges the faithful and efficient service rendered by Mr. Homer P. Ritter, expert observer, by Mr. F. A. Young, aid, and by Messrs. M. Victor Safford and Chas. E. Mendenhall, recorders.

During the winter and part of the spring of 1890-1891, Mr. Marindin was engaged in office duty, and with the aid of Mr. Ritter, prepared for publication a report on the changes in the shoreline and anchorage areas of Cape Cod (or Provincetown) Harbor, as shown by a comparison of surveys made between 1835, 1867, and 1890. This report was submitted March 28, 1891, and will appear in full in Appendix No. 8 Part II. An abstract of it was compiled and published in June, 1891, as Bulletin No. 24. Another report, bearing date of April 20, completed the examination of the cross-sections of the shores of Cape Cod, and affords valuable data for the study of the changes on the coast. [See Appendix No. 9, Part II].

Early in April, Mr. Marindin was instructed to re-organize his party for the resumption of the physical survey of the south shore of Nantucket from the limits which had been reached during the preceding season, and upon reaching Nantucket May 18, preparations were at once begun for pitching camp at Weweeder, and for putting into operation the siphon tide-gauge.

Some reconnaissance was also made preliminary to the active prosecution of field work.

Before the end of June, an examination of the hydrography of Miacomet Rip had been finished, together with the survey by cross-sections of the shores as far as Surf-side, thus connecting with the work of the previous season.

Mr. Marindin observes that in advance of a thorough comparison there are indications of a steady encroachment of the sea upon the south shore of the island, this shore being subjected to the effects of heavy gales from the southward, the most severe gales occurring during the winter, but as the prevailing winds in summer are also southerly there is but little intermission in the wear and tear of the line of coast. At Surf-side, and for some distance to the east and west, the bluffs were washed into the sea during the preceding winter, and it became necessary to remove farther inland some long stretches of the railway track, part of which indeed had been a total loss.

All of the work which could be done to advantage from the Camp at Weweeder having been finished by the end of June, 1891, the party moved into camp at Great Neck Madequet at the west end of the island. From this camp, field operations were in active progress at the close of the fiscal year.

For the season of 1890, and for that of 1891 to June 30, Mr. Marindin reports the following statistics.

Physical Hydrography.

Number of points determined by the plane table to locate sections.....	58
Number of miles of transit lines measured.....	19
Number of cross sections laid out and measured.....	205
Number of plane table determinations of section marks.....	284
Number of miles of shore-line run, including bluff line.....	20
Number of miles run of spirit leveling.....	51
Number of miles of roads and railroads traced with plane table.....	8
Number of miles of cross-sections sounded out.....	165
Number of cross-sections sounded.....	188
Number of soundings on cross-sections.....	11 319
Number of angles taken while sounding.....	4 206
Number of permanent bench-marks established.....	3

Hydrographic re-survey of Nantucket Shoals.—For the important and difficult work of the re-survey of the shoals to the southward and eastward of the island of Nantucket, a double hydrographic party was organized in the summer of 1890, and placed in charge of Lieut. Edward M. Hughes, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Bache*. The hydrographic party of Lieut. W. P. Elliott, U. S. N., Assistant Coast and Geodetic Survey, commanding the schooner *Eagre*, with the steamer *Daisy* and three steam launches joined the party of Lieut. Hughes at Nantucket August 3. The schooner *Scoresby* was towed from New York by the *Daisy*.

It was a subject of regret at the outset that so much of the most favorable weather of the season had been lost by the necessity of waiting for the passage of the appropriation bill. The erection and occupation of signals and the establishment of tide-gauges was begun without delay, and soundings were first obtained on August 8. Field work was actively prosecuted from that date until October 22, when it was closed in consequence of the severe storms which had prevailed during the month, the *Bache* having been disabled by the loss of her tiller, etc., and the *Eagre* by the carrying away of her foremast.

Lieut. Hughes has submitted a very full report of the progress of the work, to complete which two more seasons will probably be required.

The position and environment of Nantucket Shoals render the prosecution of a satisfactory hydrographic survey quite difficult. The area to be covered is great, extending far beyond the limit of visibility of the highest objects on shore; the rise and fall of the tides at a given time is unequal in different sections off the coast; the currents are strong and uncertain in direction; fogs and haze prevail during much of the summer, and storms in the autumn, and there is in the vicinity no safe harbor for vessels drawing more than eight or nine feet of water.

The report submitted by Lieut. Hughes shows that every effort was made by himself and the officers and men of his command to carry out plans of work so arranged as to obtain the most satisfactory results practicable. To the steam launches was assigned that portion of the work just to the eastward of Nantucket Island, extending off-shore as far as signals could be seen. Over this area, lines were run north and south at a distance apart of one quarter of a mile; these were crossed by lines run east and west at the same distance apart, and over the prolongation of Bass Rip the lines were multiplied, being but an eighth of a mile apart. In addition to this system executed by the launches, about eighteen lines were run by the *Bache* in general directions N NW. and S SE. In the view of the fact that the launches, making Nantucket their headquarters, had to steam eighteen miles to and from their working ground, the number of miles of soundings run by them is very creditable.

Directly to the eastward of the area assigned to the launches, the work was extended by the steamer *Daisy*. To the charge of the party on the *Daisy*, Lieut. L. K. Reynolds, U. S. N., was assigned. Lines were run north and south between the meridians of $69^{\circ} 50'$ and $69^{\circ} 46'$ west; also a few lines east and west to the south of the area covered by the launches, and to the eastward of Bass Rip.

All of the hydrography to the southward of the parallel of $41^{\circ} 15'$ north latitude was executed by the party on the steamer *Bache*. Over three-quarters of this work consisted in the development of the characteristics of the bottom within sight of signals on shore, but it also included 223 miles of off-shore soundings from Nantucket to the vicinity of the $4\frac{1}{2}$ fathom shoal to the southward and westward of Davis South Shoal Light Vessel. The inshore work, extending from that done in the *Bache* by Lieut. Moser in 1889 to Bass Rip, and as far south as parallel $41^{\circ} 09'$ north latitude, is fully completed with the exception of one day's ship-work directly south of Miacomet Rip.

The lines of soundings of both the *Blake* and the steam launches were carried to within an eighth of a mile of the beach, the space beyond this limit having been fully covered by the boat work of the party of physical hydrography located on the eastern and southern shores of Nantucket in charge of Assistant H. L. Marindin, Coast and Geodetic Survey. In the tidal observations also, Lieut. Hughes acknowledges valuable aid rendered by Mr. Marindin in

furnishing him with the readings of his automatic tide-gauge at the "Haulover," where it was first established, and at its second location, Forked Pond. These determinations of times and heights of the tide were supplemented by those of the box gauges put up by Lieut. Hughes at Great Point and near Tom Nevers Head.

For the reductions of soundings, the complicated nature of the tides, supposed to be due to the meeting of the tidal systems of the Gulf of Maine and of the Atlantic near the meridian of 70° west longitude, made it necessary to devise sub-divisions of the tidal areas so arranged that the corrections required to obtain a common plane of reference for the soundings could be more readily deduced and applied.

Wherever it was practicable to use Light-houses, church steeples and prominent objects along shore as signals they were made available for this purpose, and but four large tripod signals were erected. But for off-shore lines floating signals were necessary, and Lieut. Hughes obtained these by anchoring the two schooners, *Eagre* and *Scoresby*, on the shoals nearly on a line from Sankaty Head to Davis South Shoal, while at the same time the steamers *Bache* and *Daisy* took positions to the westward so located as to outline a system of well conditioned triangles, extending to Davis South Shoal Light-Vessel. Observers occupied, simultaneously, triangulation points on shore, and on the *Bache* and *Daisy*, and the positions of the *Eagre*, *Scoresby*, and the Light-vessel were accurately determined.

The results obtained from the use of these floating signals, while not entirely satisfactory, were much more trustworthy than any that would have depended upon a vessel's course and run in such strong and varying currents. As a result of his experience, Lieut. Hughes recommends for long-distance floating signals the use of fairly staunch vessels equipped with moorings nearly as heavy as those of Light-vessels in order that an extremely short scope of cable may be given, and then there will be a reasonable certainty that each vessel will not drag. A swivel should also be fitted to each cable to prevent its kinking and possibly starting the anchor. For the smaller floating signals, he recommends that authority should be obtained for the loan by the Light-House Board of twelve first class buoys, which should be accompanied by their moorings, these to be of the heaviest character and shortest possible scope consistent with their being planted in 10 fathoms of water and insured against dragging. Six of these should be can buoys, and six should be the longest spar buoys, and they should be placed in position during the month of May in order that actual sounding can begin not later than June 1.

The officers serving on the *Bache* were Lieut. W. L. Burdick, U. S. N.; and Ensigns J. F. Luby and L. C. Bertolette, U. S. N. Lieut. Burdick had charge of the tidal reductions; Ensign Luby acted as draughtsman, and Ensign Bertolette had charge of the progress sheet. Messrs. J. L. Dunn and T. S. Martin served as recorders, the former acting as observer throughout the season, while the latter kept the records up to date.

The following named officers served with the party on the schooner *Eagre* and steamer *Daisy*: Lieut. L. K. Reynolds, U. S. N.; Ensigns J. H. Rohrbacker, W. W. Buchanan, E. H. Durell, and F. H. Brown, U. S. N.; Messrs. A. R. Hasson and W. S. Crosby served as Pay Yeomen, and Wm. B. Proctor as Ship's writer.

Early in October, Lieut. Elliott was detached from the party in command of Lieut. Hughes, and with the *Eagre* and two steam launches proceeded to Monomoy under instructions to execute certain additional hydrography required on Handkerchief Shoal. Reference to this work is made under the next heading.

The statistics of the work, for the season of the combined party engaged in the re-survey of Nantucket Shoals are as follows:

Hydrography:

Area sounded in square geographical miles.....	261
Number of miles (geographical) run while sounding.....	2 002
Number of angles measured.....	11 558
Number of soundings.....	54 913

The results of this re-survey are shown on one hydrographic sheet, scale 1-40 000.

A hydrographic re-survey of Aransas Pass, Texas, executed by Lieut. Hughes during the winter of 1890-1891 is referred to under a subsequent heading in this Report. Also other hydrographic work on the coast of Louisiana between Barataria Bay and Last Island.

Upon returning to New York, after the completion of his southern work in the spring of 1891, Lieut. Hughes was instructed to prepare the *Bache* for resuming the hydrographic survey Nantucket Shoals, and he had reached the working ground a short time before the end of the fiscal year.

Additional soundings and revision of hydrography on Handkerchief Shoal and its vicinity.—Advantage was taken of the presence of Lieut. W. P. Elliott, U. S. N., with the party under command of Lieut. E. M. Hughes, engaged in a re-survey of Nantucket Shoals, to issue instructions directing the first-named officer to make some additional soundings over the area surveyed by him in 1889 on Handkerchief Shoals and in the vicinity, and also to investigate the sources of certain disagreements in the plotted soundings.

The party of Lieut. Elliott on board the schooner *Eagre* and with the steam launches Nos. 23 and 25, left Nantucket and proceeded to an anchorage off the west end of Monomoy Point on October 3. On that afternoon a tide-gauge was set up, observations were begun, and a line of levels run to refer the zero of gauge to an established bench-mark. The weather now became squally and rainy and it was found necessary to shift the anchorage to Chatham Roads. A water signal was established by pumping down on Handkerchief Shoals, and a similar attempt made on the Stone Horse, but the bottom was found to be too hard, and a spar signal was finally anchored there. Hydrographic work was done whenever practicable, the launches being away from the ship on all occasions that the weather would permit, but the entire month up to the 21st was almost constantly stormy, and on that date instructions were received to suspend field operations for the season and proceed to New York.

The officers attached to the *Eagre* were Lieut. L. K. Reynolds, U. S. N., and Ensigns J. H. Rohrbacker, W. W. Buchanan, E. H. Durell, and F. H. Brown, U. S. N.; Messrs A. R. Hasson and W. S. Crosby served as Pay Yeomen, and Mr. W. B. Proctor as Ship's writer.

Lieut. Elliott reports the following statistics:

Hydrography:

Number of miles run in sounding	106
Number of angles measured	876
Number of soundings	6 485

In June, 1891, Lieut. Elliott, having reorganized his party on board the *Eagre*, left New York under instructions to take up a hydrographic survey of Shelter Island Sound. Reference to this work is again made under a subsequent heading.

Topographical re-surveys and triangulation preparatory thereto on the shores of Buzzards Bay and Nantucket Sound.—For the continuation of the topographical re-survey of the south coast of Massachusetts, Assistant D. B. Wainwright was instructed on July 24, 1890, to take up plane table work from the limits of Assistant Vinal's topography executed during the preceding season in the vicinity of Falmouth and Wood's Holl, and to carry it to the eastward along the north shore of Nantucket Sound. The width of the belt of topography along shore was to be the same as in the original surveys as shown on coast chart No. 112.

Mr. Wainwright took the field August 1, and had made good progress in the area of work of most detail from the vicinity of Falmouth to Waquoit Bay, when it became desirable that he should temporarily suspend this part of the survey, and, for the requirements of a hydrographic party, run the shore line as far as Hyannis Light. His season's work involved therefore the survey of a coast line of 3 miles on Nantucket Sound with such interior work as time would permit.

Owing to the wear of the shores and the consequent loss of most of the old triangulation points, new points had to be determined from such bases as could be made available. By the latter part of September all of the stations needed for the topography had been fixed in geographical position, and the shore-line survey had been finished. The party thereupon returned

to Falmouth, and continued the topography of the interior until November 10, when field operations were suspended.

Mr. Wainwright observed that the points of land standing out farther in the Sound and more exposed to the influence of stormy weather had not suffered as much from erosion as those in more sheltered localities which bordered on swifter tidal currents.

The low shore lines towards Hyannis, varied by occasional bluffs composed of compact sand, have only worn away a few yards during the last forty years.

Mr. W. B. Hindmarsh served as foreman in the party and rendered valuable service by his intelligent interest in the work and his familiarity with plane table methods. Mr. A. J. McAdory, who served as recorder, and Mr. W. T. Oliver, level rodsman, were faithful and efficient.

The statistics of field work are:

Triangulation:

Number of signals erected	5
Number of stations occupied for horizontal measures	6
Number of geographical positions determined	5

Topography:

Area surveyed in square statute miles	16
Length of general coast line in statute miles	23
Length of shore line of ponds in statute miles	5
Length of roads in statute miles	10
Scale of topographical sheets	1-10 000

Later in the fiscal year Mr. Wainwright was instructed to take up and complete the remaining portion of the District of Columbia survey which had been assigned to him.

Upon the completion of this work, reference to which is made under its proper heading he re-organized his party under instructions to resume the topographical survey of the north shore of Nantucket Sound from the limits of his work of the preceding season, and by the middle of June, 1891, had begun the regular mapping of the country,

Further progress will be adverted to in the next annual report.

Establishment of an automatic tide gauge at Bristol, R. I.—In the summer of 1890, Mr. Nathaniel G. Herreshoff, a citizen of Bristol, R. I., interested both scientifically and practically in the tidal phenomena of Narragansett Bay and its tributaries, very generously offered to set up and keep in operation without charge to the Government an automatic tide-gauge at Bristol, provided the Coast and Geodetic Survey would furnish the gauge.

This offer was accepted by the Superintendent, and a gauge with a supply of registry paper having been forwarded to Mr. Herreshoff he put it promptly into operation, the record beginning August 6, 1890. Since that date, and up to the close of the fiscal year, by far the best series of observations has been secured that has yet been obtained between Boston and New York.

Physical hydrography. Observations of temperatures, densities and currents to the south of Marthas Vineyard in co-operation with the work of the U. S. Fish Commission.—Under the heading "Special Operations" towards the close of this part of the Report will be found a notice of the cruise of the steamer *Blake*, Lieut. C. E. Vreeland, U. S. N., Assistant Coast and Geodetic Survey, commanding, to the south of Marthas Vineyard in July and August, 1890, for the purpose of observing temperatures, densities, and currents, in coöperation with the U. S. Fish Commission, represented by Prof. William Libbey, of Princeton College. Prof. Libbey has furnished an abstract of his report of this work which is published as Appendix No. 7 in Part II.

These observations, begun July 9 were completed August 5, whereupon the *Blake* was ordered to New York for extensive repairs required to fit her for the next winter's work in the Gulf Stream. In September these repairs were temporarily suspended to enable the vessel to be put at the service of the Superintendent for comparative tests of the Pillsbury and Haskell current meters in the waters of Long Island Sound.

On her return to New York the repairs were pushed forward by Lieut. Vreeland, and on December 26 the *Blake* was ready for sea.

Reference is made under a subsequent heading to the Gulf Stream explorations carried on during the winter and spring of 1890-1891.

Physical hydrography. Observations of tides and currents, densities and temperatures in Long Island Sound in connection with the work of the U. S. Fish Commission.—The investigations in physical hydrography undertaken jointly in Long Island Sound by the U. S. Fish Commission and by the U. S. Coast and Geodetic Survey in the summer of 1890 were referred to in the last annual report, and are noticed more in detail under the heading "Special Operations" following the abstracts of field reports.

Mr. E. E. Haskell, Expert Observer, was placed in charge of the work on the part of the Coast and Geodetic Survey, and has submitted a preliminary report of the work of the season which closed October 10. By an arrangement made with the Fish Commission, quarters and transportation were furnished to Mr. Haskell on board their steamer, the *Fish Hawk*, Lieut. Robert Platt, U. S. N., commanding.

Following are the statistics of the season:

Physical hydrography:

Miles (geographical) run in sounding.....	11
Number of soundings on cross-sections	334
Number of angles measured.....	333
Number of current stations.....	18
Number of observations of currents.....	2 052
Number of tidal stations (automatic).....	3
Number of observations of density of water.....	510
Number of observations of temperature of water.....	510

In January, 1891, Mr. Haskell reported to Lieut. C. E. Vreeland, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Blake*, under instructions for duty as Hydrographer on board of that vessel.

This service will be referred to later in this report under the heading "Gulf Stream Explorations."

Hydrographic survey of Shelter Island Sound near the eastern end of Long Island, N. Y.—In accordance with instructions from the Superintendent, dated May 19, 1891, supplemented by detailed instructions from the Hydrographic Inspector, Lieut. Wm. P. Elliott, U. S. N., Assistant Coast and Geodetic Survey, commanding the schooner *Eagre*, left New York early in June and on the 4th of that month, after a delay of two days by fog, arrived at Sag Harbor, L. I. On the 6th of June the *Eagre* was joined by steam launch No. 23, and a hydrographic survey of Shelter Island Sound was then taken up.

This work was in active progress at the close of the fiscal year, and will be adverted to in the next annual report.

Ensigns E. T. Witherspoon and C. P. Eaton, U. S. N., were attached to the party of Lieut. Elliott.

The statistics to June 30 are:

Hydrography:

Area of hydrography in square nautical miles.....	10
Number of miles run in sounding.....	195
Number of angles measured	2 648
Number of soundings.....	19 327

Topographical survey of the Connecticut River from Lyme Ferry to Salmon River.—Upon receiving instructions early in August, 1890, to organize a party for the topographical survey of the Connecticut River, Assistant John W. Donn proceeded without delay to make search for the triangulation points needed to determine the shore lines of the lower river from Lyme Ferry to the northward. The well ordered triangulation already in existence, the points of which

which were recovered with comparative ease, greatly facilitated his work, so that all of the shore line required by the hydrographic party of Assistant Vinal, and also the determinations of a large number of hydrographic signals were completed, and at the same time the marginal topography was advanced.

The scheme for the topographic survey of the lower Connecticut was laid out on two plane-table sheets, scale of each 1-10 000, the first including the area between Lyme Ferry and Deep River, and the second, that from Deep River to Salmon River.

As the work of the hydrographic party approached the southern limit of topographic sheet No. 1, Mr. Donn advanced his shore line survey on sheet No. 2 and completed it to Salmon River in ample time for Mr. Vinal's requirements.

The general aspect of the country, Mr. Donn observes, was quite unlike what he had expected to find it. Instead of being a highly cultivated and well inhabited region, it was to a great degree a wilderness. Marshes of large extent covered much of the surface of the lower river, while on the eastern side the roads were almost without exception of the poorest character.

On the lower sheet the marginal topography and shore line were completed, though Mr. Donn recommends that upon the resumption of the survey a widening of the margins at several points will be advisable should time permit. On the upper sheet only the shore line was finished.

For the season beginning August 13, and ending October 24, the statistics are as follows:

Topography:

Area surveyed in square statute miles	16
Length of shore line of river in statute miles.....	67
Length of shore line of creeks in statute miles	10
Length of roads in statute miles.....	21

Towards the end of November, Mr. Donn was instructed to proceed to Staten Island, New York, and make a comparison between the topography executed by the Coast Survey in 1856 and the recent survey by Vermule and Bien, Engineers to the Joint Boundary Commission, New York and New Jersey. Upon the completion of this service, a report of which was made to the Superintendent, he was directed to resume the topographical survey of the District of Columbia. Reference in detail to the completion of this survey will be found under a subsequent heading in this part of the Report.

Topographical survey of the Connecticut River from Middletown, Connecticut to the Salmon River, and from Middletown northward.—The topographical survey of the Connecticut River from Middletown southward to a junction with the survey assigned to Assistant Donn was placed in charge of Assistant W. C. Hodgkins, by instructions dated August 7, 1890.

Immediately after his arrival in Middletown Mr. Hodgkins made a general reconnaissance of the country in the vicinity and a search for the station marks of the triangulation. A sufficient number of these having been recovered, the survey of the shore line and adjacent topography was begun, and by November 7, had been completed to the mouth of Salmon River, joining with the work of Assistant Donn. Field operations were thereupon closed.

Mr. James Page rendered acceptable service in the party as recorder.

The statistics are:

Topography:

Area surveyed in square statute miles	6
Length of shore line of river in statute miles.....	37
Length of shore line of creeks in statute miles	9
Length of roads in statute miles, including railroads.....	36

The two topographic sheets, scale 1-10 000, showing the results of the work have been transmitted to the archives.

Early in June, 1891, Mr. Hodgkins was instructed to resume his topographical work on the Connecticut River from Middletown northward. Having previously dispatched his fore-

man, Mr. W. P. Bullock, to the field with orders to put up the signals needed at the stations of the triangulation and elsewhere, he left Washington, June 12, and arriving at Middletown the same evening, began plane table work the next day.

Its progress will be stated in the next annual report. A large proportion of wooded or partly wooded areas somewhat delayed the work at the outset, the flag signals having to be secured to the tops of the tallest trees that could be found.

Hydrographic survey of the Connecticut River from Lyme Ferry to Cromwell above Middletown.
Topographic survey of the Connecticut.—A hydrographic survey of the Connecticut River, from the limits of the recent re-survey at Saybrook to such point above as might be reached by the topographical parties, was assigned to Assistant W. Irving Vinal by instructions dated August 12, 1890. Having received a boat from the Brooklyn Navy Yard, Mr. Vinal organized his party at Essex, Conn., and began work August 18.

Owing to recent changes in the locality, all traces of the tide staff and reference bench mark put up at Saybrook Point by Lieut. J. D. Keeler, U. S. N., had been destroyed; it became necessary therefore to observe an entirely new series of tides, and this was done at Essex, the observations being continued during an entire lunation and several permanent bench-marks established. For the reduction of soundings made in the course of the survey, other gauges were placed at Chester, Higganum, and Middletown, their distances apart being such as to admit of observations of slack water extending from one to another. Planes of reference were determined by a careful series of simultaneous readings at high and low water.

The Connecticut, a narrow river, with banks often precipitous, required more than the usual number of signals for the hydrography. Shore line and the geographical positions of the principal points used in the work were furnished by the topographical parties. Stormy weather and unusual freshets were prevalent in the months of September and October. The banks of the river, the docks and the meadow lands were completely overflowed, landmarks obliterated and the appearance of the country entirely changed. Much delay was thereby caused in the progress of the work.

Mr. Vinal has submitted a descriptive report to accompany the four hydrographical sheets, scale 1-10 000, upon which the results of his survey are shown. To this report is appended a full statement of results for planes of reference at the several tidal stations, as deduced from the observations. His survey was completed between Saybrook Point and Cromwell, about two miles above Middletown by November 15, when field operations were closed.

Mr. C. L. Gardner, who served as foreman in the party, was familiar with the details of field work and rendered valuable assistance. Mr. L. A. Baldwin served as recorder, displaying great aptitude for the work and contributing largely to its success by his diligence and efficiency.

For the season, the statistics are:

Hydrography:

Area sounded in square geographical miles	20
Number of miles (geographical) run while sounding	241
Number of angles measured	2 116
Number of soundings.....	23 648

During the winter and spring of 1890-1891, Mr. Vinal was engaged at the Office in assorting, arranging, and cataloguing the specimens of sea-bottom which had accumulated there as part of the records of hydrographic work.

Having received instructions early in June to take up the topographical survey of the Connecticut River from the limits of Assistant Donn's survey of 1890, and then to continue the hydrography to Hartford, he organized his party at Chester, Conn., on June 15, and was actively engaged in prosecuting his surveys at the end of the fiscal year.

Hydrographic re-surveys of Shinnecock, Quantuck, and Moriches Bays south coast of Long Island.—At the beginning of the fiscal year, Assistant C. T. Iardella, having been in the field since May 20, 1890, had completed a topographic re-survey on the south coast of Long Island from

Indian Reservation to South Hampton, and had taken up a hydrographic re-survey of Shinnecock Bay. This he carried on from Shinnecock Neck to the westward, and upon finishing it, took up and completed the hydrography of Quantuck Bay, and then began the hydrography of Moriches Bay, which was partly finished when field work was suspended for the season on the 10th of October.

In addition to the bays just named, the following small bays and creeks were surveyed; Tiana Bay, Taylors Creek, Header Creek, Smiths Creek, Atlantic Creek, Phillips Creek, and Penneman's Creek. From 2 to 5 feet of water are the depths in these creeks; they are used almost wholly by small boats. In Tiana Bay, $1\frac{3}{4}$ miles west of Ponquogue Point, 6 feet can be carried to tidewater. The Shinnecock Canal, an artificial water-way made two years ago to connect the waters of Great Peconic and Shinnecock Bays has now nearly filled up with sand, owing to faulty construction, but may soon be reopened.

Six to seven feet of water can be carried from Ponquogue Point in Shinnecock Bay to Great South Bay through Quantuck and Moriches Bays and the artificial canals connecting them, and a large number of vessels pass through.

For the season, the statistics are:

Hydrography:

Area sounded in square geographical miles	64
Number of miles (geographical) run while sounding	235
Number of angles measured.....	1 699
Number of soundings.....	15 842

The results of the survey are shown on two hydrographic sheets, scale 1-10 000.

After closing field operations, Mr. Iardella was assigned to duty at the Office and was thus occupied until early in May, 1891. He was then instructed to resume the hydrographic survey of Moriches Bay from the limits of his work of the preceding season, completing the hydrography of the west end of the bay, and connecting it with that of Great South Bay, which had been executed by the parties of Assistants Hosmer and Iardella in the years 1874 and 1875.

At the end of the fiscal year he had finished this work, and was preparing to begin a topographical survey from Southampton to the eastward.

Mr. Iardella observes that West Moriches Bay is eight miles in length and from one-quarter of a mile to one mile wide. Good water can be had in the channel of depths from 6 to 10 feet, so that vessels drawing 5 feet can navigate it from the entrance at Great South Bay to Pawcuck Point, West Hampton. There is no ebb and flow of tides in the bay, the depth of water varying only with the wind. It was observed that the tide-gauge indicated a rise of 3 or 4 inches during the prevalence of northwest winds, while northeast winds lowered the water level from 4 to 5 inches.

With the report of his season's work Mr. Iardella has submitted a sketch showing its limits, and a table of statistics. These are as follows:

Hydrography:

Area sounded in square geographical miles	3
Number of miles (geographical) run in sounding	146
Number of angles measured.....	792
Number of soundings	11 085
Scale of hydrographic sheet	1-10 000

Hydrographic examination off Rye Beach, New York.—In Notice to Mariners, No. 132, published September 30, 1890, report was made of a dangerous ledge discovered off Parsonage Point, Rye Neck, N. Y. This ledge has 8 feet of water over it, with deep water on all sides, and though quite out of the track of ordinary commerce, would be a danger to vessels seeking a harbor in the vicinity. The hydrographic examination which led to the discovery of this ledge was made by Lieut. Commander S. M. Ackley, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Endeavor*. He found also that the 7-foot spot shown on the charts between Forbes Rock and Transport Rock should be changed to a 3-foot spot.

Hydrographic surveys and examinations made by Lieut. Commander Ackley earlier in the fiscal year are referred to under preceding headings in this volume.

Longitude determination by exchanges of telegraphic signals between stations at Cape May, N. J., Albany, N. Y., and Detroit, Mich. Determinations of latitude and of the magnetic elements.—The completion of the primary lines of longitude determinations connecting stations on the Pacific Coast with Minneapolis, Minn., in September, 1890, is referred to under a subsequent heading in this report. The scheme of longitude work begun in May, 1891, involved the extension of these northern primary lines to Cape May, which is the eastern terminus of the transcontinental arc of the 39th parallel. The lines to be determined were Cape May-Albany, Albany-Detroit, Detroit-Chicago, and Chicago-Minneapolis.

Assistant C. H. Sinclair was placed in general charge of operations, and Aid G. R. Putnam assigned to the charge of the coöperating party. On reaching Cape May, Mr. Sinclair found that the observatory which had been built in 1881 for the longitude exchanges between Washington, D. C., and Cape May was still standing and needed but slight repairs to fit it for use. Mr. Putnam arrived at Albany May 1 and established an astronomical station there on the site of the station of 1858 near the Dudley Observatory.

Longitude signals were exchanged in the first position of the observers on the nights of May 5, 7, 9, 10, and 18, after which Mr. Sinclair proceeded to Albany and Mr. Putnam to Cape May, and after much delay, owing to unfavorable weather, a second set of exchanges was obtained on the nights of June 1, 8, 9, 10, and 11. While at Cape May, Mr. Sinclair determined the latitude of the station by seventy-five observations on twenty-two pairs of stars on four nights, using zenith telescope No. 6. At this station the magnetic elements were determined by Mr. Putnam by observations on six days.

He then proceeded to Detroit (Mr. Sinclair remaining at Albany), and on June 13 selected a place for the longitude station as near as possible to the position of the old observatory of the Lake Survey, which was torn down a few days after his arrival. Before the instrument piers in this building were moved; he referred them carefully to the curb line of Grand River Avenue and to the wall of the old office of the Lake Survey. He then established his longitude station on the east side of Washington Avenue and on the north side of Grand River Avenue in grounds belonging to the Electric Sanitarium, and took measurements to refer the point occupied to the Lake Survey piers.

In the first position of the observers, longitude signals were exchanged between Albany and Detroit on the nights of June 23, 24, 25, 26, and 27, and in the second position (Mr. Sinclair at Detroit and Mr. Putnam at Albany) on one night (June 29) before the close of the fiscal year.

At Detroit Mr. Putnam occupied a magnetic station, located as near as practicable to the old station in the grounds of Harper Hospital. As the observations for magnetic declination showed a considerable range, they were continued for seven days.

Reference will be made in the next annual report to the progress of the longitude work at the other stations occupied up to the close of the season.

Service assigned to Messrs. Sinclair and Putnam earlier in the fiscal year is referred to in this report in notices of longitude stations occupied in Georgia, Florida, and Texas, in Minnesota and North Dakota, in Utah and Montana, and in Missouri.

Continuation of the topographical survey of the Hudson River.—After completing a topographic and hydrographic survey of Sparrow Point, Md., referred to in a subsequent heading, Assistant John W. Donn was instructed June 6, 1891, to make arrangements for an early resumption of the Hudson River survey.

Mr. Donn reached Cold Spring with his foreman, Mr. L. A. Baldwin, on June 20, and began the erection of signals on the mountains. While awaiting the arrival of his projections, and for the purpose of establishing a high point of reference, he ran a line of levels to the top of Bull Mountain, 1 421 feet, and that elevation was referred to in much of the contour work on the heights adjacent.

After the projection had been received, the remainder of the month was consumed in the

occupation of the triangulation points in the mountain tops and in the determination of positions upon the upper plane table sheet.

The progress of this survey will be stated in the next Annual Report.

Duty assigned to Mr. Donn on the Connecticut River and in the District of Columbia is referred to under appropriate headings in this volume.

Tidal Observations Continued at the Automatic Tide-Gauge Station, Sandy Hook, New Jersey.—The series of tidal observations at Sandy Hook, New Jersey, which was begun in December, 1886, has been continued successfully during the fiscal year. Mr. J. G. Spaulding has remained in charge of the automatic gauge at this important station, which is maintained as a port of reference for the tides of the Atlantic coast from Fire Island Inlet on the south shore of Long Island to Ship Shoal Inlet on the eastern shore of Virginia.

In the Tide Tables for 1891, published by the Survey in May, 1890, are given the predicted times and heights of high and low water at the Sandy Hook station for every day in the calendar year, together with a table of tidal differences and ratios whereby these times and heights can be found for thirty-four additional stations on the coasts of New York, New Jersey, Delaware, Maryland, and Virginia.

Reconnaissance and Signal Building in Connection with Geodetic Operations in the Southwestern Part of the State of New Jersey.—Field work on the triangulation of the State of New Jersey, which had been suspended since September, 1889, was resumed by Prof. E. A. Bowser, Acting Assistant, on April 1, 1891. His first work was the building of a tripod and scaffold at station Colsons to enable him to see over the tall timber on the line to Bridgeton, Williamstown, and Taylors. The height of this scaffold to the platform was 64 feet. On April 9, the scaffold having been completed, a reconnaissance was begun on the lines from Colsons to stations Bridgeton and Taylors for determining lines of sight through the tree tops. Many of the trees on these lines are from 90 to 100 feet high.

Subsequently a signal 130 feet in height was erected at Colsons, and a tripod signal 68 feet high at Taylors.

The work was in active progress at the end of the fiscal year, and its progress will be adverted to in the next Annual Report.

The work of Prof. Bowser, and that of other officers engaged in State surveys, was placed in immediate charge of Assistant George A. Fairfield by instructions of the Superintendent dated March 27, 1891.

Continuation of the detailed survey for the Revision of the Maps of the Water-Front of the City of Philadelphia.—At the opening of the season for the field work of the water-front survey of the City of Philadelphia, August 1, 1890, Assistant R. M. Bache, in charge of the work, took up the filling in of a gap between Venango and Otis streets in order to make the survey continuous from Bridesburg to Greenwich Point. This break of continuity, somewhat over 2 miles in an air line, was incidental to the original plan for the work, the needs of certain portions of it having been recognized as relatively more pressing.

After the 19th of September, Mr. Neville B. Craig, who had up to that time been employed upon the work was relieved from duty upon it, and Mr. Bache took steps to proceed with the work upon another basis. The Chief Engineer and Surveyor of the City agreed with him that for the map below Greenwich Point a scale of 1-2400 would be more desirable than one of 1-1200, since it would permit of the representation of the Back Channel of League Island upon a chart of reasonable width.

Some triangulation preliminary to the topography being needful, Mr. Bache proceeded to occupy stations for measurements of horizontal angles, but the month of October proved to be more stormy than any he had experienced in field work, successive days of rain being followed by severe gales which made it almost impracticable to observe. By watching every opportunity however he obtained the positions of all the points needed except in the case of two triangles, for the measurement of angles in which a few days work in the spring will be required. The number of points determined was fourteen. Field operations were suspended November 18.

Tidal Observations at Chestnut Street Wharf, Philadelphia.—In order to obtain data for testing, in a practical way, the published predictions of high and low water at Philadelphia, as given in the Tide Tables for the calendar year 1890, Assistant Spencer C. McCorkle was instructed to establish a temporary tide gauge at Chestnut Street wharf in that city, and to have a record kept of the times of high and low waters, and the duration of stand, and also, when practicable, of the times of ebb and flow of the current and the duration of its stand.

These observations were kept up under the supervision of Mr. McCorkle, during the months of July and August, and part of September, 1890, and the records have been sent to the office.

Official duties performed by Mr. McCorkle while in charge of the sub-office at Philadelphia during the year are referred to under the heading, "Sub-offices," towards the close of this portion of the report.

Topographic and hydrographic survey of Sparrow Point, Patapsco River, and of the waters in the vicinity.—Upon the completion of the detailed topographic survey of the District of Columbia, reference to which is made under a subsequent heading, Assistant John W. Donn was instructed to make a topographic survey of Sparrow Point, Patapsco River, Md., and a hydrographic survey of the waters surrounding it.

Having transferred his party to Sparrow Point, Mr. Donn began his survey May 13, 1891. For the establishment of the plane of mean low water, a tide station was put up on the east side of Bear Creek, and observations made in connection with those at the permanent tide-station at Fort Carroll.

Triangulation points were recovered and occupied, and the short lines run of Bear Creek to the railroad bridge, and of Sparrow Point to the Holly Grove wharf. Advantage was taken of all favorable weather to push forward the hydrography.

The survey was finished June 12. Mr. A. L. Baldwin rendered efficient service as foreman in this work, as he had before done in the District of Columbia. The statistics reported are:

Topography:

Area surveyed in square miles.....	0.75
Miles of shore line surveyed	4.75

Hydrography:

Number of miles run in sounding	71
Number of angles measured	889
Number of soundings	7 383

Towards the close of the fiscal year Mr. Donn took up under instructions the continuation of the topographical survey of the Hudson River, N. Y.

Observations begun at Rockville, Maryland, for investigating the variations of latitude in coöperation with the work of the International Geodetic Association.—The International Geodetic Association having requested that the U. S. Coast and Geodetic Survey should coöperate in the researches relating to variations of latitude, the Superintendent instructed Assistant Edwin Smith towards the end of March, 1891, to make the necessary observations at a station in Rockville, Md., carrying them on as nearly as practicable in conformity with the methods adopted by the Association, and followed in the observations made under its direction in 1889 and 1890 at Berlin, Potsdam, and Prague.

In pursuance of these instructions, Mr. Smith put up a temporary observatory near his residence at Rockville, and, after some delays due to great pressure of work in the instrument shop of the office, he mounted the zenith telescope by the end of May, and began regular observations June 13. These were continued on the remaining nights during the month whenever the weather was favorable, five in all.

Mr. Smith states in his report, brought up to the close of the fiscal year, that as the progress made to that date has been comparatively small, he deems it best to defer giving a full description of the location of the observatory, of the instruments and methods, until the completion of the work.

He will, however, submit a description of the zenith telescope, which was specially reconstructed for these observations, in his report as Chief of the Instrument Division of the Office. He states that the location of the station is a favorable one; that the observatory is commodious and well suited to its purpose, and that the instruments are of the best type belonging to the Survey.

For the observations of latitude, ninety-one pairs of stars have been selected, extending over the twenty-four hours. These stars are divided into fifteen groups, averaging fifteen pairs each, every group overlapping the preceding and following groups by not less than one-half of its pairs. The methods of observing are those of the International Geodetic Association.

During the entire fiscal year Mr. Smith was in charge of the Instrument Division of the Coast and Geodetic Survey Office. Reference in some detail to this service is made later in this volume under the heading, "Coast and Geodetic Survey Office," and his report of the operations of the Division will be found with the annual report (Office Report No. 1) of the Assistant in charge of the Office near the close of this volume.

Determinations of relative gravity at the Smithsonian Institution, Washington, D. C.—The pendulum swings observed by Assistant E. D. Preston at the station, Smithsonian Institution, Washington, D. C., in October, 1889, and again in July, 1890, were primarily intended for comparison with similar observations made by him at stations on the west coast of Africa and on some islands in the middle and west Atlantic while attached to the Solar Eclipse Expedition of 1889 to Africa.

An abstract of the results for gravity obtained by Mr. Preston at Washington, and at the West African and Atlantic stations, has been published in Bulletin No. 22, and his full report of the observations and their discussion was published in Appendix No. 12, Report for 1890.

Mr. Preston observes that the pendulum observations embodied in his paper were not intended to be used for absolute measures of gravity. But as oscillations were made in both positions of the instrument, and as the length was measured in order to test its invariability, a comparison can be made with values of gravity otherwise deduced. Accordingly, in concluding his report, he arrives at a close approximation to the value of gravity at Washington, namely: $g = 980.05$ dynes.

The preparation of his reports, and investigations and experiments relating to new and improved forms of pendulum apparatus, occupied Mr. Preston during the fiscal year until the spring of 1891. Towards the end of March he was instructed to proceed to Honolulu, Hawaiian Islands, and coöperate there with a representative of the International Geodetic Association in carrying on their researches on the variations of latitude. He was directed also to observe the transit of Mercury of May 9, to make magnetic observations at a number of stations, and to determine the force of gravity at Honolulu and at one or two stations on the island of Hawaii, preferably at the sea level, and, if practicable near the top of Mauna Kea.

Reference to these operations has been made under the heading "Special Scientific Work."

Completion of the detailed topographical survey of the District of Columbia by Assistants J. W. Donn, D. B. Wainwright, and W. C. Hodgkins, and by Sub-assistant J. A. Flemer.—In making his report announcing the completion early in May, 1891, of the detailed topographical survey of the District of Columbia, Assistant John W. Donn expresses his gratification that this elaborate work, begun by him in 1880, had been carried to a successful conclusion within the estimate of cost originally made. He refers to those officers who for several years were co-laborers with him in a service involving great labor, much exposure and hardship, as accomplished topographers, whose record in the work was throughout one of faithful endeavor.

Following is an abstract from Mr. Donn's report, and also abstracts from the reports of Assistants D. B. Wainwright and W. C. Hodgkins, and of Sub-assistant J. A. Flemer.

Upon receiving instructions dated November 10, 1890, directing the resumption of the topographical survey of the District, Mr. Donn began the preliminary work of extending level lines over the corner included between the northeastern and northwestern boundary lines, that being the part upon which his work was laid out. Temporary bench marks had

been established in former years in several portions of this area, but the lapse of time had obliterated most of them.

The comparatively open winter was quite favorable to rapid progress, and as a very large part of the area was heavily timbered the party was able to advance with but little interruption from snow or cold weather. The contour work lying on both sides of Rock Creek was, however, heavy and intricate, and the stream itself presented a considerable obstruction to rapid progress on account of the absence of means for crossing. Temporary crossings had to be constructed whenever it became necessary in leveling for contour to command the hill faces on both sides of the creek.

This part of the work was finished in April, and Mr. Donn then took up the re-survey of the Potomac River at the Aqueduct Bridge and carried it along the north shore as far as the Long Bridge to a junction with Mr. Flemer, coming from the east, and on the south shore to the east end of Analostan Island, where a junction was made with the work of Mr. Wainwright.

The statistics of the work thus reported are as follows: (They are not large, the principal roads and creeks having been previously finished.)

Topography (scale 1-4800):

Approximate area of survey in acres.....	600
Miles of roads surveyed.....	3
Miles of creeks.....	3
Miles of river shore-line.....	5

For about ten days in November Mr. Donn suspended his work in the District to make a comparison desired by the Superintendent of topography on Staten Island, executed in 1855-56 with more recent surveys by Vermule and Bien of New York.

Other work assigned to him on the Connecticut, Hudson and Patapsco Rivers is referred to under headings in the States of Connecticut, New York, and Maryland.

Upon resuming the topographical survey of the District of Columbia, Nov. 18, 1890, Assistant D. B. Wainwright took up work on an area in the vicinity of the Government farm, west of the Livingston road. This consisted almost entirely of open fields, and had been omitted during the preceding spring on account of the standing grain. After this followed the survey of a wooded piece of ground along the southeast boundary line of the District between the Wheeler and the Livingston roads. This also had been left over from the preceding spring, as its surface is marked with thick woods and underbrush and it could be mapped rapidly only during the winter.

Most of the season was spent, however, in the north corner of the District in the survey of an irregularly shaped area extending from the Broad Branch road to Rock Creek, nearly all of which was wooded, but the most difficult portion lay between the Broad Branch and Milk House Ford roads. This was covered with low pines and cut up with small valleys.

In the early part of May, this part of the work having been finished, Mr. Wainwright ran the shore line of the Virginia side of the Potomac River from Analostan Island to the corner of the District below Alexandria. This was completed before the end of the month and the party was then disbanded.

Mr. Wainwright acknowledges the energy and faithfulness of the following named persons employed on the work: Mr. W. B. Hindmarsh as levelman, and, in case of need, as topographer; Mr. R. J. McAdory as telemeter rodsman, and frequently as levelman, and Mr. William Oliver as level rodsman.

The statistics are:

Topography (scale 1-4800):

Area surveyed in square statute miles.....	1.06
Length of roads in statute miles.....	15
Length of shore line of creeks in statute miles.....	3
Length of shore line of river in statute miles.....	10

Other duty assigned to Mr. Wainwright is reported under a heading in the State of Massachusetts.

Assistant W. C. Hodgkins, having resumed work on the topographical survey of the District of Columbia, under instructions issued Nov. 18, 1890, organized his party for the completion of the unfinished areas of topography which had been assigned to him.

He began in a small but densely wooded area lying between the northeast boundary of the District and the track of the Southern Maryland Railroad, southeast of Burrville.

This finished, he took up work on the south side of Central Avenue near the District boundary, and gradually extended his survey southwest to the Benning Road, and thence still further west and southwest to a junction with previous work near the Ridge Road.

Almost the whole of this area was covered with dense woods of pine, oak and mixed growth, with thick underbrush. Owing to this, and to the irregular character of the surface, which greatly increased the amount of contouring to be done, progress was comparatively slow. During December and January, the weather was generally favorable, but in February and March it was very wet, and the resulting rapid development of foliage toward the end of March and throughout April operated also to retard the work.

On April 14, the topography of an uncompleted area near Swann geodetic station was taken up. This station is about $2\frac{1}{4}$ miles southwest of the north corner of the District. In connection with the other parties engaged in the District survey, work in this locality was finished April 30. Returning then to the eastern section some supplementary topography was executed along the Bowen Road, and a re-survey made of the Benning Race Course which had but recently been fitted up for use.

On May 16, 1891, the party was disbanded, Mr. Hodgkins having finished the surveys of all the uncompleted areas which had been assigned to him.

The statistics of the season's work are as follows:

Topography:

Number of stones planted for bench marks.....	2
Number of bench marks established on other permanent objects.....	15
Number of miles of standard levels run.....	10
Number of acres of topography surveyed.....	654

Earlier in the fiscal year, Mr. Hodgkins began a topographical re-survey on the Connecticut River, in which he was occupied till November, 1890, and in June, 1891, he resumed this work. Reference to these re-surveys is made under a preceding heading in this volume.

The first work which engaged the attention of Sub-assistant J. A. Flemer on taking the field in the District of Columbia on November 24, 1890, was the completion of the detailed topography of an unfinished area of about 200 acres about the Receiving Reservoir between the Chain Bridge Road and the Murdock Mill Road. In the course of the work a granite bench mark (No. 199) was established in position, and after the completion of the survey the party was moved to the neighborhood of the U. S. Reform School, where the area to be filled in contained about 290 acres. Two granite bench marks were placed in position on this area (Nos. 197 and 200). The work here occupied the party from January 14 to March 6, 1891, and as soon as it was finished the survey of an unfinished area lying around Connecticut Avenue extended and to the west of the Chapel Road was taken up. This tract contained about 160 acres, and was executed on an unfinished sheet of Assistant Donn's. The work of extending Connecticut Avenue had been begun since the date of Mr. Donn's survey, and at the time Mr. Flemer took up the completion of the sheet, the grading of the avenue and blasting operations were in progress; hence Mr. Flemer's survey represents the state of the topography in the early part of April.

On the 8th of April the party was moved to the terminus of the Daniels Road to close up a gap of about 116 acres. A bench-mark of granite (No. 189) was established on this tract, and upon its completion Mr. Flemer took up the survey of the river front from the Anacostia Bridge to the Long Bridge. No leveling being required for this work, the party was reduced to two rodsman, and the area of about 700 acres was completed between April 29 and May 26. To facilitate the junction of the shore line with the survey of the city of Washington, many

curbstone lines, numerous buildings and property lines, and the Navy Yard and Arsenal grounds were laid down on the plane-table sheet. This work was executed upon a new projection.

There still remained to be delineated an unfinished stretch of shore line of about two miles in length on the Virginia side of the Potomac from Little Falls to the landing of the Potomac Boat Club. This line was surveyed May 28 and 29, and the party then disbanded, the work assigned to Mr. Flemer in the detailed topographical survey of the District of Columbia having been finished.

The only new line of levels started from the initial bench mark at the Government Printing Office was one which was carried to the U. S. Reform School Farm. All of the gaps to be filled, except those on which the four granite bench marks already adverted to were established, had bench marks of a permanent character in their immediate neighborhood, and these were available for starting the contour work.

The results of the work of Mr. Flemer's party are shown on eight plane-table sheets, five of which were partly finished sheets from the archives, upon which the incomplete portions were filled. Three sheets were newly projected, the old ones covering the same areas being too much worn to be taken into the field.

For the season the statistics are :

Topography :

Area surveyed (scale 1:4800) in square statute miles	2'3
Length of shore line of rivers in statute miles.....	11'7
Number of miles of standard level lines run	9
Number of permanent bench marks established with underground marks.....	4
Number of bench marks established on other permanent objects	26

Early in June Mr. Flemer proceeded to Maine under instructions to resume the topographic survey of the Northeastern Boundary Lakes from the limits of his work executed in the summer and autumn of 1890, reference to which has already been made in this volume.

Determinations of the magnetic declination at the station near the Coast and Geodetic Survey Office, Washington, D. C.—Some determinations of the magnetic declination were made by Assistant Charles A. Schott on six days between June 26 and July 2, 1891, at the station south of the Coast and Geodetic Survey Office with the Russian Compass Declinometer, with a view of ascertaining the amount of probable error of observation inherent to instruments of this kind, and preparatory to the construction of several of these declinometers for use by triangulation parties on lines of known direction.

Experimental work conducted with a view to the use of metallic tapes in measurements of bases.—A preliminary report has been submitted by Assistant R. S. Woodward upon the experimental work conducted by him during December, 1890, and January and February, 1891, with a one hundred metre steel tape in the National Botanic Garden, Washington, D. C. This tape being intended for use in making one of the measurements of a base of verification at Holton, Indiana, it became desirable to ascertain by experiments carried on under varying conditions of weather the degree of precision attainable in measurements with steel tapes using mercurial thermometers to determine temperature.

For this purpose a one hundred metre comparator was set up on the south side of the Botanic Garden. This consisted of a row of posts ten metres apart which served to support, align, and stretch the tape. The reference marks are engraved on brass plates, which are nailed to the tops of wooden posts of such height that the plates are in the same horizontal plane. An ivory millimetre scale is attached to one of the plates, and serves to refer the end mark of the tape to the zero mark of the plate. Changes in length of the tape can thus be read off to the nearest tenth of a millimetre. The tension of the tape is applied by means of a spring balance, reading to ounces with precision quite enough for the work. The tension is easily controlled by means of a spring moved by suitable gearing.

Up to the middle of February, 1891, the thermometers used to determine the temperature of the tape were three in number, of the Centigrade scale, graduated to half degrees, originally on brass scales. But experiments having shown that these thermometers were much more sensitive when off their scales, they were detached, graduated on their stems, and their bulbs covered with blackened metallic sheaths, it having been found that the use of these sheaths served also to increase their sensitiveness.

Mr. Woodward's observations were made on twenty-three dates, and were so arranged by him as to include, 1, observations on the tape and the thermometers to get rate of expansion of tape and to determine the average error of laying a tape length; 2, similar observations when the tape is inclined at a known slope; 3, observations of sag and stretch of tape for comparison with theory; and 4, observations on the thermometers to determine their sensitiveness under various conditions.

Full details in regard to these experiments, with the record and discussion of results are given in his report, which is accompanied by papers showing graphically the results of the tape comparisons and the experiments with thermometers; also by a paper in which is formulated the mathematical theory of tapes. Space is not available here for other than a reference to the conclusions derived by Mr. Woodward concerning the precision attainable in the measurement of base lines with steel tapes, using mercurial thermometers to determine temperature. Distinguishing between the classes of errors in such measurements as are cumulative and those which are compensating in their aggregate effects, and putting μl for the probable error due to the first class of errors in laying a single tape length l , and $m\mu l$ for the probable error due to the second class, N being taken as the number of tape lengths in the whole base, and n as the number of independent measures of the line, the probable error of the mean of n measures of the base, expressed as a fraction of its length will then be

$$\mu \sqrt{1 + \frac{m^2}{Nn}}$$

From this expression it appears that the probable error of the base tends towards μ as a limit as N and n increase, and with a base of any considerable length this limit is soon reached if n is more than a few units.

Mr. Woodward concludes that the tape length at some standard temperature can be determined with a probable error not greater than the one-millionth part, and that other sources of cumulative error can hardly increase this probable error to two one-millionths. And that for a line four kilometres in length the probable error ought not to exceed the one-five-hundred-thousandth part of a single measurement.

Actual tests in the field will be obtained during the summer of 1891 by Mr. Woodward, who has been assigned to conduct the steel tape measurements of the base of verification to be measured near Holton, Indiana.

Examination for location of a shoal reported near Smith's Point Light, mouth of Potomac River.—A report having been received at this office from the master of the schooner *Carrie A. Lane* that his vessel had grounded upon a shoal, not laid down on the charts, near Smith's Point Light-house, Lieut. L. K. Reynolds, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Endeavor*, was instructed to stop while *en route* to Old Point Comfort, and make such an examination of the locality as would determine definitely whether the shoal existed.

Lieut. Reynolds reported under date of April 7, that the depths shown by the soundings and the bearings taken agreed fairly well with those on the chart, and tended to disprove the existence of the shoal. It appeared further from information given by the Light-keeper that at the time of the grounding, the schooner, a large three masted one, drawing about 12 feet of water, was only about $\frac{1}{8}$ of a mile from the Light-house, and well inside the 11-foot buoy.

Hydrographic work upon Cape Hatteras Shoals in connection with the proposed site for a Light-house on the western part of the Northern Outer Shoal.—In compliance with a request received from the Light-House Board for a re-survey of the Northern Outer Shoal off Cape Hatteras to show its exact condition at date, in view of the proposed location of a Light-house on Diamond Shoal,

the Superintendent directed Lieut. C. E. Vreeland, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Blake*, to make the survey required. He was instructed also to receive on the *Blake* a representative of the Light-House Service who would remain on board during the execution of the work.

For this survey Lieut. Vreeland was furnished with a projection, scale 1-20 000. The signals established were determined in position by the measurement of a short base on shore, and by a triangulation of which Cape Hatteras Light and the adjoining Life-saving stations were among the points occupied. All of the soundings required to develop fully the hydrography were obtained on May 29, 30, and 31, 1891, after which the *Blake* returned to Hampton Roads, and the sounding sheet and records were forwarded to the Office.

The officers attached to the *Blake* and assisting in this survey were Lieut. Harry Kimmel, U. S. N.; Ensigns W. S. Muir, J. H. Rohrbacker, and B. Wright, U. S. N.; and Assistant Surgeon E. S. Bogert, jr.

The statistics reported are:

Number of miles run in sounding.....	57
Number of angles measured.....	172
Number of soundings	850

Reference to the duty assigned to Lieut. Vreeland early in the fiscal year to the south of Marthas Vineyard is made in a preceding part of this volume, and under a heading subsequent to this one is given an abstract of the cruise of the *Blake* under his command in the exploration of the Gulf Stream.

Determinations of the magnetic elements at stations in North and South Carolina.—Upon resuming his magnetic field work in the spring of 1891 under instructions issued April 6, Assistant James B. Baylor went to Washington, D. C., and made observations at the magnetic station near the Office for the value of the induction co-efficient of his magnet.

After having had some needed repairs made to his magnetometer, he proceeded to South Carolina, and in that State and then in North Carolina, determined time, latitude, azimuth, and the magnetic declination, dip, and intensity at the following named places:

1. Florence, Darlington county, S. C. Station located in the northwest corner of the National Cemetery and occupied May 4 to 6, 1891.
2. Marion, Marion county, S. C. Station established in an open lot northwest of the town near the Planters' Hotel, and occupied May. 7.
3. Fair Bluff, Columbus county, N. C. Station established in an open space between the properties of Col. T. F. Town and Mr. J. A. Mears. Occupied May 8 and 9.
4. Lake Waccamaw, Fleming, N. C. The station was located on the grounds of Mr. G. S. Gillespie on the northern edge of the village, and occupied May 11 and 12.
5. Wilmington, New Hanover county, N. C. The station of 1854 has been built upon. A new station was established in the grounds of the U. S. Marine Hospital in the eastern suburbs of the city. It was occupied May 14 and 15.
6. Burgaw, Pender county, N. C. The station was located in the southwest corner of the Court House Square, and occupied May 18 and 19.
7. Warsaw, Duplin county, N. C. The location of the station was in the large open square adjoining the Methodist Church in the southeastern suburbs of the village. It was occupied May 20 and 21.
8. Kinston, Lenoir county, N. C. The station was established in the southeastern suburbs of the town in the center of the broad avenue known as King Avenue, just opposite Kinston College. The observations were made on May 23.
9. Goldsboro, Wayne county, N. C. The station was located in the southeastern corner of of the Court House Square and occupied May 26.
10. Wilson, Wilson county, N. C. A location for the station was selected in the grounds of the Wilson Graded School in the northern suburbs of the town, and the observations were made May 31 and June 1.

11. Tarboro, Edgecumbe county, N. C. The station was established in the large open common in the center of the town and in front of the Tarboro Graded School. It was occupied June 3.

12. Washington, Beaufort county, N. C. The station is in the large open lot near the foot of Main Street at its intersection with Telfair Street in the eastern suburbs of the town. The observations were made on June 6 to 9.

13. Jamesville, Martin county, N. C. The station was established in the open lot adjoining the White Methodist Church in the southeastern suburbs of the town. Observations were made June 10.

14. Edenton, Chowan county, N. C. Observations were made June 12 at a station selected in the open space in front of the Court House.

15. Elizabeth City, Pasquotank county, N. C. The station was located in the Albemarle Park Fair Grounds, one mile south of the center of the town and on the bank of the Pasquotank River, and the observations were made June 13 and 14.

Mr. Baylor took care to secure each of his stations by surface and underground marks, and by referring their positions to neighboring and prominent objects. Descriptions and sketches accompany his records.

On June 26 he proceeded to Columbus, Ohio, under instructions to begin another magnetic tour, and was in readiness to observe there by July 1, 1891. Report of this service is necessarily referred to the fiscal year 1892.

Hydrographic examination for a shoal reported off Hetzel Shoal, Cape Canaveral, and determination of the position of Martin's Industry Light-vessel, off Port Royal Entrance.—Information having been received from the Hydrographic Office, Navy Department, of the striking of the steamship *Saratoga* on a shoal north of Hetzel Shoal, off Cape Canaveral, Florida, Lieut. C. E. Vreeland, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Blake*, was instructed to make an examination of the locality on his way north in April, 1891. Lieut. Vreeland reports, as the conclusion derived from close investigation made April 14 and 15, that the *Saratoga* must have touched on one of the $3\frac{1}{4}$ -fathom spots indicated on the chart on the eastern edge of Hetzel Shoal.

The *Blake* then proceeded towards Port Royal Entrance and anchored close aboard Martin's Industry Light-vessel at noon, April 16. The angles upon Tybee Light and the range beacons needed to determine the position of the Light Ship were then observed from her deck.

Tidal observations continued at the automatic tidal station on Tybee Island, Savannah River Entrance.—The series of observations of the tides by means of an automatic gauge on Tybee Island, a short distance northwest of Tybee Light, Georgia, which were begun September 28, 1889, have been continued successfully throughout the year by Mr. Eugene Veith, in charge of the station.

Surveys for the preparation of detailed maps of the grounds included in the Chickamauga and Chattanooga National Military Park.—Under the heading of "Special Operations" will be found a notice of the surveys begun at the request of the Chickamauga and Chattanooga National Military Park Commission in order that topographical maps of a trustworthy character of the grounds included in the park might be prepared. Assistant C. H. Boyd was detailed to report for duty to the Commission early in October, 1890, and an abstract of his report of progress is given under the heading just named.

Determinations of latitude and longitude at Augusta, Ga.; at Gainesville, Fla.; and at Jacksonville, Tex.—In compliance with a request from the Director of the Geological Survey, arrangements were made by the Superintendent in September, 1890, for determinations of the differences of longitude: Washington, D. C.—Augusta, Ga.; Washington, D. C.—Gainesville, Fla.; and Washington, D. C.—Jacksonville, Tex., and later in the winter for observations of latitude at Augusta, Gainesville, and Jacksonville.

Assistant C. H. Sinclair was directed to take charge of the work at the three stations just named, and Mr. George R. Putnam was associated with him and instructed to make the

observations required at the Naval Observatory, Washington. It was not deemed desirable that the observers should change places to eliminate the effect of personal equation. Three nights of observation at each station were to suffice, and at the close of exchanges the observers were to meet for the determination of their personal equation, observations for this purpose having been made also before the exchanges of longitude signals began.

Three nights, September 17, 18, and 19, for personal equation having been obtained by Messrs. Sinclair and Putnam with satisfactory results, Mr. Sinclair proceeded to Augusta, Ga., and selected a site for his station, with the permission of the Postmaster, in the grounds of the new Post Office.

Measurements were made to refer the center of transit to the flag pole on the Post Office building. A prolonged spell of rainy weather delayed the beginning of longitude exchanges; but the three nights desired were obtained on October 3, 4, and 5, completing this branch of the work. Before leaving, Mr. Sinclair marked out a meridian line at the request of the city engineer, putting down wooden stubs, which that officer undertook to replace with stone monuments.

On October 6 the instruments were forwarded to Gainesville, Alachua county, Fla., where a station was selected in an open space to the east of the Western Union Telegraph Office, and the center of the transit referred by measurement with steel tape and by horizontal angles to the rod on center of cupola of Court House.

Exchanges of longitude signals with Washington having been obtained on the nights of October 8, 9, and 15, Mr. Sinclair sent his instruments to Jacksonville, Cherokee county, Tex., on the 16th, arriving there himself on the 20th. He established his station in a vacant lot about 250 feet to the east of the depot of the International and Great Northern Railroad. Signals for longitude were exchanged with Washington on October 27, 29, and 31. A meridian line was laid out and the ends marked with blocks of marble.

Mr. Sinclair then went to St. Louis, Mo., to meet Mr. Putnam, partly to complete the work already accomplished by making with him a second set of observations for personal equation and partly to arrange for the occupation of the two longitude stations in Missouri, reference to which will be found under the next heading.

The instruments forwarded from Jacksonville were set up in the observatory of the Washington University, St. Louis, and personal equation observations were made between Messrs. Sinclair and Putnam November 3, 4, and 5. The results of these observations showed a very satisfactory agreement with those made at Washington in September.

Mr. Sinclair was subsequently directed to observe for latitude at the three stations—Jacksonville, Gainesville, and Augusta. This work he completed during the month of December.

Its statistics are:

Latitude:

Number of pairs of stars observed.....	76
Whole number of observations	228
Average number of observations on a pair.....	3

In January, 1891, he reported in person to the Superintendent.

Gulf Stream Explorations, Observations of surface and sub-surface currents continued.—On December 28, 1890, the steamer *Blake*, Lieut. C. E. Vreeland, U. S. N., Assistant Coast and Geodetic Survey, commanding, having been fitted for the continuation of current observations in the Gulf Stream, left New York, and proceeded to the Straits of Florida, off Jupiter Inlet, where it had been planned that her work should begin.

In accordance with instructions, Mr. E. E. Haskell, Expert in physical hydrography, had reported on board for duty as Hydrographer. The *Blake* was supplied with the Pillsbury Current Meter which had been used for several years preceding in Gulf Stream investigations, and also with the Haskell Direction Current Meter. These instruments had been compared and tested in September, 1890, under the direction of the Superintendent in the waters of Vineyard Sound.

The month of January, 1891, was remarkable for continued bad weather off the southern Atlantic coast, and at each of the four anchorages attempted by the *Blake* an anchor was lost, and on the last anchorage made the anchor boom was carried away, compelling the steamer to be taken to Havana for repairs. The section off Jupiter Inlet was therefore temporarily abandoned.

In the month of February three current stations were occupied in the Gulf of Mexico, station X-2 off the west end of Cuba; station X-3, northeasterly from the Campeche Bank, and station X-4, on the northeast foot of the Campeche Bank. Five anchorages were also made during this month on section Y to the northwest of Dry Tortugas. In the remainder of the season, three more anchorages were made on this section, and ten on sections Z, V, and N, adjacent to it. Their position is shown on the chart which accompanies Mr. Haskell's report. The observations of currents were made at depths of from $3\frac{1}{2}$ to 200 fathoms, the Haskell meter being generally used at $3\frac{1}{2}$ to 30 fathoms, and the Pillsbury meter at greater depths.

Lieut. Vreeland observes that the weather throughout the season was generally unfavorable, and with regard to the results he is of opinion that it is impossible to get fairly trustworthy records of the force and direction of currents in a sea roused by a wind of 4 to 5 Beaufort scale, and in a wind of greater force than 5 it is unsafe to remain at anchor. Fully half of the time at sea was therefore necessarily passed in lying-to, waiting for wind and sea to subside, or in making way back to anchorage.

He thinks that the results acquired, while instructive, are by no means conclusive, but they will be useful, however, for purposes of comparison with those to be gained by future investigation.

Mr. Haskell has indicated upon the chart submitted with his report, by means of arrows, the velocity and direction of the current found at $3\frac{1}{2}$ fathoms depth at each station, and has plotted upon cross section paper the velocity curves for the twenty-one stations occupied between January 10 and April 9, taking the times of occupation as the abscissae and the velocities as the ordinates.

The phases of the moon are also shown, and its declination north or south indicated by its position above or below the line of origin of the ordinates, and its upper or lower transit by the subscript "u" or "l".

Mr. Haskell's full report with illustrations is published as Appendix No. 10 to Part II.

The *Blake* left the Gulf for Hampton Roads April 12, stopping on the way to investigate a newly reported shoal off Cape Canaveral, and to determine the position of Martin's Industry Light-vessel. Mention has been made of these surveys under a preceding heading.

Topographical reconnaissance of the west coast of Florida between Cape Sable and Cape Romano.—Assistant Joseph Hergesheimer, having been directed to resume his field work on the west coast of Florida, began a topographical reconnaissance of that coast at Cape Sable on February 28, 1891. Between Cape Sable and Shark River Bay he found numerous islands and bays into which run creeks that drain the swamps and glades behind the immediate coast line of the Gulf. The land is all low, and wooded mostly with mangrove trees. The creeks are deep, with rocky bottoms, although no rocks appear on the surface or along the shores.

Between Shark River Bay and Pavilion Key the country was found to consist of shoal bays, from 6 to 10 miles back from the coast, connected by channels out of which run numerous creeks to the coast. In winter the water of these bays is salt, and during the rainy season (summer) it is fresh to within short distances of the coast. The creeks and bays are densely wooded along the shores, and the country between them is composed of patches of wire grass, ponds, marshes, and woods. The buttonwood throughout the country is in much demand, being converted into charcoal for the Key West market.

Between Pavilion Key and Coon Key near Cape Romano, the northern limit of the reconnaissance, the creeks that open upon or near the coast head in the marsh close to the

main land on a general line from the main land at the Royal Palm Hammock to the cypress back of Chatham River.

Drinking water is scarce throughout the country, and the settlers have to depend in winter on rain water or on water obtained from the heads of the bays near the main land. The entrances to the creeks on the coast south of Pavilion Key are obstructed by oyster bars, and the channels are narrow, and crooked, but with plenty of water in the creeks after passing the outside bars. In width the creeks range from 20 to 150 metres.

Mr. Hergesheimer has submitted with his report two progress sketches showing the general character of the country and the outlines of the creeks, rivers, and bays as surveyed with compass and sketched, or simply located approximately in position and limits. It remains to be decided whether a plane table survey based upon a carefully executed triangulation is demanded at present.

Field operations were closed April 7.

The statistics are:

Topographical reconnaissance:

Area of in square statute miles..... 400

Length in miles of compass and sketch surveys 70

Work executed in Maine earlier in the fiscal year by Mr. Hergesheimer has been referred to under a previous heading in this volume.

Triangulation, topography, and hydrography of Escambia Bay, Florida, completed.—In order to complete work begun during the previous fiscal year, Sub-assistant P. A. Welker proceeded under instructions issued in January, 1891, to Pensacola, Florida, and organized his party on board the schooner *Quick* for the triangulation, topography and hydrography of Pensacola Bay and its tributaries. The triangulation was taken up at the line Hickory-Emanuel, about 3 miles above the city of Pensacola and carried to the head of Escambia Bay by March 26.

In order to avoid cutting heavy timber, it was necessary to fix the stations of the triangulation on the sand dunes close to the shore, and as the drifting sand is constantly changing the outlines of these dunes, it was a matter of some difficulty to mark the stations securely. This was accomplished in most cases by sinking into the sand at the points to be marked, drain tiles filled with concrete made of Portland cement and shells. A few points were marked by stones 28 inches long and 8 inches square on top. At each station point four reference posts were placed 4 feet long and 8 inches square.

Whenever the weather was too foggy or stormy for observation of horizontal directions, the signals needed for topography were put up, and on March 31 this part of the work was begun. Much of it had to be done while the members of the party stood or waded waist deep through the dense timber swamps and soft marsh land at the mouths of the rivers and bayous.

On the completion of the plane-table survey to the head of Escambia Bay on April 30, the hydrography was taken up and continued until May 21. A 30-foot naphtha launch belonging to the Survey was of great use in advancing the sounding work satisfactorily.

Field operations were closed May 27, and the schooner laid up at Milton, Florida.

For the season the statistics are as follows:

Triangulation:

Number of stations occupied..... 11

Number of geographical positions determined..... 24

Topography (scale 1-10 000):

Approximate area in square statute miles..... 18

Number of miles of shore line surveyed..... 21

Number of miles of roads and railroads surveyed..... 13

Number of miles of marsh line surveyed..... 11

Number of miles of creeks surveyed..... 52

Hydrography (scale 1-10 000):

Area of hydrography (square miles).....	11
Number of miles run in sounding.....	320
Number of angles measured.....	1 927
Number of soundings.....	30 823

Mr. M. A. Coles served faithfully as recorder and as extra observer during the season.

After leaving the field Mr. Welker took up office work at his home till June 14, when he proceeded under instructions to Utah to report for duty to Assistant Eimbeck.

Completion of the survey of Perdido Bay and its tributaries, Florida and Alabama. Triangulation, topography, and hydrography.—The general survey of Perdido Bay and its tributaries, Florida and Alabama, which had been begun by Assistant Stehman Forney in December, 1890, and in part finished during the winter and spring of 1890-1891, as stated in the last Annual Report, was resumed by that officer in March, 1891, and completed June 2.

Camp having been established at Mifflin Landing, Alabama, Mr. Forney turned the schooner *Transit* over to Mr. John B. Boutelle, acting aid, and placed him in charge of the triangulation of Perdido river from its mouth to the branch 4 miles above, known as the Blackwater, while Mr. Forney himself, aided by Mr. O. B. French, as topographer, took up the topography and hydrography of the upper end of Wolf Bay and its tributaries.

After Mr. Boutelle had finished the triangulation assigned to him, he joined the main party and rendered valuable service in the general work of the survey.

Owing to unfavorable weather during the early part of March, field work could not be begun until the 27th of that month, but as fine weather prevailed during April and May, the survey was energetically pushed forward, and was completed nearly a month earlier than had been estimated. The party was disbanded June 9, and later in the month Mr. Forney reported at the office, and received instructions to prepare for the resumption of the survey of the Kennebec River, Maine. An abstract of his report of work executed on the Kennebec during the summer and autumn of 1890, is given under a preceding heading in this volume, and under a heading in the Middle Division, report is made of his reconnaissance for a triangulation of the Rio Grande del Norte, from El Paso, Texas, in connection with a proposed survey of the boundary line between the United States and Mexico.

In closing his report Mr. Forney expresses his indebtedness to Messrs. Boutelle and French for able and faithful coöperation in the work.

The statistics of the season are as follows:

Triangulation:

Area, in square statute miles.....	5
Number of signal poles erected.....	14
Number of stations occupied for horizontal measures.....	17
Number of geographical positions determined.....	17

Topography:

Area surveyed, in square statute miles.....	100
Length of shore line of rivers in statute miles.....	69
Length of shore line of creeks in statute miles.....	63
Length of roads in statute miles.....	15
Number of topographic sheets (scale 1-10 000) finished.....	4

Hydrography:

Area sounded, in square geographical miles.....	68
Number of miles (geographical) run while sounding.....	352
Number of angles measured.....	1 475
Number of soundings.....	17 740
Number of hydrographic sheets (scale 1-10 000) finished.....	3

Continuation of the reconnaissance and occupation of stations for the extension of the primary triangulation in Alabama towards the Gulf of Mexico.—The party in charge of Assistant F. W. Perkins,

engaged in carrying to the southward and southwestward in Alabama the primary triangulation towards the Gulf of Mexico, remained in the field till September 5, 1890. An abstract of the progress of this work from the beginning of the season in February of that year to June 30 was given in the last Annual Report.

Mr. Perkins has submitted with his report a sketch showing the progress of the triangulation and of the reconnaissance, which, at the close of the season had been advanced to the southward of the parallel of $31^{\circ} 30'$ north.

Sub-assistant W. B. Fairfield rendered most acceptable service in the work until he was transferred to other duty in May. During the latter part of June, Mr. W. B. English was assigned to duty in the party; his industry and aptness made up largely for his want of experience.

Following are the statistics of the season:

Reconnaissance:

Area of, in square miles.....	2 700
Number of lines of intervisibility determined.....	15
Number of points selected for scheme.....	6

Triangulation:

Area of, in square statute miles.....	1 500
Signal poles erected, number of.....	11
Observing tripods and scaffolds built.....	7
Number of days occupied in opening and verifying lines of sight.....	38
Number of stations occupied for horizontal measures.....	5
Number of stations occupied for vertical measures.....	4
Number of geographical positions determined.....	10
Number of elevations determined trigonometrically.....	15

Azimuth:

Number of observations on star for azimuth.....	48
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Early in December Mr. E. E. Torrey, foreman of signal building, was directed to continue the work of erecting the observing tripods and scaffolds in Alabama in advance of the occupation of stations, and to report for that purpose to Mr. Perkins, who took up later in the season duty on the coast of Louisiana, which is referred to subsequently in this volume.

Connection of Memphis, Tennessee, with Corinth, Mississippi, by lines of geodetic leveling.—Two of the sides of the geodetic leveling triangle, Cairo-Corinth-Memphis, having been determined, the side Cairo-Corinth by the Coast and Geodetic Survey, and the side Cairo-Memphis by the Mississippi River Commission, the measurement of the third side Memphis-Corinth was assigned to Assistant Isaac Winston towards the end of October, 1890.

Upon reaching Memphis, Mr. Winston organized his party, Mr. F. A. Young, aid, and Mr. Edmund Quinn, recorder, having reported to him for duty, and the work was begun November 8.

The bench-mark, which had been established by the U. S. Engineers on the Custom-house at Memphis, Tenn., was found undisturbed and in good condition, and was taken as the initial point of the line.

In accordance with the system of work which has been adopted for several years past, two independent lines were run, one forward and the other backward, by two observers, using different instruments. From Memphis to La Grange, Tenn., the line forward, 81 kilometres, (50.33 miles) was run by Mr. Winston, with geodetic level No. 5, and the line backward, or check measurement, was run by Mr. Young with geodetic level No. 6.

The party was then transferred to Corinth, Miss., and the line started from a bench-mark on the Court-house which Mr. Winston had established during a preceding season when engaged in completing the direct line of geodetic leveling connecting Cairo and Mobile.

From Corinth to La Grange, 72 kilometres (44.8 miles) Mr. Winston ran the forward line with level No. 5, and Mr. Young the backward line with level No. 6. Whenever the discrep-

ancy between the forward and backward measures between bench marks exceeded the established limit of error, a remeasurment was made by either observer or instrument indifferently as might conduce to the progress of the work.

The lines follow the Memphis and Charleston Railroad, and in most cases the instrument was placed in the center of the track with the rods held outside of the rails to secure a firm foundation for the foot plates.

Mr. Winston acknowledges the kindness of Captain Pegram, Division Superintendent of the East Tennessee, Virginia, and Georgia railway system, in directing local trains to take on and put off the party between regular stations. This privilege aided materially in advancing the progress of the work.

On January 23, the line was completed, thus establishing a check connection between the geodetic leveling lines on the Mississippi river and the lines connecting Cairo with the Gulf of Mexico at Mobile.

Mr. Winston, in his report, commends the skill and energy of his aid, Mr. Young, who has become quite expert in the use of levels of precision. Mr. Quinn's services as recorder were very acceptable.

Upon reporting at the office Mr. Winston was directed to complete his field computations; later he was assigned to other office duty, and in April, 1891, was instructed to resume work on the transcontinental line of geodetic leveling in the vicinity of Jefferson City, Mo.

Reconnaissance between Lakes Huron and Erie on the Detroit and St. Clair Rivers and country adjacent to determine a scheme of triangulation connecting with the triangulation of the U. S. Lake Survey.—In order to ascertain the practicability of a scheme of well conditioned triangulation at a moderate cost, which should extend along the Detroit River and the eastern boundary of Michigan from Lake Erie to Lake Huron and connect on the south with the triangulation of the U. S. Lake Survey, Assistant C. H. Boyd, was instructed early in August, 1890, to report at the office for conference with the Superintendent, and thence to proceed to Detroit, Mich., and make the reconnaissance required.

After going carefully over the ground to be covered by the proposed triangulation, Mr. Boyd reported that it was without natural elevations; was thickly settled, wooded with valuable forests and orchards, and that several large cities and towns would be obstacles to the progress of the work.

To develop a symmetrical scheme of triangulation based upon the Lake Survey line, Middle Sister-Stoney Point, Mr. Boyd estimated that signals of about 100 feet in height would be required, and that a minimum cost for each signal would involve an expenditure of nearly \$10,000. It appeared undesirable, therefore, for the survey to undertake the work, the representation of new features since the traverse survey made 30 years ago not being of importance enough to warrant the expense.

A request having been made for Mr. Boyd's detail to execute certain surveys for the Chickamauga and Chattanooga National Military Park Commission, he was directed to report to that Commission for duty under its direction.

Continuation of geodetic operations in the State of Wisconsin.—Upon taking the field June 16, 1890, under instructions to continue the triangulation of the State of Wisconsin, Prof. John E. Davies, Acting Assistant, began preparations for the occupation of station Arlington with special reference to the observation of the line Arlington—Observatory Hill.

It had been ascertained that to clear this line, either heavy cutting would be needed through the woods on a high granite ridge known as Pophams Ridge, about 6 miles south of Arlington, or else a high signal would have to be erected on Observatory Hill. The latter plan was decided upon, and the erection of this signal (75 feet in height), the putting up of five new signals to replace those blown down or beyond repair at stations to be observed upon, and the addition of from 15 to 20 feet to be made to the height of the poles at two stations, required so much time that after the completion of the work at Arlington, but one other station, Observatory Hill, could be occupied during the season.

In August a reconnaissance was undertaken by Prof. Davies in order to obtain a provisional scheme of triangulation from Dubuque, Iowa, to La Crosse, Wis., connecting with the general scheme of the triangulation of the State. Seventeen points were selected for this scheme, a sketch of which has been transmitted to the Office.

Field operations were suspended for the season September 20. In June, 1891, Prof. Davies was instructed to complete the work at Observatory Hill, and to occupy Fitzsimmons as a geodetic station, its geographical position having been determined by the late Assistant C. O. Bontelle in 1887.

The work of Prof. Davies and that of other officers engaged in State Surveys was placed in immediate charge of Assistant George A. Fairfield by instructions of the Superintendent, dated March 27, 1891.

Continuation of the primary triangulation advancing to the westward near the 39th parallel in Indiana to a connection with that advancing to the eastward in the same State, and reconnaissance for a base of verification.—The progress of the primary triangulation party under the charge of Assistant A. T. Mosman, engaged in advancing the transcontinental triangulation to the westward in the State of Indiana was reported up to July 1, 1890, in the last annual volume. The primary stations, Culbertson and Glasgow, having been occupied under his direction since the beginning of field operations at the end of May, Mr. Mosman moved his party on July 2 to station Correct, Ripley county, about 4 miles south of the town of Versailles.

All of the observations at this station had been completed by July 19, except those on station Stout, the rebuilding of the signal, 136 feet high, at that point not having been finished. The destruction of this signal by a cyclone was mentioned in the last Annual Report. Upon its completion, July 26, it was found necessary to cut a number of trees, some of them 130 feet high, which obstructed the line for the first 7 miles, and then, in order to avoid some additional cutting for a distance of 5 miles through some very heavy timber, Mr. Mosman built up some 42 feet more at Stout, making the entire height 168 feet. On top of the narrow support thus obtained, a heliotrope was mounted, but as it was not visible from the observing tripod at Correct, 116 feet high, night signals were resorted to, the large refraction being depended upon to elevate the light at Stout enough to enable it to be seen from Correct. After much delay owing to unfavorable weather, the work at Correct was finished on the night of August 27, all of the observations required to determine the horizontal directions to Glasgow and to Stout having been obtained.

The party was then transferred to station Mud Lick, Jefferson county, 6 miles north of the town of Madison. Observations made here between August 30, and September 2, completed the work at this station.

The line of junction, Green-Stout, of the transcontinental triangulation advancing to the westward in Indiana with that advancing to the eastward having been now determined by the parties of Assistants Mosman and Fairfield, respectively, Mr. Mosman was instructed early in September to make a reconnaissance for a site of a base of verification in the country in the vicinity of stations Glasgow and Correct. By September 15, he had selected a site near the village of Holton, Ripley county, and after several trial lines had been run to find the best way of avoiding obstructions, the base line was definitely located and staked out. Its approximate length was found to be 5 500 metres, or about $3\frac{1}{2}$ miles.

Before the line could be connected with the triangulation, it was necessary to build signals at each end 100 feet high. On October 23, these were completed, and the ends of the line were marked by stone monuments. Much cutting was necessary, even after the 100 feet signals had been built, in order to open lines to the other stations, but on November 7 they were all clear, and before the end of the month the base had been connected with the triangulation by observations for horizontal directions at stations Green, North Base, South Base, Glasgow, and Correct.

On November 29, the base line was measured with a fifty-metre tape, and a second measurement was made December 1.

Field operations were closed for the season and the party disbanded December 4.

Sub-assistant W. B. Fairfield was attached to the party during the whole season. He occupied two stations, Stow and Culbertson, before Mr. Mosman took the field, and performed all his duties with zeal, intelligence, and accuracy.

Mr. E. E. Torrey was foreman in the party and served also as recorder, assisting also in the observations by reading one microscope. The building of the high tripod and scaffold signals he attended to personally, and his services generally are highly commended in the report of his chief.

Upon reporting for duty at the office in Washington, Mr. Mosman took up the computations of his field work and prepared his records and results for deposit in the Archives.

The statistics of the season are as follows:

Reconnaissance for site of base:

Area of, in square statute miles.....	21
Lines of intervisibility determined as per sketch submitted	7
Number of points selected for scheme	5

Base Line:

Primary, length of, in metres.....	5 500
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Triangulation:

Area of, in square statute miles.....	488
Signal poles erected, number of.....	8
Observing tripods and scaffolds built, heights in feet.....	136, 100, 100
Number of days occupied in opening and verifying lines of sight.	29
Geographical positions determined, number of.....	10

Connection of the primary triangulation near the 39th parallel advancing to the eastward in the State of Indiana with that advancing to the westward in the same State.—At the beginning of the fiscal year, as stated in the last Annual Report, the party of Assistant George A. Fairfield were pitching camp preparatory to the occupation of Green station, about 12 miles northeast of North Vernon, Jennings county, Ind. The line Green-Stout was the line of connection of the two branches of the transcontinental triangulation near the 39th parallel, one of which, for several seasons preceding, had been advanced to the eastward by Assistant Fairfield, and the other to the westward by Assistant Mosman.

On July 11, which was as soon as the weather permitted, observations of horizontal directions were begun at station Green, and by the 21st they had been completed on all of the stations to be observed except Stout, the high signal at this point, which had been destroyed by a cyclone towards the end of June, being still in course of reconstruction. After its completion, July 26, much heavy cutting of timber was found necessary to clear the line between the two stations, and the signal light at Stout was not seen until advantage was taken by Mr. Fairfield of a superstructure 18 feet high which had been put by Mr. Mosman on top of the 136 feet signal at Stout. Mounting his light at this elevation, 154 feet, the station light at Stout showed clearly, and the work at Green was finished August 14.

Camp was then struck and the party moved to station Stout in Jefferson county, about 15 miles in a southwardly direction from North Vernon. The lines to station Green and Correct were cleared, but as Mr. Mosman was then occupying Correct, and observing on a light mounted on a superstructure at Stout, the theodolite could not be mounted at this station till he had finished. Notice to this effect having been received by Mr. Fairfield, August 28, the instrument was set up and observations begun the next day. All were completed September 2, except those on stations Green and Correct. More trees had to be cut on the line to Green, and it was found necessary to build a superstructure 40 feet high on the signal at Correct in order to avoid extremely heavy cutting. This was done as soon as possible after all observations needed had been obtained by Mr. Mosman, (who was then at his station Mud Lick), on Correct. Work at Stout was finished and the two systems of triangulation connected on September 13, 1890.

Mr. J. B. Boutelle, extra observer, was attached to the party throughout the season, and at two of the stations having very high signals made all of the observations. This, Mr. Fair-

field had no hesitation in allowing him to do, knowing that he was a rapid and skillful observer. Mr. R. L. McCormick served efficiently as recorder.

The statistics of the work for the period July 1 to September 20, 1890, are as follows:

Triangulation:

Area of, in statute miles.....	276
Days occupied in opening and verifying lines of sight.....	19
Number of stations occupied for horizontal measures.....	2
Number of geographical positions determined.....	6

After disbanding his party and making due disposition of his instruments and camp equipment, Mr. Fairfield proceeded to his home on leave of absence. Early in November he was appointed acting assistant in charge of the office during a month's absence on leave of Assistant B. A. Colonna. After the return of Mr. Colonna to the charge of the office, Mr. Fairfield was directed to act as executive officer to the Superintendent during a temporary absence of Assistant Braid.

In March, 1891, he was instructed to take charge of and direct in behalf of the Superintendent the operations of the parties engaged in furnishing points for State surveys. In this duty he was occupied during the remainder of the fiscal year.

Preparations for the measurement of a primary base of verification at Holton, Ind.—Assistant A. T. Mosman, having received instructions to make preparations for the measurement of a primary base of verification at Holton, Ind., gave direction to his foreman, E. E. Torrey, to begin the preliminary work of laying out a camping ground—the lumber needed for tent floors, stable, ice house, and comparing house having been sawn and delivered on the ground during the preceding winter.

Mr. Mosman reached the working ground on May 5, 1891, having been preceded about ten days by Mr. Torrey. On the 6th, in accordance with instructions, he went to Charleston, W. Va., where Sub-assistant W. B. Fairfield met him by appointment to confer with him in regard to the location of a second base line near St. Albans, West Virginia.

All preparations needful for the beginning of the measurement were pushed forward, in expectation of the early arrival of Assistants Woodward and Tittmann with the base apparatus from Washington, but delays of an unavoidable nature occurred in making the comparisons at the Office, and the time between June 3 and the end of the fiscal year was therefore utilized by setting section stones and carefully aligning them in position at distances of 1 200, 2 100, 3 000, 4 000, and 5 000 meters from South Base.

In this and other preliminary work Mr. Mosman had the services of the following-named members of his party who had arrived at camp in June: Prof. J. H. Gore, Temporary Aid John S. Siebert, and Recorders Th. Gjertsen, Frank B. Cope, and Robert Pennington.

Stones were also set at 3 900 and 4 900 metres from South Base to mark the ends of the kilometre which it had been arranged should be measured with a standard bar encased in ice. Levelings were made to determine the height of the base line above sea level, lines of level being run in both directions between the bench mark of the transcontinental line of geodetic leveling near Cochran and 26 miles east of Holton, to the station at North Base. This leveling was begun June 15 by Mr. Siebert, assisted by Mr. Gjertsen, and was finished June 27.

Prof. Gore, with the aid of Messrs. Pennington, Cope, and Gjertsen, ran a line of levels from a bench mark at Osgood left by Mr. Siebert to the Courthouse at Versailles, Ind., a distance of 5 miles, a bench mark being cut on the sill of the Courthouse east door, and referred by lines of leveling to the primary triangulation stations Correct, 4 miles to the south, and Reizin, 7 miles east.

Bench marks were left by Mr. Siebert at Milan, Delaware, Osgood, and Poston, on or near the Ohio and Mississippi Railroad, and the height of primary triangulation station Glasgow was determined at the same time.

Levels were run by Prof. Gore along the line of the base from north base to south base, making each kilometre or section stone a bench mark of known elevation.

An abstract of the account of the measurement of the base, which was begun in July, will appear in the next Annual Report.

Reconnaissance for the location of a base line in West Virginia and for its connection with the transcontinental triangulation.—It having become desirable to locate a site for a base line in West Virginia of from 2 to 5 miles in length, and so situated as to be readily connected with the transcontinental triangulation, Sub-assistant W. B. Fairfield was instructed to take the field as soon as possible after April 1, 1891, and make the reconnaissance required, conferring with Assistant Mosman in regard to the section of country to be examined.

Leaving Washington April 10, Mr. Fairfield examined in succession the counties of Raleigh and St. Nicholas to the southwest and northeast of the Kanawha River, but the irregular and broken character of the country in both counties, the valleys being narrow and flanked by hills on either side, afforded no location suitable for a base.

He then took up an exploration of the country to the westward of Kanawha Falls, in the valleys and bottom lands of the Kanawha River, and soon after reaching St. Albans, a small town in Fayette county, about 12 miles to the west of Charleston, he found a base line site of sufficient length and favorably situated for a connection with the primary triangulation.

The line starts in the town of St. Albans at a point about 60 feet north of the Chesapeake and Ohio Railroad, and about 400 metres (1 312 feet) west from the railroad station, and extends to the eastward 3 725 metres (2 311 miles) to the bank of Two-and-three-quarter-mile Creek, beyond which it is not practicable to extend it. The site is free from obstructions, and almost level. There is one place where the land falls gradually some 15 feet in elevation, but this presents no serious obstacle to the measurement.

Mr. Fairfield has submitted with his report a sketch showing the scheme resulting from his reconnaissance for the connection of the base with the transcontinental triangulation. Owing to the configuration of the country he had much difficulty in obtaining points for the first figure coming off the base, but he was eventually successful, and has presented a scheme which is regarded as very satisfactory.

The work was finished June 17, and Mr. Fairfield left St. Albans the next day for Holton, Ind., where he consulted with Assistant Mosman in regard to the base line. Soon after, he was instructed to join the party of Assistant Perkins, engaged in advancing the primary triangulation to the westward and to the eastward from Fort Wallace, Kansas.

Occupation of stations in continuation of the triangulation of the State of Tennessee, and for its connection with the triangulation of the State of Kentucky.—At the beginning of the fiscal year, Prof. A. H. Buchanan, Acting Assistant, had been in the field since June 10, engaged in selecting a scheme of triangulation and erecting signals for the connection of the triangulation of the State of Tennessee with that of the State of Kentucky.

This work he finished July 31, 1890, having erected signals at stations Cross, House, Clinch, McLean, White Rock (on the Virginia and Kentucky line), Short, and English. These seven signals ranged in height from 40 to 50 feet, and care was taken to build them of black locust and chestnut, the most desirable material available.

During the remainder of the season of 1890, Prof. Buchanan occupied two of his old stations, Cockspur and Melton, to observe upon the new points. On September 30 he suspended field operations, and on June 2, 1891, under instructions from the Superintendent, supplemented by detailed instructions from Assistant George A. Fairfield, in immediate charge of State Surveys, he resumed work by occupying station Luper. The observations at this point were completed June 20, and on June 30 the party had been moved to station Cross, and were ready for observing.

Prof. Buchanan has submitted a report with sketch showing the advance of his triangulation to the close of the fiscal year. The statistics for the season of 1890 and 1891, July 1 to June 30, are as follows:

Triangulation:

Signals erected	7
Stations occupied	3

ABSTRACTS OF REPORTS FROM FIELD PARTIES, FISCAL YEAR 1891.

MIDDLE DIVISION.

STATES AND TERRITORIES BETWEEN THE MISSISSIPPI RIVER AND THE ROCKY MOUNTAINS.

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

Progress Sketches No. 2, Nos. 4, 5, 6, and Nos. 10, 15, and 16, show the localities of field work in the Middle Division. A list of Progress Sketches will be found at the close of this volume.

Reconnaissance and occupation of stations in continuation of the triangulation of the State of Minnesota.—Geodetic operations in the State of Minnesota were resumed by Prof. W. R. Hoag, Acting Assistant, at the beginning of the fiscal year, in accordance with instructions issued toward the end of May, 1890.

Prof. Hoag's chief work during the season was to finish the measurements of horizontal angles at all stations previously occupied, and to close observations at the stations of the pentagonal figure Wallace, Marcott, Prescott, Hampton, Buck Hill. Vertical measures with micrometer for differences of heights were made at all the stations.

A reconnaissance was conducted in the northwestern part of Hennepin county to extend the triangulation in that direction, and a station for occupation was selected at Haddon.

During the latter part of August a reconnaissance was carried to the east and north toward Duluth, covering points in Wisconsin adjacent to Minnesota. During the latter part of September, station Wallace was occupied, and the lines to Hampton, Marcott, and Buck Hill were opened.

Field operations were suspended September 20.

Following are the statistics reported :

Triangulation :

Number of stations occupied for horizontal measures	12
Number of stations occupied for vertical measures	12
Number of geographical positions determined	14

Early in June, 1891, Prof Hoag was instructed to resume geodetic work by carrying a reconnaissance down the Mississippi River from the line Hampton-Prescott, near the town of Hastings, Minn., towards La Crosse, Wis., having in view a connection with one of the lines of the reconnaissance of Prof. Davies which had been carried up the river from Dubuque to La Crosse.

In this duty he was actively engaged at the close of the fiscal year.

The work of Prof. Hoag and that of other officers engaged in State Surveys was placed in immediate charge of Assistant George A. Fairfield by instructions of the Superintendent, dated March 27, 1891.

Determinations of longitude at stations in Minnesota and North Dakota, Utah and Montana, by exchanges of telegraphic signals.—The beginning of a series of longitude operations planned to furnish a northern connection from Salt Lake City and Chicago with the Pacific coast longitudes was referred to in the last Annual Report. On July 1, 1890, Assistant C. H. Sinclair at Salt Lake City, Utah, and Assistant R. A. Marr at Helena, Mont., had everything in readiness at their respective stations for exchanging telegraphic signals for longitude. In the first position of the observers, exchanges were obtained on the nights of July 2, 3, 6, 7, and 10; Mr. Sinclair then proceeded to Helena and Mr. Marr to Salt Lake City, and a second set of exchanges was obtained July 12, 13, 15, 21, and 22, completing the line Salt Lake City-Helena.

From Helena Mr. Marr went to Bismarck, North Dakota, and established a longitude station in the grounds of the Court House. Longitude signals were exchanged with Helena on July 28 and 30 and August 1, 3, and 4. The observers then changed places and a second set of exchanges was obtained August 6, 8, 12, 13, and 16, completing the determination.

The instrumental outfit at Helena was then transferred by Mr. Marr to Minneapolis, Minn., and signals were exchanged with Mr. Sinclair at Bismarck August 20, 21, 25, 26, and 27. After the exchange of places by the observers, the determination of the line Bismarck-Minneapolis was completed by exchanges made August 28, 29, 30, and 31.

While at Helena, Mr. Sinclair determined the latitude of the station by seventy-two observations on twenty-four pairs of stars on four nights with zenith telescope No. 6. At Bismarck one hundred and sixteen observations were made on thirty-six pairs of stars on five nights for the determination of latitude.

Mr. Sinclair observes that when the lengths of the lines determined for longitude are considered, 548, 681, and 471 miles respectively, the number of exchanges, thirty in two months, is above the average.

After the completion of the season's work the longitude parties early in September returned to Washington in accordance with instructions.

Mr. Sinclair acknowledges the intelligent and satisfactory service rendered in the work by Mr. Geo. R. Putnam, who joined the party as recorder, and whose previous experience in observing for time, latitude, and the magnetic elements made his assistance of special value.

In December Mr. Marr decided to accept an offer made to him of a professorship in the Virginia Military Institute, Lexington, Va., and accordingly tendered his resignation as an Assistant in the Coast and Geodetic Survey, to take effect January 1, 1891. The Secretary of the Treasury having been duly notified, acceded to the recommendation of the Superintendent that Mr. Marr's resignation be accepted.

In taking this action the Superintendent expressed to Mr. Marr his regret at the severance of their official relations, and his gratification with the manner in which the important professional duties entrusted to him had always been discharged.

Determinations of latitude and longitude at stations in the State of Missouri.—In coöperation with the Geological Survey of the State of Missouri under the direction of Prof. Arthur Winslow, State Geologist, Assistant C. H. Sinclair was instructed, towards the end of October, 1890, to proceed to St. Louis, and make arrangements with Prof. H. S. Pritchett, of the Washington University, for the determination of the longitude of two stations in the State by exchanges of telegraphic signals with St. Louis. Observations were also to be made for the latitude of these stations, Ironton and Potosi.

The station at St. Louis was in the grounds of the Washington University. Observations for personal equation between Prof. Pritchett and Mr. Sinclair were made November 3, 4, and 5. On November 6, Mr. George R. Putnam, who had been directed to aid Mr. Sinclair, went to Ironton, Iron county, Mo., and selected a site for an astronomical station about 100 metres southeast of the depot of the St. Louis, Iron Mountain and Southern Railroad. Pilot Knob Summit is about $\frac{4}{5}$ of a mile north and a little to the east of the station. Two stones were set to mark the ends of a meridian line, and the station was referred to the summit of Pilot Knob, to the cupola of the Public School, and to the tower of the Presbyterian church.

The work was delayed at the outset by rain and cloudy weather, but on November 12, 13, and 18, longitude signals were successfully exchanged with Prof. Pritchett at St. Louis. Mr. Putnam determined the latitude of the station by one hundred and three observations on thirty-one pairs of stars.

On November 19 the instruments were transferred to Potosi, Washington county, Mo., where a site for the station was selected in the grounds of the Court House. Stones were set to mark the ends of a meridian line, and the position of the station was referred to the cupola of the Public School and to the Court House cupola.

Exchanges of longitude signals were obtained with St. Louis on November 20, 23, and 24.

Latitude was determined by Mr. Putnam, who made sixty-six observations on twenty-four pairs of stars.

The observers then returned to St. Louis, and obtained two nights determinations of personal equation with Prof. Pritchett November 27 and 28.

Mr. Sinclair then went to Jacksonville, Tex., as stated under the preceding heading, while Mr. Putnam proceeded under instructions to the Office, where he was assigned to duty in the gravity party under charge of Assistant E. D. Preston.

Transcontinental line of geodetic leveling extended to the westward in Missouri from Jefferson City to Kansas City.—Upon being relieved early in April, 1891, from office duty, and instructed to prepare for field work, Assistant Isaac Winston proceeded to Jefferson City, Mo., and re-organized his party for extending to the westward from a station near that city the transcontinental line of geodetic leveling.

Mr. F. A. Young, aid, reported for duty April 20, and field work was begun the next day, and continued to the end of the fiscal year, at which date the lines of leveling of precision had been carried to Dresden, Pettis county, a town 10 kilometres (6.2 miles) west of Sedalia, Mo., and 125 kilometres (77.7 miles) from the starting point.

In this distance fourteen permanent bench marks were established.

The line follows the Missouri Pacific Railway, and the work was executed according to the system used for several years past in the standard leveling of the Survey, the forward line (west) having been run by Mr. Winston with one instrument, and the backward line (east) by Mr. F. A. Young, aid, with another.

During the progress of the line westward, advantage was taken of the proximity of several of the stations of the transcontinental triangulation to connect them with the line of levels, and elevations were thus determined for the points Medlock, Christian, Cole, Heard, and Hubbard.

At the close of the fiscal year the party was actively engaged in prosecuting field operations. Mr. Winston makes special acknowledgement of the valuable service rendered by Mr. Young.

Occupation of stations continued and reconnaissance extended for carrying to the westward in Kansas the transcontinental triangulation near the 39th parallel.—Assistant F. D. Granger, in charge of the party for extending to the westward in Kansas the primary triangulation near the 39th parallel, was engaged at the beginning of the fiscal year in the occupation of the station Vine Creek, Ottawa county. Observations of horizontal and vertical measures were completed at this station July 22, six primary, five secondary, and eleven tertiary objects having been observed. The party was then transferred to Iron Mound, a station in Saline county, about 7 miles southeast of Salina, the county seat. At this point five primary, one secondary, and seventeen tertiary objects were observed. Upon completing work here August 13, preparations were made to take up the reconnaissance for the selection of stations to the westward. Beginning August 21, this work was pushed ahead unremittingly till the close of the season, November 12, at which date connection had been made with the most eastern points of the scheme brought into Kansas from Colorado by Assistant F. W. Perkins in 1882.

The general character of the scheme is one of quadrilaterals. Mr. Granger's object was to provide a plan of triangulation requiring as few observing tripods and scaffolds as possible, and to avoid the necessity for very high tripods, since these would be totally unprotected from the prevailing strong winds, and would be greatly in danger of destruction. The scheme submitted, calls for only six signals over 25 feet in height. The sketch accompanying the report shows by figures in red the height of signal needed at each station, and by figures in black the height of each point above sea level. From these it appears that the land rises rapidly toward the west from Thompson station, 1 605 feet to station Schmidt, 2 568 feet, a distance of upwards of 120 miles.

From any two of the connecting points shown in the sketch it will be possible to start a triangulation either to the north or to the south. Observations for differences of heights were made with a gradiometer. The selection of points for connecting the triangulation with the

astronomical station at Ellsworth had to be postponed for want of time. Mr. Granger made a cursory examination of the country during the course of his reconnaissance in order to note localities that would be suitable for a base line, and reports that lines of from 5 to 12 kilometres in length can be obtained either in the broad valley of the Saline River, west of Salina, or on the high prairie in the vicinity of Russell, or on the high land in the neighborhood of Ransom, near Schmidt station.

Mr. M. A. Coles served efficiently as recorder in the party.

The statistics of the season's work are as follows:

Reconnaissance:

Area of, in square statute miles	2 574
Lines of intervisibility determined as per sketch submitted	7
Number of points selected for scheme	18

Triangulation:

Area of, in square statute miles	408
Stations occupied for horizontal measures	2
Stations occupied for vertical measures	2
Number of geographical positions determined	3
Number of elevations determined trigonometrically	3

In the spring of 1891 Mr. Granger was instructed to organize his party for the occupation of the stations selected during his reconnaissance.

Leaving Washington May 19, he arrived at Junction City, Kans., on the 23d, and having re-organized his party, began the erection of signals preparatory to observations of horizontal directions. By the close of the fiscal year four signals had been built, two of which were observing tripods, and a fifth signal, also an observing tripod, and 57 feet high, was well underway at station Heath. At this station on June 24, the party went into camp, and began observations soon after June 30.

Progress subsequent to that date will be stated in the next Annual Report.

Extension of the transcontinental triangulation near the 39th parallel to the westward and eastward from Fort Wallace, Kans.—In May, 1891, Assistant F. Walley Perkins was instructed to proceed to Western Kansas and organize a party for the extension to the westward and eastward of the primary triangulation near the 39th parallel from the vicinity of Fort Wallace at the head waters of the Smoky Hill River.

The building of signals was begun May 7, the points of the reconnaissance of 1881, having been, for the most part, readily recovered. All arrangements for the work were completed by the end of the fiscal year, and some observations had been made at station Wallace Bluffs. An abstract of progress with statistics will be given in the next Annual Report.

Duty assigned to Mr. Perkins in Alabama and Louisiana earlier in the fiscal year is referred to under a preceding and a subsequent heading in this report.

Hydrographic surveys on the coast of Louisiana between Barataria Bay and Last Island.—After finishing the hydrographic resurvey of Aransas Pass Texas, a report of which appears under a following heading, Lieut. Edward W. Hughes, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Bache*, proceeded under instructions to the coast of Louisiana, and took up the hydrography of a part of the coast about 45 miles in length, extending from the middle of Grand Isle to the eastern end of Isle Dernière. From the coast line the soundings were carried off-shore to the outer 10-fathom curve.

In addition to this, hydrographic surveys were made of Lake Pelto, and of Terre Bonne, Timbalier, and Caminada Bays and their entrances. The weather being exceptionally favorable, the hydrography, begun March 13, 1891, was prosecuted with but few interruptions until April 24, when it was completed.

The results of this survey are shown on four projections, three for the inshore or boat work on a scale of 1-20 000, and one for the off-shore or steamer work on a scale of 1-80 000.

Lieut. Hughes remarks that the shores of Terre Bonne Bay are entirely uninhabited, and those of Timbalier Bay are nearly so. On West Timbalier Island about half a dozen small

houses, and about as many scattered along the eastern and western shores of the Bay were the only signs of human habitation encountered until after passing the mouth of Bayou La Fourche, when the country becomes thinly settled.

The waters of Terre Bonne and Timbalier Bays are deserted except by a few luggers. Beds of oysters (uncultivated) are found in Lake Pelto and in Terre Bonne and Timbalier Bays; they are of excellent flavor, but the beds have been nearly exhausted in recent years to supply the demands of a migratory canning establishment, for some time at Morgan City, but since removed to Mobile, Ala.

Lieut. Hughes gives, in his report, full details respecting the tidal observations, which were begun March 13, and continued without interruption (from 6 a. m. till 6 p. m.) to the close of the season. The tide-gauge was established at Timbalier Light-house. For nearly one-half of the time occupied in the survey there was an extraordinary persistence of southeasterly winds, producing unusually high tides on the coast and in the bays; hence the plane of reference obtained for the soundings was probably somewhat above the normal.

In the passes and entrances of the bays the tidal currents are of considerable strength and usually set fairly in or out as the tide flows or ebbs, and in a direction generally normal to the coast line.

The officers attached to the *Bache* were Lieut. W. L. Burdick, U. S. N., Ensigns W. W. Buchanan, J. F. Luby, Ford H. Brown, and W. B. Hoggatt, U. S. N.

Following are the statistics of work on the coast of Louisiana:

Hydrography:

Area sounded, in square geographical miles	983
Number of miles (geographical) run while sounding.....	1 511
Number of angles measured	8 379
Number of soundings	55 422
Number of specimens of bottom preserved	50

On May 1, 1891, the *Bache* left New Orleans for New York, and upon her arrival, May 11, at the last named port, Lieut. Hughes proceeded at once to refit her for a season's work on Nantucket Shoals, in continuation of the important resurvey which had been placed in his charge in the summer of 1890. An abstract of his report of this work during 1890 has been given under a preceding heading.

Reconnaissance for the connection of the triangulation of the Mississippi River in the vicinity of Donaldsonville with that of the Gulf of Mexico by way of the Atchafalaya River.—In January and February, 1891, Assistant F. W. Perkins made a careful reconnaissance of the country between Morgan City at the head of the Atchafalaya River and Napoleonville on Bayou La Fourche, about 12 miles south of Donaldsonville on the Mississippi River, with a view to determine the practicability of laying out a scheme of triangulation which would furnish a satisfactory check upon that of the Gulf by connecting it with the triangulation of the Mississippi.

He found that the greater part of the region examined was a swamp or floating marsh, heavily wooded with cypress, gum, ash, oak, etc., the trees being generally from 85 to 100 feet in height, reaching occasionally 110 or 120 feet, and so much enlarged at the base that trunks 18 inches in diameter were often from 4 to 5 feet in diameter at chopping height. Water stands on most of this area at depths of from a few inches to 2 or more feet.

As the ground offered no sufficient support for large signals of the usual type, and since the opening of lines through such heavy timber would entail a very large expenditure, Mr. Perkins reported the facts to the Office, suggesting at the same time a series of expedients by which stations could be occupied and a connection finally effected between the two systems of triangulation. The Superintendent, upon a review of the subject, decided that it would not be advisable to enter upon the work for the present, and accordingly Mr. Perkins was instructed to disband his party and return to Washington.

In April he was directed to make preparation for taking up the primary triangulation near the 39th parallel westward and eastward from the vicinity of Fort Wallace, Kans.

Observations of the magnetic elements, absolute and differential, continued at the automatic registry station, San Antonio, Tex.—Reference was made in the last Annual Report to the establishment of a self-registering magnetic station at San Antonio, Tex., during 1889-1890; to the beginning of a photographic record of changes in magnetic force on March 17, 1890, under direction of Assistant Andrew Braid, and to the transfer of the direction of the work on May 23 to Assistant R. E. Halter, aided by Mr. L. G. Schultz.

Mr. Halter has submitted his report for the fiscal year 1891. On July 1, 1890, only the unifilar and bifilar magnetographs were in position and recording, the vertical force magnet having been taken by Mr. Braid to Washington to have remedied certain defects found in its original construction. Upon its return to San Antonio, July 24, Mr. Halter placed it in position, determined its scale value by oscillations and deflections, and by August 1 had it adjusted to begin its continuous record. From that date the record of all three magnetographs was continuous throughout the year, except that on September 17 there was a loss of six hours occasioned by the breaking of the clamp of the unifilar cylinder after the clock had been started, thus stopping the driving clock.

Time was determined by observations made on or near the first of each month, and on the 14th, 15th, and 16th of every month absolute determinations of the magnetic declination, dip, and intensity were obtained. The scale values of the bifilar and vertical force magnets were determined by observations on seven different days.

Early in October an electrical street railway was put into operation about $\frac{1}{4}$ of a mile south from the observatory, and its influence was very materially felt on the magnets and shown on the records. It is quite apparent, since the effect of this railway upon the automatic record has been investigated, that another site will have to be selected for the observatory, one that will be entirely free from the possibility of such a disturbing force.

Mr. Halter acknowledges the very efficient service rendered by Mr. Schultz, who did the greater part of the work under his supervision.

The statistics for the year are as follows:

Number of observations for time.....	288
Number of observations for temperature	4 959
Number of scale readings (eye)	2 136
Number of hourly scale readings from traces (unifilar)	8 754
Number of hourly scale readings from traces (bifilar)	8 754
Number of hourly scale readings from traces (vertical force).....	8 034
Number of observations for absolute declination	1 225
Number of observations for absolute intensity	1 152
Number of observations for absolute dip	3 586
Number of observations for scale values	1 344

Hydrographic resurvey of Aransas Pass, entrance to Aransas Bay, Texas.—A resurvey of the entrance to Aransas Bay, Texas, having become desirable by reason of shore line and hydrographic changes on the bar and in Aransas Pass since the survey of 1875, Lieut. E. M. Hughes, U. S. N., Assistant, Coast and Geodetic Survey, commanding the steamer *Bache*, was instructed to proceed to the coast of Texas and make a detailed survey which should develop the channel into Aransas Bay and indicate the changes that had taken place since the last survey.

The *Bache* arrived off Aransas Pass early in the morning of February 22, 1891, but on that day and the next so heavy a sea was breaking over the bar as to make its passage impracticable by the steamer's boats. Lieut. Hughes thereupon signaled the life-saving station, and by means of the surfboat which came off in response to his request he landed an officer with a small party to establish a tide gauge and set up signal poles. Tidal observations were begun on the evening of the 23d, and on the 24th, the surf having sufficiently subsided, the whale-boat landed with a sounding party and camp outfit, followed next day by a similar party. Both crews remained on shore till the completion of the hydrographic work on March 2.

None of the points of the former survey being extant, with the exception of Aransas Lighthouse, Lieut. Hughes availed himself of a tracing of the U. S. Engineer's survey of 1887,

scale 1-5 000, which was forwarded to him from the office with the projection indicating the limits of his work. This tracing exhibited a number of points determined by triangulation from a carefully measured base. Most of these points were found without difficulty. Coördinates for plotting them were kindly furnished to Lieut. Hughes by Maj. C. J. Allen, U. S. Civil Engineer.

The tide gauge was placed at the end of the boat wharf at Ropesville, on Mustang Island, just inside Aransas Pass, and one mile distant from the bar. Tides were observed here continuously day and night till the close of field work, the mean range found from twelve high and twelve low waters being 0.61 of a foot.

On the bar a depth of but $7\frac{1}{4}$ feet was found at mean low water. Owing to the general trend of the coast in this locality, the northers almost invariably haul to the northeast and to the eastward and raise as dangerous a sea on the bar as do the winds from the southward. Lieut. Hughes was informed by the master of the Light-house supply steamer *Armeria* that Aransas Bar is the only one on the coast from Eastport to the Rio Grande where he does not attempt to use his large steam launch, and the Assistant U. S. Engineer stated that during their survey of Aransas Pass a month had sometimes passed during which the seas were so continuously heavy that they could not do a day's hydrographic work on the bar.

No directions can be given for crossing the bar on account of the absence of notable landmarks. There is but one pilot for Aransas Pass. He maintains two range beacons, and shifts them with the change of channel, but these are of no value to strangers, not being sufficiently distinctive. A few small coasters, regular traders, of from 50 to 80 tons are at present the only vessels entering the Pass, and they have the stage of water on the bar indicated to them by a pre-arranged signal from shore.

Marked changes in the shore lines of the Pass were noted upon comparison with the shore lines of the survey of 1875. These changes have been indicated on the progress sheet which has been sent to the office by Lieut. Hughes with his records.

The officers attached to the *Bache* were Lieut. W. L. Burdick, U. S. N.; Ensigns W. W. Buchanan, J. F. Luby, Ford H. Brown, and W. B. Hoggatt, U. S. N.

Following are the statistics of the work:

Hydrography:

Area surveyed, in square geographical miles	10
Miles (geographical) run in sounding	14
Number of angles measured	1 566
Number of soundings	10 526

Upon the completion of the resurvey of Aransas Pass, Lieut. Hughes proceeded in the *Bache* to execute hydrographic surveys in the vicinity of Terre Bonne Bay, Coast of Louisiana.

Reconnaissance for a triangulation of the boundary line between the United States and Mexico along the Rio Grande from El Paso, Texas, to the southward and southeastward.—Instructions bearing date of November 18, 1890, issued to Assistant Stehman Forney, directed him to proceed to El Paso, Texas, for the purpose of making a reconnaissance for a primary triangulation to extend southward and eastward along the Mexican Boundary, and ultimately to extend to the mouth of the Rio Grande, the points being selected with a view to this extension and also to the subsequent execution of a secondary or tertiary scheme of triangles for topographical purposes. He was directed also to provide for the connection of his scheme with the Boundary Monument at Fort Bliss and with the base lines measured near Sierra Blanca by the U. S. Geological Survey and by the Texas Geological Survey, respectively.

Mr. Forney left Washington, in pursuance of these instructions, on December 3, and proceeded to El Paso, stopping two days on the way at Houston, Texas, to confer with Prof. W. H. Streeruwitz, of the Texas Geological Survey, respecting the facilities for water and transportation in the western part of the State.

Upon his arrival at El Paso, December 10, he visited El Paso Peak, Mexico, and the Boundary Monument on the Mexican side of the Rio Grande, near Fort Bliss; also Franklin

and Orange Peaks, northeast of El Paso. Mr. Forney had been advised that as far as practicable it would be well for him to locate his stations on the American side of the Rio Grande, but letters were furnished to him from the Department of State which facilitated his negotiations with the Mexican authorities when it should become necessary for him to occupy Mexican territory. He left El Paso with his party on December 27, and proceeded to Cerro Alto in the Hueco Mountains, camping at the Hueco Tanks. This remarkable and interesting formation he describes as an immense pile of rocks, 325 feet high, standing alone on the prairie, and resembling the crater of an extinct volcano, with hundreds of natural tanks, many of them filled with rain water, and containing from 50 gallons to 10 000 gallons each. From these tanks it is 25 miles to the nearest water, except a small tank near the summit of Cerro Alto, 5 miles to the northeast.

The full report of his reconnaissance from El Paso to the Capote Mountains, 170 miles to the south and east, which Mr. Forney has submitted, accompanied by a sketch, gives detailed information regarding the localities selected for stations of the proposed triangulation, stating in each case the facilities for obtaining water and forage, the distances to which provisions and camp equipage will have to be packed, etc. The highest mountains visited were Navajo Peak, Mexico, 6 675 feet in elevation; Cerro Alto, Tex., 7 150 feet; Organ Peak, Tex., 6 300 feet; Franklin Peak, Tex., 5 500 feet; Sierra Blanco Peak, Tex., 7 400 feet; Boracho Peak, Mexico, 6 800 feet; Livermore Peak, 8 300 feet, the highest peak in the Eagle Mountains, Texas, a point from which all of the stations but four in the scheme are visible; Bosque Bonito, Mexico, 6 500 feet, and Van Horn Peak, 6 070 feet in the Van Horn Mountains, Tex.

The scheme of triangulation, as developed, covers an area of 4 440 square statute miles, and to complete the triangulation to the end of the reconnaissance will involve the occupation of twenty-five stations, five on the Mexican and eighteen on the American side of the Rio Grande.

A good connection of the scheme was developed with the base lines measured by the United States and the Texas Geological Surveys, respectively; either or both lines can be connected with the primary work. A 10-mile base over an almost level country can be measured if required anywhere on the plateau between El Paso, Tex., and the Quitman Mountains. Both ends of the line defining the 105th meridian, and measured by Prof. R. S. Woodward, can be connected with the scheme.

Mr. Forney states that his letters from the Mexican Legation at Washington ensured himself and party a kindly reception and courteous treatment from the Mexican authorities. He expresses his indebtedness to Prof. W. H. Von Streeruwitz, of the Texas Geological Survey, for valuable information relating to the country, and for allowing Mr. Ralf Von Wyszecki, of that Survey, to accompany him as foreman. Mr. Von Wyszecki was well acquainted with the location of all the water tanks and holes on the American side of the Rio Grande, and the party thereby saved much time that would have been spent in hunting for water. Mr. Forney has appended to his report a special report on the general geological features of the country, prepared at his request by Mr. Von Wyszecki.

Mr. W. R. Martin, Division Superintendent, El Paso Division, Southern Pacific Railroad, gave to his agents, conductors, and other employés, directions to render any assistance in their power to the reconnaissance party.

Duty assigned to Mr. Forney on the coast of Maine and of Florida during the fiscal year is referred to under separate headings in this volume.

ABSTRACTS OF REPORTS FROM FIELD PARTIES, FISCAL YEAR 1891.

WESTERN DIVISION.

STATES AND TERRITORIES BETWEEN THE ROCKY MOUNTAINS AND THE PACIFIC.

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

Progress Sketches No. 2, Nos. 4, 5, 6, Nos. 10 to 13 inclusive, and Nos. 17 to 20 inclusive, show the localities of field work in the Western Division. A list of Progress Sketches will be found at the close of this volume.

Establishment of a trial course off the Pacific coast for the speed trials of the new naval cruiser, San Francisco.—The detail of Lieut. D. Delehanty, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Hassler*, for the work of laying off a measured trial course not less than 40 miles in length off the coast of California for the speed trials of the new naval cruiser *San Francisco* is referred to more fully under the heading of "Special Operations."

Work of this character exemplifies the incidental value to the Government of the existence of a carefully executed network of triangulation along the coast. An officer entrusted with fixing exactly the length of a trial course for naval purposes has at his command a number of shore stations, some of them conspicuously marked, and all well determined in geographical position, and from these can select such points as will enable him to define with all needful accuracy the limits required.

Lieut. Delehanty reported the completion of his special survey July 31, 1890, and then took up the recovery and permanent marking of a number of triangulation stations in the vicinity of Santa Barbara. After that he was assigned to the charge of hydrographic surveys in the vicinity of Cape San Martin.

Completion of the hydrography of the coast of California in the vicinity of Piedras Blancas and Point Sur Lights. Determination of the position of Von Helm Rock in the vicinity of San Simeon.—Under date of May 29, 1891, Lieut. D. Delehanty, U. S. N., Assistant Coast and Geodetic Survey, commanding the Steamer *Hassler*, has reported the completion of the hydrography of the coast of California in the vicinity of Piedras Blancas and Point Sur Light-houses to the south and north of Cape San Martin.

The results of the survey are shown upon three hydrographic sheets, scale 1-20 000, and include the hydrography of that part of the coast extending from Ragged Point station near Arroyo San Carpofero to Cooper's Point, south of Point Sur.

Lieut. Delehanty reports also the success of the search for Von Helm Rock, a serious danger to navigation in the vicinity of San Simeon, the exact location of which had not been previously determined. This rock is chimney shaped, the area of its top being 15 by 40 feet, and it has slightly less than 15 feet of water over it at low tide, with from 18 to 20 fathoms all around it. It is in the track of coasting steamers bound to San Simeon from the southward, and Lieut. Delehanty recommends that it be buoyed without delay. A copy of his report, with the following bearings which locate the rock has been sent to the Light-House Board.

Von Helm Rock bears from Piedras Blancas Light-house S. $63^{\circ} 49'$ E. (mag.) distant 11.38 miles.

Von Helm Rock bears from San Simeon Wharf S. $47^{\circ} 44'$ E. (mag.) distant 7.2 miles.

Von Helm Rock bears from Estero Point N. $64^{\circ} 12'$ W. (mag.) distant 7.15 miles.

Von Helm Rock bears from Cambria Rock S. $30^{\circ} 00'$ E. (mag.) distant 1.95 miles.

Von Helm Rock bears from White Rock N. $89^{\circ} 05'$ W. (mag.) distant 1.225 miles.

For the coast hydrography executed during the season the statistics are:

Number of miles run in sounding	305
Number of angles measured	4 158
Number of soundings	4 543

For the work of developing Von Helm Rock, the statistics are:

Number of miles run in sounding	1.75
Number of angles measured	84
Number of soundings	117

The following-named naval officers were attached to the party on the *Hassler*: Lieut. Charles A. Gove, U. S. N.; Ensigns J. B. Blish, H. B. Wilson, W. L. Dodd and S. R. Hurlbut, U. S. N.

Triangulation and topography on the coast of California between Cape San Martin and Point Sur.—

At the beginning of the fiscal year the party in charge of Assistant A. F. Rodgers had been in the field on the coast of California, between Cape San Martin and Point Sur, since April 17, 1890, engaged in making a connection of the coast triangulation south of Monterey with the main series.

Eleven stations had been occupied up to June 21; the party was then transferred to Jolon, Monterey county, and Sub-assistant Nelson, who had been serving part of the time with Assistant Rodgers and part of the time on detached duty, was directed to rebuild signals at the following-named stations of the coast triangulation: Silon Peak, San Martin, Alder Top, Lopez, and Lopez Point; the signals at the three points first named being needed to connect with the primary line Santa Lucia—Rocky Butte.

This work having been completed on June 10, preparations were at once begun for the occupation of stations, and by July 18, the party had camped on Santa Lucia Mountain, 6 000 feet in height, and had commenced observations. Between the 18th and 23d the main station and Santa Lucia West were both occupied, and camp was then moved to Cone Peak, 5 000 feet in elevation. Observations at this station having been finished on July 31, the following-named points were then occupied in succession: Lopez, 800 feet high; Lopez Point, 100 feet; Boronda, 1 300 feet; Gamboa, 1 600 feet; Rock Slide, 3 700 feet; and Dolon, 1 600 feet; the last observations at Dolon having been made August 16.

To close the scheme of triangulation from Cape San Martin to Point Sur there remained now the occupation of Rocky Butte, and to this duty Mr. Rodgers gave his personal attention, directing Mr. Nelson to remain at Jolon to bring up to date the computations of field work, and tabulate the geographical positions which would before long be required for the plane table projections.

Observations at Rocky Butte were finished August 29; Mr. Rodgers then went to San Francisco on official business, returning September 16 to Jolon, where he was engaged during the rest of the month in projecting topographical sheets and other duty preparatory to beginning the plane table survey.

The field computations had been brought up by Mr. Nelson to cover the limits of two topographical sheets, including the shore line from Mansfield Cone station to Lopez Point station, and in accordance with instructions Mr. Rodgers organized a double party, assigning the southern sheet to Mr. Nelson, and taking the northern one himself. The limits of the lower sheet had been partially surveyed during a preceding season by Assistant Rockwell under the general direction of Mr. Rodgers.

The topographical work begun in October was continued without interruption until December 8, when the two plane table sheets then in hand were finished. During October Lieut. D. Delehanty, U. S. N., Assistant coast and Geodetic Survey, who was conducting a hydrographic survey of that part of the coast, requested and received a tracing of the shore line from Mansfield Cove to Lopez Point, with descriptions of the stations of the triangulation.

Mr. Rodgers observes that the crest line included within the area covered by his topographical sheets is from 3 to 4 miles distant from the ocean, and between 3 000 and 5 000 feet in height, and that to dilate upon the rough character of the topography would tax the descriptive powers of those who had seen it, and the belief of those who had not.

Upon closing field operations, December 13, for the season, Mr. Rodgers and Mr. Nelson left for San Francisco, and began the preparation of the records and results of their work for the Archives. During the winter and part of the spring, duplicates of the records and the first computations were forwarded to Washington; in these were included lists of fifty-nine new geographical positions.

The importance of resuming field work at the earliest possible time in the spring of 1891 was kept in view by Mr. Rodgers, but he did not find it practicable to begin till early in May. He then established himself in camp at Posts, 38 miles south of Monterey; Mr. Nelson, who had preceded him a few days, having fixed his camp at Gamboa, 25 miles distant, on the 28th of April.

Topographic work with a double party was resumed as soon as the prevailing fogs would permit, and steadily prosecuted until June 30, Mr. Rodgers taking up a shore line survey on one of the new sheets from Partington station to Pfeiffer Point, and Mr. Nelson having assigned to him the shore line on the other sheet extending from Lopez Point to Dolon station.

The progress of this survey after July 1 will be adverted to in the next Annual Report.

Mr. Rodgers expresses his appreciation of the efficient service rendered by Mr. Nelson during the season.

For the fiscal year the statistics are as follows:

Triangulation:

Area, in square statute miles.....	550
Number of stations occupied for horizontal measures.....	10
Number of geographical positions determined.....	59

Topography:

Area surveyed, in square statute miles.....	53.4
Length of general coast, in statute miles.....	18.7
Length of shore line of creeks and streams, in statute miles.....	28
Length of roads and trails, in statute miles.....	36.5

Determinations of gravity with new and improved apparatus at stations in California and Washington, and at a station in British Columbia.—A set of the new and improved pendulum apparatus, already referred to under the heading of "Special Scientific Work" as having been made at the office under the direction of the Superintendent, was taken by him to the Pacific coast in April, 1891, for the purpose of obtaining differential determinations of gravity at such points as he should select during his tour of inspection upon that coast.

This set marked A, and containing three half-second pendulums made of aluminum bronze, was first used on the Pacific coast at San Francisco. The pendulums were swung about the middle of April at the Lafayette Park Observatory of the Coast and Geodetic Survey, where the Kater pendulums had been swung by Assistant Edwin Smith in 1883, and the Peirce pendulums by Assistant E. D. Preston in 1883 and 1887.

At San Francisco, the Superintendent had the aid of Sub-assistant Fremont Morse, who was directed to report to him for duty in the gravity observations, and who accompanied him throughout the work.

Towards the end of April the Superintendent and Mr. Morse went on board the steamer *Patterson*, Lieut. Commander H. B. Mansfield, U. S. N., Assistant Coast and Geodetic Survey, at Port Townsend, Washington, and on the 23d of that month left for Port Simpson, B. C., where

the *Patterson* arrived a few days later and took in tow the steam launch *Cosmos*, which had been laid up there during the winter. At Port Simpson a pendulum station was established in the yard of the Hudson Bay Company's buildings, and a series of swings of the three pendulums obtained.

The Superintendent then proceeded in the *Patterson* to Alaska, and occupied a number of stations in that territory, reference to which is made under the heading "Division of Alaska."

Upon returning to the State of Washington in June, the Superintendent occupied a gravity station at Seattle. For the use of the basement of the High School building as a location for the station, and for facilities afforded in the work, he expresses his indebtedness to Mr. Frank Barnard, Superintendent of Public Schools. The Western Union Telegraph Company, with the liberality that has always characterized its dealings with the Coast and Geodetic Survey, furnished time signals from the Mare Island Navy Yard at San Francisco. Assistant Pratt joined the party at Seattle, and aided in many ways in expediting the work, especially in respect to local arrangements.

Early in July the apparatus was carried to the Lick Observatory, on Mount Hamilton, California, and a series of swings were made there at the station which had been occupied in 1887, by Mr. Preston, with the Peirce pendulums. At Mount Hamilton, the hospitalities of the Director of the Lick Observatory, Prof. E. S. Holden, were extended to the party, and everything that could be asked was done, precisely as in all former occupations of this important point by parties of the Survey. The necessary time observations were undertaken by the Observatory and carried out with great care and exactness; indeed the Survey is under obligations for assistance to the entire corps of astronomers resident upon the mountain.

At all of the stations occupied upon the Pacific coast, the Superintendent was assisted by Mr. Morse, and he desires to express his appreciation of the very conscientious and highly satisfactory manner in which the duties assigned to that officer were discharged.

Although the operations at the Lick Observatory, and those about to be mentioned, do not all belong to the fiscal year represented in this report, yet some mention of them is necessary to a complete statement of the nature of the gravity campaign, the determinations being those of relative gravity, and it being essential therefore that they should be referred to the two base stations, the Smithsonian Institution, Washington, D. C., and the Stevens Institute, at Hoboken, New Jersey.

Upon returning from the Pacific coast, the pendulums were first swung at the Smithsonian Institution, the Superintendent having the aid of Assistant Smith, and of Mr. E. G. Fischer, Chief Instrument Maker to the Survey. At Hoboken, also, Mr. Smith aided in the work. At both of these base stations, during the progress of the pendulum swings in October and in November, 1891, time signals were received from the Naval Observatory, for which Dr. Mendenhall expresses his thanks to Capt. F. V. McNair, U. S. N., Superintendent of the U. S. Naval Observatory, to Prof. S. J. Brown, U. S. N., in special charge of the Time Service, and to the Western Union Telegraph Company for the care with which the signals were transmitted.

A full report of the gravitation work here briefly referred to will be found in Appendix No. 15, Part II, of this Annual Report.

Primary triangulation and general charge of the operations of civilian parties upon the Pacific coast. Observations for investigating the variations of latitude. Moon culminations at the astronomical station, Lafayette Park, San Francisco, in connection with those observed by the Alaska Boundary parties, etc.—In virtue of the assignment of Assistant George Davidson to the general charge of the operations of the civilian parties upon the Pacific coast, which has been in force for several years past, he continued to submit to the Superintendent plans for the prosecution of the work of those parties in the States of California and Washington and in the Territory of Alaska; he conferred with the Assistants and Sub-assistants, examined all estimates and referred them to the Superintendent, and received and transmitted all official correspondence between the Superintendent and the officers of the Survey on duty on the Pacific coast.

Special reference to Mr. Davidson's charge of the Sub-office at San Francisco is made under a heading near the close of this part of the volume. In October, 1890, upon the return of Mr. Mark B. Kerr, of the U. S. Geological Survey, from the attempt to ascend Mount St. Elias, he was given the use of a drawing table in the Sub-office for preparing a map of his explorations. A photograph of this map was transmitted to the Superintendent. Assistance was rendered also through Mr. Geo. F. Davidson to Mr. E. J. Glave, who had returned from Alaska after descending one of the branches of the Alsegh River. Under Mr. Davidson's supervision several hundred of his photographic films were developed.

Occupation of the primary triangulation station, Mount Conness.—Reference was made in the last Annual Report to the beginning of preparations in June, 1890, for the occupation of Mount Conness, a lofty peak of the Sierra Nevada, by the main triangulation party of Assistant Davidson.

At the beginning of the fiscal year, Assistants J. J. Gilbert and Isaac Winston and Sub-assistant Frement Morse, who had been detailed for duty in the party, were actively at work upon the approaches to the mountain, the summit of which is about 12 500 feet above the sea. The force of laborers, heliotropers, and wagoners was divided into three camps with Mr. Winston in the lead, and had a continuous struggle to cut through miles of snow drifts, repair roads, and get the teams with but half-loads over the many long and heavy grades. A bridge had to be rebuilt over Yosemite Creek; this was done by Mr. Gilbert, the creek, 40 feet wide and 6 feet deep, tearing like a torrent. A lower camp was finally established as the limit of wagon transportation at Soda Springs in the Tuolumne Meadows, 8 680 feet above the sea, and from this a pack trail was made to the summit, the camp for the observing party being fixed 300 feet below. The tents were pitched in holes dug into the sharply sloping mountain sides of disintegrated granite, and protected on the down-hill side by dry walls.

Mr. Davidson arrived at the summit August 2 and examined it with Mr. Gilbert; he found it an irregular crag of less than 8 feet square that had been broadened by fitting in rocks; the pier for the theodolite was of cement and rock; the observatory had been built by Mr. Gilbert with boards brought over 100 miles, and was stayed by sixteen sets of double wire secured to outlying rocks.

Around this granite buttress there is a sheer descent of about 1 400 feet. Life lines were a necessity in getting to the top.

Heliotropers having been posted by Assistant Lawson at Mount Mocho and Mount Diablo, by Mr. Winston at Round Top, Mount Grant, and Lone Mountain, and an azimuth mark and reference station established by Mr. Finley, recorder, at Mount Hoffman (10 800 feet in height), the theodolite was mounted by Mr. Davidson and observations were begun.

The work of observing was then subdivided as follows:

Assistant Davidson, with Mr. Edmonds as recorder, made the noon and afternoon observations for horizontal directions, azimuth, and vertical measures by micrometer; Assistant Gilbert, with Mr. Edmonds as recorder, the morning observations for horizontal directions; Assistant Winston the magnetic observations and vertical angles, and Sub-assistant Morse, with Mr. Finley as recorder, the observations for time and latitude. The connection of the primary station with the observatories for latitude, time, vertical angles, and magnetics was made by Assistants Davidson and Gilbert, who measured a base and observed the horizontal angles required.

At this great elevation it was found that results for measurement of horizontal directions from noon observations were as satisfactory as those from observations made in the afternoon. The morning was, however, the best time for observing; by noon the heated air from the profound depths on the south and west ascended, and disturbed greatly the images of the heliotropes. Moreover, in the afternoon, great masses of cumulus clouds would form along the whole crest-line of the Sierra, move northeastwardly and develop terrific thunder squalls and vivid lightning.

From long previous experience in observing, Mr. Davidson determined to observe once only in any one position, except on lines over 100 miles long. During the measurement of hori-

zontal directions therefore, he moved the theodolite into forty-seven positions, thus doubling the number of graduated lines read upon the microscope micrometers. The former number of positions, with two observations or more in each, was twenty-three.

Mr. Davidson remarks that he had never before been placed where he found it not practicable to observe for azimuth at night. But as it was impracticable at Mount Conness, he adopted the plan of observing upon Polaris at any hour angle when the atmosphere was steady enough to permit the star to be seen. At the best of times the star was a very minute object, and the telescope had to be pointed very closely in order to find it. Results for azimuth were secured in twenty-nine of the forty-seven positions.

Time and latitude were determined at a station established on a rocky level table just under the rocky trail from the summit and 250 feet below; time being observed by Mr. Morse, and latitude on one night by Mr. Gilbert, on five nights by Mr. Winston, and on four nights by Mr. Morse. For time, the Davidson Meridian Instrument No. 1 was used, and for latitude the Troughton and Simms Zenith Telescope No. 1.

Magnetic observations, which included measures of magnetic declination and the magnetic intensity were made through three days by Mr. Winston, at a station near the latitude observatory.

Measurements of vertical angles by double zenith distances were made by Mr. Winston with vertical circle No. 80. Heights of the surrounding peaks of the Sierra Nevada and of the mountains in Nevada were determined by Mr. Davidson with a small verticle circle at a point eccentric to the main station, getting measures upon twenty or thirty objects.

The work at Mount Conness was finished on September 10, 1890, and every effort was then made to push out of the field before the snows began. Fortunately the whole movement of instruments and camp equipment down the mountain to the lower camp at Soda Springs and thence by wagons 120 miles to Oakdale was carried out without an accident. At the lower camp Mr. Davidson acknowledges his indebtedness for much local information and many favors to Mr. John Lambert, who has a claim there, and acts as guide, etc.

To his colleagues in the work, both officers and men, Mr. Davidson expresses his high appreciation of their indefatigable labors.

Upon returning to San Francisco he made a special report in answer to a letter from the Secretary of the Interior with regard to the alleged spoliations in the Yosemite Valley and Mariposa Big Tree Grove. This report, bearing date of November 8, 1890, was transmitted to the Secretary of the Interior through the Superintendent. He made also, at the request of the Superintendent, in November, a special unofficial report upon the principal lines and features of work over land and water on the Pacific coast.

Following are the statistics of the observations made on Mount Conness:—

Triangulation:

Number of main stations observed upon	5
Number of peaks observed upon for direction	11

Azimuth (Polaris):

Number of days of observation	14
Number of sets or positions	29
Number of pointings on reference mark and on star	580
Number of ocular pointings	160

Latitude:

Number of pairs observed for latitude	30
Average number of observations on a pair	7½

Observations for latitude at the Lafayette Park astronomical station, San Francisco.—Under the heading "Special Scientific Work" reference has already been made in this volume to the investigation of the subject of variations in latitude undertaken by the Survey in coöperation with the work of the International Geodetic Association. In May, 1891, Assistant Davidson having received instructions to begin a series of latitude observations in conformity with the plan of

the Association, prepared a suitable list of stars, and began observations at the Lafayette Park astronomical station, San Francisco, on the 25th of that month.

Assistant Gilbert and Sub-assistant Morse took part in the latitude work. In the observation for time, Mr. Frank W. Edmonds assisted, and in those for value of micrometer Mr. Edmonds and Mr. Thos. D. Davidson.

The stars to be observed for latitude with the zenith telescope were arranged in groups, the first two groups being composed of fourteen pairs and triplets. The observations were made every clear night, and each group was observed for three hours. Up to June 30, thirty-six pairs of stars had been observed upon thirty nights, and four hundred and thirty-eight observations had been made upon λ Ursae Minoris on seven nights for the value of the micrometer screw.

A final report of this work will be submitted by Mr. Davidson.

Secular change of the magnetic declination.—In order to keep up the regular series of magnetic observations at the station "Presidio" of 1852, Mr. Gilbert by direction of Mr. Davidson observed the magnetic declination, horizontal force, and dip through eight days in the month of October. This was longer than the usual series because there appeared to be large and unusual magnetic disturbances upon two occasions. The records and computations of these observations were transmitted to the Archives.

Moon culminations observed at the Lafayette Park station, San Francisco, in connection with those intended to be taken by the Alaska Boundary parties.—In order to obtain data for determining with as much accuracy as the method of moon culminations would admit of, the longitudes of the stations occupied on the 141st meridian by Assistant McGrath at its crossing on the Yukon River, and by Sub-assistant Turner on the Porcupine River, in the Alaska Boundary work, Mr. Davidson was instructed to have observations of lunar transits made at the Lafayette Park station, San Francisco, in connection with those which Messrs. McGrath and Turner were to make in Alaska.

Observations at San Francisco were begun in the October lunation and continued every available night to include the lunation in March, sixty-four lunar transits and seven hundred and sixty-four transits of stars in connection therewith having been observed. The work was arranged thus: the observations during November, 1890, and January, 1891, were made by Assistant Gilbert; those during October and December, 1890, February, 1891, and the last part of the March lunation by Sub-assistant Morse. For the first half of the March lunation, Messrs. Gilbert and Morse observed for personal equation. All of the observations were computed by Mr. Morse.

Tidal stations at Sausalito, California, and Kadiak Island, Alaska.—These tidal stations are referred to under separate headings.

Coast Pilot of California, Oregon, and Washington.—Mr. Davidson has continued to gather material supplementary to the fourth edition of the Coast Pilot of California, Oregon, and Washington, and has on hand about 150 pages in manuscript, with much material not yet arranged.

Continuation of the tidal record at the automatic tidal station, Sausalito, Bay of San Francisco.—Mr. Emmet Gray has continued to keep up the tidal record at the automatic tidal station, Sausalito, Bay of San Francisco, under the direction of Assistant George Davidson. The record at this station was begun February 10, 1877. Mr. Davidson has examined each month's tidal roll and tabulations, and has transmitted them to the office.

Levelings were made monthly between the staff and the two bench marks. This work was done at first by Sub-assistant Morse, but latterly by M. F. W. Edmonds, who makes also the transit observations at the Lafayette Park station for determining the error and rate of the Sausalito tidal chronometer.

At the request of the Superintendent, Mr. Davidson submitted several forms of tide tables with illustrations, and transmitted forms proposed by Assistant Rodgers and by Mr. George F. Davidson.

Completion of resurveys and examinations of soundings in Suisun Bay, Karquines Strait, and vicinity.—Lieut. D. H. Mahan, U. S. N., Assistant Coast and Geodetic Survey, commanding

the steamer *McArthur*, whose re-surveys and examinations of soundings in Suisun Bay, Karquines Strait and vicinity, were referred to in the last Annual Report, has made a supplementary report with regard to the alleged shoaling of Karquines Strait, and respecting the channel leading to Suisun Creek, and under date of August 15, 1890, states that the records of his season's work have all been finished and forwarded to the office.

Lieut. Mahan states that the current along the north shore of Karquines Strait from Benicia Arsenal Wharf to the Pacific Ferry Slip is so swift as to make any great shoaling out of the question, and that the channel through the whole length of the Strait has not shoaled perceptibly. Near Martinez from Suisun Point to the Nevada docks, slight shoaling may have occurred owing to the formation of the land and the lessening of the current.

The channel leading to Suisun Creek was examined, and a through channel more to the westward was established, the best water being nearer to the Solano county shore than before. Other examinations were made of channels and shoals in the localities under survey, and the details of changes are given at length in Lieut. Mahan's report.

A request having been received from the Secretary of the Navy for the detail of the steamer *McArthur* to assist in the speed trial of the new naval cruiser *San Francisco*, Lieut. Mahan was directed to report for this service to Commodore John Irwin, U. S. N.

Topographic and hydrographic surveys in Coos Bay, Oregon, and primary triangulation north of San Francisco Bay.—Assistant E. F. Dickins, under date of December 4, 1890, has reported the completion of the topographic and hydrographic re-surveys of Coos Bay, Oregon. At the beginning of the fiscal year he was occupied with the hydrography of the upper bay, having established a tidal station at Marshfield where hourly observations of the tides were taken for over a month to obtain a plane of reference for the soundings. Tide staffs were erected also at the upper limits of the hydrography at stations Coos River, Catching Slough, Isthmus Slough and Coal Bank Slough, simultaneous observations being taken at each in connection with the Marshfield gauge for difference of time and height of tide.

After finishing the upper bay hydrography, August 19, Mr. Dickins transferred his party to Empire City, and having obtained the privilege of occupying the Government buildings at Rocky Point opposite the entrance to the Bay through the kindness of Capt. Thomas W. Symons, U. S. Engineers, he took up the topography of South Slough and that of the coast south of Cape Gregory. Work was carried on until October 25, when the prevalence of unfavorable weather rendered it advisable to close field operations. Mr. Dickins had his party on board the steamer for San Francisco October 31, but was bar bound till November 8.

In his report he notes the rapid development of the country about Coos Bay during the year that had elapsed since the beginning of his survey. A new town "Glasgow" had been located opposite North Bend, a wharf 3 000 feet long built out to the channel, streets had been laid out and graded, and a hotel and other buildings erected. Other town sites in process of improvement are Yarrow, between North Bend and Porter, and East Marshfield directly opposite Marshfield. The Coos Bay and Roseburg railroad is in course of construction.

Mr. Ferdinand Westdahl, draughtsman, was attached to the party during the season, and to his active and ready coöperation Mr. Dickins attributes much of the success of the work.

The statistics are:

Hydrography:

Number of miles (geographical) run while sounding	453
Number of angles measured	6 670
Number of soundings	29 988
Number of tidal stations	2

Topography:

Area surveyed, in square statute miles	11
Number of miles of shore line surveyed	25
Number of miles of shore line of creeks	3
Number of miles of roads	9

During the winter Mr. Dickins was engaged in office work, and in April, 1891, was instructed to organize a party and take up the primary triangulation north of San Francisco Bay.

Preliminary arrangements for camping out, obtaining pack-animals, making a reconnaissance trip to the primary station, Ross Mountain, etc., occupied Mr. Dickins until May 27, at which date his party was established in camp on the mountain, and piers had been built for the instruments.

Mr. Westdahl, having again reported for field duty, was sent to post heliotropers at the primary stations, Cold Spring, Mount Sanhedrin, and Mt. Helena, while Mr. Dickins posted them on Mounts Tamalpais and Diablo. Later, it was discovered that on account of an intervening ridge on the Walalla range, the line Ross Mountain—Cold Spring was impracticable; hence it became necessary to substitute Snow Mountain for Cold Spring. The delay thus occasioned, superadded to the necessity of sending the theodolite to San Francisco to repair damages caused by careless handling in transportation, prevented Mr. Dickins from making the satisfactory progress with his work that he is usually able to report.

It was expected that the instrument would be returned in good order, and observations be resumed soon after July 1.

Continuation of the survey of the Columbia River from Vancouver, Washington, towards the Dalles.—Under instructions dated early in August, 1890, Assistant Cleveland Rockwell, after completing some repairs to his boat and plane table, proceeded to Vancouver, Washington, and organized his party for the continuation of the survey of the Columbia River from the limits of his former work in that locality towards the Dalles.

The triangulation having been pushed forward during a preceding season, the topography was taken up, and the weather being favorable during September and October, good progress was made. During the latter part of October the morning fogs, which sometimes did not lift till noon, became a source of delay. By the end of the month the topographical sheet was completed, and next day field operations were closed for the season and the party discharged.

During the progress of the survey, Mr. Rockwell, under authority from the Superintendent, furnished Major Thomas H. Handbury, U. S. Engineers, with a tracing of the shore line, the triangulation, and the location of plane table points on the river to aid him in making a hydrographic survey preparatory to the improvement of the channel.

The topographic sheet shows the site of the railroad and wagon road bridge across the Columbia which is now in course of construction for the Portland and Puget Sound Railway Company. This bridge is to be a first-class steel drawbridge with double track, and also double tracks for wagon and foot travel. A large area of the sheet is taken up by the city of Vancouver and suburbs, and the military reservation of Vancouver Barracks. This occupies the site of old Fort Vancouver, originally established by the Hudson Bay Company as a factory or trading station.

Mr. Rockwell, upon leaving the field, took up the inking of his sheet, and after having made a tracing of it, transmitted the sheet accompanied by a descriptive report to the Archives. This descriptive report gives many details of interest relative to the topographical and geological characteristics of the region of his survey. On the Oregon side of the Columbia River, including Hayden's Island, and on the north side, west of the projected railroad bridge, the bottom lands, which occupy the areas shown on the sheet are subject to periodical freshets in June and July, these being wholly due to the melting snows at the headwaters of the tributaries of the Columbia. Ordinarily the highest ridges near the banks of the river remain above water, but in occasional years every foot of land shown as above stated is completely submerged. The extreme range of these floods is about 27 feet.

For the season beginning August 23 and ending October 31, the statistics are:

Topography:

Area of topography, in square statute miles	24
Number of miles of river shore line surveyed	17
Number of miles of Hayden's Island	10
Number of miles of shore line of ponds, lakes, sloughs and creeks	60
Number of miles of marsh outlines	8
Number of miles of roads, including railroads	70

In accordance with instructions issued towards the end of April, 1891, Mr. Rockwell re-organized his party for the continuation of the Columbia River survey, and went into camp at Fisher's landing on the Oregon side of the river May 12. Progress before the end of the fiscal year was greatly delayed by the weather, rain falling on twenty days during the month of June. On June 30 part of the topography had been completed on the first plane table sheet, and also the triangulation upon which this was based. Progress after that date will be stated in the next Annual Report.

Hydrographic survey of Willapa Bay, Washington.—Lieut. J. M. Helm, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Gedney*, to whom was assigned the execution of the hydrography of Willapa Bay and approaches, Washington, has submitted a full descriptive report to accompany his hydrographic sheets. At the outset, he calls attention to the many changes of hydrographic features which have taken place since the partial survey made by Lieut. Burnett, U. S. N., in 1887, near the entrance. Until 1890, the bay was known as Shoalwater Bay, and was so named on the charts, but by a recent decision of the U. S. Board on Geographic Names, it will henceforth be called Willapa Bay. The original name was Whil-a-pah.

Lieut. Helm observes that since 1887, the present North Channel has broken through the middle sands and these sands have grown out towards the westward and also towards the southward and eastward. The south channel has been narrowed, and is now nearer Lead-better Point. Changes have taken place inside of this Point; the outlines of Log Island have changed considerably and a new island has appeared on which one of the hydrographic signals was located. Crescent Island and the small island to the westward of it near the main land have disappeared. The outlines of Snag Island have undergone considerable change.

Lieut. Helm's survey was plotted on three hydrographic sheets, scale 1-20 000, with limits as follows: No. 1, from the outside bar to Toke Point; No. 2, the northern portion of the bay as far south as Oysterville, and No. 3, the bay south of Oysterville. The hydrography, begun July 25, had not been entirely completed when it became advisable, on November 9, to suspend operations in the field for the season.

The many shoals and mud flats in Willapa Bay which are mostly bare at low water and have narrow channels between them are its characteristic hydrographic features. The bar across its mouth extends for some distance off shore. On approaching from seaward, Cape Shoalwater Light-house will, in good weather, probably be the first definite landmark made, but in hazy, smoky, or foggy weather, a vessel approaching from seaward would be on the shoals, in the breakers and on dangerous ground before any land could be made. Heavy breakers on the middle sands and on the North Spit will ordinarily be seen, and the buoy at the entrance to the South Channel would be probably the first landmark found.

Among the recommendations made by Lieut. Helm for improvements in the Aids to Navigation in the locality of his survey are the following: the substitution of larger buoys for those now in the South Channel, and the placing them not more than a mile apart; the establishment of a large whistling buoy well off the North Channel for the benefit of vessels passing along the coast in thick weather as well as for those making for the Bay, and the construction of a Light-house of the first order to replace the fourth order light now on Cape Shoalwater.

Lieut. A. G. Rogers, U. S. N., Ensign Guy W. Brown, U. S. N., and Assistant Surgeon P. H. Bryant, U. S. N., were attached to the party on the *Gedney* throughout the season. Ensign W. H. G. Bullard, U. S. N., aided in the work until August 15, and Ensigns A. N. Mayer and J. H. Gibbons, U. S. N., from July 30, and August 23, respectively, till the end of the season.

The statistics are:

Hydrography:

Area sounded, in square geographical miles.....	90
Number of miles (geographical) run while sounding.....	769
Number of angles measured	8 792
Number of soundings	38 543
Number of tidal stations established	6

During the winter of 1890-1891, and until early in the spring the party was occupied at Oakland, Cal., in office work. The engines of the *Gedney* were overhauled, and repairs made to the ship and boats.

Having received instructions to resume and complete the hydrography of Willapa Bay, Lieut. Helm arrived on the working ground April 16, and at the end of the fiscal year had finished the survey of the Bay proper, leaving some of the river channels for a later development. The Willapa and Nasel Rivers remained to be surveyed above South Bend and Stanley, respectively. The Palux River was completed $4\frac{1}{2}$ miles above Bay Centre to the head of navigation. Some changes on the bar since the work of the preceding season having been reported, a new examination was to be made whenever weather and time would permit.

For the season of 1891, and up to June 30, the following named officers were attached to the party on the *Gedney*:

Ensigns J. H. Gibbons, A. N. Mayer, and J. M. Poyer, U. S. N., and Assistant Surgeon P. H. Bryant, U. S. N. Ensign A. L. Key, reported for duty March 31, and was detached June 16.

The statistics of field work for 1891 to the end of the fiscal year are as follows:

Hydrography (scale 1-20000):

Area sounded, in square geographical miles.....	37
Number of miles (geographical) run while sounding.....	482
Number of angles measured	6 169
Number of soundings.....	31 417

Topographical re-survey of the water front of Port Townsend, State of Washington.—Improvements either accomplished or projected on the water front of Port Townsend, Washington, rendered it desirable that a careful re-survey should be made at that port in order that a new chart could be published at an early date.

Assistant J. F. Pratt was assigned to this work by instructions dated in March, 1891, and finding at the outset that no triangulation data were available, he measured a wire base of 975 metres (3198.8 feet) on the wharf and its inshore planked street continuation of the Port Townsend Southern Railway.

This base was expanded topographically by a triangle on each side sufficiently to determine objects on the opposite shore of the Bay which constituted the basis of the plane table triangulation for the entire work.

All signals and other objects still extant which were shown on the tracing of the hydrography executed in 1887-1888 were determined by intersections, and also all spires and cupolas of a permanent character which might be of service in future surveys.

Mr. Pratt observes that Port Townsend is the Port of Entry for all the Puget Sound Basin, although within the past year other more important towns within the district have been constituted Sub-ports. Between 1888 and 1890 the town had its largest growth, the population having increased from about 2,000 in 1888 to about 5,000 in 1890.

During the year ending May 31, 1890, the clearances for foreign ports numbered 1 148, of which number 1 029 were of American vessels. For domestic ports there were 182 clearances, all of which, with one exception, were of American vessels.

For the same period, the entrances from foreign ports were 1 003, of which 921 were American vessels, and from coastwise ports 359, of which 343 were of American vessels.

For the re-survey of the Port Townsend water-front, begun 1891, March 16, and completed May 1, the results are shown upon three projections, each on a scale of 1-10 000. The statistics are:

Base line:

Subsidiary, length of, in metres.....	975
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Topography:

Area surveyed, in square statute miles.....	7.25
Length of roads, in statute miles.....	15.5

In this re-survey were included the city limits of Port Townsend and the outlying places, Fort Townsend, Irondale, and Port Hudlock.

Mr. Pratt was directed to report in person to the Superintendent at Seattle in June for temporary duty in connection with the gravitation experiments to be undertaken there, and upon being relieved from this service he was charged with a re-survey, topographical and hydrographical, of the city of Seattle and vicinity, a work rendered necessary by the fire of two years before which had destroyed the entire business portion and water front, and by rapid growth and improvements since that date.

Hydrographic surveys in Skagit Bay, Drayton Harbor, Boundary Bay, and the Gulf of Georgia.—

Reference was made in the last Annual Report to the beginning in April, 1890, of a hydrographic survey of Skagit Bay, Washington, by the party in charge of Lieut. J. N. Jordan, U. S. N., Assistant Coast and Geodetic Survey, commanding the schooner *Earnest*.

Work in Skagit Bay having been finished July 24, the vessel was moved to Drayton Harbor, near the Northwestern Boundary, and the erection of signals was then begun for the hydrography to be executed in Boundary Bay and the Gulf of Georgia. With the exception of smoke from forest fires, and fogs, nothing interfered with progress, and the survey was carried on until November 8, when owing to the prevalence of southerly gales, Lieut. Jordan did not deem it economical to continue field operations.

During the following winter he was occupied at Olympia in office work, and had the vessel overhauled and put in order for next season, and the steam launch sent to Seattle to have new tubes put in her boiler.

On April 24, instructions for the resumption of field operations having been previously received, Lieut. Jordan proceeded to an anchorage in the Lucia Islands, and began hydrographic work on two of the projections from the limits reached during the preceding season, having also on hand a third projection including the Canal de Haro. Advantage was taken of slack tides and calm weather to work in the more exposed waters, and as the soundings were carried on alternately on the three sheets, the hydrography included in their limits had been finished by June 30 as far to the westward as a line from Point Doughty, Orcas Island, to East Point Light, Saturna Island, British Columbia.

Later progress will be referred to in the next Annual Report.

The officers attached to the *Earnest* during the fiscal year were Ensigns Harry George and E. Moale, U. S. N. Mr. J. A. Chestnut, Pay Yeoman, served till Feb. 28, 1891, when he left the survey and was replaced by Mr. B. J. Crowley, appointed Pay Yeoman, April 1, 1891.

A summary of the statistics of field work during the year is as follows:

Hydrography:

Approximate area, sounded over in square geographical miles.....	220
Number of miles run in sounding.....	1 551
Number of angles measured.....	7 445
Number of soundings	29 006

*Surveys of the water fronts of the cities of Whatcom, New Whatcom, and Fairhaven on Bellingham Bay, Washington, for the Harbor Line Commission of that State.—*At the beginning of the fiscal year Assistant J. J. Gilbert was on duty with the primary triangulation party of Assistant George Davidson on Mount Conness, California. After the observations at that station had been finished, he remained attached to Mr. Davidson's party, engaged at San Francisco, partly in office work, and partly in connection with Sub-assistant Morse in making observations of moon culminations at the Lafayette Park Observatory to be used in connection with those obtained by the Alaska Boundary parties.

In May, 1891, Mr. Gilbert, under instructions from the Superintendent, reported in person to the Harbor Line Commission of the State of Washington, and took up for that Commission a survey of the water fronts of the cities of Whatcom, New Whatcom, and Fairhaven.

Reference to this service is again made under the heading "Special Operations."

Exchanges of telegraphic signals for longitude between Salt Lake City, Utah, and Helena, Montana.—

For a report of these exchanges of telegraphic longitude signals, see the second heading in the "Middle Division."

Occupation of stations and reconnaissance for site of primary base-line in continuation of the transcontinental triangulation near the 39th parallel in eastern central Utah.—The plan of work for the season of 1890 of the party in charge of Assistant William Eimbeck, engaged in the extension to the eastward of the transcontinental triangulation near the 39th parallel in Utah, included the occupation of Wasatch and Mount Ellen, main stations in that triangulation.

Having left Washington in pursuance of instructions dated June 13, 1890, Mr. Eimbeck, upon reaching Salt Lake City towards the end of June, began the organization and fitting out of his party, and the necessary preparations having been made, took the field about the middle of July, proceeding by way of Juab and Mayfield to Wasatch.

This station is located upon the principal summit of the broad and extensive table mountains bearing the same name. Its elevation above sea-level is 11,200 feet. To reach the top, a pack trail, 7 miles long, had to be opened, and the station had to be prepared for the safe and adequate mounting of the instruments.

The work executed included observations of horizontal directions and of vertical angles; determinations of the latitude; observations for azimuth, complete sets of observations for magnetic declination, dip and horizontal intensity, and the trigonometric connection of the telegraphic longitude station at Gunnison, Utah, with the main triangulation. This station had been determined in geographical position by Lieut. (now Major) G. M. Wheeler, U. S. Engineers, while in charge of the Geographical Explorations west of the one hundredth meridian.

The whole force of the party was occupied at Wasatch in the various operations referred to until September 3. It was deemed inadvisable to attempt to occupy Mount Ellen at that advanced stage of the season, and accordingly Mr. Eimbeck transferred his party *via* Juab and Thistle to Sunnyside on the Rio Grande Western Railway; and thence to Patmos Head triangulation station, which has an elevation above sea level of about 9,800 feet, and is located upon the rim or margin of the West Taraputs Plateau in eastern Central Utah.

The occupation of this second station, including necessary preparations, and a reconnaissance for the location of a primary station upon the Book Mountains in Colorado, and for an auxiliary station in the Green River Valley near Blake City, Utah (a proposed longitude station), required fully seven weeks. At Patmos Head the work was of a similar character to that at Wasatch. There was carried out at each station a topographical survey rather more extended and elaborate than was needed for its mere description, the object being to obtain data for the study of the deflection of the plumb line.

At Wasatch, the scheme of triangulation required the determination of nine principal directions, four of which were provided with heliotropes, while the remainder, inclusive of the reference mark, were observed by means of ordinary framed signals. At Patmos Head, eight principal horizontal directions were determined, five of which were observed by means of heliotropes.

The second order points determined during the season were numerous and important. The hypsometric work accomplished was also very extensive, and included besides all primary and secondary points, complete series of special observations for the detailed study of the range and variations of atmospheric refraction at the high levels of the mountain peaks.

In the determination of the astronomical latitudes, from twenty to twenty-three pairs of stars were observed with the zenith telescope on five or six different nights. For the determinations of astronomical azimuth, the method of observing Polaris in opposite positions of its diurnal path, as heretofore reported, was followed uniformly. These observations, evenly distributed over the morning and evening hours, extended over five days at each station and gave excellent results.

Upon the completion of the field work of 1890, and after making the usual arrangements for the safe keeping of the party equipment during the winter, Mr. Eimbeck repaired to Washington, and reported to the Superintendent for office duty. He then took up the reduction and discussion of some of the results of the season's observations, and devoted part of his time also, at the request of the Superintendent, to preparing plans and specifications for a

base apparatus of the duplex type. This he had designed and first suggested in February, 1885, and its construction had now been directed with a view of testing it in actual measurement in the field.

Early in the spring of 1891, Mr. Eimbeck received instructions to resume field work, in pursuance of which he returned to Utah, arriving at Salt Lake April 30. The first work to be done was to extend the examinations for the location of a primary base-line site, some progress in which had been made in former seasons. The region over which these examinations were carried was the northern portion of the Jordan Valley, the San Pete Valley, and the extensive flat lands bordering upon the Great Salt Lake, opposite Ogden City. The several conditions entering into the selection of this base-line site were carefully studied by Mr. Eimbeck, and in the latter part of June he submitted for the consideration of the Superintendent a number of schemes of more or less geometrical symmetry and susceptible of more or less ready connection with the triangulation.

While this work was in hand, Mr. Eimbeck gave personal attention also to the organization of a field party for the occupation of the longitude station at Ogden, Utah, in order to perfect its connection with the triangulation, and to extend the telegraphic longitude astronomically to the triangulation station, Ogden Peak, some 7 miles distant to the eastward. This was accomplished by the reciprocal azimuth method, which he had suggested a year before, and which gives results wholly independent of the triangulation.

Mr. Eimbeck joined this party at Ogden on the 24th of May, and the concluding observations were made June 16, their completion having been retarded by high winds and stormy weather.

Preparations were then taken up for the re-occupation of Ogden Peak triangulation station, in which work the party was engaged at the close of the fiscal year.

Mr. Eimbeck expresses his high appreciation of the services of Sub-assistant P. A. Welker, who was attached to his party during both seasons, and whose diligence and conscientious devotion to duty deserved much praise. At the longitude station near Ogden, Mr. E. P. Austin, computer on the American Nautical Almanac, rendered acceptable aid as extra observer.

Messrs. O. B. French, Thomas E. McVickers, and R. L. Faris served efficiently as recorders.

51—DIVISION OF ALASKA.

Under this heading are included the coasts of Alaska which border on the North Pacific Ocean, on Bering Sea, and on the Arctic Ocean: also the inlets, sounds, bays, and rivers.

The localities of field operations in Alaska are shown on Progress Sketch No. 3. See a list of Progress Sketches at the close of this volume.

Determinations of gravity with new and improved apparatus at stations in southeastern Alaska, and at a station on St. Paul Island, Pribilof Group, Bering Sea.—The differential determinations of gravity made by the Superintendent with new and improved apparatus constructed at the office under his direction have been referred to under the heading "Special Scientific Work," and also in a report of the gravity stations which he selected and occupied in the States of California and Washington under the heading "Western Division."

Arrangements having been made that he should take passage for Alaska on board the steamer *Patterson*, Lieut. Commander H. B. Mansfield, U. S. N., Assistant Coast Survey, commanding, Dr. Mendenhall, with Mr. Fremont Morse, Sub-assistant, having reached southeastern Alaska in May, 1891, swung the new pendulums during that month at Juneau, Pyramid Harbor, Yakutat Bay, and Sitka, these stations having been occupied in the order named. In June, stations were occupied at Wrangell and at Burroughs Bay. [See Appendix No. 15, Part II.]

With regard to the operations in Alaska, the Superintendent observes that they were necessarily of a more doubtful character than usual, owing to the extremely unfavorable conditions under which the work had to be done. In all cases, the apparatus was used in the open air, being protected only by a light tent, and often by the tent fly alone. The weather was far from being favorable for astronomical work, and time observations were difficult and rare. The duration of swings at any one station was short, often but five or six hours of a single day. In spite of these numerous discouragements, a field reduction of the observations

shows that the work is likely to be of considerable value, and even if it does not prove to have a high degree of accuracy, the high latitude of the stations, and the absence of all previous observations of the kind, except at Sitka, will justify the comparatively small cost and time incident to the undertaking.

All that could be done in the way of time observations for rating the very inferior chronometer used was done by Ensign Poundstone, U. S. N., attached to the *Patterson*, whose interest in the work and faithfulness in doing his part of it under trying circumstances, the Superintendent wishes to acknowledge. To Lieut. Commander Mansfield, and to all of his officers, he expresses his indebtedness for continued efforts to do all in their power towards making the gravity observations successful.

On July 10, 1891, the Superintendent was appointed by the President as one of the United States Commissioners to visit the Pribilof Islands in Bering Sea, and availed himself of that opportunity to carry his gravity apparatus to St. Paul Island, where the pendulums were swung for a few hours.

General surveys continued in southeastern Alaska. Triangulation, topography, and hydrography of Taku Inlet, Stephens Passage from Douglass Island to the northward, Gastineau Channel, Lynn Canal and Behm Canal.—Reference was made in the last Annual Report to the beginning early in May, 1890, of the season's work in southeastern Alaska by the party in charge of Lieut. Commander H. B. Mansfield, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Patterson*.

Barlow Cove, at the head of Admiralty Island, was found to offer the only fair harbor at the outset of the survey; this was chosen therefore as the first anchorage of the *Patterson*, and a primary base-line was measured on the western side of Shelter Island, a mean of six measurements, agreeing closely, giving a length of 4050.64 metres (about 2½ miles.)

At this harbor, a tide staff was set up and observations continued night and day for a lunar month. Tide-gauges were also erected at six other anchorages made by the *Patterson* during the season, and the several gauges were connected by simultaneous observations, as directed in the General Instructions for Hydrographic Work.

The following named stations were occupied for determinations of time, latitude, longitude, and azimuth: Point Lena, Lynn Canal, Auke Station, Young Point, Stephens Passage, Chilkat and Funter Bay Stations, Lynn Canal. Previous to and upon the conclusion of observations at each of these stations, the astronomical station at Cape Fanshaw was occupied for one night, so that but short periods were allowed to lapse during which errors could accumulate.

Determinations of the magnetic declination, dip, and intensity were made at points conveniently distant from the astronomical stations.

A fifth magnetic station was occupied at Chilkoot on the Lynn Canal, but the results obtained were not trustworthy, as the whole peninsula was found to be full of magnetic iron.

The entire triangulation was computed from the primary measured base, using the mean length before stated, and the connection of this triangulation with that of 1888 in the upper part of Stephens Passage was effected with very accordant results. The field sheets for the topography and hydrography were plotted from the computed triangulation, and the general plan of work carried on differed in no important details from that of the preceding season.

Fourteen harbor and large scale sheets were made from the surveys included in the projection sheets of Lynn Canal and vicinity; among these were Barlow Cove, scale 1-20 000; William Henry Harbor, 1-10 000; Pyramid Harbor and Portage Cove, 1-40 000; and Gastineau Channel and Juneau Harbor, 1-20 000.

Lieut. Commander Mansfield gives in his report full descriptions of the inlets, harbors, and anchorages included within the limits of his survey. These descriptions will be of much value in the latest editions of the Alaska Coast Pilot, part of the proof sheets of which have been received from the Public Printer. The photographs of views taken in Lynn Canal, Gastineau Channel, Taku Inlet, and the neighboring passages, channels, etc., lend additional interest to the report.

The season of 1890 was marked by very favorable weather and comparatively little rainfall. The general features of the country were the same as those of preceding seasons, except

that, as would naturally follow in going north, the snow line and the timber line were noticeably lower. The high mountains approach nearer to the water, but the timber, undergrowth, wild flowers and grasses are the same as in Frederick Sound. Game was less plentiful than in the season of 1889. Lynn Canal is a great thoroughfare for Indians and mining prospectors, which probably accounts for the scarcity of game.

Gold and silver are found at a number of points, and at every few miles claims have been located, the value of which, as estimated by the owners, is something fabulous, but as to their real value, no facts could be obtained. Lieut. Commander Mansfield observes that there is, undoubtedly, a great deal of gold bearing quartz in this section, but most of it, if not all, is of a very low grade, and cannot be profitably worked at present.

Outside of mining, the great industry of this section is the salmon fishing and canning. During the season of 1890, there were three canneries located at the head of Chilkat Inlet, which employed some 400 people, whites, Chinese, and Indians, and packed 53 000 cases.

Field operations were closed on September 17, and on the 18th of that month the *Patterson* left Juneau, stopping at Cape Fanshaw to pick up the astronomer; at Port Simpson to place the steam launch *Cosmos* on the ways; at Departure Bay to coal, and at Port Townsend for mail, arriving at San Francisco, October 6, 1890.

The officers attached to the party were Lieut. E. J. Dorn, U. S. N., executive officer; Ensign H. C. Poundstone, U. S. N., navigator and astronomer; Ensigns G. R. Slocum, Joseph Strauss, W. H. Faust, and F. W. Jenkins, U. S. N.; T. L. Carter, Assistant Engineer, U. S. N.; H. L. Ford, Master-at-arms, served as draughtsman, and J. G. Smith and J. B. Dornin as Pay Yeomen. Passed Ass't Surgeon H. T. Percy, U. S. N., was attached as medical officer.

Following are the statistics of the season:

Base lines:

Primary, length of, in metres	4 050.63
Secondary, length of, in metres	2 828.74 and 2 704.46
Harbor measurements, four base lines, having lengths in metres of 1 115.08, 572.06, 1 013.5, and 631.1, respectively.	

Triangulation:

Area of, in square statute miles	980
Signal poles erected, number of	296
Observing tripods and scaffolds built	272
Number of stations occupied for horizontal measures	370
Number of stations occupied for vertical measures	118
Number of geographical positions determined	336
Number of elevations determined trigonometrically	110

Latitude, longitude, and azimuth work:

Number of stations occupied for determinations of latitude, longitude, and azimuth	4
Number of pairs of stars observed for latitude	70

Magnetic work:

Number of stations occupied for observations of the magnetic declination, dip, and intensity	5
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Topography:

Approximate area of topography in square statute miles	1 000
Length of general coast line in statute miles	887

Hydrography:

Area sounded, in square geographical miles	703
Number of miles (geographical) run while sounding	2 359
Number of soundings	17 518
Number of tidal stations established	7
Number of specimens of bottom preserved	92
Number of current stations	31

During the winter of 1890-1891, the records and results of the work were in preparation for transmission to the archives.

Under instructions from the Superintendent, dated February 6, 1891, and detailed instructions from the Hydrographic Inspector of February 10, the *Patterson* was fitted for another season in Alaska, and left San Francisco, April 12, for Port Townsend, Washington.

At Port Townsend, Dr. T. C. Mendenhall, Superintendent, took passage for Alaska, accompanied by Sub-assistant Fremont Morse. The Superintendent had availed himself of a visit of inspection to the Pacific Coast, to make gravity determinations at stations on that coast with new and improved apparatus.

The officers of the *Patterson* were Lieut. Commander H. B. Mansfield, U. S. N., Assistant Coast and Geodetic Survey, commanding; Lieut. E. J. Dorn, U. S. N.; Ensigns H. C. Poundstone, W. L. Howard, F. L. Chapin, W. G. Miller, and W. H. Faust, U. S. N.; Passed Ass't Surg. H. T. Percy, U. S. N., and Ass't Eng. T. F. Carter, U. S. N. Messrs. W. L. Ford, J. G. Smith, and J. C. Dornin, U. S. N., served as draughtsmen.

On the way north, the steamer took in coal at Victoria, Departure Bay, B. C., and called at Port Simpson, B. C., for the steam launch *Cosmos*, arriving at Burroughs Bay, Behm Canal, southeastern Alaska, on April 30.

Lumber, coal, and stores for a camping party were landed here, and on May 6, after a base line had been measured, a party of officers and men was left in charge of Ensign W. L. Howard to continue the survey.

The *Patterson* then, by direction of the Superintendent, visited Loring, Port Chester, Kasa-an, Juneau, Taku Inlet, Fritz Cove, William Henry Harbor, Hooniah, Glacier Bay, Bartlett Bay, Yakutat, Sitka, Killisnoo, and Wrangell, returning to Burroughs Bay on June 3, and reaching the working ground in Walker Cove June 8.

On June 14, the *Patterson* conveyed the Superintendent to Loring, where he took passage with Mr. Morse on a mail steamer, June 17, and the *Patterson* returned, June 18, to her working ground in Rudyard Bay.

Progress subsequent to that date will be stated in the next Annual Report.

Surveys relating to a preliminary location of the boundary line between Alaska and the British Possessions in North America.—Under the heading "Special Operations," will be found abstracts of the reports of Assistant J. E. McGrath and Sub-assistant J. H. Turner of the progress of their respective parties engaged in preliminary surveys relating to the location of the boundary line between Alaska and the British Possessions in North America.

The latest report from Mr. McGrath, who remained during two winters at his station on the Upper Yukon River, is by a letter dated August 23, 1890; Mr. Turner, who spent his second winter at St. Michael, Norton Sound, has submitted a general report to the end of the fiscal year 1891.

Tidal record continued during part of the year at the automatic tidal station, St. Paul, Kadiak Island, Alaska.—The series of tidal observations with an automatic tide-gauge at St. Paul, Kadiak Island, Alaska, which was begun August 1, 1880, was continued until April 30, 1891, Mr. F. Sargent as observer in charge of station, under the general direction of Assistant George Davidson.

Monthly levelings between the staff and the bench-mark closely adjacent were made by the observer. The Alaska Commercial Company afforded the usual facilities in the use of their wharf and warehouse. Whenever practicable, Mr. Davidson has asked the services of officers of the Navy, the Revenue Marine, and the Alaska Commercial Company to examine the clock and apparatus, and their reports of its condition and of Mr. Sargent's care as observer have been favorable.

In February, 1891, a great storm carried away part of the wharf, and drifted the tide-gauge and house to the opposite island. Mr. Sargent with a native crew subsequently secured the instruments and the house, and in about ten days had the gauge in good running order.

SPECIAL OPERATIONS.

Observations of temperatures, densities and currents to the south of Marthas Vineyard in co-operation with the work of the U. S. Fish Commission.—Reference was made in the last Annual Report to the advantages accruing jointly to the Survey and to other branches of the Government service by coöperation in work whenever such coöperation could be obtained so as to secure results of value to both services and at a less cost. It was in pursuance of these aims that at the beginning of the fiscal year instructions were issued to Lieut. C. E. Vreeland, U. S. N. Assistant Coast and Geodetic Survey, commanding the steamer *Blake* to organize a party aboard that vessel for a season's work in conjunction with the U. S. Fish Commission to the south of Marthas Vineyard.

The Fish Commission was represented by Prof. William Libbey of Princeton College, who, with his assistants, was received on board the *Blake*, with the understanding that Lieut. Vreeland and the officers of his party would extend to Prof. Libbey every facility for making the observations of temperatures, densities and currents desired by the Commission.

The *Blake* left Brooklyn July 6, 1890, for Woods Holl, Mass., and work was begun July 9, temperature lines being run as follows: From latitude $41^{\circ} 10'$ north on the meridian of $71^{\circ} 30'$ west due south to latitude $38^{\circ} 50'$ north, and from that point due east ten minutes of longitude; thence north 140 miles, thence east ten minutes of longitude, thence south 140 miles, and so on, the easternmost line corresponding to the meridian of 70° west. Five of these lines were then duplicated. The temperatures were noted at depths between 5 fathoms and the bottom, where bottom was found at less than 200 fathoms, and between 5 fathoms and 200 fathoms in greater depths. In all, 210 stations were occupied and 2 266 miles were run. The records have been placed in possession of the Fish Commission.

Professor Libbey has communicated an abstract of his report of this work, which will be found in Appendix No. 7, Part II.

Physical hydrography. Observations of tides, currents, and densities and temperatures in Long Island Sound in connection with the work of the U. S. Fish Commission.—Reference was made in the last Annual Report to the beginning of the work in Long Island Sound undertaken jointly by the Fish Commission and the Coast and Geodetic Survey. The cruise of the U. S. Fish Commission steamer *Fish Hawk*, Lieut. Robert Platt, U. S. N., commanding, afforded an opportunity for the prosecution by the Survey of certain investigations in physical hydrography which it was desirable to make in the Sound, and the offer kindly made by the Fish Commission to furnish quarters and transportation to the officer of the Survey assigned to this work, and to coöperate with him otherwise in its execution was gladly accepted.

At the beginning of the fiscal year the work was in full progress, Mr. E. E. Haskell, Expert observer in the Survey having reported early in June to Mr. Richard Rathbun, of the Fish Commission, in charge of Scientific Inquiry, and having completed the rating of the current-meters to be used in the work, established in position three automatic tide-gauges.

The operations during the remainder of the season consisted of tidal observations, current observations, and observations of densities and temperatures.

Tidal observations. For the determination of the rate of propagation and the height of the tide-wave of the sound simultaneously with the observations of currents, three stations were

selected, one at New London, one at New Haven, and one at Willet's Point. At each of these stations, self-registering tide-gauges were established and maintained in operation throughout the season.

Current observations. The velocity and direction of the current at the surface of the Sound, at mid-depth and at bottom were observed on each lunar half hour at eighteen stations, an interval of at least twelve consecutive lunar hours being covered at each station. Seven of the stations were occupied for twenty-four consecutive lunar hours each.

In the location of these stations, the positions of which are shown on the sketch accompanying Mr. Haskell's report, two objects were kept in view; first, to determine the circulation of the Sound, and, second, to ascertain the direction of movement of material dumped on the dumping grounds in the waters of the State of Connecticut. Stations 1 to 13 inclusive were located for the study of the circulation; of these stations 1 to 4 were on a cross-section at the eastern end of the Sound between the mouth of the Connecticut River and the northern shore of Long Island for the purpose of obtaining an approximation to the volume of the flow of flood and ebb; stations 10, 11, and 12 were on a cross-section at the western end between Rye Neck and Matinicock Point. Stations 3, 5, 6, 7, 8, 9, 11, and 13 were in the longitudinal axis of the Sound, and were occupied to trace the current movement as distinguished from the tide-wave movement. It was found, for example, that the flood tide-wave travels over the Sound from Little Gull Island to Throg's Neck, a distance of 93 statute miles, in two hours, while the flood current would not move over more than 12 or 15 statute miles in the whole duration of that tide.

Current stations 14, 15, 16, 17, and 18 were located on the dumping grounds of Bridgeport, Norwalk, Stamford, Milford, and New Haven, respectively.

Densities and temperatures. At each of the current stations Nos. 4 to 18 inclusive, the density and temperature of the water at surface and bottom were observed once every hour during the entire time of occupation of the station. These observations were made by Mr. W. C. Kendall, Biologist of the *Fish Hawk*, with salinometer and thermometer belonging to the Fish Commission.

Mr. Haskell will take an early opportunity of preparing for publication a report describing the methods of his work and presenting its results.

He makes acknowledgement to Capt. Platt and the officers of the *Fish Hawk* for their attention and assistance. Field operations were closed October 20.

Surveys for the preparation of the detailed maps of the grounds included in the Chickamauga and Chattanooga National Military Park.—The Chickamauga and Chattanooga National Military Park Commission, constituted by Act of Congress approved August 19, 1890, having, through the Secretary of War, applied to the Secretary of the Treasury for the detail of Assistant C. H. Boyd to make the surveys needed to prepare topographical maps of the grounds included in the Park, the Superintendent took action accordingly, and under date of October 4, 1890, instructed Mr. Boyd to report for duty to the Commission.

On that date he left for the field, and up to the middle of June, 1891, was continuously engaged upon the required surveys and the engineering work connected therewith.

By the Act creating the Park it is to consist of two features: 1. The field of battle of Chickamauga, which the United States will purchase, and which may be called the Park proper; and 2. The eight roads of approach thereto, the jurisdiction over which has been ceded to the United States by the States of Georgia and Tennessee. These approaches cover the battle fields of Lookout Mountain, Missionary Ridge, and Chattanooga.

The Park proper comprises an area of about 16 square miles, in which somewhat more than 200 persons have ownership, the territory being a part of the Cherokee lands allotted in sections of 160 acres to settlers in 1837. In November and December, 1890, these sections were all run and re-marked, the farm boundaries established, and the lands classified so that estimates of their value could be made as a basis for purchase.

In order to control the various surveys to be made in the process of this work, and to connect all with the triangulation of the Coast and Geodetic Survey, geodetic operations were

begun from the base, Pigeon Mount-High Point, to extend over the Park and its approaches, and to cover the city of Chattanooga. Mr. Boyd had occupied six second order points for measurements of horizontal and vertical angles before field work was suspended for the summer. Preliminary surveys for the location of some 45 miles of the approaches had also been made.

The office work pertaining to these surveys is in active progress at a sub-office established in Chattanooga by the Commission for the use of Mr. Boyd and his assistants.

By direction of the Secretary of War he came to the War Department the middle of June for consultation with the Commissioners, after which, and with their assent, he took his own immediate office work to his home in Portland, Me. In the autumn he will resume field work under the direction of the Commission.

Establishment of a trial course off the Pacific coast for the speed trials of the new naval cruiser San Francisco.—The Secretary of the Navy having requested the Superintendent of the Coast and Geodetic Survey to lay off an accurately measured course of not less than 40 miles for the speed trial of the new naval cruiser *San Francisco*, the Superintendent decided to entrust the execution of this important work to Lieut. D. Delehanty, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Hassler*.

A projection, scale 1-80 000, of the vicinity of Santa Barbara, Cal., where it had been determined to lay off this course, was accordingly sent to Lieut. Delehanty in May, 1890, and he was instructed to establish it in water not less than 20 fathoms in depth, and to mark the terminal points in the most accurate manner by means of range signals.

After a careful examination of the Santa Barbara Channel, Lieut. Delehanty selected for the western terminal range the astronomical station of the Coast Survey, $1\frac{2}{10}$ miles (nautical) to the east of Point Conception Light-house; and for the back range, a point bearing north $11^{\circ} 08'$ west (magnetic), distant 1 256 metres (4 120 feet). And having marked each point by a brick monument, he erected over them strong tripod signals $27\frac{1}{2}$ feet high.

The eastern terminal range is similarly marked. For this range the front signal was put up on a low bluff 97.5 metres (297 feet) to the westward of station White of the coast triangulation, and the back signal near the old adobe chapel and distant from the front signal 2 354.8 metres (7 725.7 feet).

Upon consultation with Commodore John Irwin, U. S. N., President of the Board for the speed trial of the *San Francisco*, and with Capt. C. M. Goodall, who would command the vessel during her trial, it was decided that one intermediate range would be sufficient; and this was marked by the Santa Barbara Lighthouse and by a tall windmill distant from the lighthouse 547 metres (1 794.6 feet).

As the eastern terminus was to be the starting and finishing point of the course, the intermediate range was laid off as near 4 miles from it as practicable in order to mark approximately the 76th mile, this being the distance the ship is required by contract to make in four hours.

Under date of July 31, 1890, Lieut. Delehanty reports the completion of the laying out of the course. On the 21st of that month he went over it in the *Hassler* with Commodore Irwin and Capt. Goodall, and both of these officers expressed themselves as satisfied with it in every respect.

The projection showing the course in distance and direction, the ranges established, and their connection with the triangulation, etc., is now on file in the archives of the Survey.

Surveys of the water-fronts of the cities of Whatcom, New Whatcom and Fairhaven, on Bellingham Bay, Washington, for the Harbor Line Commission of that State.—On the 20th of April, 1891, Assistant J. J. Gilbert reported in person, in accordance with instructions, to the Superintendent at Seattle, and, under certain conditions, was by him directed to report for duty to the Harbor Line Commission of the State of Washington.

An order having been obtained from the Hydrographic Inspector turning over the steamer *Helen* to Mr. Gilbert for the service that would be required of him for the Commission, he took

charge of the *Helen* at Eagle Harbor and towed her to Port Blakely, where about ten days were consumed in making the necessary repairs.

On the 11th of May, all arrangements having been satisfactorily made, Mr. Gilbert reported in person to the Harbor Line Commission and was verbally instructed to proceed to Bellingham Bay and make a survey of the water-fronts of the cities of Whatcom, New Whatcom, and Fairhaven, and extend the survey one mile beyond the boundaries of those cities.

This survey was begun May 27, and at the end of the fiscal year Mr. Gilbert reported from Fairhaven that he had practically finished the work at that point, and would return next day to Olympia to make some computations in order that the Commission might have some results at their coming meeting.

Statistics of the whole work, with an account of its completion, will be given in the next Annual Report.

Surveys relating to a preliminary location of the boundary line between Alaska and the British possessions in North America.—Progress made in executing the surveys relating to a preliminary location of the eastern boundary line of Alaska, and involving the occupation of stations near the crossing of the 141st meridian on the Yukon and Porcupine Rivers, was stated in the last Annual Report up to the latest advices received from assistant J. E. McGrath, in charge of the party on the Upper Yukon, and from Sub-assistant J. H. Turner, in charge of the party on the Porcupine.

At the date at which this Annual Report is transmitted to the Department, the latest letter from Mr. McGrath received at the office is one bearing date of August 23, 1890, from his camp on the Upper Yukon. His first winter in Alaska having been marked by an almost constant succession of foggy, stormy, and otherwise unfavorable weather, he decided to remain another winter in the hope that he might be more successful in obtaining the observations desired. His letter relates chiefly to the preparations required to be provided against the emergencies incident to a winter sojourn at his isolated station.

It was fortunately in his power to furnish timely aid to Mr. Wells, of the Frank Leslie Alaskan expedition, who arrived at his camp June 23, with his assistant, Mr. Schanz, and two hands, short of provisions. They had come down the Yukon to McQuestion's trading post, expecting to find supplies, and with Mr. Schanz quite ill, but were disappointed, and could have gone no further without help. Before Mr. Schanz left for St. Michael in August he had fully recovered his health, and prepared for the Survey a copy of his map of the route traveled by the party of Mr. Wells from Pyramid Harbor to the Yukon.

Mr. McGrath, upon his return to San Francisco, has been instructed to proceed to Washington and report to the Superintendent, and will submit at the earliest date practicable a full report of the operations of his party in Alaska.

At the time of transmission of the last Annual Report to the Department, the latest advices from Mr. Turner were by letters dated January 1 and 24, 1890, which did not reach Washington until June 30. He has now submitted a general report of his field operations from the dates just named to the time of his leaving his station on the Porcupine River in July, 1890, and thence to his arrival at St. Michael, Norton Sound; his enforced sojourn there during the winter of 1890-1891, and his subsequent departure for San Francisco in July, 1891.

From a preliminary reduction of the astronomical observations at Camp Colonna, his station on the Porcupine, Mr. Turner found for its geographical position:

Latitude $67^{\circ} 25' 05''$ North.

Longitude $91^{\circ} 23' 56''$ West of Greenwich.

As the season of 1890 advanced, the fogs of winter were replaced gradually by cumulus clouds. After the 1st of February, the days lengthened rapidly, and about the beginning of May the continuous twilight rendered observations on stars extremely difficult, so that the observations for latitude progressed but slowly.

Meteorological observations were kept up, and on the 8th of March one of the lowest temperatures of the season, $48^{\circ}.5$ below zero of Fahrenheit, was recorded. The most brilliant auroral display witnessed by the party occurred about this time. It was not until the 20th of

April that the temperature crossed the zero line, and although after this date the rise in temperature was quite rapid and marked, there was nevertheless violent alternations, as, for instance, on the 17th of May, when a cold wave, accompanied by furious snow storms, swept over the country with a minimum temperature of 15° Fahrenheit, and again on June 4, when the temperature fell suddenly from 65° Fahrenheit to 25° Fahrenheit, with killing frosts, checking vegetation for three weeks or more.

Triangulation.—Since the astronomical observations placed the station about $\frac{1}{2}$ mile to the east of the International Boundary line, it was decided to execute a small triangulation in the immediate vicinity. For this purpose a base of about 900 metres in length was measured on the ice in a diagonal line across the river, and at the points selected on some of the neighboring hills, signals were erected, and horizontal angles measured with an 8-inch theodolite. On June 1, Boundary Mount station was occupied, the theodolite being transported with difficulty across the spongy tundra*. At this station, 4 miles from the river, the measurements of horizontal angles between the signals were made at midnight, the sun being elevated about two diameters above the northern horizon. Strange mirages were produced by the unequal heating of the different atmospheric strata.

Topography.—As early as practicable during the season, a topographical survey of the camp and its vicinity was begun, and was continued with frequent interruptions during the latter part of May and through the month of June. The topographical sheet shows on a scale of 1:5 000 the position of the camp and of the various observatories, the new Rampart House, and the country for a mile or more on either side of the boundary. Curves of equal elevation were run 10 feet apart, a 4-inch Casella theodolite in the hands of Assistant Astronomer H. W. Edmonds being used for this purpose. A datum plane for levels was taken 43 feet below the surface mark of Northwest Base, and corresponds with the river level at Northwest Base at the time the survey was executed.

Since the river abounded in rapids, and the stage of water was subject to great and uncertain fluctuations due to a varying rainfall, no hydrography was done.

Magnetic observations.—Observations of the magnetic declination were made once a week through twenty-four hours, and continued without interruption until May. In June observations were made of the magnetic elements on thirteen days, this month having been selected on account of the diminished force of the aurora. Abnormal fluctuations proved conclusively, however, that although invisible on account of continuous daylight, the aurora existed throughout the summer months. Observations for azimuth in connection with the magnetic work were made on the sun.

Latitude.—Observations for latitude were begun in March and substantially completed in April. A close agreement amongst the measures is not probable, since the temperature had a range of upwards of fifty degrees during the course of this branch of the work.

Moon culminations.—Lunar transits were observed at the March lunation, and again in April, the last observation having been made on April 3. Persistent cloudiness prevented the observation of any additional occultations.

Sledge expeditions.—In March Mr. Turner organized a sledge expedition from his camp on the Porcupine River to the Arctic Ocean. His object was, as far as the configuration of the country would permit, to follow the course of the International Boundary to the Arctic, making preliminary surveys, *en route*. On March 27 he started northward, accompanied by John Firth, Hudson's Bay Company's trader at Rampart House; Gustav Bergman, and Edwin Engelstad of his own party, and three Indians, carrying along four sleds, on one of which was packed a sextant with artificial horizon, a 4-inch Casella theodolite, an azimuth compass, a sidereal and a mean-time pocket chronometer, and a camera outfit. Unfortunately, the two chronometers began to behave badly on the second and third days from camp, and the mean-time chronometer finally stopped, so that Mr. Turner was unable to do more than make a geographical reconnaissance of the route traveled.

* A treeless plain covered with moss.

He reports that he crossed the range of mountains running parallel to the Arctic Coast from the Mackenzie River to the eastern limit of Lieut. Stoney's explorations on the Kowuk and Colville Rivers. This range was represented by Lieut. Allen in the map accompanying his report on the exploration of the Copper, Tanana and Koyukuk Rivers, and was crossed by Mr. Turner over a pass 3 000 feet above the sea. Between this range and the Porcupine River, he found a vast plain about 60 miles wide and 100 miles long, heavily timbered with spruce, birch, aspen, and cottonwood, and resembling in every respect the plain around Fort Yukon.

Between the mountain range bordering the Porcupine River plain on the north and the Arctic Ocean, a bewildering mass of broken ranges was visible. Peaks of from 6 000 to 8 000 feet in height were numerous, and a striking difference was noticeable between the climates on the northern and southern side of this dividing range, which Mr. Turner named the Davidson Mountains, and which form the true water-shed between the Porcupine River and the Arctic Sea. North of this range, vegetation becomes scanty. Isolated clumps of straggling spruce are found in the canons with southern exposures. Twenty-five miles from the coast the spruce disappears, being replaced by scrub willow, which seldom reaches a height of 15 feet. After crossing the Davidson Mountains, the route followed the bed of a small river, frozen to the bottom. The temperature on the 8th day out fell to 50° below zero of Fahrenheit. On April 10 the party reached the shores of the Arctic, opposite Herschel Island. A gale blew from the southeast, sweeping the fine snow in blinding clouds before it, obscuring objects half a mile distant. The thermometer marked 30° below zero Fahrenheit, and not a living thing was visible. A line of white hummocky ice skirted the shore.

On the following day, the wind abated somewhat and the air cleared, revealing frozen sea as far as the eye could reach.

That morning (April 11, 1890,) Mr. Turner obtained some observations for azimuth and determined the meridian altitude of the sun, after which the party started homeward, and arrived at their camp on the Porcupine six days later, having made the round trip of 400 miles (approximately) in eighteen days.

Some days after his return, he fitted out another expedition, putting Assistant Astronomer Edmonds in charge, and instructing him to push south to Assistant McGrath's camp if possible. But the spring thaws set in early, and after having travelled 40 miles, Mr. Edmonds was forced to return. He found a heavily wooded broken country, abounding in rivers and lofty mountains.

Before the beginning of July, arrangements were begun for leaving Camp Colonna and proceeding down the Porcupine and the Yukon to St. Michael in the hope of finding there a steamer for San Francisco.

On the 15th of July, all preparations had been completed; the astronomical observatory was left in charge of Post-trader John Firth, who kindly volunteered to protect it from injury; and all of the instruments, provisions and personal effects with the remainder of the camp outfit were packed in two large lighters belonging to the Alaska Commercial Company. The party then started down the Porcupine, for the survey of which Mr. Turner had made all the arrangements needful. At certain points sextant observations on the sun and stars were to be made and meridian altitudes of the sun observed for latitude by Assistant Astronomer Edmonds, while Mr. Turner undertook to make a plane table survey of the river, using the method of "head lines." A man in a skiff preceded the party by a mile or two, erecting poles at intervals for azimuth lines. Distance was carried by telemeter readings, and the country contiguous was sketched in as far as practicable. By pursuing this method systematically, he was enabled to survey the Porcupine from Camp Colonna to Fort Yukon in twenty-two days, the total distance covered being 210 miles.

Three monuments were erected on the line of the boundary as approximately ascertained. No. 1 consists of a stone pile 12 feet high and 7 feet in diameter at the base; conical in shape, and having a base stone of about 1 000 lbs. in weight as a surface mark. It stands at the foot of the cliffs 100 metres distant from the north bank of the Porcupine and is plainly visible

from the river. The corresponding monument on the south side of the river is twenty steps from the bank, and its dimensions are substantially those given for No. 1 (the reference monument), except that it is built of earth, there being no large stones in its immediate vicinity. It stands near the center of a *tundra* glade covering several acres.

In addition to these two monuments, a large mound of earth was thrown up on the summit of Sunaghun hill overlooking the river. It forms a conspicuous landmark.

Four miles south of the river, the boundary crosses a well defined rocky peak 2 000 feet above the level of the sea. It bears the name of "Canalaska Mountain," a composite title, the peak lying in both the American and the British possessions.

The mouth of the Porcupine River was reached on the 6th of August, and pending the arrival of the river steamer, which was expected daily, Mr. Turner made a thorough examination of the delta at Fort Yukon, and found that the main channel of the Porcupine enters the Yukon about 5 miles below the old fort, and not, as stated by Schwatka, 15 miles below.

The long expected steamer *Arctic* hove in sight Aug. 13, and next morning Mr. Turner and his party with the two lighters left for St. Michael. Drifting down the stream was slow and laborious; there were but four fair days during the month of August, and owing to delays from stormy weather, it was not till August 30 that the party reached St. Michael.

Here, greatly to their disappointment, they were informed that the Revenue Cutter *Bear* on which they had expected to take passage for San Francisco, had left the port August 22. Finding that a stay during the coming winter at St. Michael was inevitable, Mr. Turner immediately set his party at work to prepare for it.

An astronomical observatory was quickly erected; the meridian telescope placed in position, and regular observations begun for time, latitude, longitude, and azimuth. The meteorological instruments were read twice a day. A base, $2\frac{1}{2}$ miles long was measured on the ice, and a scheme of triangulation developed, upon which was based a topographical survey, the results of which appear in two plane table sheets, one of St. Michael and vicinity, scale 1-1 000, and one of St. Michael Harbor, and portions of St. Michael Island, scale 1-20 000.

Observations for the determination of the magnetic elements were made in October, November, March, and June at the station occupied for that purpose in July, 1889.

Tidal observations were begun May 15, and continued through the month of June. These show that there is but one well marked tide at St. Michael, and that the effect of the winds on the tide is such as to make it difficult to determine the establishment of the port.

During his stay in Alaska, Mr. Turner made a valuable collection of bird and animal skins which he presented to the University of California. The expenses of this collection he bore personally. While at St. Michael, he made a study of the native (Tatchek) language, and will in due time prepare a treatise on the subject.

On July 9, he left St. Michael in the steamer *St. Paul* for San Francisco, by way of Unalaska. Having obtained some magnetic and other observations at this port, he closed his field operations July 17, 1891.

The members of his party throughout the season were as follows: Harry W. Edmonds, assistant astronomer; H. N. Kieraulff, physician and surgeon; Gustav Bergman, foreman; John Meade, assistant foreman; Wm. Rundquist, cook, and W. E. Lingard, C. P. Harkort, Otto Polte, and E. Engelstad, laborers.

In concluding his report of this arduous service, Mr. Turner commends the faithful service and devotion to duty of all of the members of his party, and more particularly of Assistant Astronomer Edmonds, whose interest in the work was exceeded only by his own.

The statistics from the date of beginning field operations June 28, 1889, to July 17, 1891, are as follows:

Base-lines:

Number of base-lines measured	2
Lengths of base-lines measured	2.5 mile and 0.6 miles.

Triangulation:

Area of, in square statute miles	20
Number of stations occupied for horizontal measures	12
Number of stations occupied for vertical measures	2
Number of geographical positions determined	23
Number of elevations determined trigonometrically	12

Latitude, longitude, and azimuth work:

Number of latitude stations occupied	7
Number of pairs of stars observed for latitude	46
Average number of observations on a pair	3
Number of longitude stations (chronometric)	7
Number of azimuth stations	6
Number of nights of observations for azimuth	3
Number of stars observed for azimuth	3

Magnetic work:

Number of stations occupied for observations of the magnetic declination, dip, and intensity	5
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Topography:

Area surveyed, in square statute miles	823
Length of general coast line in miles	50
Length of shore line of rivers in miles	491
Length of shore line of creeks in statute miles	103
Length of shore line of ponds in statute miles	20

Topographic sheets, limits and localities of:

1. Camp Colonna and vicinity, scale 1-5 000.
2. Camp Colonna to Fort Yukon, scale 1-200 000.
3. St. Michael, scale 1-5 000.
4. St. Michael Harbor, scale 1-20 000.

The following astronomical observations were also made. For the moon culminations, corresponding observations were undertaken by Assistant Davidson, at the Lafayette Park station, San Francisco.

Moon culminations:

At Camp Colonna	13
At St. Michael	25

Occultations:

At Camp Colonna	1
At St. Michael	5

ABSTRACTS OF ANNUAL REPORTS FROM THE ASSISTANT IN CHARGE OF THE OFFICE, THE HYDROGRAPHIC INSPECTOR, THE DISBURSING AGENT, AND THE ASSISTANT IN CHARGE OF THE OFFICE OF STANDARD WEIGHTS AND MEASURES.

ABSTRACT OF THE ANNUAL REPORT OF THE ASSISTANT IN CHARGE OF THE OFFICE.

The Assistant in charge of the Office, Mr. B. A. Colonna, in his annual report (office report, No. 1, at the close of this volume) acknowledges the effective coöperation of the Chiefs of the several Office Divisions, and refers to the organization by direction of the Superintendent of a Chart Board, and a Board on the Library and Archives as having done much to increase the efficiency of the service. The Chart Board has led to systematic coöperation in those directly concerned in the production and distribution of charts, while the Board on the Library and Archives has considered plans for the better classification and arrangement of the original records of the Survey, and has from time to time recommended lists of books needed, many of which have been added during the year.

An Advisory Board on Instruments and their Construction was organized by direction of the Superintendent, in October, 1890, and since that time has had before it all important matters of construction of instruments, except those relating to the new pendulum apparatus which was made under the Superintendent's special direction. The discussion and criticism elicited by the various experience of the officers composing this Board has been of great benefit to the Survey.

Assistant Charles A. Schott continued on duty as Chief of the Computing Division, supervising and arranging the work of the several computers, the nature of which is shown in his annual report. Among the scientific papers which he has submitted were a discussion of the magnetic observations made by Bering on the coasts of Kamchatka and Eastern Siberia in 1727-1729, the results of which furnished means for improving our knowledge of the secular variation of the magnetic declination; a report on determinations of azimuth from micrometric observations of a close circumpolar star near elongation, and a report on the secular variation and annual change of the magnetic force at stations occupied in connection with the Eclipse Expedition to the west coast of Africa in 1889-1890. These papers were published as *Bulletins*, Nos. 20, 21 and 23, respectively.

The annual report of the Drawing Division is submitted by Assistant W. H. Dennis, who has continued on duty as Chief of that Division during the year. Mr. Dennis appends to his report tabular statements of charts, the drawings of which for publication were completed or in progress during the year, and of information furnished in reply to special calls.

He notes the result of an important experiment made during the year, that of drawing and engraving for publication a chart on zylonite. This material, which is transparent, enables the draughtsman to trace upon it the topography directly from the original plane-table sheet when the chart is to be drawn upon the same scale, and the engraver, by using the reverse side, works directly from the drawing without further tracing or transferring, thus eliminating to a great degree the chances of error.

With regard to the experiments in engraving upon zylonite, Assistant Herbert G. Ogden, Chief of the Engraving Division, states in his annual report that they have met with a large measure of success. The prints from the zylonite are very satisfactory, and the work has been reproduced in copper by the electrotyping process. The zylonite process promises to provide a method intermediary between photo-lithography and engraving on copper, but just to what extent can not be stated until the process has been more fully developed.

Mr. Ogden reports that considerable progress was made towards completing the engraving of the 1-80 000 series of coast charts of the Atlantic Coast, the 1-400 000 series of general coast charts of the Gulf Coast, and the 1 400 000 series of the Pacific Coast.

A re-organization of the plate printing office was effected during the year with very satisfactory results. Mr. F. Moore continued to serve as foreman. In the electrotype and photograph rooms, of which Mr. D. C. Chapman has immediate charge, the batteries were put in thorough order and some of the details of their construction were improved.

Mr. Ogden refers to his designation by the President as a member of the U. S. Board on Geographic Names, and to his subsequent election by the Board as a member of the Executive Committee, and acknowledges the able assistance rendered him in these additional duties by Assistant Isaac Winston. The voluminous correspondence required by the work was conducted by Mr. Winston. He compiled also a Geographic Directory of Southeast Alaska for the consideration of the Board, and when detached for field duty had begun an exhaustive comparison of the nomenclature in the official Light-house lists with that of the charts of the Survey.

Mr. Ogden has appended to his report a tabular statement for file in the archives, giving the titles of new charts or new editions of charts, the engraving of which was begun, continued, or completed during the year, and the names of the engravers and a synopsis of their work.

The annual report of the Tidal Division, which is submitted by its Chief, Mr. A. S. Christie, refers to the efforts made to increase the usefulness of the Tide Tables for the

Atlantic and Pacific Coasts in the edition of tidal predictions for 1892. The manuscripts of these tables were prepared, sent to press, and partly read in proof before June 30, 1891. In the volume for the Atlantic Coast the number of subordinate stations has been increased from 650 to 687. Extensive and important changes were made in the volume for the Pacific Coast; the high and low waters were arranged in their consecutive and natural order, and the times and heights of the higher high and the lower low waters were printed in bold-faced type; the total number of subordinate stations was increased to 281, and a number of pages added embodying tables and information of value.

In the tidal predictions for Eastport, Me., Mr. Christie reports a distinct improvement in accuracy, gained by substituting for constants derived from Pulpit Harbor, Penobscot Bay, the results of a harmonic reduction of a year's tidal observations at Eastport, the constants thus derived being used in the tide-predicting machine for the 1892 tides at that port. For the tides at Sitka, Alaska, a much closer approximation in prediction was obtained by the employment in the machine of constants derived from an interpolation between those of Astoria and those of Kadiak Island.

Assistant Gershom Bradford, Chief of the Chart Division, reports that seven new charts from copper plates, and seven photo-lithographed charts, fourteen in all, were published during the year. A new edition of the Chart Catalogue of 1890 was published, and the preparation of an edition for publication in 1892 was begun. All corrections for Aids to Navigation were carefully made on the charts before issue, and in bringing this branch of the work to a high degree of efficiency Mr. Bradford acknowledges the cordial coöperation of the Hydrographic and Engraving Divisions.

Referring to a falling off in the general issue of charts during the year, Mr. Bradford points out that the greater part of it is due to a diminution in the number for free distribution, and states the causes which have operated to produce this. He transmits with his report for file in the archives a tabular statement of the number and value of charts issued and received during the fiscal year.

Mr. M. W. Wines, Chief of the Miscellaneous Division, who is charged with the distribution of the Annual Reports and other publications of the Survey, with the general supervision of the sale-agents and the returns of sales made by them of charts, coast-pilots, tide-tables, etc., and with duties pertaining to his position as general office assistant, submits in his annual report for file in the Archives tabular statements showing the amount of business transacted during the fiscal year, these statements including a list of the titles of the publications and the number of copies received from the Public Printer, a list showing the number of copies distributed of each of the Annual Reports from 1851 to 1889 inclusive, and a table of returns of sales of publications from all agencies on the Atlantic and Pacific coasts.

The total number of these agencies at the end of the fiscal year was eighty-six, of which there were sixty-eight on the Atlantic and Gulf Coasts and eighteen on the Pacific. There were sent to the agents for sale during the year 31 465 copies of charts, 3 875 tide-tables, and 521 coast-pilots. The returns of sales show that 26 807 copies of charts, 3 347 copies of tide-tables and 419 coast-pilots were disposed of. It is noticeable that while the sales of charts at the Pacific Coast agencies were but a little more than one-sixth of the number sold on the Atlantic Coast, the sales of tide-tables on the Pacific Coast were double the number of those sold on the Atlantic, and the sales of coast-pilots more than four times the number.

In closing his report, Mr. Wines commends the chief messenger, W. H. Butler, and the office messengers and laborers generally for the faithful performance of their duties.

The annual report of the Chief of the Instrument Division, Assistant Edwin Smith, refers to the work done during the fiscal year in the three sections of which it may be said to be composed, the instrument division office, its work shop, and the carpenter shop. Mr. Smith observes that the instrument and carpenter shops are essentially repair and experimental shops, and the construction of new instruments is incidental to the work, being mostly confined to such instruments as cannot be purchased or made to order except at very much greater cost and delay.

The most important work accomplished during the year was the construction of two sets of pendulum apparatus of a new and improved pattern; the fitting out of the party for the measurement of the primary base-line at Holton, Ind., and the making of instruments for its use; the reconstruction of two zenith telescopes for the use of officers charged with observations of latitude in coöperation with the researches on the variations of latitude instituted by the International Geodetic Association, and the reconstruction of two 12-inch direction theodolites.

Mr. Smith devotes a part of his report to a description of the new pendulum apparatus made under the direction of the Superintendent, one set of which was completed for him in March, 1891, and taken by him to determine relative gravity at a number of stations on the Pacific coast, and another set finished for Assistant Preston and taken by him in April to the Hawaiian Islands. Each set of this apparatus is packed for shipment in two boxes weighing 352 pounds. Mr. Smith observes that a pendulum apparatus so compact and complete has never before been made, and that where time can be obtained by telegraph from a fixed observatory, it is possible to determine gravity with it at no less than from six to ten or even twelve stations a month with a degree of accuracy not hitherto exceeded.

The other important works already mentioned are described with some fullness of detail, for which reference must be made to the report itself. (Office report No. 1.) The organization of an Advisory Board on Instruments and their Construction, as directed by the Superintendent in October, 1890, was of great benefit to the Division, some valuable suggestions having been part of the results of the discussions and exchanges of views among the several members.

Accompanying his report, Mr. Smith has submitted for file in the Archives tables giving lists of instruments repaired during the year, of new instruments made, of instruments made practically new by reconstruction, of new instruments purchased, and of work done for the Office of Standard Weights and Measures.

Mr. Francis H. Parsons, Chief of the Library and Archives Division, was transferred from the list of Field Assistants to the charge of that Division August 29, 1890. From the beginning of the fiscal year up to that date the Division had been in charge of Mr. Artemas Martin.

In his annual report Mr. Parsons refers to the organization by the Superintendent in October, 1890, of a Board on the Library and Archives, and to the purchase of a large number of valuable professional books recommended by the Board as having largely increased the usefulness of the library.

The Board has had also under consideration plans for a better classification and indexing of the records of the Survey. As one of the members of the Board, Mr. Parsons expresses his acknowledgments to the other members for their courtesy and readiness to aid him in the discharge of his duties.

Among the improvements planned and carried out during the year were the arrangement and classification of the collection of foreign charts belonging to the office, which was done under the direction of Mr. Parsons by Mr. E. J. Pond, who was detailed for the purpose from the Drawing Division, and the indexing and classification of the specimens of sea-bottom, about 20 000 in number, which had been accumulating for many years past. This work, which involved in many instances the identification of the specimens, was performed with great skill and industry by Assistant W. I. Vinal, who was directed to report to Mr. Parsons December 1, 1890, and who had arranged and catalogued nearly half the number when assigned to field service early in June, 1891.

Mr. Parsons acknowledges very acceptable aid in arranging the foreign geodetic publications rendered by Prof. J. Howard Gore, on duty under the special direction of the Superintendent.

Mr. Artemas Martin, who had preceded Mr. Parsons as Chief of the Division, retained his connection with it during the fiscal year.

It is proposed, as soon as the necessary clerical force can be available, and additional room provided, to arrange by States and prepare a complete index of the original geodetic

records. With the indexing and arrangement of the tidal records by States progress has already been made by Messrs. Little and Jackson, detailed for that purpose from the Tidal Division.

Mr. Parsons transmits with his report for file in the Archives an abstract of records received during the fiscal year, and of books and pamphlets received in the library.

Under the immediate direction of the Assistant in charge of the Office, Dr. Wm. B. French continued to assist in executive details, and to receive and account for all moneys derived from the sales at the office of charts, publications, old property, and from other sources. He aided in the office correspondence, and had charge of the arrangement of all office bills on vouchers for official approval and the filing of duplicates.

Mr. E. B. Wiis served as file and dispatch clerk; Miss F. Cadel as type-writer; Miss Kate Lawn as type-writer on the Annual Report of the Superintendent; Miss F. B. Bailey as type-writer and stenographer to the Assistant in charge of the Office until October 31, 1890, when she resigned her position in the Survey; Miss I. M. Peck was employed during the year in miscellaneous clerical work.

Mr. W. B. Chilton continued to serve as clerk in the office of the Superintendent.

ABSTRACT OF THE ANNUAL REPORT OF THE HYDROGRAPHIC INSPECTOR.

The Annual Report of the Hydrographic Inspector, Lieut. Commander S. M. Ackley, U. S. N., which is published as Office Report No. 2, recites the progress of hydrographic work on the Atlantic and Pacific Coasts during the year, and is accompanied by the reports of the Chiefs of the Coast Pilot and Hydrographic Divisions of the office.

Up to March 18, 1891, Commander C. M. Thomas, U. S. N., was on duty as Hydrographic Inspector, and upon being relieved and assigned to duty at the Navy Department was succeeded by Lieut. Commander Ackley.

The very complete tabular statement of hydrographic surveys executed during the fiscal year which accompanies the report of this officer shows the locality of each survey, the number and scale of the hydrographic sheets on which it is plotted, the number of volumes of records, and the statistics of the work.

Lieut. Commander Ackley submits also the report of the Coast Pilot Division, of which he had the charge until his assignment as Hydrographic Inspector. After that date, as no officer was ordered to replace him, he exercised a general supervision of this branch of his office, having the assistance of Ensign E. A. Anderson, U. S. N., and of Mr. John Ross in bringing forward Parts I and II of the Atlantic Coast Pilot for publication. Field work executed by Lieut. Commander Ackley, in the summer and autumn of 1890, for the correction and verification of the manuscript of these parts of the Coast Pilot, is reported under headings in the "Eastern Division," coasts of the New England States and New York. The two parts in one volume form a complete guide to the Atlantic Coast from the St. Croix River to Cape Ann.

The Hydrographic Division was under the charge of Lieut. R. T. Jasper, U. S. N., during the year.

The experience of this officer, gained during the direction of work in this important branch of the service, has led him to make certain suggestions in regard to chart publication, with special reference to the early issue of preliminary charts, which will receive due consideration. He observes that great benefit has been derived from the arrangement made with the Light-house Board whereby the Survey is promptly informed of changes in Aids to Navigation, and he hopes that a similar arrangement may be made with the U. S. Engineers, so that all important changes in depths, and all new channels, jetty constructions, etc., may be indicated on the charts at as early a date as practicable.

Lieut. Jasper reports the completion of a series of coast charts on which are shown the limits of all hydrographic sheets of the Atlantic Coast now on file in the archives, and states that a similar series will be made out for the Gulf and Pacific Coasts.

He commends the skill and industry of the hydrographic draughtsmen in the Division, Messrs. E. Willenbucher, W. C. Willenbucher, and F. C. Donn. During the year they plotted forty-three original sheets, corrected one hundred and forty-six reduced drawings and proofs and did a large amount of miscellaneous draughting and work on proof of charts for publication.

The duties of draughtsman and clerk in the office of the Chief of the Division were performed in a highly satisfactory manner by Mr. E. H. Wyvill. Mr. J. H. Roeth continued to serve acceptably as clerk to the Hydrographic Inspector.

At the close of Lieut. Commander Ackley's report will be found lists of Naval Officers attached to the Survey during the fiscal year, and on June 30, 1891; and a list of the names of vessels, their tonnage, etc., in the service of the Survey during the fiscal year.

ABSTRACT OF THE ANNUAL REPORT OF THE DISBURSING AGENT.

Mr. John W. Parsons, Disbursing Agent, submits the Annual Report of the Disbursing Office of the Survey, and with it the statement of expenditures on account of the Coast and Geodetic Survey which is required by Section 264 of the Revised Statutes to be transmitted annually to Congress (Office report No. 3).

Mr. Parsons states that a marked increase of promptness in making final settlements with field officers was attained during the year, and adverts to the radical change inaugurated on July 1, 1890, in the system of rendering accounts to the Accounting Officers of the Treasury, whereby all accounts are closed out and balanced on the last day of each and every month, and within ten days after are usually on file in the Department. An examining committee appointed by the Secretary of the Treasury went very thoroughly over the books, accounts and vouchers of the office in January and February, 1891, and proved every item of expenditure and checked every balance. The complete adjustment thus arrived at of the assets and liabilities of the office was reported to the Secretary.

The following named persons served in the Disbursing Office during the periods named: Mr. W. H. Lanman, as clerk until January 27, 1891, when he resigned; Miss Paula E. Smith, as writer, for the year; Mr. A. B. Simons, as clerk from January 2 to April 15, 1891, when he was detailed for duty in the Treasury Department; Miss Alice F. Carlisle, as clerk, when not occupied as confidential typewriter to the Superintendent; Mr. N. G. Henry, from March 21, 1891, as confidential clerk and cashier to the Disbursing Agent.

ABSTRACT OF THE ANNUAL REPORT OF THE ASSISTANT IN CHARGE OF THE OFFICE OF STANDARD WEIGHTS AND MEASURES.

After returning from Europe and delivering to the Superintendent the National Prototype Metre, No. 21, and National Prototype Kilogramme No. 4, as stated in the last Annual Report, Assistant O. H. Tittmann resumed charge of the Office of Standard Weights and Measures on July 19, 1890, relieving Assistant F. H. Parsons, who was altogether detached from that office on September 8.

In his annual report (office report No. 4) Mr. Tittmann gives a resumé of the current work of the office under the heads of Standard Weights, Standards of Length, Standard Capacity Measures, Standards furnished to the States, and Electrical Standards.

The acquisition of a set of twenty platinum-iridium weights of the same alloy as the International Standards, was of importance, and their densities, relative masses, and absolute values having been carefully determined, they are now the standard subsidiary weights of the office.

A complete set of customary and metric weights and measures, with the exception of a standard end metre, was furnished to the State of Washington, and a set of avoirdupois and ounce weights to the State of Massachusetts. Numerous comparisons of weights were made for the District of Columbia.

To the liberality of Dr. René Benoit, Director of the International Bureau of Weights and Measures, the office owes the possession of its first electrical standard of precision, a standard legal ohm, which was received through the Department of State, April 9, 1891.

Having been designated by the Superintendent to make an examination, requested by the Secretary of the Treasury, of standards for testing sugars, in use at the Custom houses in Boston, New York and Philadelphia, Mr. Tittmann visited those cities, and embodied the results of his researches in a detailed report submitted December 31, 1890.

In March, 1891, Mr. Tittmann was appointed to represent the Office of Standard Weights and Measures as a member of a Commission organized by the Commissioner of Internal Revenue for the purpose of recommending standards and methods to be used in analyzing by the optical method sugars on which a bounty is paid. The recommendations made by this Commission have been adopted by the Internal Revenue Bureau.

Mr. L. A. Fischer, Adjuster, served during the year with ability, making verifications and adjustments of standards, and assisting in other operations demanding technical skill.

Mr. John F. Hayford was assigned to duty December 15, and was chiefly engaged in weighing and determining the densities of weights intended to be used as the reference and working standards of subsidiary weights. He will, as time permits, correlate all of the office weights of different denominations by reference to the Prototype Kilogramme.

Mr. Tittmann has submitted with his report an abstract in tabular form showing the work done in the verification of weights and measures during the fiscal year.

SUB-OFFICES, U. S. COAST AND GEODETIC SURVEY.

Sub-office in Philadelphia.—At the Sub-office in Philadelphia, the charge of which was continued with Assistant S. C. McCorkle, the charts, coast pilots, tide-tables, notices to mariners, and other publications of the Survey are kept readily accessible to public inspection, and all the inquiries relating to them are promptly answered. Requests for information which cannot be complied with at the Sub-office are referred to the office in Washington.

Mr. McCorkle reports that courtesies were extended to and received from other branches of the Government service having offices in the city. These were the Corps of Engineers, U. S. Army, the Light-house Engineer, U. S. A., the Light-house Inspector, U. S. N., and the Branch Hydrographic Office, U. S. N. All requests for information received from these offices met with a prompt response.

The local organizations or firms interested in commerce and navigation which obtained information were the Philadelphia Maritime Exchange, the Board of Port Wardens, the Board of Trade, the Pennsylvania Railroad, the Franklin Institute, Messrs. Henry Winsor & Co., and Messrs. Peter Wright & Sons.

There were 738 visitors to the Sub-office during the year, the larger number of them by far in quest of information.

Reference to a series of tidal observations which Mr. McCorkle was instructed to make at Chestnut street wharf, Philadelphia, will be found under a heading in the "Eastern Division."

Sub-office at San Francisco.—Assistant George Davidson, who continued in charge of the Sub-office at San Francisco, in addition to the other duties devolving upon him and referred to under headings in the "Western Division" and the "Division of Alaska," reports that he has answered directly all calls for information or referred the same to the Superintendent, whether coming from field officers or from persons not connected with the Survey.

When Mr. Davidson took the field in the primary triangulation work on Mount Conness, July 22, 1890, he left the Sub-office in charge of Assistant Jas. S. Lawson until his return in September, when he resumed the charge of it. Mr. Lawson gave assistance in duty at the Sub-office throughout the year, and especially during the times of Mr. Davidson's absence on observatory work.

Mr. Frank W. Edmonds continued to serve as clerk, and made all observations needed for determining time in the latitude work, and for the error and rate of the Sausalito tidal chronometer.

Vicente Denis, messenger and porter, continued in charge of instruments and camp equipage stored at the Sub-office, and wound regularly the astronomical clock and chronometers at the Lafayette Park Observatory. The usual inventory of instruments, books, and general property was made out in December by Sub-assistant Morse.

The following-named officers were specially employed under the direction of the Superintendent.

Assistant S. Charles Peirce, in gravity research; Assistant Geo. A. Fairfield, since March, 1891, in the immediate supervision of State Surveys; Assistant Andrew Braid, as Executive Officer to the Superintendent; and Assistant Edward Goodfellow, in the preparation for publication and the editing of the Annual Reports and Bulletins of the Survey.

During the year, the employment of Mr. Charles Junken as a civilian expert was continued with special reference to the reduction and discussion of all observations transmitted to the Archives that would be available for the preparation of new charts of Alaska, or new editions of old charts, and for the compilation for publication of the Alaska Coast Pilot. Mr. Junken completed the drawing of a chart of Lynn Canal and Stephens Passage, based upon work of the hydrographic parties in charge of Commander C. M. Thomas, U. S. N., and Lieut. Commander H. B. Mansfield, U. S. N., Assistants, Coast and Geodetic Survey, in 1888 and 1890, and revised and brought up to date the manuscript of the Alaska Coast Pilot from the Straits of Fuca and Dixon Entrance to Yakutat Bay, originally prepared by Commander H. E. Nichols, U. S. N., while on Coast Survey service. This work was sent to press before the end of the fiscal year.

With regard to the progress of the Survey in Alaska, and generally upon our Pacific Coast to the southward, I would observe that while my recent visit of inspection to those coasts did not fail to impress me with the many difficulties to be encountered, due in part to the prevalence of dense fogs and to other climatic peculiarities, to the bold and rugged character of the topography, to the lack of facilities for land transportation, and to the exposed and at times hazardous character of the off-shore hydrographic work, yet I was at the same time convinced that the methods adopted to overcome these difficulties were effective, and that with adequate appropriations, they will enable the Survey to keep pace with the extraordinary development of the commercial, mining, and agricultural resources of the country. This development demands at the earliest practicable date trustworthy charts of the whole coast, and all other information conducive to the safety of commerce and navigation.

FIELD AND OFFICE DETAILS.

TABULAR STATEMENTS AND ANNUAL OFFICE REPORTS.

TABLE No. 1.

Distribution of the field parties of the Coast and Geodetic Survey upon the Atlantic, Gulf of Mexico, and Pacific Coasts, and in the interior of the United States during the fiscal year ending June 30, 1891.

TABLE No. 2.

Statistics of field and office work of the Coast and Geodetic Survey for the fiscal year 1891, and total to June 30, 1891.

TABLE No. 3.

Information furnished to Departments of the Government in reply to special requests, and to individuals upon application, during the fiscal year ending June 30, 1891.

OFFICE REPORT No. 1.

Report of the Assistant in charge of the Office for the fiscal year ending June 30, 1891.

OFFICE REPORT No. 2.

Report of the Hydrographic Inspector for the fiscal year ending June 30, 1891.

OFFICE REPORT No. 3.

Report of the Disbursing Agent for the fiscal year ending June 30, 1891.

OFFICE REPORT No. 4.

Report of the Assistant in charge of the Office of Standard Weights and Measures for the fiscal year ending June 30, 1891.

TABLE No. 1.—1891.

Distribution of the Field Parties of the Coast and Geodetic Survey upon the Atlantic, Gulf of Mexico, and Pacific Coasts, and in the interior of the United States during the fiscal year ending June 30, 1891.

I.—EASTERN DIVISION—STATES EAST OF THE MISSISSIPPI RIVER.

States.	Parties.	Operations.	Persons conducting operations.	Localities of work.
Maine.	No. 1	Triangulation	Joseph Hergesheimer, assistant; J. S. Siebert.	Triangulation of the Schoodic Lakes, forming part of the Northeastern Boundary between the United States and Canada. (See also Florida.)
Maine.	2	Topography	J. A. Flemer, sub-assistant	Topographical survey of the Schoodic Lakes to the northward of Vanceboro. (See also District of Columbia.)
Maine.	3	Topography and hydrography.	J. A. Flemer, sub-assistant; S. P. Bradley and W. B. Paca, acting aids.	Continuation of the topographic and hydrographic survey of the St. Croix River from the vicinity of Vanceboro, Me., to the southward. (See also District of Columbia.)
Maine.	4	Hydrography	Lieut. Commander S. M. Ackley, U. S. N., assistant; Ensign E. A. Anderson, U. S. N.; John Ross.	Completion of the hydrographic survey of Eastport Harbor, Me. (See also Massachusetts and New York.)
The New England and Middle States.	5	Magnetic observations	James B. Baylor, assistant	Magnetic observations at stations in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, and Pennsylvania. (See also North and South Carolina.)
Maine.	6	Physical hydrography	Lieut. Commander S. M. Ackley, U. S. N., assistant.	Observations relating to changes in river beds, coast of Maine. (See also Massachusetts and New York.)
Maine and Massachusetts.	7	Hydrographic examinations.	Lieut. Commander S. M. Ackley, U. S. N., assistant; Ensign E. A. Anderson, U. S. N.; John Ross.	Hydrographic examinations for the Coast Pilot on the coasts of the New England States. (See also New York.)
Maine.	8	Topography and hydrography.	Stebman Forney, assistant	Topographic and hydrographic survey of the Kennebec River, Me., from Gardiner to Augusta. (See also Florida, Alabama, and Texas.)
Massachusetts	9	Town boundary surveys.	Henry L. Whiting, assistant, and Commissioner of the Massachusetts State Survey; C. H. Van Orden, assistant.	Continuation of the work of determining town boundaries in the State of Massachusetts. Service as a member of the Mississippi River Commission.
Massachusetts	10	Physical hydrography	Henry L. Marindin, assistant; Homer P. Ritter, expert observer; F. A. Young, aid; M. V. Safford and C. E. Mendenhall, recorders.	Coast of the Island of Nantucket from Great Point to Siasconset, and thence to Surfside Hotel.
Massachusetts	11	Hydrography	Lieut. E. M. Hughes, U. S. N., assistant; Lieut. W. P. Elliott, U. S. N.; Lieut. W. P. Burdick, U. S. N.; Lieut. L. K. Reynolds, U. S. N.; Ensigns J. F. Luby, L. C. Bertelotte, J. H. Rohrbacker, W. W. Buchanan, E. H. Duvall, and F. H. Brown, U. S. N.	Hydrographic resurvey of Nantucket Shoals. (See also Louisiana and Texas.)
Massachusetts	12	Hydrography	Lieut. W. P. Elliott, U. S. N., assistant; Lieut. L. K. Reynolds, U. S. N.; Ensigns J. H. Rohrbacker, W. W. Buchanan, E. H. Duvall, and F. H. Brown, U. S. N.	Additional soundings and revision of hydrography on Handkerchief Shoal and in its vicinity. (See also New York.)
Massachusetts	13	Topography	D. B. Wainright, assistant; W. B. Hindmarsh, foreman; R. J. McAdory, recorder; W. T. Oliver, level rodman.	Topographical resurveys and triangulation preparatory thereto on the shores of Buzzards Bay and Nantucket Sound. (See also District of Columbia.)

TABLE No. 1.—Continued.

State.	Parties.	Operations.	Persons conducting operations.	Localities of work.
Rhode Island.....	No. 14	Tidal observations.....	N. G. Herreshoff, voluntary observer.	Automatic tide gauge established at Bristol, R. I.
Massachusetts, Connecticut, and New York.	15	Physical hydrography.....	Lieut. C. E. Vreeland, U. S. N., assistant; Prof. William Libbey, U. S. Fish Commission.	Observations of temperatures, densities and currents to the south of Marthas Vineyard in the approaches to the coasts of Massachusetts, Connecticut, and New York. (See also North Carolina, South Carolina, and Florida and Gulf Stream Explorations.)
Connecticut and New York.	16	Physical hydrography.....	E. E. Haskell, expert in physical hydrography.	Observations of tides, currents, densities and temperatures in Long Island Sound, in connection with the work of the U. S. Fish Commission. (See also Gulf Stream Explorations.)
New York.....	17	Hydrography.....	Lieut. W. P. Elliott, U. S. N., assistant; Ensigns E. T. Witherspoon, and C. T. Eaton, U. S. N.	Hydrographic survey of Shelter Island Sound, near the east end of Long Island, N. Y. (See also Massachusetts.)
Connecticut.....	18	Topography.....	John W. Donn, assistant.	Topographical survey of the Connecticut River from Lyme Ferry to Salmon River. (See also New York, Maryland, and the District of Columbia.)
Connecticut.....	19	Topography.....	W. C. Hodgkins, assistant; James Page, recorder.	Topographical surveys on the Connecticut River from Middletown to Salmon River and from Middletown northward. (See also District of Columbia.)
Connecticut.....	20	Hydrography and topography.	W. I. Vinal, assistant; C. L. Gardner, foreman; L. A. Baldwin, recorder.	Hydrographic survey of the Connecticut River from Lyme Ferry to Cromwell above Middletown. Topography of the Connecticut.
New York.....	21	Hydrography.....	C. T. Iardella, assistant.	Hydrographic resurveys of Shinnecock, Quantuck, and Moriches Bays, south coast of Long Island.
New York.....	22	Hydrographic examinations.	Lieut. Commander S. M. Ackley, U. S. N., assistant.	Hydrographic examination off Rye Beach, New York. (See also Maine and Massachusetts.)
New York and New Jersey.	23	Longitude determinations, and observations for latitude.	C. H. Sinclair, assistant; Geo. B. Putnam, aid.	Longitude of station at Cape May, N. J., determined by exchanges of telegraphic signals with Albany, N. Y. Observations for latitude of stations also. (See also Georgia and Florida, Missouri and Texas, and Utah and Montana.)
New York.....	24	Topography.....	John W. Donn, assistant; L. A. Baldwin, foreman.	Continuation of the topographical survey of the Hudson River. (See also Connecticut, Maryland, and the District of Columbia.)
New Jersey.....	25	Tidal observations.....	J. G. Spaulding, observer.	Tidal observations continued with automatic tide gauge at Sandy Hook, New Jersey.
New Jersey.....	26	Geodetic operations.....	Geo. A. Fairfield, assistant, in immediate charge of State Surveys; Prof. E. A. Bowser, acting assistant.	Reconnaissance and signal building in connection with geodetic operations in southwestern New Jersey.
Pennsylvania.....	27	Topographical additions and revisions.	R. Meade Bache, assistant; Neville B. Craig, (part of season.)	Continuation of the detailed survey for the revision of the maps of the water front of the City of Philadelphia.
Pennsylvania.....	28	Tidal observations.....	Spencer C. McCorkle, assistant.	Tidal observations at Chestnut Street wharf, Philadelphia.
Maryland.....	29	Topography and hydrography.	John W. Donn, assistant.	Topographic and hydrographic survey of Sparrow Point, Patuxent River, and of the waters in the vicinity. (See also Connecticut, New York, and the District of Columbia.)
Maryland.....	30	Latitude observations.....	Edwin Smith, assistant.	Observations for latitude of a station at Rockville, Md.
District of Columbia.....	31	Relative determinations of gravity.	E. D. Preston, assistant; Stehman Forney, assistant.	Determinations of relative gravity at the Smithsonian Institution, Washington, D. C.
District of Columbia.....	32	Topography.....	John W. Donn, assistant; D. B. Wainwright, assistant; W. C. Hodgkins, assistant, and J. A. Flemer, sub-assistant.	Completion of the detailed topographical survey of the District of Columbia. (See also Connecticut, New York, and Maryland.)
District of Columbia.....	33	Magnetic observations.....	Charles A. Schott, assistant.	Determinations of the magnetic declination at the station near the Coast and Geodetic Survey office, Washington.
District of Columbia.....	34	Experiments relating to measurements of bases.	R. S. Woodward, assistant.	Experimental work conducted with a view to the use of metallic tapes in measurements of bases.

Distribution of the field parties of the Coast and Geodetic Survey during the fiscal year 1891.

States.	Parties.	Operations.	Persons conducting operations.	Localities of work.
Virginia	No. 35	Hydrographic examinations and surveys.	Lieut. L. K. Reynolds, U. S. N., assistant.	Examination of locality of a shoal reported near Smiths Point Light, Chesapeake Bay, and hydrography of Horseshoe Shoal and vicinity, Chesapeake Entrance.
North Carolina	36	Hydrographic survey	Lieut. C. E. Vreeland, U. S. N., assistant; Lieut. Harry Kimmell, U. S. N.; Ensigns W. S. Muir, J. K. Rohrbacker, and B. Wright, U. S. N.; Assistant Surgeon E. S. Bogart, jr., U. S. N.	Hydrographic work upon Cape Hatteras Shoals in connection with the proposed site for a lighthouse on the western part of the Northern Outer shoal. (See also Massachusetts, Connecticut, and New York, South Carolina and Florida, and Gulf Stream Explorations.)
North and South Carolina.	37	Magnetic observations.	Jas. B. Baylor, assistant	Determinations of the magnetic elements at stations in North and South Carolina. (See also the New England and Middle States.)
South Carolina and Florida.	38	Hydrographic surveys and examinations	Lieut. C. E. Vreeland, U. S. N., assistant.	Determination of the position of Martins Industry Light-vessel off Port Royal Entrance, S. C., and hydrographic examination for shoal reported off Hetzel Shoal, Cape Canaveral, Florida. (See also New England States, New York, and North Carolina.)
Georgia	39	Tidal observations	Eugene Veith, observer.	Tidal observations continued at the automatic tidal station on Tybee Island, Savannah River Entrance.
Georgia and Tennessee	40	Special topographical surveys.	C. H. Boyd, assistant	Surveys for the preparation of detailed maps of the grounds included in the Chickamauga and Chattanooga National Military Park. (See also "Special Operations", and Michigan.)
Georgia, Florida, and Texas.	41	Longitude determinations and observations for latitude.	C. H. Stuchair, assistant; G. R. Putnam, aid.	Determinations of longitude by exchanges of telegraphic signals, and observations for latitude at Augusta, Ga., Gainesville, Fla., and Jacksonville, Tex. (See also New York and New Jersey, Missouri and Utah and Montana.)
Off the coast of Florida and in the Gulf of Mexico.	42	Physical hydrography	Lieut. C. E. Vreeland, U. S. N., assistant; E. K. Haskell, hydrographer.	Gulf Stream Explorations continued. (See also Massachusetts, Connecticut, and New York, North Carolina and South Carolina and Florida.)
Florida	43	Topography	Joseph Hergeshimer, assistant	Topographical reconnaissance of the west coast, between Cape Sable and Cape Romano. (See also Maine.)
Florida	44	Triangulation, topography, and hydrography.	P. A. Walker, sub-assistant.	Tributaries of Pensacola Bay.
Florida and Alabama	45	Triangulation, topography, and hydrography.	Stehman Forney, assistant; John B. Boutelle and O. B. French, acting aids.	Completion of the survey of Perdido Bay and its tributaries. (See also Maine and Texas.)
Alabama	46	Reconnaissance and triangulation.	F. W. Perkins, assistant; W. B. Fairfield, sub-assistant; E. E. Torrey, foreman, W. B. English.	Continuation of the reconnaissance and occupation of stations for the extension of the primary triangulation in Alabama towards the Gulf of Mexico. (See also Louisiana and Kansas.)
Mississippi and Tennessee	47	Geodetic leveling	Isaac Winston, assistant; F. A. Young, aid; Edmund Quinn, recorder.	Connection of Memphis, Tenn., with Corinth, Miss., by lines of geodetic leveling. (See also Missouri.)
Michigan	48	Reconnaissance	C. H. Boyd, assistant	Reconnaissance between Lakes Huron and Erie on the Detroit and St. Clair Rivers and country adjacent for a scheme of triangulation to connect with that of the Lake Survey. (See also Georgia and Tennessee.)
Wisconsin	49	Geodetic operations	Geo. A. Fairfield, assistant, in immediate charge of State Surveys; Prof. J. E. Davies, acting assistant.	Continuation of geodetic operations in the State of Wisconsin.
Indiana	50	Triangulation and reconnaissance for site of base line.	A. T. Moesman, assistant; W. B. Fairfield, assistant; E. E. Torrey, foreman.	Continuation of the primary triangulation advancing to the westward near the 39th parallel in Indiana to a connection with that advancing to the eastward in the same State. Reconnaissance for a base of verification.
Indiana	51	Triangulation	Geo. A. Fairfield, assistant; J. B. Boutelle, extra observer; R. L. McCormick, recorder.	Connection of the primary triangulation near the 39th parallel advancing to the eastward in the State of Indiana with that advancing to the westward in the same State.

TABLE No. 1.—Continued.

States.	Parties.	Operations.	Persons conducting operations.	Localities of work.
Indiana	No. 52	Preparations for base measurement.	A. T. Mosman, assistant; Prof. J. H. Gore and J. S. Siebert, temporary aids; Th. Giersten, Frank A. Cope, and Robert Pennington, recorders.	Preparations for the measurement of a base of verification at Holton, Ind.
West Virginia	53	Reconnaissance for site of a base line.	W. B. Fairfield, sub-assistant.	Reconnaissance for the location of a base line in West Virginia and for its connection with the transcontinental triangulation.
Tennessee	54	Geodetic operations	Geo. A. Fairfield, assistant, in immediate charge of State Surveys; Prof. A. H. Buchanan, acting assistant.	Occupation of stations in continuation of the triangulation of the State of Tennessee.

II.—MIDDLE DIVISION.—STATES AND TERRITORIES BETWEEN THE MISSISSIPPI RIVER AND THE ROCKY MOUNTAINS.

States.	Parties.	Operations.	Persons conducting operations.	Localities of work.
Minnesota	No. 1	Geodetic operations	Geo. A. Fairfield, assistant, in charge of State Surveys; Prof. W. R. Hoag, acting assistant.	Reconnaissance and occupation of stations in continuation of the triangulation of the State of Minnesota.
Minnesota and North Dakota (Middle Division), and Utah and Montana (Western Division).	2	Longitude determinations and observations for latitude.	C. H. Sinclair, assistant; R. A. Marr, assistant.	Determinations of longitude by exchanges of telegraphic signals at stations in Minnesota and North Dakota, and in Utah and Montana. Observations for latitude also. (See also New York and New Jersey, Georgia, Florida, and Texas.)
Missouri	3	Longitude determinations and observations for latitude.	C. H. Sinclair, assistant; Geo. R. Putnam, aid.	Determinations of longitude by exchanges of telegraphic signals at stations in Missouri, and observations for the latitude of the stations.
Missouri	4	Geodetic leveling	Isaac Winston, assistant; F. A. Young, aid.	Transcontinental line of geodetic leveling extended to the westward in Missouri from Jefferson City to Kansas City. (See also Mississippi and Tennessee.)
Kansas	5	Reconnaissance and triangulation.	F. D. Granger, assistant; M. A. Coles, recorder.	Occupation of stations continued and reconnaissance extended for carrying to the westward in Kansas the transcontinental triangulation near the 39th parallel.
Kansas	6	Reconnaissance and triangulation.	F. W. Perkins, assistant; R. E. Duval, foreman.	Transcontinental triangulation extended to the westward and eastward from Fort Wallace, Kansas. (See also Alabama and Louisiana.)
Louisiana	7	Hydrography	Lieut. Edw'd M. Hughes, U. S. N., assistant; Lieut. W. L. Burdick, U. S. N.; Ensigns W. W. Buchanan, J. F. Luby, Ford H. Brown, and W. B. Hoggatt, U. S. N.	Hydrographic surveys on the coast of Louisiana between Barataria Bay and Last Island. (See also Texas and Massachusetts.)
Louisiana	8	Reconnaissance	F. W. Perkins, assistant.	Reconnaissance for the connection of the triangulation of the Mississippi River in the vicinity of Donaldsonville, with that of the Gulf of Mexico by way of the Atchafalaya River. (See also Alabama and Tennessee.)
Texas	9	Magnetic observations	R. E. Halter, assistant; L. G. Shultz.	Observations of the magnetic elements absolute and differential, continued at the automatic registry station, San Antonio, Texas.
Texas	10	Hydrography	Lieut. E. M. Hughes, U. S. N., assistant; Lieut. W. L. Burdick, U. S. N.; Ensigns W. W. Buchanan, J. F. Luby, Ford H. Brown, and W. B. Hoggatt, U. S. N.	Hydrographic resurvey of Aransas Pass, Entrance to Aransas Bay, Texas. (See also Louisiana and Massachusetts.)
Texas	11	Reconnaissance	Stehman Forney, assistant; Ralph Von Wyszecski, foreman.	Reconnaissance for triangulation along the Rio Grande from El Paso, Texas, to the southward and south-westward. (See also Maine, Florida, and Alabama.)

*Distribution of the field parties of the Coast and Geodetic Survey during the fiscal year 1891.***III.—WESTERN DIVISION.—STATES AND TERRITORIES BETWEEN THE ROCKY MOUNTAINS AND THE PACIFIC.**

States or Territories.	Parties.	Operations.	Persons conducting operations.	Localities of work.
California -----	No. 1	Special hydrography ---	Lieut. D. Delehanty, U. S. N., assistant.	Establishment of a trial course off the coast of California for the speed trials of the new naval cruiser San Francisco.
California -----	2	Hydrography -----	Lieut. D. Delehanty, U. S. N., assistant; Lieut. Charles A. Gove, U. S. N.; Ensigns J. B. Blish, H. B. Wilson, W. L. Dodd, and S. R. Hurlbut, U. S. N.	Completion of the hydrography of the coast of California in the vicinity of Piedras Blancas and Point Sur Lights. Determination of the position of Von Helm Rock in the vicinity of San Simeon.
California -----	3	Triangulation and topography.	A. F. Rodgers, assistant; John Nelson, sub-assistant.	Coast of California between Cape San Martin and Point Sur.
California, Washington, and Alaska.	4	Determinations of gravity.	Dr. T. C. Mendenhall, superintendent.	Determinations of gravity with improved apparatus at stations in California, Washington, and Alaska.
California -----	5	Primary triangulation and general charge of land operations.	George Davidson, assistant; J. J. Gilbert, assistant; Isaac Winston, assistant; Fremont Morse, sub-assistant; F. W. Edmonds, clerk; F. H. Finley, recorder.	Occupation of Mount Conness, primary station in the Sierra Nevada. Moon culminations at the astronomical station, San Francisco, in connection with those observed in Alaska. Magnetic observations at the Presidio of San Francisco.
California -----	6	Tidal observations ---	George Davidson and James S. Lawson, assistants; Emmet Gray, observer.	Record continued at the automatic tidal station, Sausalito, Bay of San Francisco.
California -----	7	Hydrographic resurveys and examinations.	Lieut. D. H. Mahan, U. S. N., assistant.	Completion of resurveys and examinations of soundings in Suisun Bay, Karquines Strait and vicinity.
California -----	8	Primary triangulation	E. F. Dickens, assistant; F. Westdahl, acting aid.	Primary triangulation north of the Bay of San Francisco.
Oregon -----	9	Topography -----	E. F. Dickens, assistant; F. Westdahl, acting aid.	Topographic and hydrographic surveys in Coos Bay, Oregon, and coast topography south of Cape Gregory.
Oregon and Washington.	10	Triangulation and topography.	Cleveland Rockwell, assistant.	Continuation of the survey of the Columbia River from Vancouver, Washington, towards the Dalles.
Washington -----	11	Hydrography -----	Lieut. J. M. Helm, U. S. N., assistant; Lieut. A. G. Rogers, U. S. N.; Ensign Guy W. Brown, U. S. N.; Assistant Surgeon P. H. Bryant, U. S. N. During parts of the season: Ensigns W. H. G. Bullard, A. N. Mayer, and J. H. Gibbons, U. S. N.	Hydrographic survey of Willapa Bay, Washington.
Washington -----	12	Special topography ---	J. F. Pratt, assistant -----	Topographical resurvey of the water front of Port Townsend.
Washington -----	13	Hydrography -----	Lieut. J. N. Jordan, U. S. N., assistant; Ensigns Harvey George and E. Moale, jr.	Hydrographic surveys in Skagit Bay, Drayton Harbor, Boundary Bay, and the Gulf of Georgia.
Washington -----	14	Special surveys; triangulation and topography.	J. J. Gilbert, assistant -----	Surveys of the water fronts of Whatcom, New Whatcom, and Fairhaven, for the Harbor Line Commission of the State of Washington.
Montana and Utah -----	15	Longitude determinations.	C. H. Sinclair, assistant; R. A. Marr, assistant.	Exchanges of telegraphic signals for longitude between Salt Lake City, Utah, and Helena, Montana. (See also New York and New Jersey, Georgia, Florida and Texas, Minnesota and North Dakota).
Utah -----	16	Primary triangulation.	William Einbeck, assistant; P. A. Welker, sub-assistant.	Occupation of stations in continuation of the transcontinental triangulation along or near the 39th parallel in Utah.

TABLE No. 1—Continued.

IV.—DIVISION OF ALASKA, INCLUDING THE COAST, INLETS, SOUNDS, BAYS, RIVERS, AND THE ALEUTIAN ISLANDS.

Territory.	Parties.	Operations.	Persons conducting operations.	Localities of work.
Southeastern Alaska, St. Paul Island, Pribilof group, Bering Sea, and British Columbia near the Alaska boundary line.	No. 1	Determinations of gravity.	Dr. T. C. Mendenhall, superintendent; Fremont Morse, sub-assistant.	Stations at Burroughs Bay, Wrangell, Sitka, Juneau, Pyramid Harbor, and Yakutat Bay, Southeastern Alaska; at St. Paul Island, Pribilof group, Bering Sea, and at Port Simpson, B. C., near the Southern Boundary of Alaska. (See also California and Washington.)
Southeastern Alaska	2	Hydrographic work involving general surveys.	Lieut. Comd'r H. B. Mansfield, U. S. N., assistant. Officers attached to party during season of 1890: Lieut. E. J. Dorn, U. S. N.; Ensigns H. C. Poundstone, G. R. Slocum, Jos. Strauss, W. H. Faust, and F. W. Jenkins, U. S. N. During season of 1891: Lieut. E. J. Dorn, U. S. N.; Ensigns H. C. Poundstone, W. L. Howard, F. L. Chapin, W. G. Miller, and W. H. Faust, U. S. N.	During season of 1890, survey of Taku Inlet; Stephens Passage from Douglas Island northward, Gastineau Channel and Lynn Canal. Season of 1891; Behm Canal.
Northeastern Alaska	3	Preliminary surveys relating to boundary line.	J. E. McGrath, assistant; J. Henry Turner, sub-assistant.	Occupation of stations near the junction of the 141st meridian with the Yukon and Porcupine Rivers, Alaska, in connection with a preliminary survey of the boundary line between Alaska and the British Possessions in North America.
Gulf of Alaska	4	Tidal observations	George Davidson, assistant; F. Sargent, observer.	Tidal record continued during part of the year at the automatic tidal station at St. Paul, Kodiak Island, Alaska. (See also California.)

SPECIAL OPERATIONS.

Parties.	Persons conducting operations.	Localities of work.
No. 1	Lieut. C. E. Vreeland, U. S. N., assistant; Prof. William Libbey of the Fish Commission.	Observations of temperatures, densities, and currents to the south of Marthas Vineyard in cooperation with the work of the U. S. Fish Commission.
2	Prof. Richard Rathbun, of the Fish Commission; E. K. Haskell, U. S. C. and G. S., Expert Observer; Lieut. Robert Platt, U. S. N., commanding steamer <i>Fish Hawk</i> .	Observations of tides and currents, densities and temperatures in Long Island Sound in connection with the work of the U. S. Fish Commission.
3	C. H. Boyd, assistant.	Surveys for the preparation of detailed maps of the grounds included in the Chickamauga and Chattanooga National Military Park.
4	Lieut. D. Delehanty, U. S. N., assistant.	Establishment of a trial course off the Pacific coast for the speed trials of the new naval cruiser <i>San Francisco</i> .
5	J. J. Gilbert, assistant.	Surveys for the Harbor Line Commission of the State of Washington of the water fronts of the cities of Whatcom, New Whatcom, and Fairhaven, Bellingham Bay.
6	J. E. McGrath, assistant; J. H. Turner, sub-assistant.	Surveys relating to a preliminary location of the boundary line between Alaska and the British Possessions in North America.

TABLE No. 2.—1891.

*Statistics of Field and Office Work of the Coast and Geodetic Survey for the fiscal year 1891,
and total to June 30, 1891.*

	Total to June 30, 1890.	During fiscal year 1891.	Total to June 30, 1891.
RECONNAISSANCE.			
Area in square statute miles	388 521	14 629	403 150
Parties, number of.....		2	
BASE LINES.			
Primary, number of.....	15		15
Primary, length of, in statute miles.....	101		101
Subordinate, number of	138		138
Sudordinate and beach measures, length of.....	528		528
TRIANGULATION.			
Area in square statute miles	256 441	8 536	264 977
Stations occupied for horizontal measures, number of	12 883	533	13 416
Geographical positions determined, number of	24 739	535	25 274
Stations occupied for vertical measures, number of.....	921	10	931
Elevations determined trigonometrically number of	2 305	22	2 327
Heights of permanent bench marks by spirit leveling, number of.....	803	38	841
Lines of spirit leveling, length of, in statute miles.....	4 115	170	4 285
Triangulation and leveling parties, number of.....		18	
ASTRONOMICAL WORK.			
Azimuth stations, number of.....	228	4	232
Latitude stations, number of	355	11	366
Longitude stations, telegraphic, number of.....	154	7	161
Longitude stations, chronometric or lunar, number of.....	112	2*	114
Astronomical parties, number of		7	
MAGNETIC WORKS.			
Stations occupied, number of	838	19†	857
Magnetic observatories in operation	5	1‡	5
Magnetic parties, number of			
GRAVITY MEASURES.			
Home stations occupied, number of	19	7§	26
Foreign stations occupied, number of.....	23	1	24
Parties, number of.....		1	

* In addition to these two new stations one old station was re-occupied.

† In addition to these nineteen new stations twenty old stations were re-occupied.

‡ Station of last year, occupation continued.

§ In addition to these seven stations two old stations were re-occupied.

TABLE No. 2—Continued.

	Total to June 30, 1890.	During fiscal year 1891.	Total to June 30, 1891.
TOPOGRAPHY.			
Area surveyed, in square statute miles.....	33 910	2 483	36 393
Length of general coast, in statute miles.....	8 832	1 009	9 841
Length of shore line, in statute miles, including rivers, creeks, and ponds.....	96 407	1 206	97 613
Length of roads, in statute miles.....	47 461	231	47 692
Topographical parties, number of		15	
HYDROGRAPHY.			
Parties, number of, in charge of naval officers.....		11	
Parties, number of, in charge of civilian officers.....		10	
Number of miles (geographical) run while sounding.....	461 533	11 381	472 914
Area sounded, in square geographical miles.....	150 883	2 686	153 569
Miles run additional of outside or deep-sea soundings.....	92 995		92 995
Number of soundings.....	19 907 165	415 721	20 322 886
Deep-sea soundings.....	13 247	23	13 270
Deep-sea temperature observations.....	15 455	2 500*	17 655
Current stations, number of, occupied by hydrographic parties.....		42	
Deep-sea current stations, number of.....		23	
Deep-sea subcurrent observations, number of		2 750	
Deep-sea surface current observations, number of		850	
Specimens of bottom, number of.....	13 533	150	13 683
Automatic tide gauges established.....	96	3	99
Automatic tide gauges discontinued	87	6	93
Parties doing tidal work exclusively.....		4	
Parties doing tidal work in connection with hydrographic work.....		22	
Staff and box gauges established.....	2 081	71	2 152
Staff and box gauges discontinued	2 078	72	2 150
RECORDS.			
Triangulation, originals, number of volumes.....	5 874	147	6 021
Triangulation, originals, number of cahiers.....		5	
Astronomical observations, originals, number of volumes.....	1 951	30	1 981
Astronomical observations, originals, number of cahiers.....		21	
Magnetic observations, originals, number of volumes.....	676	5	681
Magnetic observations, originals, number of cahiers.....		79	
Pendulum observations, originals, number of volumes.....		23	
Duplicates of above, number of volumes.....	6 335	188	6 523
Duplicates of above, number of cahiers		69	
Geodetic leveling observations, number of vols., originals.....		37	
Geodetic leveling observations, number of vols., duplicates		27	
Computations, number of volumes	4 205	140	4 345
Computations, number of cahiers		65	
Hydrographic soundings and angles, originals, number of volumes.....	11 564	362	11 926
Hydrographic soundings and angles, duplicates, number of volumes.....	3 464	250	3 714

* Made for the U. S. Fish Commission; also 500 observations of specific gravity of sea-water, surface, and sub-surface.

Statistics of Field and Office Work of the Coast and Geodetic Survey for the fiscal year 1891, and total to June 30, 1891—Continued.

	Total to June 30, 1890.	During fiscal year 1891.	Total to June 30, 1891.
RECORDS—continued.			
Tidal and current observations, originals, number of vols.	4 470	190	4 660
Tidal and current observations, duplicates, number of vols.	2 954	96	3 050
Aggregate years of record from automatic tide gauges . . .	270 $\frac{1}{2}$	51 $\frac{1}{2}$	276 $\frac{3}{4}$
Tidal stations for which reductions have been made	1 476	77	1 553
Aggregate years of record reduced	280	16	296
MAPS AND CHARTS.			
Topographic maps, originals	1 970	50	2 020
Hydrographic charts, originals	2 195	61	2 256
ENGRAVING AND PRINTING.			
Finished charts published from engraved plates, total number of.	475	19	494
Engraved charts withdrawn from circulation	164	9	173
Engraved plates of preliminary charts and diagrams for the Coast and Geodetic Survey reports, number of.	722	2	724
Electrotype plates made	2 182	46	2 228
Charts published by photolithography, number of		29	169*
Charts published by photolithography withdrawn from circulation.		11	
Engraved plates of Coast Pilot charts	80		80
Engraved plates of Coast Pilot views	98	6	104
Printed sheets of maps and charts distributed	782 618	52 959	835 577
Printed sheets of maps and charts deposited with sale agents.	369 733	31 465	401 198
Printed sheets of maps and charts sold at Coast and Geodetic Survey office.		683	

* Beginning July 1, 1884, to and including June 30, 1891.

TABLE No. 3.—1891.

Information furnished to Departments of the Government in reply to special requests and to individuals upon application during the fiscal year ending June 30, 1891.

Date.	Name.	Data furnished.
1890.		
July 2	Mississippi River Commission.....	Tracing of hydrography from Grandview Reach to Donaldsonville, La.
3	A. M. Harrod, Civil Engineer, New Orleans, La.....	Topographic and hydrographic survey of island bounded by Rigolets, Chef Menteur, Lakes Pontchartrain and Borgne, Louisiana.
5	Richards and Sause, New York City.....	Hydrographic survey, vicinity of Bay Point, New York Harbor.
8	F. H. Bigelow, Nautical Almanac Office, Washington, D. C.....	Bulletins Nos. 5, 6, 7, and six magnetic charts for the epochs 1885 and 1890.
10	J. P. Bradley, Deer Park, Md.....	Geographical position of Oakland and height of Deer Park above the ocean.
11	Samuel S. Cantain, Master Tug <i>Ocean King</i> , Mt. Desert Ferry, Me.....	Table showing hourly rise and fall of tide for different ranges.
17	M. Baker, U. S. Geological Survey.....	Formula for magnetic declination at Kalamazoo, Mich.
17	W. A. Goodyear, State Geologist, California.....	Height above the ocean of 14 stations in or near Mendocino county, Cal.
17	E. Ricksecker, Seattle, Wash.....	Tracing and strengthening contours on photographs of topography of Seattle, Washington.
18	J. P. Kelly, Resident Engineer of Canals, Albany, N. Y.....	Description of two bench marks, Rondout, N. Y.
22	E. C. Voss, U. S. Signal Service, Lacrosse, Wis.....	Geographical position and height above sea of Lacrosse, Wis.
23	J. L. Smithmeyer, Washington, D. C.....	Description of five bench marks, Old Point Comfort, Va.
24	J. L. Smithmeyer, Washington, D. C.....	Description of two bench marks, Old Point Comfort, Va.
25	Chas. L. Harrison, Civil Engineer, Chicago, Ill.....	Information relating to different patterns of tide gauges.
26	Wm. G. Ford, Jr., Bath Beach, N. Y.....	Description of two bench marks, Bath Beach, N. Y.
28	James S. Cooley, Glen Cove, N. Y.....	Tidal data Hempstead Harbor, L. I.
29	N. Spofford, Engineer, Haverhill, Mass.....	Geographical position of and remarks on Borden's triangulation station, Salisbury Marsh.
29	J. C. Henkenius, State Engineer's Office, California.....	Astronomical latitude and longitude of station "Needles," California.
31	A. P. Killinger, Civil Engineer, Cedar Springs, Va.....	Epoch of maximum east declination at Marion, Va., and pamphlets on terrestrial magnetism and isogonic charts for 1885 and 1890.
31	Col. L. L. Langdon, Fort Hamilton, N. Y. Harbor.....	Geographical positions and descriptions of trigonometrical stations in the vicinity of the Narrows.
August 4	C. C. Merrick, Chicago, Ill.....	Distances furnished from Mobile, Ala., and New Orleans, La., to Havana and Central and South American ports.
4	W. G. Ford, New York City.....	Hydrographic survey of Gravesend Bay, N. Y.
6	Wm. L. Bacot, Stapleton, Staten Island, N. Y.....	Description of eight tidal bench marks on Staten Island.
11	Nath'l G. Herreshoff, Bristol, E. I.....	Description of three tidal bench marks near Bristol, E. I.
14	Prof. A. W. Phillips, Yale College, Connecticut.....	Tidal differences New York and New London every hour of moon's transit.
14	L. Turner, Washington, D. C.....	Distance and direction of Coveville, Va., and Washington, D. C.
14	H. K. Averill, Civil Engineer, Plattsburg, N. Y.....	Annual change of the magnetic declination in the vicinity of Lake Champlain.
14	Maj. W. P. Stanton, U. S. A., Boston, Mass.....	Magnetic declination at Marshall Point Light-house in 1831 and 1890.
15	Amos Ross, Pensacola, Fla.....	Topographic and hydrographic survey of Perdido Bay, Florida and Alabama.
15	W. C. Bibb, Montgomery, Ala.....	Topographic and hydrographic survey of Perdido Bay, Florida and Alabama.
15	S. Percy Jones.....	Topographic and hydrographic survey of Perdido Bay, Florida and Alabama.
16	Maj. W. S. Stanton, U. S. A., Eng'r 1st and 2d L.-H. Dist.....	Description of tidal bench mark at Marshall Point, Me.
19	H. F. Garrison, Sec'y Harbor Line Comm'n, Tacoma, Wash.....	Description of two bench marks at Tacoma and Seattle, Wash.
19	W. T. Rosell, Capt. Engineers, U. S. A.....	Height of bench-mark No. 87 in the D. C.
19	L. E. Bryant, Supt. Coal Mines, Harriman, Tenn.....	Geodetic data and descriptions of stations Brushy, Luper, and Melton, Tenn.
19	E. T. Wilson, Lieut., U. S. A., Ft. Wadsworth, N. Y.....	Descriptions of stations and geodetic data vicinity of the Narrows, N. Y.
20	C. Roemer, Jr., Topographer, P. O. Department.....	Four hundred and fifty-six geographical positions in Arkansas and Colorado, also in Utah and Indian Territory.
20	Lieut. E. A. Wilson, U. S. A.....	Chart No. 369, with approximate positions of the triangulation points about New York Narrows plotted thereon.
20	John T. Freeman, Washington, D. C.....	Hydrographic survey of part of Annapolis Harbor, Md.
22	H. I. Lovick, County Surveyor, New Berne, N. C.....	Table of magnetic declination at New Berne, N. C., between 1760 and 1896, also App. No. 12, Report for 1886, three magnetic charts and Bulletin No. 14.
22	Lieut. Arthur P. Naro, U. S. N., Branch Hydrographic Office, N. Y.....	Tidal currents setting on and off south shore Long Island.
23	W. G. Ford, Jr., Bath Beach, New York Harbor.....	Magnetic chart for 1885 and 1890; App. 12, Report for 1886, and copy of Bulletin No. 14.

TABLE No. 3—Continued.

Date.	Name.	Data furnished.
1890.		
Aug. 27	R. A. Bigelow, New York	Height of mountains in Vt. and elevation of Lake Champlain above sea level.
28	Director Geological Survey	Geographical positions and descriptions of stations, Long Island Sound, between latitude $40\frac{3}{4}^{\circ}$ and 41° , longitude $73\frac{1}{2}^{\circ}$ and $73\frac{3}{4}^{\circ}$, and latitude $41\frac{1}{2}^{\circ}$ and $41\frac{3}{4}^{\circ}$, and longitude $73\frac{1}{2}^{\circ}$ and $73\frac{3}{4}^{\circ}$.
29	Lieut. E. T. Wilson, Ft. Wadsworth, New York Harbor	Geographical positions of two stations on the Quarantine and descriptions of stations.
Sept. 1	Geo. P. Metcalf, Glen House, White Mountains, N. H.	Magnetic declination 4 miles east of Mt. Washington in 1890, also annual change.
1	A. N. Skinner, U. S. Naval Observatory	Geographical position and description of astronomical station at Denver, Colo.
3	Office of Harbor Line Commission, Tacoma, Wash.	Description of stations and thirty-two geographical positions, vicinity of Seattle and formulae and factors for geodetic computation of positions.
9	R. A. Bigelow, New York	Height of Ascutney Mountain, Vt.
10	Prof. M. B. Snyder, Central High School, Philadelphia	Magnetic charts for 1885 and 1890; pamphlets and Bulletins Nos. 5, 6, 7, and 14, bearing on terrestrial magnetism.
Sept. 18	Sumner H. Bodfish, Civil Engineer, for Col. P. C. Hains, Engineer Corps, U. S. N.	Description of five bench marks at Old Point Comfort, Va.
20	S. C. Lancaster, Civil Engineer, Jackson, Tenn	Height of bench mark at Post office and Railroad Bridge above the Gulf of Mexico.
22	J. W. Rand, Surveyor, Vanceburg, Ky.	Four magnetic charts for epochs 1885 and 1890 and copy of Bulletin No. 14.
24	Hon. N. W. Aldrich, U. S. Senate	Six copies of the topographic survey of Point Judith and vicinity, Rhode Island.
24	Hon. Warren O. Arnold, M. C.	Two copies of the topographic survey of Point Judith and vicinity, Rhode Island.
25	Francis Cushing, Portland, Me	Topographic and hydrographic survey of Cushing Island and vicinity, Maine.
26	A. K. White, Surveyor, Beach Creek, Clinton County, Pa.	Magnetic declination at a place in Randolph County, between 1780 and 1895.
27	H. M. Bacon, Surveyor, Addison, Webster County, W. Va.	Table of magnetic declination for Addison, W. Va., between the years 1780 and 1895; two magnetic charts and Bulletin No. 14.
27	A. M. Ford, Salem N. J.	Highest tide at Sandy Hook, N. J., during September, 1889.
27	Gen. B. F. Butler, Lowell, Mass.	Copy of the map of final attack on Fort Fisher, North Carolina.
27	C. P. Bolles, Washington, D. C.	Copy of the map of final attack on Fort Fisher, North Carolina.
Oct. 6	S. H. Emmens, Emmens, Pa.	Geographical position of Emmens and magnetic declination at that place, also annual change and magnetic chart for 1885.
6	L. Turner, Washington, D. C.	Position of Tallahassee, Fla., and distance from Washington, D. C.
7	J. D. Condict, Edgartown, Mass.	Topographic survey, vicinity of Cape Poge, Mass.
8	J. W. Field, Chincoteague Island, Va.	Magnetic declination at present and in 1792 together with present annual change of the declination.
10	Dr. B. H. Kidder, Naval Academy, Maryland	Topographic survey of part of Marthas Vineyard, Mass.
13	P. Atkinson, Chicago, Ill.	Copy of small magnetic charts of the United States for 1888.
15	A. S. Pennington, Paterson, N. J.	Tidal constants for Bay Head Life Saving Station, New Jersey.
18	Verplanck Colvin, Superintendent Adirondack and State Land Survey of New York.	Approximate azimuth of Gomer Hill as seen from Penn. Mountain.
21	W. E. Mott, Burlington, N. J.	Magnetic declination at Montauk Point, Long Island.
21	Fava, Jr. & Co., Architects and Engineers, Washington, D. C.	Geographic position of Gordonsville, Va., and of trigonometrical points Clark and Peters.
22	Census Bureau, Washington, D. C.	Tidal and current data at forty-one ports on Atlantic and Pacific coasts.
23	Capt. W. M. Blake, U. S. Engineers	Geographic positions and descriptions of stations in Charlotte Harbor, Florida.
25	Young & Lewis, Astoria, Oregon	Magnetic declination at Astoria at present and in the years 1855, '56, '57, with Appendix No. 12, Report for 1886, and two magnetic charts.
25	J. F. Sheahan, New Rochelle, N. Y.	Magnetic declination at New Rochelle, magnetic chart for 1885, Appendix No. 12, 1886, and Bulletin No. 14.
30	Capt. W. M. Black, Corps of Engineers, U. S. A., New York City.	Description of two bench marks, Charlotte Harbor, Florida.
Nov. 5	Capt. W. M. Black, Corps of Engineers, U. S. A.	Position of triangulation points plotted on published chart No. 175, Charlotte Harbor and vicinity, Florida.
8	Chief of Engineers, U. S. A.	Topographic and hydrographic survey, vicinity of lakes Washington and Union, Washington.
10	D. C. Commissioners, Washington, D. C.	Twenty-six geographical positions and descriptions of stations for survey of Rock Creek Park.
12	Maj. W. S. Stanton, U. S. Engineers	Geographical position of Lubec Narrows Light-house, Me.
14	Director U. S. Geological Survey	Longitude and approximate latitude of Augusta, Ga., of Gainesville, Fla., and of Jacksonville, Tex.
17	V. Macpherson, Engineer Horse Creek Coal Co., Birmingham, Ala.	Magnetic declination at the creek in 1820, 1875, and 1890, with pamphlet and isogonic chart.

Information furnished to Departments of the Government in reply to special requests and to individuals upon application during the fiscal year ending June 30, 1891.

Date.	Name.	Data furnished.
1890.		
Nov. 20	A. W. Erdman, Morristown, N. J.	Magnetic declination in eastern Kentucky a century ago.
24	Chief Signal Officer	Relative accuracy of several base maps of the Coast and Geodetic Survey.
29	U. S. Naval Observatory	Geographical positions of three stations in Covington, Ky.
Dec. 1	W. Newbrough, Surveyor General's Office, Salt Lake City, Utah.	Magnetic charts of the United States for 1885 and 1890.
1	W. H. Brown, Chief Engineer, P. R. R. Co.	Appendix No. 11, Report for 1882, Appendix No. 14, Report for 1887, and advanced sheets of Appendix 15, Report for 1889.
2	Gen. H. Johnson, St. Louis, Mo.	Magnetic declination, dip, and intensity at St. Louis, Mo., also law of change of declination since 1822.
2	J. H. Willard, Captain, Corps of Engineers	Latest and best value of the relation of the lengths of the foot and the metre.
5	Col. D. C. Houston, U. S. Engineers	Hydrographic survey of Coscob Harbor, Connecticut.
9	M. P. Jackson	Geographical position of Durham, Durham County, N. C.
13	Director Geological Survey	Geographical position of Parkersburg, W. Va.
15	O. M. Carter, Lieutenant, Corps of Engineers, Savannah, Ga.	Description of bench marks, entrance to Saint Simon Sound, Georgia.
16	Iron and Coal Company, Pine Mountain, Kentucky	Isogonic maps for 1885 and 1890. Annual change of the declination at present.
16	G. A. Porterfield, Charleston, W. Va.	Present magnetic bearing of an old line run by compass.
17	H. W. McCray, County Surveyor, San Benito County, Cal.	Geographical positions of stations Hepsedam and Santa Ana and angles measured at Santa Ana.
17	S. H. McElroy, New York City	Hydrographic survey of New York Bay from 39th street, Brooklyn, to Bay Ridge Dock, New York.
18	Director Geological Survey	Descriptions of astronomical stations Point Pleasant and Clarksburg, W. Va.
18	F. P. Spaulding, Engineer and Surveyor	Information about milestones in the southeast line of District of Columbia.
23	Director Geological Survey	Height of Augusta, Ga.
26	J. F. Cassell, D. E. M. of W., Balto. & Ohio R. R.	Height of bench mark on bridge of Tygarts Valley at Grafton.
27	Director Geological Survey	Geographical positions of ten trigonometrical stations near boundary of Illinois and Wisconsin.
Dec. 30	Capt. J. A. Willard, Corps of Engineers	Length of Delta Base, La., and relation of the metre to the foot.
1891.		
Jan. 6	T. U. Taylor, University of Texas, Austin, Texas	Magnetic declination at Austin in 1855 and 1891; annual change of declination and magnetic declination charts for 1885 and for 1890.
6	I. S. Dunning, Aurora, Ill.	Geographical positions and descriptions of points in the vicinity of Chicago; magnetic charts for 1885 and 1890, and Bulletin No. 14.
7	Chief of Engineers, U. S. A.	Topographic survey of the vicinity of the town of St. Marks, Fla.
9	W. J. Spellman, Vincennes, Ind.	Latitude and longitude of astronomical station at Vincennes; height of bench mark at Vincennes above the ocean; distribution of magnetic declination in 1885 and 1890.
9	S. R. Bell, Mayor, Union City, Ind.	Geographical position of Union City; magnetic declination in 1890, and annual change for the same place.
9	F. Danford, Belfast, Me.	Topographic survey of Little River, south of Belfast, Me.
14	Major W. S. Stanton, U. S. Engineers	Topographic and hydrographic survey of the St. Croix River below Calais, Me.
15	P. C. Warrington, U. S. Geological Survey	Geographical position of a stone in the 3d principal meridian, a few miles north of Vandalia, Ill.
20	J. H. Walker, Utah	Experimental station Logan, Utah. Meteorological tables for barometric reduction.
20	G. A. Marr, Engineer Missouri River Commission	Geographical positions of Helena, Montana, Bismarck, N. D., and Omaha, Nebr.
20	H. L. Eaton, Engineer, Somerville, Mass.	Descriptions of triangulation stations, vicinity of Cambridge and Boston, and tables for computation of geographical positions and for map projections, also list of geographical stations and geodetic results State of Massachusetts.
22	T. W. Symons, Captain, Corps of Engineers	Geographical positions and geodetic data of the triangulation of upper part of Coos Bay, Oregon.
22	J. Carmichael, Shenandoah, Page Co., Va.	Explanation of isogonic curves.
22	U. S. Geological Survey	Latitude and telegraphic longitude of stations Jacksonville, Tex., Gainesville Fla., and Augusta, Ga.
22	J. B. Henck, Montecello, Cal.	Copy of the location of the "Naval Trial Course" of the San Francisco, with the hydrography.
22	Capt. T. W. Symons, Corps of Engineers, U. S. A.	Description of bench mark, Coos Bay, Oregon.
23	J. R. Broumard, Robertson Co., Texas	Magnetic courses for 1885 and 1890 in Haskell Co., Texas, and annual decrease of declination during these epochs. Also isogonic charts for 1885 and 1890 and copy of paper on secular variations.
29	Wm. Senter & Co., Portland, Me.	Predicted tides, Eastport and Portland, Me., 1892.
29	R. F. Sherman, Albany, N. Y.	Times of high water at Albany, N. Y., for January, 1891.

TABLE No. 3—Continued.

Date.	Name.	Data furnished.
1891.		
Jan. 31	A. S. Winger, Warren, Pa.-----	Magnetic declination at Warren between 1883 and 1890. Annual change of the declination at Warren.
31	W. B. Hutton, New York-----	Results of spirit levelings vicinity of New York and of tidal levels and flow of currents.
31	W. P. Paret, U. S. Asst. Eng'r., St. Simons Mills, Ga.-----	Magnetic declination at Fernandina and Amelia L. H. between 1831 and 1889.
Feb. 3	W. K. Nottingham, County Surveyor, Eastville, Va.-----	Magnetic declination at Eastville in 1891 and annual change of same.
4	S. W. Mackee, U. S. Dep. Surveyor, Salt Lake City-----	Two pamphlets on atmospheric refraction and computations of heights in Cal.
4	R. T. Sherman, No. 284 Broadway, Albany, N. Y.-----	Times of high water at Albany, N. Y., from Feb. to Dec., inclusive, 1891.
6	L. Turner, Washington, D. C.-----	Azimuth of line from Charlestown, W. Va., to Washington, D. C., and distance from Lawrenceville, Ga., to Washington, D. C.
7	Geologist of Missouri-----	Latitude and longitude of Ironton and Potosi, Mo.
10	W. G. Ramsey, Hancock, Md.-----	Height of bench marks near Cumberland, Md.
11	J. C. Trautwine, Civil Engineer, Philadelphia-----	Magnetic declination in El Paso Co., Texas, and annual change.
11	H. W. Clogston, Bloomfield, Ind.-----	Height and description of bench marks in Indiana.
14	Lieut. J. C. Sanford, Sec'y Missouri River Commission-----	Latitude of Helena, Mont.
14	J. C. Soherts, Bremond, Robertson Co., Texas-----	Magnetic declination in Haskell Co., Texas, and tables of the position of the pole star.
19	J. B. Beers & Co., New York City-----	Topographic survey of the Hudson River from Spuyten Duyvil to Newburg. Ten topographical sheets.
24	E. B. Savage, Sec'y Mass. & N. H. Boundary Survey-----	Information about station Salisbury Marsh (Borden).
28	C. F. Palfrey, Captain, Corps of Engineers-----	Copy of the report on the resulting height of the bench mark on the St. Louis bridge as determined by three different routes, also five pamphlets on spirit levels.
March 3	M. A. Straight, Paola, Kansas-----	Height of the source of the Mississippi River above the Gulf.
4	Southern Home Seekers Guide, Pine Bluff, N. C.-----	Magnetic declination in lat. 35°, long. 79°, at present and in 1885; also annual change.
6	M. H. Bright, Tarrytown, N. Y.-----	Heights of stations Kickuit and Buttermilk and distance of the former from the Hudson.
6	M. L. Williams, Div. Eng'r and Surveyor, Rienzi, Miss.-----	Height of bench mark at Booneville, Miss., above the Gulf level.
6	Treasury Department, Bureau of Statistics-----	Forty-four diagrams illustrating statistics of exports and imports, gold and silver production, emigration, debt and interest, etc., of the United States, from 1855 to 1890.
6	Chief of Engineers, U. S. A.-----	Topographic survey in the vicinity of Portland, Me.
7	U. S. Geological Survey-----	Topographic survey of the Kennebec River below Augusta, Me.
7	Manly B. Cuny, 1736 M St., Washington, D. C.-----	Mean daily rise of tide: (1) Bar of Coos Bay entrance; (2) Umpqua River entrance; (3) Port Orford; (4) Bar of Willapa Bay.
9	Military Park Commission-----	Topographic survey of north part of Lookout Mountain to Rossville Gap, Tennessee.
9	M. A. Miller, Chief Eng'r, Pineville, Wyoming Co., W. Va.-----	Geodetic positions of stations Ivy, Summerville, Keeney, and Table Rock.
12	Capt. Willard, U. S. Engineers, Vicksburg, Miss.-----	Geographical positions of stations at Vicksburg, Miss., Texarkana, Ark., and Red River Landing, La.
12	U. S. Geological Survey-----	Topographical survey of the Connecticut River below Middletown, Conn.
13	T. H. McHenry-----	Longitude of Spokane Falls, Wash.
14	L. Bell, New York-----	Copies of appendices and charts bearing on terrestrial magnetism.
14	H. B. Hendrick, N. A. Office-----	Magnetic declination vicinity of Winchester, Va., and changes in 1810 and 1842.
14	J. C. Trautwine, Philadelphia-----	Table of times of elongation of Polaris, Bulletin No. 14.
18	Col. J. A. Smith, U. S. Engineers-----	Topographic and hydrographic survey of junction of Morrymeeting Bay and Androecoggin River, Me.
18	F. J. Garbaniti, Rahway, N. J.-----	Data as to the most northern, eastern, southern, and western points of the United States and Alaska.
21	G. H. Walker & Co., Boston, Mass.-----	Proof of chart of Provincetown Harbor with 18 feet curve drawn thereon.
21	A. L. Rhodes, Ass't Att'y U. S.-----	Copy of the reduction of topography and hydrography of Suisun Bay, Cal.
21	J. P. Abbott, Antioch, Cal.-----	Copy of the reduction of topography and hydrography of Suisun Bay, Cal.
21	W. G. Raymond, Berkley, Cal.-----	Copy of the reduction of topography and hydrography of Suisun Bay, Cal.
24	L. J. Storey, Lockhart, Texas-----	Magnetic chart for 1885 and copies of appendices No. 9 of 1881 and No. 12 of 1886.
26	H. Taylor, P. R. R. Co., Philadelphia-----	Height above sea of three stations in the city of Washington.
27	L. J. Storey, Lockhart, Texas-----	Annual change of the magnetic declination at Austin, at Fredericksburg, and at San Antonio, Texas.
27	John E. Sanford, Harbor and Land Com., Boston, Mass.-----	Description of bench mark at Clark's point, Buzzards Bay, Mass.

Information furnished to Departments of the Government in reply to special requests and to individuals upon application during the fiscal year ending June 30, 1891.

Date.	Name.	Data furnished.
1891.		
March 27	Maj. J. I. Rodgers, U. S. A. -----	Projection covering Cape Disappointment and vicinity, and projection of part of San Francisco Bay, Cal., scale 1-7200.
27	Calderon Carlisle, Washington, D. C. -----	The position of the schooner <i>W. P. Seward</i> at the end of the sea days, June 23 to July 3, 1887, plotted on two copies of chart No. 900.
28	T. H. Kane, New York -----	Results of spirit levelings in the vicinity of New York.
31	J. Sims, Surveyor, Clover Depot, Va. -----	Table of magnetic declination in Halifax county, Va., for any year in the present century.
31	State Department -----	Drawing of map of the Pribilof Islands, Alaska, for photo-lithographing.
April 1	D. C. Heath & Co., Boston, Mass. -----	Copy of Figure A, Plate I, of the Kohl collection for reproduction.
13	Norfolk and Washington Steamboat Co. -----	Two copies of chart No. 376, colored, and table of distances to prominent places between 7th Street wharf, Washington, D. C., and Boston Steamship Company's wharf, Norfolk, Va.
14	Mr. H. F. Gause, President Harlan & Hollingsworth Co., Wilmington, Del. -----	The above distances were furnished.
15	H. Wilhelm, County Surveyor, Toledo, Ohio. -----	Three magnetic charts and three appendices on magnetic results.
17	J. Pierce, Baltimore, Md. -----	Seven geographical positions, vicinity of Baltimore, description of stations, and triangulation sketches.
17	U. S. Geological Survey -----	Copy of topography of Homosassa River, Florida.
17	U. S. Geological Survey -----	Topographic survey of Kennebec River, Maine.
17	U. S. Geological Survey -----	Topographic survey of Androscoggin River, Maine.
19	Solicitor General of the U. S. -----	The position, courses, and distance sailed by schooner <i>W. P. Seward</i> on sea days of July 2d and 4th, 1887, plotted on published chart No. 900; also a map of the locality on a large scale for use in Supreme Court.
20	Justice Gray, U. S. Supreme Court. -----	Designs for seal of the Circuit Court furnished.
20	Connecticut Shell-fish Commission -----	Tracing of high and low water line from Welch's Point to Pond Point, Conn., from topographic survey.
22	A. P. Cochran, Staunton, Va. -----	Magnetic bearing of line in 1778, 1796, 1828, and 1891; Appendix No. 12, Report for 1886 and two magnetic charts.
24	Lieut. J. Biddle, U. S. Engineers -----	Geographical positions and geodetic data vicinity of Knoxville, for a survey of the Tennessee River to Chattanooga.
24	R. E. Peary, Civil Engineer, U. S. N. -----	Projection on scale 1-600 000 of Smiths Sound, Greenland.
April 27	Lieut. J. Biddle, U. S. Engineers -----	Heights of trigonometrical stations and of R. R. stations at Chattanooga and at Knoxville.
28	A. M. Da Costa, Kansas City, Mo. -----	Blue prints of reduction of recent surveys of Willapa Bay, Washington.
28	George H. Emerton, Hoquiam, Wash. -----	Blue prints of reduction of recent surveys of Willapa Bay, Washington.
28	Thomas Cooper, President Chamber of Commerce, South Bend, Wash. -----	Blue prints of reduction of recent surveys of Willapa Bay, Washington.
28	Cranch & Cardell, Seahaven, Wash. -----	Blue prints of reduction of recent surveys of Willapa Bay, Washington.
28	Hon. John B. Allen, Wallawalla, Wash. -----	Blue prints of reduction of recent surveys of Willapa Bay, Washington.
28	R. P. Peirce, Tacoma, Wash. -----	Blue prints of reduction of recent surveys of Willapa Bay, Washington.
28	Herman Trott, Seahaven, Wash. -----	Blue prints of reduction of recent surveys of Willapa Bay, Washington.
29	Maj. H. C. Dunwoody, Acting Chief Signal Officer. -----	Height of standard bench mark in the District of Columbia as determined by Coast and Geodetic Survey.
May 1	C. Uncas Lewis, New Orleans, La. -----	Statement in regard to surveys in the vicinity of Grand Pass, Mississippi River.
2	Mr. Hyde, U. S. Geological Survey -----	Geographical positions and descriptions of stations in Vermont.
2	Lieut. J. Biddle, U. S. Engineers -----	Descriptions of stations of 1890, vicinity of Chattanooga, Tenn., and Ga.
2	A. P. Davis, U. S. Geological Survey -----	Geographical positions, coast of California, San Diego to San Pedro.
4	Maj. H. C. Dunwoody, Signal Corps. -----	Description of bench mark, Long Bridge, 1867.
5	Chief of Bureau of Yards and Docks, Navy Department. -----	Description of bench marks, (1) Pt. Orchard, (2) Dyes Inlet, (3) Puget Sound.
5	F. H. Bigelow, Nautical Almanac Office. -----	Thirty-three geographical positions of transit of Venus stations in U. S.
6	Maj. W. R. Dunton, U. S. A. -----	Isogonic charts for 1885 and 1890, and copies Appendix No. 12 of 1886, and No. 7 of 1888, also copy of Bulletin No. 14, and magnetic declination at Dorset, Vt., together with annual increase.
6	S. S. Gannett, U. S. Geological Survey -----	Angles observed at Catawissa, Pa.
7	Director Geological Survey -----	Ninety geographical positions and descriptions of stations in southern part of New York State.
7	Director Geological Survey -----	Sixty-five geographical positions between the Hudson River and the Connecticut Boundary, with descriptions.
8	A. P. Davis, Geological Survey -----	Twenty-one geographical positions and descriptions of stations, coast of California, between San Pedro and San Diego.
9	Prof. J. K. Rees, Columbia College -----	Geographical positions of Monadnock, Kearsarge, and Sunapee, with heights and descriptions of stations.
12	Director Geological Survey -----	Positions and descriptions of stations Mt. Equinox, Gleebe, and Style.

TABLE No. 3—Continued.

Date.	Name.	Data furnished.
1891.		
May 12	Mr. Brooks, U. S. S. Fish Hawk	Descriptions of trigonometrical stations in Tangier and Pocomoke Sounds, Virginia and Maryland.
14	Secretary Nettleton, Treasury Department	Customs map of the United States corrected and brought up to date.
14	Capt. T. W. Symons, U. S. Engineers	Topographic and hydrographic survey, vicinity of Padilla Bay, Wash.
18	T. H. B. Johnson, Ft. Smith, Ark	Height above the Gulf level and description of the two bench marks at Fort Smith.
18	Berlin H. Wright, De Leon Springs, Fla	Phase inequality, (1) Fort Clinch, near Fernandina, Fla.; (2) Fort Taylor, Key West; (3) Egmont Key, Fla.; (4) San Diego, Cal.; (5) Fort Point, near San Francisco.
18	Lieutenant Winslow, U. S. N.	Statistics of oyster beds in parts of Pamlico Sound, N. C., plotted on charts Nos. 142 and 143 from hydrographic sheets.
20	D. T. Wheaton, Engineer, Morris, Stevens Co., Minn.	Magnetic declination at Morris in May, 1891, annual change, and isogonic chart for 1885 and two appendices on secular change.
20	Lieut. Arthur P. Nazro, U. S. N., Branch Hydrographic Office, New York City.	Forty-seven pages of tables of temperature and density, Sandy Hook, N. J., from June 7, 1887, to March 31, 1891.
22	W. K. Brooks	Positions of triangulation points Tangier and Pocomoke Sounds, Virginia and Maryland.
22	B. L. Lloyd, Engineer, Cumberland Gap, Tenn.	Magnetic declination at Cumberland Gap, annual change of declination, magnetic chart for 1885, and pamphlet on secular variation.
25	W. M. Beaman, Topographer, U. S. Geological Survey.	Eighteen geographical positions and descriptions of stations, vicinity of Kennebec River, Me.
29	Prof. W. Libbey, jr., Princeton College, New Jersey.	Five pages of manuscript on the subject of tables referring to projections of maps and terrestrial magnetism.
June 1	G. C. Comstock, Director Washington Observatory, Madison, Wisconsin.	Copy of resulting latitude of the observatory from observations made by the Coast Survey in 1873.
3	Director Geological Survey	Geographical positions of 7 stations in North Carolina and 1 in Kentucky.
3	Director Geological Survey	Geographical positions of 5 stations in southeastern Tennessee.
3	Capt. T. W. Symons, U. S. Engineers	Hydrographic survey, vicinity of Skagit Bay, Wash.
9	Harbor Line Commission, Washington	Topographic and hydrographic survey, vicinity of Seattle, Wash.
9	U. S. Fish Commission	Projection scale 1-40,000 of Tangier Sound, Va.
10	Law Department of Counsel to the Corporation of N. Y. City.	Comparative surveys of water front of part of Harlem and East Rivers, made in 1838, 1855, and 1885.
10	New Jersey Geological Survey.	Topographic survey along the New Jersey coast from Seabright to Elberon.
11	B. A. Bailey, Civil Engineer, Topeka, Kansas	Magnetic declination at a number of points in Kansas, also annual change.
11	C. W. Poole, Rockport, Cape Ann, Mass.	Question of visibility of Mt. Washington from Poole's Hill, Cape Ann, examined.
12	A. W. Rice, New Britain, Conn.	Magnetic declination at Hartford, Conn., in 1891, and pamphlets on secular variation and distribution of the magnetic declination with charts for 1885 and 1890.
13	Harbor Line Commission, Washington	Hydrographic survey, vicinity of Port Townsend, Wash.
15	Major Hutton, Baltimore Harbor Commission.	Two hydrographic projections of Baltimore Harbor, 1st scale 150 feet to inch, 2d scale 300 feet to inch.
16	National Military Park Commission.	Topographic survey, vicinity of Chattanooga, Tenn.
16	Prof. W. Hoover, Ohio University, Athens, Ohio.	Three pamphlets on magnetic declination.
23	Hon. J. H. Mitchell, U. S. Senate.	Hydrographic surveys of the mouth of Columbia River, Oregon and Washington.
24	Robbins & Graham, Titusville, Fla.	Hydrographic surveys, vicinity of Cape Canaveral, Fla.
24	Frank Lehr, County Surveyor, Wallawalla, Wash.	Description of astronomical station with resulting latitude and longitude.
26	E. L. Brown, Brockton, Mass.	Three magnetic pamphlets and two isogonic charts.
27	Capt. O. M. Carter, U. S. Engineers	Hydrographic surveys of the bar of St. Simon Sound, Ga.
27	W. W. Seymour, Louisa, Lawrence Co., Ky.	Change of magnetic declination in eastern Kentucky, between 1785 and 1891.
30	Warren, Chapman & Farquhar, Newport, R. I.	Topographic survey of Arthur Kill from Tottenville to Port Richmond, Staten Island, N. Y.

OFFICE REPORT NO. 1.—1891.

REPORT OF THE ASSISTANT IN CHARGE OF THE OFFICE FOR THE FISCAL YEAR
ENDING JUNE 30, 1891.U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington D. C., November 10, 1891.

SIR: I have the honor to submit the Annual Report of the Office for the fiscal year ending June 30, 1891, and along with it the Annual Reports of the various Divisions thereof as follows:

1. The Computing Division, Assistant C. A. Schott, chief.
2. The Tidal Division, Mr. A. S. Christie, chief.
3. The Drawing Division, Assistant W. H. Dennis, chief.
4. The Engraving Division, Assistant H. G. Ogden, chief.
5. The Chart Division, Assistant Gershom Bradford, chief.
6. The Miscellaneous Division, Mr. M. W. Wines, chief.
7. The Instrument Division, Assistant Edwin Smith, chief.
8. The Library and Archives Division, Mr. F. H. Parsons, chief.

The chiefs of these various divisions have conducted the work committed to them in a satisfactory manner (see details in their respective reports herewith). Coöperation has been effective in advancing the work, and increased efficiency is noted in the personnel of the Office.

The correspondence of the Office has been gradually assigned to the various divisions to which it naturally pertains, and the system of opening and registering all the mail at the Superintendent's Office and of having the correspondence signed by the Superintendent only has worked well.

The same duties are performed by the same persons as heretofore, but the whole correspondence goes out over the signature of the head of the Survey.

Early in the year the Superintendent organized two Boards which have done much to increase the efficiency of the Office. The first was organized as follows:

INSTRUCTIONS.

U. S. COAST AND GEODETIC SURVEY,
Washington, D. C., August 1, 1890.

The Assistant in charge of the Office, the Hydrographic Inspector, the Chief of the Drawing Division, the Chief of the Engraving Division, the Executive Officer to the Superintendent:

GENTLEMEN: You are hereby constituted a Board for the recommendation to the Superintendent of a program for chart publications by this Office. You will please organize at the earliest practicable date and submit a report for my consideration as soon as circumstances will permit. You are authorized to call upon the Office for the data and statistics you may require for the comprehensive study of the subject; and it is my desire that you shall meet as frequently as necessary to make modifications or improvements in the program that may seem desirable to meet new conditions as they arise.

You will also report to me as occasion may require all deficiencies in the field work that come under your observation that you consider essential for the speedy completion or proper production of the chart or charts of any locality.

Yours respectfully,

T. C. MENDENHALL, *Superintendent.*

This Board has given us the systematic coöperation of those directly concerned in the production and handling of our charts, and the effect has been excellent. The second was organized as follows:

U. S. COAST AND GEODETIC SURVEY,
Washington, D. C., October, 1890.

The Assistant in charge of the Office, Hydrographic Inspector, Chief of Computing Division, Chief of Drawing Division, Chief of Tidal Division, Chief of Division of Library and Archives, Executive Officer to the Superintendent, Mr. Courtenay, of the Computing Division, and the Assistant in charge of the Office of Standard Weights and Measures:

GENTLEMEN: You are hereby constituted a Board on the Library and Archives.

You will organize as early as is practicable and proceed to the consideration of a plan for the better classification and arrangement of the original records of the Survey, so that they may be conveniently accessible at all times for their indexing or cataloguing, so as to be of easy reference, and for such a system of book keeping in connection with them as will preserve a complete history of every sheet or volume. If you consider it desirable you are requested to suggest such rules relating to the deposit of original records in the Archives and the conditions under which they may be withdrawn as will secure the maximum facility in their use with the minimum probability of their loss or destruction.

You will report from time to time to the Superintendent such conclusions as you may have reached.

You will also consider the special needs of the Library in the way of addition or of arrangement.

You will report upon the desirability of completing sets of Journals or Proceedings of Scientific Societies which may now be fragmentary.

You may recommend from time to time lists of books which should be on the shelves of the Library, and anything which, in your judgment, will add to the usefulness and efficiency of the Library.

Yours,

T. C. MENDENHALL, *Superintendent.*

I think that I can safely assert that the result of the labors of this Board has been to bring into the Library of the Survey more useful and needed books pertaining to our specialty than have ever been secured in any single previous year.

Dr. Wm. B. French has continued to act as my immediate assistant in matters of executive detail, and to receive and account to me for all moneys from sales of charts, publications, old property, and other sources. He has aided in the Office correspondence, received, adjusted and arranged all the Office bills on vouchers in proper form for my approval, and filed a duplicate copy of each bill.

Mr. E. B. Wills has had charge of the "leave of absence" account from the 1st of November, 1890; has attended to the receipt and sending of all registered mail, the dispatch and receipt of express and freight matter, and has filed the Office correspondence and arranged part of it for binding.

Miss F. Cadel was employed upon the typewriter during the year in miscellaneous copying and in addressing wrappers for "Notices to Mariners," and in mailing the latter. On the 31st of July the Office lost her services by reason of transfer to the Department of the Interior, Indian Bureau.

Miss Kate Lawn continued to use the typewriter during the whole year, in preparation of copy for the Annual Report of the Superintendent, in miscellaneous copying, and in a variety of other work called for by the various chiefs of divisions in the Office.

Miss F. B. Bailey was engaged as stenographer and typewriter to the Assistant in charge of the Office, and rendered efficient and faithful service. On October 31 her connection with the Survey ended by resignation.

Miss I. M. Peck has been employed during the year in miscellaneous work, such as copying, addressing mailing slips for "Notices to Mariners," etc.

Mr. W. C. Maury was temporarily employed from September 3d to the 20th in some special copying for which there was immediate need. His services were dispensed with as soon as the work was completed.

The following-named persons whose salaries are provided for under the head of "Pay of Office Force," have been detailed for special duty, as follows:

William B. Chilton, clerk in the Office of the Superintendent, under his special direction.

Ferdinand Westdahl, draughtsman; Frank W. Edmonds, clerk, and Vicente Denis, messenger, with Assistant George Davidson, in charge of the Sub-office at San Francisco, Cal.

E. Willenbucher, William C. Willenbucher, F. C. Donn, and E. H. Wyvill, draughtsmen, and J. H. Roeth, clerk in the Office of the Hydrographic Inspector.

There have been no deaths in the office force during the year.

In conclusion, I beg to express my gratification at the continued able support that I have received from the chiefs of the several Divisions of the Office, and to thank you for the courtesy which you have shown me personally and the consideration which you have extended to me in the performance of my various duties.

Respectfully yours,

Dr. T. C. MENDENHALL,
Superintendent U. S. Coast and Geodetic Survey.

B. A. COLONNA,
Assistant in charge of the Office.

**REPORT OF THE COMPUTING DIVISION, U. S. COAST AND GEODETIC SURVEY OFFICE,
FOR THE FISCAL YEAR ENDING JUNE 30, 1891.**

COMPUTING DIVISION, *June 30, 1891.*

SIR: In conformity with regulations, I have the honor to submit herewith the usual Annual Report of work done in the Computing Division during the fiscal year ending June 30, 1891.

The charge of the Computing Division was continued with the undersigned; the personnel remained the same as last year, and but very little temporary assistance was had from outside sources. Mr. J. Page was assigned to field duty August 12, 1890, and returned on November 12, 1890; Mr. J. B. Boutelle was attached to the Computing Division between October 6, 1890, and March 26, 1891; Mr. F. A. Young reported for duty February 11, and was detached April 15, 1891; Miss I. M. Peck gave her services to this Division for three weeks, since June 8; Mr. D. L. Hazard continued as computer for the State of Massachusetts. The work of triangulation in that State, however, is so heavy that most of the strength of this Division had to be given to it. It was, therefore, only possible to attend to the current work of the Survey, during the past year.

I was engaged in directing and supervising the computations and reporting the results; in preparing and furnishing such scientific information as was referred to this Division in connection with office and field requirements, or connected with general correspondence of the Survey; I advanced the reduction and discussion of the hourly observations of the horizontal component of the magnetic force at Los Angeles, Cal., 1882-'89; discussed the magnetic observations made by Bering on the coasts of Kamchatka and Eastern Siberia in 1727-'29 (Bulletin No. 20), and applied the results for the improvement of the expressions for secular variation at several stations; prepared an account of the method of observing an astronomical azimuth by means of ocular micrometric measures of a circumpolar star when near elongation (Bulletin No. 21); determined the induction and distribution coefficients of magnetometer No. 11, and discussed the magnetic observations of the U. S. Eclipse Expedition to the West Coast of Africa, 1889-'90 (Bulletin No. 23). Special reports were also submitted relative to the present state of the field work of the measures of the transcontinental arc of longitude about latitude 39° between Cape May and Eastern Kansas.

An account of the work performed by each computer and clerk during the fiscal year is herewith presented. It is made up from the daily and monthly reports.

Edward H. Courtenay, continued and brought nearly to a close the adjustment of the secondary triangulation of Massachusetts, made between 1885 and 1889, inclusive, in connection with the State Survey. In this work he had the assistance of Mr. D. L. Hazard, of the State Survey. Mr. Courtenay has charge of the geographical registers; supervises the preparation of information or data needed by the field parties engaged in all branches of the Survey; has charge of the duplicate records of the Survey relating to astronomy, geodesy, and magnetism, and directs part of the labor of Messrs. Kummell, Boutelle, and Page. I regret to report that Mr. Courtenay's state of health was not so satisfactory as usual.

Myrick H. Doolittle prepared the abstract of horizontal directions of the primary triangulation in Kansas of 1889 and 1890, and adjusted the figure between Kansas City and Junction City; computed the positions of the secondary and tertiary stations of the transcontinental triangulation between St. Louis, Mo., and Junction City, Kans.; prepared the abstracts of horizontal directions of the primary triangulation in Ohio and Indiana of 1889-'90; adjusted the figure introducing the Holton base, Indiana; adjusted the triangulation between the Olney and Holton base lines; computed the secondary and tertiary positions of the transcontinental arc in West Virginia and Ohio, in particular of the survey of Cincinnati and vicinity, also in Indiana and Illinois. Mr. Doolittle also computed the triangulation of Atchafalaya Bay and River, Louisiana, 1890, and made good progress with the preparation of the abstracts of horizontal directions in Southeast Tennessee, connecting with the main triangulation in Georgia. He also completed the first figure adjustment locating stations Cohutta and High Point.

Henry Farquhar computed the latitudes of Altoona, Pa., 1890; of Howlett, N. Y., 1883; of Chenier Tigre, La., 1889; of Reizin, Ind., 1889; of Minerva, Ky., 1887; of Gould, Ohio, 1885, and made some progress with the computation for latitude of San Francisco, 1888. Mr. Farquhar also determined the mean places of stars (declination) for the use of field parties, a work of considerable labor, involving the use of all available star catalogues and the determination of the star's proper motion.

Louis A. Bauer computed the telegraphic longitude of Altoona, Pa., 1890; and the azimuths of Toledo, Ohio, 1890; of Chenier Tigre, La., 1889; of Gould, Ohio, 1885; of Piney, W. Va., 1883; of Minerva, Ky., 1887; of Osborn, Ind., 1887; of Weed Patch, Ind., 1889; of Reizin, Ind., 1889; of Newton, Ill., 1883; of Adams, Kans., 1888; of Tepusquet, Cal., 1882; of South Base, Matagorda, Texas, 1883; of Lospe, Cal., 1883; of Castle Mt., Cal., 1885, and of Hepsedam, Cal., 1885-86; revised magnetic computations of Alaska, 1889; reduced the bifilar hourly readings at Los Angeles, 1882-89, to a uniform temperature; computed the magnetic observations made by Sub-Assistant Preston on the Solar Eclipse Expedition to the West Coast of Africa in 1889-90; revised the reduction of spirit levels between Villa Ridge, Ill., and Greenfield, Tenn., 1888-89, and made some progress with the reduction of the magnetic observations of Assistant Baylor in the Southwestern States in 1890.

Charles H. Kummell was engaged in miscellaneous geodetic computations, including abstracts of directions and angles, triangle sides, and positions, also in revisions and checks in connection with the geographical registers. Mr. Kummell also attended to the solution of normal equations required in the adjustment of the triangulation in Massachusetts; computed the length of the speed trial-line in Santa Barbara Channel; computed the position of the Newport News Shoal Light, and the New York World's building; also the heights of stations Hepsedam and Santa Aña, Cal.

James Page attended to miscellaneous geodetic computations and revisions relating to abstracts of directions, eccentric stations, triangle sides, and geodetic positions. After the completion of his duty in the field he was engaged in the revision of magnetic tables of the horizontal force component at Los Angeles, Cal., and reduced the observations of spirit levels in Illinois, Kentucky, and Tennessee, from Villa Ridge to Greenfield, 1888 to 1889.

William C. Maupin was engaged in copying the descriptions of stations and sketches required for the use of trigonometrical, hydrographic, and plane table parties; he attended to the geographical registers, and to miscellaneous clerical duties.

John B. Boutelle revised the tables of the hourly values of the magnetic declination and horizontal force at Los Angeles, Cal., 1882-'89; attended to the computation of geographical positions, and to duplicating scientific reports.

Fred. A. Young computed apparent places of stars, and attended to some magnetic revisions and geodetic computations of positions.

Ida M. Peck attended to the duplication of geodetic results.

Respectfully yours,

MR. B. A. COLONNA,

Assistant in charge of the Office.

CHAS. A. SCHOTT,

Assistant U. S. Coast and Geodetic Survey,

Chief of the Computing Division.

**REPORT OF THE TIDAL DIVISION, U. S. COAST AND GEODETIC SURVEY OFFICE, FOR
THE FISCAL YEAR ENDING JUNE 30, 1891.**

TIDAL DIVISION, *June 30, 1891.*

SIR: I have the honor to submit this, my report of the Tidal Division for the fiscal year ending June 30, 1891.

SUMMARY OF THE WORK DONE DURING THE YEAR.

1. An aggregate of six years, six months of record from automatic tide gauges, with tabulated half-hourly heights of the sea, high and low waters, temperature and density of the sea, and meteorological data, 150 original and 132 duplicate volumes of observations from staff and box gauges, have been received, examined and registered, and 296 letters prepared.
2. The Tide Tables for the Atlantic and Pacific Coasts for the year 1892 have been prepared, and about 130 pages read and revised in proof. In the volume for the Atlantic Coast the number of subordinate stations has been increased from 650 to 687. The volume for the Pacific Coast has undergone more extensive changes, as follows: The high and low waters in the principal table are placed in consecutive and natural order, and typographical devices add still further to the perspecuity of the arrangement. The constants for the more important subordinate stations are printed upon the same page with the daily predictions for the principal station. A few subordinate stations have been dropped as not needed, and others introduced, the net increase of 63 bringing the total number up to 281. The tables of lunar data have been thrown into more intelligible form. The rising and setting of the sun and moon for San Diego, San Francisco, Astoria, and Port Townsend, and Sitka, are given for the first time. Some 15 or 20 pages of matter which finds an appropriate place in these tide tables have been added, including the regulations for preventing collisions at sea; general information upon the Life-Saving Service, with instructions and a list of life-saving stations on the Pacific Coast; instructions for saving drowning persons, and for resuscitating the apparently drowned; and the Signal Service cautionary, storm, and wind-direction signals. The volume closes with a complete alphabetical index of all the tidal stations.
3. Tide notes have been prepared and furnished for 138 stations for publication on 39 charts; and five notes on tidal currents.
4. Twenty-seven requisitions from field parties have been filled, involving the preparation of 85 descriptions of benchmarks with references to the tidal planes.
5. Tidal information, including 61 tide notes and 43 benchmark descriptions, has been prepared and furnished in response to thirty-three calls from persons not connected with the Survey.
6. In harmonic analysis of tides, a year each at Eastport, Boston, Providence, Sandy Hook, Bridesburg, and Sausalito, have been continued or commenced, the work done being the equivalent of three complete years.
7. Non-harmonic "1st reductions" have been made of 75 series, the equivalent of seven years of continuous observations; and phase and declination reductions of 27 series, the equivalent of four years of continuous observations.
8. A beginning has been made on the arranging, binding, and indexing, by State and station, of all original and all duplicate tide books in the Archives, and in this and other divisions of the Office, or in the custody of field parties.
9. The work of completing tidal reductions, and preparing the results for publication in the Tide Tables, and in the Annual Reports of the Survey, has been inaugurated with the formation of convenient registers for the use of this Division.
10. The predictions for Eastport, Me., have for several years past been made with the tide-predicting machine, using constants derived from Pulpit Harbor, in Penobscot Bay. The results of the harmonic reduction of a year's observations at Eastport were put into the

machine for the predictions for 1892 with a distinct improvement in accuracy, as shown by comparison of observation in former years with predictions based on the two sets of constants, respectively.

The predictions for Sitka, Alaska, have heretofore been made by non-harmonic methods based on an imperfect reduction of several rather poor series of observed high and low waters. I have succeeded in finding a set of constants, by interpolation between Astoria and Kadiak Island, which enabled us to reproduce with the tide-predicting machine the observed high and low waters with remarkable closeness, both in time and height, and these constants were put into the machine and the predictions turned out for 1892. The predictions for previous years were undoubtedly below the required standard of accuracy, but I am confident that those for 1892 will be found to accord closely with the facts.

11. An elaborate "report on the advisability of constructing a harmonic analyser and a Thomson tide predictor" was prepared and submitted by Mr. John F. Hayford, of this Division.

PERSONS EMPLOYED IN THE TIDAL DIVISION.

The following persons have constituted the force of the Tidal Division during the year:
Computers: Mr. Alex. S. Christie, Mr. L. P. Shidy, and Mr. F. M. Little, throughout the year; Mr. John F. Hayford, until December 15, and Mr. Rollin A. Harris, since July 5.

Writers: Miss A. G. Reville, Mrs. Virginia Harrison, and Mrs. M. E. Nesbitt, throughout the year, and Mr. Rollo S. Jackson, since June 4.

A force of four computers should be added to this Division, two of whom, with one writer, should be constantly employed in the reduction of the accumulated observations of currents.

Respectfully yours,

ALEX. S. CHRISTIE,
Chief of the Tidal Division.

Mr. B. A. COLONNA,
Assistant in charge of the Office.

REPORT OF THE DRAWING DIVISION OF THE U. S. COAST AND GEODETIC SURVEY OFFICE FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

DRAWING DIVISION, June 30, 1891.

SIR: In conformity with the regulations, I have the honor to submit the Annual Report of the Drawing Division, which has remained under my direction, for the past year.

The changes in the personnel of the Division have been the retirement of Mr. Emil Molkow, on the 30th of September, and the appointment, through the Civil Service Commission, of Mr. E. J. Pond, on October 15, Mr. E. S. Mitchell, on November 25, and Mr. E. P. Ellis, on March 16, filling all vacancies in the corps of draughtsmen.

The assignment of work has been virtually the same as in previous years.

Mr. A. Lindenkohl has been employed in collecting and compiling data for the published charts, reducing hydrography, drawing projections on copper, and similar work requiring the services of a thoroughly skilled draughtsman.

Mr. H. Lindenkohl, in making drawings and reductions for engraving and lithographing, projections on copper, and in engraving on stone the additions and corrections to the magnetic charts.

Mr. E. H. Fowler, in the reduction of the survey of the District of Columbia and charts for publication.

Mr. E. J. Sommer has made projections and reductions for new progress sketches, drawings for engraving, and projections for field parties.

Mr. D. M. Hildreth has also made projections for field parties and drawings of charts for photo-lithographing.

Mr. G. F. Pohlers has drawn most of the illustrations for the Annual Reports and made drawings of charts for publication.

Mr. C. H. Deetz has made diagrams showing the location of each topographical sheet on the Atlantic and Gulf Coasts, and has also performed the clerical duties of the Division.

Mr. C. Mahon has been employed in making topographic and hydrographic reductions for engraving.

Mr. P. Von Erichsen has made tracings of the original field sheets of the District of Columbia survey for blue printing, drawings of instruments illustrating papers published by the Survey, and has inked original topographic sheets.

Mr. E. J. Pond has made a number of statistical diagrams for the Treasury Department and drawings of charts to be engraved.

Mr. E. S. Mitchell and Mr. E. P. Ellis have been employed mostly in making tracings from original sheets in answer to calls from other Departments and the public.

It is but justice to commend each individual draughtsman for strict attention to his duties, and the personal interest evinced in his work,

Early in the year the experiment was made of drawing and engraving a chart on zylonite for publication. The advantages to be gained by its use are:

1st. When the chart is made on the scale of the survey, the zylonite being transparent, the draughtsman can trace the topography directly from the original sheet.

2d. The engraver, by doing his work on the reverse side of the zylonite, works directly from the drawing without further tracing or transferring, thus eliminating to a great degree the chances of error.

3d. The economy in time and cost of material.

The result thus far has been eminently successful. The chart selected was that of Mendocino Bay, Cal. Its size is 16 by 19 inches (neat lines).

From the zylonite about one hundred and twenty copies were printed without showing any signs of wear; it was then electrotyped, producing a copper plate as perfect as the original engraving. It is now proposed to print from the zylonite until it is well worn, in order to ascertain its durability.

A list by title and number of the drawings of charts for publication which were completed or in progress during the year is submitted for file in the Archives. This list shows that thirty-four drawings of charts for publication were finished during the year; that additions to the drawings of eleven charts were completed, and that the drawings of three charts were in hand. In addition to this work there were revised and corrected for reprints the drawings of seventy-four charts, and there were made eighty-one drawings of illustrations to the Annual Report of the Superintendent.

Forty topographic and fifty-seven hydrographic projections were prepared for the use of field parties; eleven topographic sheets were inked and lettered, and twenty-seven topographic sheets were lettered and retouched.

For incorporation in Appendix No. 3, 1891, I have appended to this report a statement of information furnished in answer to applications, official or personal, which were referred to this Division during the year.

Respectfully yours,

W. H. DENNIS,
*Assistant Coast and Geodetic Survey,
Chief of the Drawing Division.*

Mr. B. A. COLONNA,
Assistant in charge of the Office.

**REPORT OF THE ENGRAVING DIVISION, U. S. COAST AND GEODETIC SURVEY OFFICE,
FOR THE FISCAL YEAR ENDING JUNE 30, 1891.**

ENGRAVING DIVISION, *October 21, 1891.*

SIR: I respectfully submit the following report on the operations of the Engraving Division during the fiscal year ending June 30, 1891. The statistics are as follows:

ENGRAVING.

Number of plates of new charts completed.....	11
Number of plates of new editions of charts completed.....	8
Number of plates of sketches and illustrations completed.....	8
Number of plates of new charts commenced.....	10
Number of plates of new editions of charts commenced.....	9
Number of plates of sketches and illustrations commenced.....	2
Number of plates of charts corrected for printing.....	734
Number of plates printed for chart room.....	884
Number of plates of sketches and illustrations corrected for printing.....	25
Number of plates in progress during the year but not completed.....	27
Number of unfinished plates on hand at the close of the year:	
New charts.....	27
New editions of charts.....	12
Sketches and illustrations.....	13

ELECTROTYPING.

Number of pounds of copper deposited.....	2 174
Number of square inches on which deposit was made.....	83 244
Number of copper plates made:	
Basso.....	35
Alto.....	36
Total.....	71

Of this number eight basso and fifteen alto plates were made for the Hydrographic Office, Navy Department, and one basso and one alto plate for the Geological Survey Office, Interior Department.

PHOTOGRAPHING.

Number of negatives made.....	100
Number of prints made, blue.....	640
Number of prints made, silver.....	64
Number of prints made, black.....	21
	— 725

PRINTING.

Number of impressions for Chart Room.....	50 746
Number of impressions for the Assistant in charge of the Office.....	1 439
Number of impressions for the Engraving Division.....	1 756
Number of impressions for the Hydrographic Inspector.....	1 775
Number of impressions for lithographers, transfer proofs.....	168
	— 55 884

The engravers were employed during the year principally as follows: Messrs. H. M. Knight, A. Petersen, J. G. Thompson, W. F. Peabody, R. F. Bartle, jr., and H. L. Thompson,

on lettering; W. A. Thompson and E. J. Enthoffer, on topography and sanding; T. Wasserbach on sanding and miscellaneous corrections and additions; E. H. Sipe and W. H. Davis on lettering and miscellaneous corrections and additions; W. A. Van Doren, A. H. Sefton, and E. A. Kubel on outlines, lettering and sanding. Messrs. Geo. Hergesheimer, H. R. McCabe, John A. Williams, and G. F. Dawson, who are under instruction learning the art of engraving, have made satisfactory progress, and all of them are now able to fill in a large proportion of their time on chart plates.

Less than 25 per cent of the average amount that has been allotted to contract engraving in former years was expended on that class of work during the year; and although the deficiency was made up to some extent by the larger force employed in the Office, the total output of work for the year has been materially reduced. Owing to the difficulty experienced in securing competition in this class of work, it seems improbable that the system can be continued, and it certainly would not be prudent to base any calculations on securing work in that way.

The most important plates completed during the year include the Approaches to New York on scale of 1-400 000, the third plate of the Delaware River, with all of the most recent surveys, new editions of the charts of Chesapeake Bay Entrance, with the resurvey of the Shoals off Cape Charles, all on 1-80 000 scale; Admiralty Inlet and Puget Sound on scale 1-80 000, and one sheet of the 1-200 000 series on the California Coast, northward from Cape Mendocino. Considerable progress was also made towards completing the 1-80 000 series of Coast Charts on the Atlantic Coast, the 1-400 000 series on the Gulf Coast, and the 1-200 000 on the Pacific Coast, south of Grays Harbor. I look forward to the substantial completion of all of these series during the current year.

The new rule requiring all charts published by the photolithographic and lithographic processes to be registered in the Engraving Division, has been in successful operation during the year. Forty-one new charts, new editions, or reprints, were furnished, making an aggregate of 13 523 sheets. The most important of these were the chart of Florida Bay, 1-80 000 scale, Harbor charts of Fishers Island Sound and Gardiners Bay, a large scale chart of Woods Holl, and two sheets on large scale 1-9600, of the water front of the city of Philadelphia, on the Atlantic and Gulf Coasts; harbor chart of Willapa Bay, Washington, southeast Alaska on one sheet scale 1-1 200 000, and the first sheet of the new Alaska series on 1-200 000 scale, embracing Clarence Strait, Revillagigedo Channel and Portland Canal, on the Pacific Coast.

Engraving on zylonite, as suggested by Assistant W. H. Dennis, the chief of the Drawing Division, was experimented with during the year and met with a large measure of success. The prints from the zylonite are very satisfactory, and we have reproduced the work in copper by the electrotyping process. The experience of the survey demonstrates that different processes are essential to meet special conditions in reproducing the surveys. Heretofore we have found engraving on copper, lithography and photolithography the most available of the many processes that have been tried, though not always meeting the special case as completely as was desired. The new zylonite process promises to provide an intermediary between the photolithograph and engraving on copper, but just to what extent cannot be stated until the process has been fully developed.

The plate printing office has continued under the charge of Mr. F. Moore, foreman. The force of printers was reorganized during the year and is now working very satisfactorily on the new basis. The chart room was furnished 3 738 more prints than during the preceding year, and the total output of the office was 2 793 prints in excess of the preceding year. The usual difficulty was experienced in supplying the chart room during the summer months as for several years previously. The appropriation for increased facilities for printing having been granted by Congress at its last session, we may confidently believe no similar delays will be encountered in the future. The printing for the chart room required the handling of 884 plates in the presses; of this number 734 required correction by the engravers before sending them to the printers. These corrections required on the average the constant labor

of three engravers throughout the year. This is a reduction over the time consumed in the preceding year, when an average of three and one-half engravers were required, and as 105 more plates were corrected, the average work on each plate was considerably less.

Mr. D. C. Chapman continued in charge of the Electrotype and Photograph rooms during the year, assisted by Mr. L. P. Keyser. The work required was about the average quantity. The batteries have been put in thorough order during the year and improved in some of the details of their construction, resulting in more regular and satisfactory work.

My assignment by the President as a member of the U. S. Board on Geographic Names, and subsequent election by the Board as a member of the Executive Committee, involves a material increase in the details requiring my attention. Thus far I have been able to act upon all cases referred to me with reasonable promptness, but delays necessarily occur when there is a pressure of work in the Engraving Division. For several months I was very ably assisted in the work by Assistant Isaac Winston. He conducted a voluminous correspondence in the inquiries that were needed, and compiled a Geographic Directory of Southeast Alaska, that will shortly be brought to the consideration of the Board. He also made an exhaustive comparison of the nomenclature in the official list of Light-houses and in our charts, and secured evidence to determine the correct nomenclature in the cases where differences existed. He also made some progress in comparing the official lists of beacons and buoys with our charts, but this was far from being completed when he was detached to resume his work in the field. I sincerely hope that when he returns to the office his services can be spared to resume these investigations.

Mr. John H. Smoot has continued as clerk of the Division, rendering his usual acceptable services, and has relieved me of many details I have found it necessary to relinquish, that I might secure the time to attend to the greater mass of more general work that now requires my personal attention. I desire also to express to you the gratification I have found in the cordial coöperation of the experienced engravers in the Division, and in the interest they have shown in the young men now under my charge learning the art of engraving.

The customary list of plates completed, commenced, and in progress during the year is submitted herewith for file in the Archives.

Respectfully, yours,

HERBERT G. OGDEN,
*Assistant U. S. Coast and Geodetic Survey,
Chief of the Engraving Division.*

MR. B. A. COLONNA,
Assistant in charge of the Office.

REPORT OF THE CHART DIVISION OF THE U. S. COAST AND GEODETIC SURVEY OFFICE FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

CHART DIVISION, *June 30, 1891.*

SIR: I have the honor to submit the following report of the Chart Division for the fiscal year ending June 30, 1891.

This Division has been under my charge during the year and I have been assisted by the following named persons, whose general duties have been as noted:

- Mr. J. H. Barker, chart correcting.
- Miss L. A. Mapes, book-keeping and correspondence.
- Miss Sophie Hein, coloring and correcting charts.
- Mrs. Jennie Fitch, coloring charts and correcting catalogue.
- Mr. Neil Bryant, receiving and stamping charts.
- Mr. R. T. Bassett, mounting and joining charts.
- Mr. H. R. Garland, issuing and correcting charts.
- Miss Libbie Ludgate, coloring charts.
- Mr. J. W. Whitaker, correcting charts.
- Miss M. L. Handlan, coloring charts.
- Mr. C. W. Childs, correcting charts.

All of the above, eleven in number, have been employed for the whole year, excepting Miss Ludgate, who was discharged at the end of September, her services being no longer needed.

The following table presents a comparison of gross issues of charts between this year and the one preceding:

Date.	Total.	Sale agents.	Free distribution.
1890.			
July.....	-972	+508	-1 480
August.....	-103	+797	-900
September.....	-2 036	+163	-2 198
October.....	-1 563	-155	-1 408
November.....	-1 697	+712	-2 409
December.....	-652	-619	-33
1891.			
January.....	+731	-355	+1 086
February.....	-501	+172	-673
March.....	-1 185	-777	-408
April.....	-599	-514	-85
May.....	-1 198	-1 095	-103
June.....	-418	+718	-1 136
Year.....	-10 192	-445	-9 747

The minus signs indicate a less issue than for the corresponding months of the fiscal year preceding ;
the plus signs a greater issue.

It appears from this table that the falling off in the issue is very considerable, upwards of 10 000 copies, or 16 per cent, but of this number, much the greater part is from the free distribution. Five thousand copies less were issued on account of the Navy Department, which is partly due to the fact that the practice of furnishing naval vessels with new prints of charts has been, to a great extent, discontinued, as it was found that in many cases the older prints could be kept corrected to date on the vessel with but little trouble. Another cause of decrease may be found in the smaller number of new charts published, only half that of the previous year, as there is always, a large demand for them. The inability last summer to furnish charts promptly as ordered by sale agents has doubtless had more or less effect. Taking all these items into consideration, the decrease is no more than was to be expected and shows no lack of appreciation of the value of our charts by mariners, the class of people who need them most. We have been able to meet the calls of sale agents much more satisfactorily thus far this summer, and there is good reason to believe that there will be an increase of sales in the coming year.

The corrections to aids to navigation have been carefully and conscientiously made, and have been kept up as closely to date as the information furnished by the Light-House Board would permit.

The Hydrographic and Engraving Divisions of the Office have cordially coöperated with this Division in the attempt to bring the business of chart correction to as near perfection as possible, by systematising the routine and by wholesome criticism of results. That very few mistakes have been detected in work so complex reflects credit on all concerned, and especially, on the correctors in this Division.

In October last the correspondence relating to charts, which had hitherto been attended to under your special direction, was turned over to this Division, and it has involved, in addition to other details, the writing of an average of 270 letters per month, or 10 per day. This work has been performed by Miss L. A. Mapes in a most intelligent and satisfactory manner.

During the year a new edition of the Chart Catalogue dated 1890, has been published, which is, in some respects, an improvement on the previous one. The bulk of the edition has been distributed and the edition of 1892 is now in preparation. As you have suggested, it is

very desirable that an annual edition of the Catalogue should be published, both for the better information of the public and to save the work of correction by hand, which, in the course of a year, becomes burdensome. In this, as in past years, I am glad to testify to the general interest shown by the members of the Division in the amount and quality of the work. The work of correction and issue is so varied and so complex in its details, and it is so necessary that the current orders should be filled promptly to avoid confusion, that an unusual amount of experience is required to fit a person for effective service, for every member should be so accomplished as to be capable of taking a part, in an emergency, in any of the operations, coloring, correcting, issuing, etc. For this reason, the force should be, so far as possible, kept up to its effective strength and provision made to fill vacancies, as they occur, with properly qualified persons.

Seven new charts from copper plates, and seven new lithographic charts, fourteen in all, have been published during the year, as shown in the list following:

Date of publication.	Catalogue No.	Title.
1890.		
Aug. 29	152	Murrells Inlet to Cape Romain (inc. Winyah Bay), S. C.
Sept. 20	20	Atchafalaya Bay to Galveston Bay, Texas.
Oct. 1	648	Port Discovery and Washington Harbor, Washington.
Nov. 1	211	Padre Island and Laguna Madre, Lat. 27° 12' to Lat. 26° 33'.
Dec. 11	146	Ocracoke Inlet to Beaufort, N. C.
1891.		
Apr. 8	126	Delaware River, Penn's Neck to Philadelphia.
June 12	458	St. Johns River, Lake Monroe to Lake Washington, Fla.
1890.		
Oct. 1	316	Kennebec River, Me., Abagadasset Point to Court House Point.
Oct. 1	316b	Kennebec River, Me., Court House Point to Gardiner.
Nov. 14	348	Woods Holl, Mass.
1891.		
Jan. 29	358	Fishers Island Sound, Conn.
Apr. 14	899	N. W. coast of America and Inland Passages. Olympia, Wash., to Mt. St. Elias, Alaska.
May 12	380	Philadelphia Water Front, Delaware River, Pa.
May 12	381	Philadelphia Water Front, Schuylkill River, Pa.

The receipts, issues, and general distribution of charts during the year are given in the following table.

Issues.	July 1st, 1890, to June 30th, 1891.	
	Number.	Value.
Sales Agents.....	31 465	\$14 319.00
Sales by Office and Chart Division.....	683	291.95
Congressional account.....	3 153	1 550.50
Hydrographic Office, Navy.....	7 521	3 256.45
Light-House Board.....	1 954	764.85
Coast and Geodetic Survey Office.....	2 996	1 233.35
Executive Departments.....	2 651	1 002.00
Foreign Governments.....	315	152.25
Miscellaneous.....	2 221	886.70
Total.....	52 059	\$23 457.05
Condemned.....	4 314	1 681.01
Total issued including 4314 condemned.....	57 273	\$25 138.06

Charts on hand and received from July 1, 1890, to June 30, 1891.

	Number.	Value.	Number.	Value.
On hand by inventory, July 1, 1890	45 156	\$15 966·00		
Received, July 1, 1890, to June 30, 1891 (plate)	48 632	21 466·00		
Received, July 1, 1890, to June 30, 1891 (stone)	7 875	3 848·55		
Returned	4 161	1 667·36		
Total on hand and received to June 30, 1891			105 824	\$42 947·91
Total issued including total condemned to June 30, 1891			57 273	25 138·06
On hand by book July 1, 1890			48 551	\$17 809·85
Difference between book and count			—40	—12·15
On hand by count July 1, 1891			48 511	\$17 797·70

Respectfully yours,

GERSHOM BRADFORD,
*Assistant, U. S. Coast and Geodetic Survey,
 Chief of the Chart Division.*

Mr. B. A. COLONNA,
Assistant in charge of the Office.

REPORT OF THE MISCELLANEOUS DIVISION OF THE U. S. COAST AND GEODETIC SURVEY
 OFFICE FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

MISCELLANEOUS DIVISION, *October 31, 1891.*

SIR: I have the honor to submit herewith the report of the Miscellaneous Division for the fiscal year ending June 30, 1891.

The following figures show, as far as it is practicable to show by figures, the amount of work done during the year.

Letters written (Sales Agents, 2982; Miscellaneous, 202)	3 184
Ledger accounts kept (Sales Agents)	94
Quarterly statements of Sales Agents examined and verified	272
Circulars to Sales Agents issued	19
Charts sent to Sales Agents	31 465
Orders for purchases issued	674
Requisitions made for printing and binding	126
Requisitions for stationery filled	449
Requisitions for miscellaneous supplies and repairs filled	461
Annual Reports distributed (see tabulated statement)	2 746
Tide Tables issued	4 421
Atlantic Coast Pilots issued	10
Sub-divisions, Atlantic Local Coast Pilot, issued	343
United States Coast Pilots, Atlantic Coast, parts IV and VI, issued	355
Pacific Coast Pilots, Alaska, part I, issued	1
Pacific Coast Pilots, California, Oregon, and Washington, issued	354
Sheets of mounted drawing paper issued	218

The number of charts sent to Sales Agents during the year, viz, 31,465, was 870 copies less than were issued during the previous fiscal year.

Eighteen agencies for the sale of publications—twelve on the Atlantic and Gulf Coasts, and six on the Pacific Coast—were established during the year; and eleven were discontinued—seven on the Atlantic and Gulf Coasts, and four on the Pacific Coast. The total number of agencies on June 30, 1891, was eighty-six—sixty-eight on the Atlantic and Gulf Coasts, and eighteen on the Pacific.

The aggregate of business done through the agencies from July 1, 1890, to June 30, 1891, is shown by a table which has been prepared for file in the Archives. It appears from this

table that the total value of the publications of the Survey in the hands of the Sales Agents on June 30, 1891, was \$9 884, and that from the sales of the publications of the Survey during the fiscal year there were received \$5 722'32 from the agencies on the Atlantic and Gulf Coasts, and \$1 376'04 from the Agencies on the Pacific Coast.

The following publications were sent to press: Annual Reports of the Superintendent for the years ended June 30, 1889, and June 30, 1890; Pacific Coast Pilot, Alaska, Part I, "Dixon Entrance to Yakutat Bay," Third Edition, 1890; United States Coast Pilot, Atlantic Coast, Parts I and II, "St. Croix River to Cape Ann;" Tide Tables for the Atlantic Coast of the United States for the year 1892; Tide Tables for the Pacific Coast of the United States for the year 1892; Bulletins Nos. 19 to 24, inclusive; Notices to Mariners, Nos. 130 to 142, inclusive; Appendices 10 to 18, inclusive, to the Annual Report of the Superintendent for the fiscal year ended June 30, 1889, and Appendices Nos. 8 to 20, inclusive, to the Annual Report of the Superintendent for the fiscal year ended June 30, 1890, which are to be printed separately in pamphlet form.

The usual distribution was made of the Annual Reports of the Superintendent, the Appendices to the same printed separately in pamphlet form, Bulletins, and Notices to Mariners, and they were also furnished in large numbers in response to numerous special applications. The distribution of Annual Reports was as follows:

Date of report.	Domestic distribution.		Foreign distribution.		Total.
	To institu- tions.	To individ- uals.	To institu- tions.	To individ- uals.	
1851.....			1		1
1852.....	2	1	1		4
1853.....	2	1	1		4
1854.....	1		1		2
1855.....	1		1		2
1856.....	2		1		3
1857.....			1		1
1858.....		1	1		2
1859.....	2		1		3
1860.....	1		1		2
1861.....	1		1		2
1862.....			1		1
1863.....	3		1		4
1864.....			1		1
1865.....	1	1	1		3
1866.....	6	2	1		9
1867.....	4	2	1		7
1868.....	5	2	1		8
1869.....	1	1	1		3
1870.....	2	2	1		5
1871.....	1	2	1		4
1872.....	6	3	4		13
1873.....	8	9	4		21
1874.....	9	7	4		20
1875.....	10	12	4		26
1876.....	7	11	4		22
1877.....	8	10	4		22
1878.....	17	30	5	1	53
1879.....	28	59	5	5	97
1880.....	30	64	5	4	103
1881.....	31	57	5	4	97
1882.....	30	57	7	4	98
1883.....	29	62	7	5	103
1884.....	31	69	6	5	111
1885.....	31	74	7	5	117
1886.....	20	89	6	5	120
1887.....	25	155	7	7	194
1888.....	640	561	227	20	1,448
1889.....		10			10
Totals.....	995	1 354	332	65	2 746

Following is a list of the publications of the Survey, with the number of copies of each received during the year from the Public Printer:

Name of publication.	No. of copies.	Name of publication.	No. of copies.
Annual Report of the Superintendent for the year ended June 30, 1888.	2 004	Appendix No. 17, Report for 1889—"Length of Five Primary Base Lines."	500
Annual Report of the Superintendent for the year ended June 30, 1889.	568	Appendix No. 18, Report for 1889—"International Geodetic Association, Ninth Conference, Paris, 1889."	300
U. S. Coast Pilot, Atlantic Coast, Part VI—"Chesapeake Bay and Tributaries."	1 510	BULLETINS.	
Pacific Coast Pilot—"California, Oregon, and Washington"-----	1 021	No. 19—On the Sounds and Estuaries of Georgia with reference to Oyster Culture.	3 000
Catalogue of Charts, and other publications, 1890-----	2 375	No. 20—The Magnetic Observations made on Bering's First Voyage to the Coasts of Kamchatka and Eastern Asia, in the years 1725-1730.	3 500
Additional information for insertion in the U. S. Coast Pilot, Atlantic Coast, Part IV, Sheet II.	500	No. 21—Determination of an Azimuth from Micrometric Observations of a Close Circumpolar Star near Elongation, by means of a Meridian or Transit and Equal Altitude Instrument, or by means of a Theodolite with Eye-piece Micrometer.	3 500
Appendix No. 7, Report for 1888—"Secular Variation of the Magnetic Declination in the United States and at some Foreign Stations" (seventh edition).	999	No. 22—Results of Observations made to determine Gravity and the Magnetic Elements at Stations on the West Coast of Africa and on some islands in the North and South Atlantic, 1889, 1890.	3 000
Appendix No. 8, Report for 1888—"Geographical Positions in the State of Connecticut."	1 000	No. 23—The Secular Variation and Annual Change of the Magnetic Force at Stations occupied by E. D. Preston, Assistant, U. S. Coast and Geodetic Survey, in connection with the U. S. Eclipse Expedition to the West Coast of Africa in 1889 and 1890, in charge of Prof. D. P. Todd.	3 154
Appendix No. 9, Report for 1888—"Tidal Levels and Flow of Currents in New York Bay and Harbor."	500	No. 24—Changes in the Shore Lines and Anchorage Areas of Cape Cod (or Provincetown) Harbor, as shown by a Comparison of Surveys made between 1867 and 1890.	3 000
Appendix No. 10, Report for 1888—"Heights from Geodetic Leveling between Mobile and Okolona, 1881-1887."	300	NOTICE TO MARINERS.	
Appendix No. 11, Report for 1888—"Heights from Geodetic Leveling between New Orleans, La., and Wilkinson's Landing, Mississippi River, opposite Arkansas City, Ark., 1879-1881."	300	No. 129, June, 1890—Chart corrections during the month-----	11 500
Appendix No. 12, Report for 1888—"Heights from Geodetic Leveling between Arkansas City, on the Mississippi River, and Little Rock, Ark., 1887, 1888."	300	No. 130, July, 1890—Chart corrections during the month-----	11 500
Appendix No. 13, Report for 1888—"Differential Method for Computing Star Places."	500	No. 131, August, 1890—Chart corrections during the month-----	11 500
Appendix No. 14, Report for 1888—"Determinations of Latitude and Gravity for the Hawaiian Government."	1 000	No. 132, September, 1890—Chart corrections during the month-----	11 500
Appendix No. 10, Report for 1889—"Measurement of the Los Angeles Base, California."	500	No. 133, October, 1890—Chart corrections during the month-----	10 500
Appendix No. 11, Report for 1889—"Distribution of the Magnetic Declination in the United States for the epoch 1890."	5 981	No. 134, November, 1890—Chart corrections during the month-----	10 500
Appendix No. 12, Report for 1889—"Encroachment of the Sea upon the Coast of Cape Cod."	300	No. 135, December, 1890—Chart corrections during the month-----	10 500
Appendix No. 13, Report for 1889—"Cross-sections of the Ocean Shore of Cape Cod."	300	No. 136—Index to Chart corrections, January 1 to December 31, 1890.	10 500
Appendix No. 14, Report for 1889—"Recent Shore Line Changes in Cotamy Beach, Marthas Vineyard."	200	No. 137, January, 1891—Chart corrections during the month-----	10 500
Appendix No. 15, Report for 1889—"Heights from Geodetic Leveling between Annapolis, Md., and Washington, D. C., in the years 1875, 1880, 1884, and 1888."	100	No. 138, February, 1891—Chart corrections during the month-----	10 500
Appendix No. 16, Report for 1889—"Gulf Stream Explorations, Observations of Currents, 1888 and 1889."	499	No. 139, March, 1891—Chart corrections during the month-----	10 500
		No. 140, April, 1891—Chart corrections during the month-----	9 500
		No. 141, May, 1891—Chart corrections during the month-----	10 000

Mr. Freeman R. Green, in addition to keeping the accounts of the sales agents, performed clerical duties throughout the year. It affords me pleasure to again bear testimony to the faithful and intelligent manner in which Mr. Green performs the work assigned to him.

Mr. Eugene Rhodes, who received a probationary appointment as stenographer and typewriter, on March 16, 1891, has served acceptably in the Division since that date.

The duties of janitor were performed by Mr. W. M. Long, and those of watchmen by Messrs. David Parker, W. H. Keith, A. B. Simons, and David Somerville in a satisfactory manner. Mr. Somerville was detailed December 27, 1890, by the Secretary of the Treasury, as substitute for Mr. Sayles J. Bowen, who, on December 10, had been appointed watchman to succeed Mr. A. B. Simons, promoted, and who was prevented by illness from performing his duties. On January 14 following, Mr. Somerville was appointed watchman in place of Mr. Bowen, and the latter was transferred to the Treasury Department.

Credit is due Messrs. W. H. Butler, chief messenger; C. H. T. Over, Sandy Bruce, William Savoy, Peter Page, William West, and John F. Crinage, appointed November 1, 1890, messengers; Charles H. Jones and Attrell Richardson, packers and folders; William R. McLane, driver; Horace Dyer and Harrison Murray, firemen; Mrs. S. E. Flynn, William P. Young, John H. Brown and Hans Bowdwin, laborers, for the faithful performance of their respective duties.

Respectfully, yours,

M. W. WINES,
Chief of the Miscellaneous Division.

Mr. B. A. COLONNA,
Assistant in charge of the Office.

REPORT OF THE INSTRUMENT DIVISION, U. S. COAST AND GEODETIC SURVEY OFFICE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

INSTRUMENT DIVISION, *June 30, 1891.*

SIR: I have the honor to submit the following report of the work of the Instrument Division for the fiscal year ending June 30, 1891.

This Division has to send out, receive, and account for all instruments and general property used in the field and in the various Divisions of the office, make the needed repairs to instruments, plan and construct new instruments, determine their constants, so far as it is practicable to do so at the office, and purchase new instruments and all material necessary for the work of the Division. It may be said to have three sections, the Instrument Division Office, the Instrument Shop, and the Carpenter Shop. The force of the Division during the year was as follows:

OFFICE.

Edwin Smith, Assistant U. S. Coast and Geodetic Survey, Chief of the Division.
R. C. Glascock, clerk, from July 1 to November 12, 1890.
Frank A. Cook, clerk, from November 15, 1890, to June 30, 1891.
William West, messenger.

INSTRUMENT SHOP.

E. G. Fischer, chief instrument maker.
O. Storm, instrument maker.
W. Gaertner, instrument maker.
S. A. Kearney, instrument maker.
M. Lauxmann, instrument maker.
W. R. Whitman, instrument maker.
C. E. Regennas, instrument maker.
W. H. Bullock, mechanic for the Office of Standard Weights and Measures, August 1 to December 31, assigned to duty in the Instrument Shop.
Jacob Schwarz, mechanic for the Office of Standard Weights and Measures, March 7 to June 30, assigned to duty in the Instrument Shop.

CARPENTER SHOP.

H. O. French, carpenter.
George W. Clarvoe, carpenter.
C. N. Darnall, carpenter.
Philip Kropp, carpenter, employed in carpenter shop on special work for the Office of Standard Weights and Measures, from March 16 to June 30.

The instrument and carpenter shops are essentially repair and experimental shops, and the construction of new instruments is incidental to this work, being mostly confined to such instruments as cannot be purchased in stock or made to order except at very much greater

cost and delay. Tables I. to V., accompanying this report, give statistics of the work of this Division, but by no means represent all the work. One hundred and eighty-four requisitions from field parties and thirty-six requisitions from the office for instruments and general property have been filled, many of them requiring several days work of two or three men.

Aside from the general repairs to instruments and the fitting out of field parties, the most important work of the Division during the year was the construction of two new sets of pendulum apparatus; the fitting out of the Holton Base party, and construction of instruments for its use; the reconstruction of Zenith Telescopes, Nos. 2 and 4, for parties to observe latitude in connection with the researches on the variations of latitude of the International Geodetic Association, and the reconstruction of the two 12-inch direction Theodolites, Nos. 145 and 146.

THE PENDULUM APPARATUS.

Early in the autumn of 1890 it was decided to construct some pendulum apparatus for the purpose of determining relative gravity in a more expeditious manner than had ever before been undertaken by the Survey. Under the direction of the Superintendent, experiments were made in the Instrument Division to determine the best form of pendulum and the best method of determining the time of vibration. Two points were very soon decided—first, that the pendulums should be quarter-metre or half-second pendulums; and second, that the method of coincidences should be adopted for determining the time of vibration. A provisional pendulum of ordinary brass, with agate knife-edge to be swung on agate planes, and a flash apparatus to be used with a break-circuit chronometer for the observation of the coincidences, was constructed and marked A. A mirror is fixed in the head of the pendulum very near the knife-edge. Another mirror is fixed to the support of the pendulum. The flash apparatus is placed some 6 to 10 feet distant in front of these mirrors. When the slit of the flash apparatus is open and the pendulum at rest, the images of the slit in the two mirrors are seen through the telescope of the flash apparatus thus — —. When a chronometer breaking an electric circuit every second is connected with the flash apparatus, the slit is opened and closed for a very short interval every second. When the pendulum is now started, the image of the slit will be seen through the telescope in the fixed mirror every second; but the image from the mirror on the pendulum will be seen only when the beat of the pendulum approaches a coincidence with a beat of the chronometer. Experiment has proven the accuracy of observation to be far beyond that required. This particular device was suggested by the Superintendent. The method is very simple, not at all fatiguing, and there is almost no liability of error. It was soon settled that the pendulum should be swung in an air-tight receiver, in which the air could be maintained at a standard density. Experiments were made to determine the best form and size of this receiver.

To determine the temperature of the swinging pendulum, a pendulum in every way a duplicate of the swinging pendulum, except the knife-edge and mirrors, was rigidly fixed in the receiver. To the rod of the fixed pendulum was attached a thermometer. The thermoelectric test at the office proved that the temperature thus obtained of the swinging pendulum would not be in error more than one-tenth of a degree centigrade.*

The experiments and investigations resulted in the construction of two sets of apparatus marked A and B. Set A was completed in March and taken by the Superintendent to California and Alaska; and set B was completed in April and taken by Assistant E. D. Preston to Honolulu, H. I. The material is on hand for two more sets, but the pressure of other work has postponed their construction to a future date. Each set of pendulum apparatus consists of the following principal parts:

Three quarter-metre or half-second pendulums made of aluminum bronze, marked 1, 2, 3.

* Since the above was written, experience in the field has shown this to be true only when the apparatus has been under a constant temperature for a considerable interval.

One similar pendulum without knife-edges to which the thermometer is attached, marked o.
Two extra thermometers.

A brass receiver, with manometer, levels, etc., attached.

An air pump.

A mercurial barometer.

A flash apparatus with telescope attached.

A sidereal break-circuit chronometer, breaking circuit every second except the o second.

Batteries, small tools, lamps, and many small parts and accessories, some in duplicate, too numerous to mention here.

The above apparatus is packed for shipment in two boxes weighing 352 pounds. So compact and complete a pendulum apparatus has never before been made. It is possible where the time can be obtained by telegraph from a fixed observatory, to determine gravity at no less than six to ten or twelve stations per month with a degree of accuracy beyond anything that had been expected. A detailed description of the apparatus will be published with the report of the first observations made.

THE HOLTON BASE OUTFIT.

The projected measurement of a base line at Holton, Ind., afforded an opportunity to test several methods of base measurement. For this purpose it was decided to establish a 100-metre comparator at the base by means of a 5-metre standard bar imbedded in ice; to measure a kilometre of the base line with this bar, and to refer the several pieces of apparatus used in the measurement of the whole base to this 100-metre comparator. To carry out this work, there were provided by the Instrument Division the following instruments and apparatus:

- 2 100-metre steel tapes Nos. 85 and 88, with reels;
- 2 100-metre aluminum bronze tapes, Nos. 89 and 90, with reels;
- 1 25-metre steel tape, No. 91, with reel;
- 1 25-metre aluminum bronze tape, No. 92, with reel;
- 2 cut-off cylinders and stands;
- 2 tape-stretching stands;
- 2 5-metre bars, Nos. 13 and 14;
- 1 5-metre standard bar, No. 17, in Y-shaped steel trough;
- 1 aligning level for standard bar, No. 17;
- 1 aligning plummet for standard bar, No. 17;
- 2 carriages for Y-shaped trough, with vertical, lateral, and transverse adjustments;
- 4 microscopes and mountings, for the 100-metre comparator.

One of the cut-off cylinders and the four microscopes were borrowed from the Engineer Corps of the U. S. Army, and belong to the Repsold Base Apparatus formerly used on the Lake Survey. The two tape-stretching stands and some of the small parts of the apparatus were made by D. Ballauf, of Washington, D. C. All of the other parts of the apparatus were made in the Instrument Shop, and involved a large amount of experimental work.

Five-metre base bars, Nos. 13 and 14, consist of steel rods mounted in wooden bars. The rods are of cold rolled steel, 9.5 millimetres in diameter, with steel contact slides and silver line surfaces. The contact ends carry agates, the forward one being ground to a true plane 2.5 millimetres in diameter, and the rear one, mounted in contact slide, being ground to a horizontal knife edge 2.5 millimetres long. Each of these rods is imbedded in a square groove running through the center of a rectangular wooden bar 14 centimetres high and 7.5 centimetres wide. These bars are each made up of eight carefully selected pieces of pine, joined together by waterproof glue. A thermometer is mounted near each end, on opposite sides, in such a manner as to insure close metallic contact between the bulbs and the rod, the scales being read through suitable openings in the sides of the bar. The bar carries on its forward end an adjustable aligning telescope, and at its center an inclination sector reading to ten seconds by two opposing verniers, with a range of six degrees on each side of the horizontal.

Tapes Nos. 85, 88, 89, 90, 91, and 92 were provided with their respective end marks by the Office of Weights and Measures. The aluminum bronze tapes were graduated in the instrument shop to millimetres for 5 centimetres on each side of each end mark.

Five-metre standard bar No. 17, a rectangular steel bar, was first carefully straightened. It was then provided with two platinum-iridium plugs, with their faces in the neutral axis, for carrying the 5-metre lines; and with a series of german silver plugs, with their faces equidistant from the axis, and having longitudinal lines ruled upon them. The bar rests in a Y-shaped trough, surrounded by ice, upon the ends of vertical adjusting screws, and is held upright by horizontal adjusting screws. It can therefore be aligned vertically by the use of aligning level No. 1, which is set upon each pair of plugs successively; and laterally by the aligning plummet, which is suspended from a wire stretched between the ends of the Y-shaped trough, and is brought successively over the line of each plug.

Parts of the trestles of the Bache-Wurdemann Primary Base Apparatus were utilized in the construction of the carriage for the Y-shaped trough.

Prismatic illumination was provided for the four microscopes borrowed for this work.

ZENITH TELESCOPES NOS. 2 AND 4.

Early in the year the Division was informed that it was desirable that the Survey should coöperate with the International Geodetic Association in their researches on the variations of latitude. For this purpose zenith telescopes were to be provided for an officer of the Survey to go to Honolulu with the observer of the International Geodetic Association, and for an observer at or near Washington, D. C. Though the Survey has for so many years determined latitude of a high degree of precision with zenith telescopes and similar instruments, it was found that the Survey had no instruments suitable for the work to be undertaken, which is of a degree of precision beyond anything heretofore required or undertaken by the Survey. Such instruments are not found in stock in the market, and to have had them made would have caused too great a delay. It was therefore decided to reconstruct the old zenith telescopes made by Troughton & Simms. These instruments, when made (1845 to 1851), were considered of a very high order, but for many years have been superseded by the meridian telescopes (combination of transit and zenith telescopes). Their reconstruction has made zenith telescopes Nos. 2 and 4 two of the best in possession of the Survey, and it is believed they will give results as fine as any yet obtained by the Talcott method. In their reconstruction the following changes were made:

- New base and leveling screws;
- New vertical axis;
- New wyes to telescope axis, with adjustment for level;
- New and larger axis for telescope;
- New micrometer screw, and micrometer box and slide reconstructed;
- New and improved clamp to telescope;
- Two new fine levels attached to telescope;
- New stride level for telescope axis;
- The whole instrument repolished, bronzed, etc.;

Electric lamps, batteries, etc., for illumination of telescope field, reading the levels, etc.

No. 4 is now in use by an Assistant of the Survey near Washington, D. C. His probable error of one observation on one pair of stars, as derived from a preliminary computation of eighty-six observations on fifteen pairs of stars on six nights, is ± 0.18 second. As the observations progress, it is thought the accuracy of observing will increase. The probable error of the observations made at Berlin, 1889-90, as computed from published results, is ± 0.17 second.

A full description of these instruments will appear with the publication of the latitude results near Washington and at Honolulu. These instruments are by no means such as would have been recommended, could entirely new instruments have been constructed. They are somewhat defective in their optical parts and general construction, and much larger and

more cumbersome than necessary. It is hoped that new latitude instruments may yet be constructed by this Division.

THEODOLITES NOS. 145 AND 146.

The work of reconstruction of these instruments was begun over a year ago. Only one man has been at work upon them, and the pressure of other work has rendered it necessary to take him off the work on the theodolites so often and for such long intervals, that it is not likely they will be completed for several months. The work is well in hand, however, and has so far progressed that we feel sure of their final success. It is intended that they shall be the finest theodolites ever in the possession of the Survey. A detailed description of them will more properly appear in next year's report.

In October, 1890, the following instructions were received:

U. S. COAST AND GEODETIC SURVEY,
Washington, D. C., Oct., 1890.

Assistants Schott, Woodward, Tittmann, Smith, and Preston, Mr. E. G. Fischer, and the Executive Officer to the Superintendent:

GENTLEMEN: You are hereby constituted an Advisory Board on Instruments and their Construction. The Chief of the Instrument Division will act as chairman, and the Board will meet from time to time, at his call, to consider such questions as may be brought before it in relation to new designs for astronomical or other instruments, or proposed radical changes in existing forms. The recommendations of the Board will be reported to the Superintendent.

Respectfully, yours,

T. C. MENDENHALL, *Superintendent.*

In conformity with the above, thirteen meetings were held during the year and all the important matters of construction came before the Board, with the exception of the pendulum apparatus, which was made under the immediate direction of the Superintendent. The base apparatus and the subject of a new comparator received the greatest amount of attention from the Board.

The Board has been of great benefit to the Instrument Division in giving to it the advantage of discussion, criticism, and varied experience.

It is becoming more evident every year that the most economical, and indeed the only way to obtain certain instruments and apparatus required by the Survey, is to construct them at this Office. It can be shown that the cost of the instruments constructed at this Office during the past six years has been less than the amount that they could have been purchased for either in this country or in Europe. These instruments have been constructed from our own designs, carefully studied by those that use the instruments, and it has been sought to embody in them the latest experience of our own and all other observers. This character of construction involves a great amount of experimental work which it is almost impossible to get in most instrument shops and only at great cost. It is now recommended that the facilities of the instrument shop be increased and that several additional instrument makers of the highest proficiency be employed, so that the Survey can hereafter construct all the finer class of instruments, particularly such as require experimental work and cannot be purchased in the market.

Respectfully, yours,

MR. B. A. COLONNA,
Assistant in charge of the Office.

EDWIN SMITH,
*Assistant U. S. Coast and Geodetic Survey,
Chief of the Instrument Division.*

TABLE I.

Instruments repaired during the year ending June 30, 1891.

2 Base bars;	2 Compasses, liquid;
1 Bellows (Engr. Div.);	4 Current meters;
4 Chronographs;	2 Gradienters;
1 Compass, azimuth;	6 Levels, wye;
6 Dip circles;	4 Level rods, geodesic;

TABLE I—Continued.

14 Heliotropes;	4 Meridian telescopes;
2 Levels, geodesic;	1 Phonograph, for Supt.;
5 Magnetometers;	19 Plane table alidades;
1 Pendulum comparator;	2 Plane table compasses;
15 Plane tables;	1 Ruling machine (Engr. Div.);
6 Plane table telemeters;	27 Sextants;
18 Protractors, 3-arm;	7 Telescopes, reconnoitering;
2 Sectors;	1 Tide-predicting machine;
8 Station transits;	1 Tracing apparatus;
38 Theodolites;	2 Transits, astronomical;
6 Tide gauges;	6 Vertical circles;
4 Transits, engineers'	150 Sextant mirrors re-silvered;
1 Transit, mining;	Office bells, clocks, locks, etc., and miscellaneous small re-
2 Zenith telescopes;	pairs to instruments and other articles too numerous to
1 Balance, spring;	mention here.
2 Calculating machines;	

TABLE II.

New Instruments, etc., made during the year ending June 30, 1891.

152 Adjusting pins;	12 Protractors, 3-arm, Nos. 96 to 107, inclusive (begun
Base apparatus:	last year);
1 Standard five-metre bar No. 17;	2 Sets of pendulum apparatus complete, each consist-
Plugs for aligning inserted and adjusted;	ing of 3 pendulums, 1 dummy pendulum, 1 flash ap-
Platinum-iridium plugs for end marks ground,	paratus and 1 receiver;
polished, and inserted;	1 Electric salinometer, experimental;
One aligning plummet made;	1 Sheave, 12-inch brass, for Haskell's Deep Sea sound-
One aligning stride level made;	ing work;
1 Cut-off No. 1 (one cylinder);	20 Station marks;
2 Secondary base bars, Nos. 13 and 14, and sectors	7 Tapes with reels:
and aligning telescopes for same;	2 100-metre steel, Nos. 85 and 88;
1 Centering apparatus for dividing engine;	2 100-metre aluminum bronze, Nos. 89 and 90;
1 Electrical condenser for chronometer, experimental;	1 50-metre steel, No. 84;
1 Gravity level, experimental;	1 25-metre steel, No. 91;
12 Signal lamps Nos. 22 to 33, inclusive;	1 25-metre aluminum bronze, No. 92;
18 Instrument and hand lamps fitted for electric illum-	(The aluminum bronze tapes were graduated);
ination;	8 Tool holders (Engraving Division).

TABLE III.

Instruments made practically new by reconstruction, during the year ending June 30, 1891.

1 Level trier;	1 Theodolite, 12-inch, No. 16;
1 Plane table No. 51 (begun last year);	3 Zenith telescopes, Nos. 2, 3, and 4. (No. 3 not completed).
2 Theodolites, 12-inch, Nos. 145 and 146 (not completed);	

TABLE IV.

New Instruments purchased during the year ending June 30, 1891.

3 Barometers, mercurial mountain;	1 Lamp, signal;
Base apparatus:	6 Leveling rods;
1 Y-shaped trough and five-metre steel bar;	78 Magnifying glasses;
2 Sets of tape-stretching apparatus;	6 Psychrometers, sling;
24 Binoculars;	8 Sextants and mirrors;
4 Chronometers, sidereal break circuit;	18 Straight edges, 2-feet, steel;
6 Compasses, liquid boat;	6 Straight edges, 4-feet, steel;
12 Compasses, prismatic;	12 Tapes, 50 feet, steel;
1 Comptometer, 8-column;	6 Tapes, pocket, 5-feet, steel;
125 Drawing instruments;	1 Telescope, reading;
Electrical instruments and apparatus:	6 Theodolites, Casella, 4-inch;
3 Galvanometers;	1 Thermograph;
1 Carhart Clark standard cell;	24 Thermometers;
1 Microfarad condenser;	5 Tide gauges, Stierle self-registering.
1 Wheatstone rheostat;	

TABLE V.

Work done for the Office of Standard Weights and Measures during the year ending June 30, 1891.

1 New appliance for marking standard bottles;	1 Polariscopes belonging to the Office of Standard Weights and Measures, repaired;
1 New micrometer screw comparator;	1 Polariscopes belonging to Agricultural Department, repaired;
1 New set of sixteen metric weights, (begun last year);	1 Polarimeter belonging to Agricultural Department, repaired;
1 Balance belonging to the District of Columbia, repaired and repolished;	2 Sets of Standard Weights and Measures for States, repaired and repolished.
1 Balance belonging to the Office of Standard Weights and Measures repaired and repolished;	

REPORT OF THE LIBRARY AND ARCHIVES DIVISION, U. S. COAST AND GEODETIC SURVEY
OFFICE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

LIBRARY AND ARCHIVES DIVISION,
September 30, 1891.

SIR: I was transferred from the list of field assistants to the position of Chief of the Library and Archives Division on the 29th of August, 1890, and assumed active charge of the Division on the 8th of September, 1890. The following report and the appended tables, therefore, cover a portion of the time when the Division was under the charge of my predecessor, Mr. A. Martin.

The Division has been for some time past, and still is, very short-handed for the amount of work which the increasing scope and demands of the Survey devolve upon it.

The records of the Survey are packed away in cases (many of them in double tiers on a single shelf), and the lack of a proper system in binding and indexing them is very apparent to any one who is in search of particular data. Owing to the lack of room, and the insufficient force to handle the routine work, and at the same time make proper arrangement and indexes of the records, I have endeavored to make the changes that were absolutely necessary for promptly handling new work, and to try and provide, as far as possible, for more ready reference to the older material when needed, trusting and hoping at the same time for additional room and an increased clerical force.

The first thing attended to upon assuming charge was to have the "Personal Account of Records" posted to date, for convenience in finding whether records had ever been received in the Archives or not; in many cases this was several years behind. The geographical register of sheets was likewise brought up to date.

A board was appointed on the 17th of October, 1890, by the Superintendent, to consider a plan for a better classification of the Records of the Survey, and for indexing them, and also to consider the needs of the library, and to report its findings to the Superintendent. So that after that date my actions have been in a measure outlined by it; but being a member of the Board myself, much has been left to my own discretion, and my experience has been given due weight in its decisions. For the courtesy and evident desire to help me in my duties, shown me by the other members of the Board, I desire to express my thanks.

In November and December I undertook to rearrange the contents of the two upper floors of this building so as to have a more compact storage, and to economize space. The volumes of reports were all refiled, and the boxes of specimens placed so as to be most accessible; these changes cleared the front room of the fourth floor, and shelves were placed in it for the reception of the collection of foreign charts belonging to the Office, which for over a year had been rolled up in packages and stored in a manner to render them inaccessible; and the need of having them where reference could be made to them was so obvious that Mr. E. J. Pond was detailed from the Drawing Division to classify and arrange them on the shelves under my direction. This work he performed in a very careful and expeditious manner.

A new system of monthly reports has been adopted, which, while showing more clearly and concisely the work of the Division, saves a vast amount of clerical labor. The method of keeping the charges of the original sheets has been changed, so that now by looking at one page you can see where the sheet is, and where it was on any date, thus preserving a history of each original survey. The numbers on the backs of the sheets have been put on thirty or forty sheets by hand, but it is such a slow process that I am now using rubber type, which answers the purpose admirably. Twenty-four original sheets, that by much handling had become torn, have been backed for preservation.

At the time when the annual inventories of the library books were turned in, the accounts were thoroughly checked, and a number of books were entered which had not appeared before, and after much correspondence on the subject with various field parties, many charges were explained which had heretofore been obscure.

Some 340 copies of old numbers of Nautical Almanacs, and also a large number of copies of the Weather Maps, have been returned to their respective offices, where they were desired for the purpose of filling in sets for libraries.

Our own sets of periodicals have been supplied with many missing numbers, partly by purchase and partly by donation, the same being the result of correspondence from this Division.

Such time as could be spared from other work has been devoted to preparing books for binding, but owing to an order from the Treasury Department we have been unable to get any bound. While doing this the pamphlets were laid aside, and will be arranged in the pamphlet cases which have been procured for them; and as soon as possible cards will be made out for them and placed in the Card Catalogue. No catalogue of our pamphlets exists at present.

A number of periodicals have been added to our list of subscriptions, and during the last two months a large number of valuable professional books, which were recommended by the Library Board, have been purchased. These last additions will largely increase the usefulness of the library to all in the Survey.

December 1st, 1890, Assistant W. I. Vinal reported to me with instructions to index and classify the bottom specimens which have accumulated here until they number about 20 000; he remained on duty engaged in this work until he took the field the 2d of June, 1891. The work of identifying these specimens was difficult in many instances, but nearly one-half of the number were catalogued before he left.

Prof. J. Howard Gore was engaged from the 9th of January, 1891, until he left for the field, on the 12 of June, 1891, in making an index of the Coast Survey publications. During this time he was always ready to give his advice and assistance upon other library matters when needed; and in arranging the foreign geodetic publications his services were especially acceptable.

Mr. Artemas Martin was on duty in the Division during the year, being in charge of it from July 1, 1890, to August 29, 1890; and from that date to June 30, 1891, assisting me in handling the routine matter and keeping the books of the Division, and in preparing the books for the bindery.

Mr. A. Upperman was employed in the Division during the year on miscellaneous work: arranging charts, putting numbers on original sheets, and checking those returned from the Office, etc.

Messrs. Little and Jackson, from the Tidal Division, are engaged in indexing the original tidal records, and arranging them so that they may be bound by States.

In concluding this report, while I would call attention to the progress already made, I would also call attention to the large amount of work which remains to be done, and respectfully request that at least two good clerks be added to the force, so that as soon as additional room can be provided, the original geodetic records, which so far have not been changed, may be arranged by States, thoroughly indexed with the necessary cross references, and bound.

As these records begin with the original organization of the Survey, and are the foundation work of it, they are very extensive, and require a great deal of labor to put them in such shape that ready reference may be made to any part of them.

During the coming year a large amount of binding will be required if force enough to prepare the records is provided.

Respectfully yours,

FRANCIS H. PARSONS,
Chief of the Library and Archives Division.

Mr. B. A. COLONNA,
Assistant in charge of the Office.

LIBRARY AND ARCHIVES DIVISION.

Abstract of Records received during year ending June 30, 1891.

Class.	Observations.		Computations.	
	Original.	Duplicate.	Office.	Field.
Topographic sheets.....	50		22 approved.	
Hydrographic sheets.....	61		57 approved.	
Horizontal measures.....	100 volumes	101 volumes	78 volumes	44 volumes.
Vertical measures.....	4 volumes	2 volumes	1 volume	
Double zenith distance measures.....	12 volumes	10 volumes		
Geodetic miscellany.....	8 volumes			
Description of stations and of bench marks.....	{18 volumes 5 cahiers	{9 volumes		
Pendulum.....	11 volumes	21 volumes		
Pendulum chronograph sheets.....	12 cahiers		7 volumes	
Magnetic.....	79 cahiers	69 cahiers	1 cahier	3 cahiers.
Magnetic.....	5 volumes		1 volume	
Magnetic.....	253 sheets	3 sheets	17 sheets	
Magnetic traces.....	565 sheets	612 sheets	5 cahiers	
Magnetic thermograms.....	135 sheets			
Latitude.....	15 volumes	15 volumes	16 cahiers	6 cahiers.
Longitude.....	{76 sheets 26 cahiers	{6 volumes	8 volumes	1 volume.
Time.....	{5 cahiers 10 volumes	{12 volumes	11 cahiers	
Azimuth.....	5 volumes	7 volumes	14 cahiers	
Levels.....	37 volumes	27 volumes		2 volumes.
Soundings.....	316 volumes	218 volumes		
Angles.....	46 volumes	32 volumes		
Tides.....	122 volumes	96 volumes		
Tides, maregrams.....	68 rolls			
Base line.....	1 volume	5 volumes		
Reconnaissance.....	4 volumes			
Log books.....	77 volumes			
Descriptive reports of sheets.....	15 cahiers			
Currents, movements of ice and miscellaneous.....	{15 cahiers 12 volumes			

Abstract of Works received in Library during year ending June 30, 1891.

	Purchased.	Free.	
Books.....	152	397	
Pamphlets.....	5	243	
Serials.....	716	1,130	
Maps.....	3	361	

OFFICE REPORT NO. 2.—1891.

REPORT OF THE HYDROGRAPHIC INSPECTOR FOR THE FISCAL YEAR ENDING
JUNE 30, 1891.

U. S. COAST AND GEODETIC SURVEY,
OFFICE OF THE HYDROGRAPHIC INSPECTOR,
Washington, D. C., October 8, 1891.

SIR: I have the honor to submit the following report of hydrographic progress, including the movements and care of the Coast Survey vessels and the reports of the Chiefs of the Coast Pilot and Hydrographic Divisions of this Office. There is appended a list of officers of the Navy who have been connected with the Survey during the past year, and a list showing the duty that those remaining were on at the end of the year 1890-'91.

HYDROGRAPHY—ATLANTIC COAST.

As soon as the necessary funds were available the hydrographic parties were sent to the field.

The Coast Pilot party, under my personal direction, proceeded to the Gulf of Maine in the steamer *Endeavor*, and in addition to the proposed Coast Pilot work executed a variety of hydrographic work, as is shown in my report as Chief of the Coast Pilot Division.

From July 8th to August 6th Lieut. C. E. Vreeland, U. S. N., Assistant Coast and Geodetic Survey, in the steamer *Blake*, was engaged in making temperature and density observations off the south side of Marthas Vineyard. On the completion of this work the *Blake* was taken to the Brooklyn Navy Yard to undergo repairs to the forward part of her spar deck. On January 5th this party started for the Gulf of Mexico, where current observations for the further development of the Gulf Stream were carried on until April 1, when the *Blake* was ordered north, stopping on the way to develop a reported shoal off Cape Canaveral and to determine the position of Martin's Industry Light-ship. On May 26th, at the request of the Light-House Board, the *Blake* was sent to make an examination of Diamond Shoal, off Cape Hatteras, in order that a determination might be made for the site of a proposed Light-house. This difficult work was fortunately accomplished in a few days, and on June 9 the *Blake* proceeded to take up the work of a re-survey of Nantucket Shoals, where she was engaged at the end of the year.

On August 3, 1890, Lieut. E. M. Hughes, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Bache*, and having under his direction the Coast Survey schooner *Eagre*, Lieut. W. P. Elliott, U. S. N., commanding, with three steam launches and the steamer *Daisy*, began work on Nantucket Shoals. This work was continued until October 22, and the hydrography to the eastward of Nantucket was completed from a line extending from Great Point to McBlair's Shoal, south to the southern end of Bass Rip. On the southeast side of the island the work extended nearly to the Surfside Life-saving Station and about 10 metres off shore. At the close of this season's work the *Bache* returned to New York, where she was put in repair for the winter's work in the Gulf of Mexico. On February 23d, this party began a re-survey of Aransas Pass, Texas. A few days of unusually favorable weather enabled Lieut. Hughes to finish this work, and on March 13th he began work on the coast of Louisiana in the vicinity of Barataria Bay, which was completed April 24th, and the *Bache* proceeded to New York, from which point she returned to Nantucket Shoals where the party was at work at the end of the fiscal year.

The Schooner *Eagre*, Lieut. W. P. Elliott, U. S. N., Assistant Coast and Geodetic Survey, commanding, after finishing the season's work on Nantucket Shoals, in connection with Lieut. Hughes' work, returned to New York, where she wintered. As soon as the weather and other circumstances would permit, this party proceeded to Sag Harbor, L. I., and began work June 5th, which was continued to the end of the fiscal year.

After the work of the Coast Pilot Division in connection with the steamer *Endeavor* was finished, that vessel was sent to Baltimore, Md., where a new boiler was put in her, and early in April Lieut. L. K. Reynolds, U. S. N., Assistant Coast and Geodetic Survey, commanding, began work in Chesapeake Bay north of Cape Henry and including the Tail of the Horseshoe. This work was successfully finished May 11th, and the *Endeavor* proceeded to the vicinity of Nantucket Shoals, where she was engaged at the end of the year.

During the fiscal year hydrographic work was also completed by civil parties of the Coast and Geodetic Survey as follows, viz:

Sub-assistant J. A. Flemer, St. Croix River, Me.

Assistant Stehman Forney, Kennebec River, Me., from Gardiner to Augusta.

Assistant Stehman Forney, Perdido Bay and Tributaries, La.

Assistant H. L. Marindin, Coast of Nantucket from Great Point to Siasconset and thence to Surf-Side Hotel.

Assistant W. I. Vinal, Connecticut River from Lyme Ferry to Cromwell.

Assistant C. T. Iardella, Shinnecock, Quantuck, and Moriches Bays, south coast of Long Island.

Assistant J. W. Donn, vicinity of Sparrow's Point, Patapsco River, Md.

Sub-Assistant P. A. Welker, Escambia Bay, Fla.

HYDROGRAPHY—PACIFIC COAST.

Survey of Alaska.—The steamer *Patterson* and party, under the command of Lieut. Commander H. B. Mansfield, U. S. N., Assistant Coast and Geodetic Survey, was engaged in the survey of Southeast Alaska. They sailed from San Francisco April 10, 1890, and began work May 5, in Lynn Canal. After a most successful season, during which a complete survey was made of Lynn Canal to its head, Taku Inlet, and a part of Stephens Passage, the work was closed September 17th and the party returned to San Francisco. This is one of the largest season's work ever accomplished by a Coast Survey party, the area covered being about 700 square miles of triangulation, topography, hydrography, and the necessary astronomical observations. On April 5, 1891, the *Patterson* again sailed for Southeast Alaska, and at the end of the fiscal year was at work in Behm Canal.

The steamer *Hassler*, Lieut. D. Delehanty, U. S. N., Assistant Coast and Geodetic Survey, commanding, at the beginning of the year was engaged in laying off a trial course in the Santa Barbara Channel, after which the party was engaged in recovering certain triangulation points near Santa Barbara. On September 1, 1890, instructions were sent to Lieut. Delehanty to execute certain hydrography near Cape San Martin. On account of the high price of coal he was not able to begin work until about January 1, 1891. This work was completed in May, and virtually finishes the hydrography of the coast of California. A few additional soundings are, however, necessary to properly develop the 100-fathom curve near San Pedro Bay.

The steamer *Gedney*, Lieut. J. M. Helm, U. S. N., Assistant Coast and Geodetic Survey, commanding, began hydrographic work in Willapa Bay July 26th, which was continued until November 9th, when the party returned to San Francisco. The survey of the same body of water was again taken up on the 16th of April, 1891, and continued to the end of the fiscal year.

The steamer *McArthur*, Lieut. D. H. Mahan, U. S. N., Assistant Coast and Geodetic Survey, commanding, was delayed in San Francisco on account of the lack of appropriation, and later on a lack of officers. On September 1st the party proceeded to the vicinity of Cape Blanco, Oregon, but was unable to accomplish any work on account of bad weather and a very exposed working ground. The *McArthur* returned to San Francisco and Lieut. Mahan was relieved of the command of the vessel by Lieut. W. P. Ray, U. S. N. On June 10, 1891, the latter officer was directed to take up the work of the party on board the schooner *Earnest* in Washington Sound, it having become necessary to disband the latter party.

The schooner *Earnest*, Lieut. J. N. Jordan, U. S. N., Assistant Coast and Geodetic Survey, commanding, after having wintered at Olympia, Wash., began work on April 14th in the waters of Washington Sound, and completed the surveys of Skagit Bay, Boundary Bay, and a part of the Gulf of Georgia. This work continued until November 8th, and was again commenced on April 24, 1891, and continued until the end of the fiscal year.

The following hydrographic work was also executed by civilian parties of the Coast Survey during the fiscal year, viz:

Assistant E. F. Dickens, Coos Bay, Oregon.

Assistant Cleveland Rockwell, Columbia River.

The following list gives the statistics of the hydrographic field work executed in 1890-1891, viz:

Statement of Hydrographic Surveys executed during the fiscal year ending June 30, 1891.

Localities.	Surveyed by—	Sheets.	Scale.	Vols.	Angles.	Soundings.	Miles run.	Square miles.	Remarks.
Entrance to Cobscook Bay, Maine	S. M. Ackley, U. S. N.	1	10 000	2	804	2 059	40	2	Coast Pilot party.
Near Mistake Harbor, Mud Hole Channel, Maine.	S. M. Ackley, U. S. N.	Add'l.	10 000	1	8	14			Plotted on sheet 1574.
Entrance to Sullivan Harbor, Maine	S. M. Ackley, U. S. N.	Add'l.	10 000	1	58	170	1		Plotted on sheet 1439.
Kennebec River, Gardiner to Augusta	Asst. S. Forney	1	10 000	3	774	5 210	47½	2	
In-shore hydrography, Nantucket Island, Great Point to Surfside.	Asst. H. L. Marindin	2	10 000	6	5,020	13 985	190½	16	Physical hydrography.
Off-shore hydrography, east and south of Nantucket Island.	E. M. Hughes, U. S. N.	3 (2 on 20 000; 1 on 40 000)		31	11,660	55 166	2 011	261	
Handkerchief Shoal, Nantucket Sound	W. P. Elliott, U. S. N.	1	20 000	4	876	6 445	106½	5	
Connecticut River, Lyme to Cromwell, Connecticut.	Asst. W. I. Vinal	4	10 000	9	2,217	23 648	243½	20	
Rocks off Rye Beach, New York	S. M. Ackley, U. S. N.		10 000	1	6	3			Coast Pilot party. Plotted on sheet 1683.
Shinnecock and Moriches Bays, Long Island.	Asst. C. T. Iardella	2	10 000	8	1,796	18 397	259½	64	
West Moriches Bay, Long Island	Asst. C. T. Iardella	1	10 000	5	780	10 846	141½	6½	
Chesapeake Bay, vicinity of Cape Henry, tail of Horseshoe and Lynn Haven Roads.	L. K. Reynolds, U. S. N.	1	20 000	10	4,840	23 449	528½	46	
Patuxent River, vicinity of Sparrows Point, Maryland.	Asst. J. W. Donn	1	10 000	3	889	7 383	71½	3½	
Location of Outer Diamond Shoal, Cape Hatteras.	C. E. Vreeland, U. S. N.	1	20 000	1	172	850	67	6	
Search for reported shoal off Cape Canaveral, Florida.	C. E. Vreeland, U. S. N.	Add'l.	20 000	1	3	460	40	1	Plotted on sheet 1410.
Escambia Bay, Florida.	Sub-Asst. P. A. Welker	1	10 000	13	2,077	31 488	266½	3½	
Perdido Bay and tributaries, Florida and Alabama.	Asst. S. Forney	3	10 000	8	1,396	16 811	328½	68	
Coast of Louisiana, Barataria Bay to Isle Derniere.	E. M. Hughes, U. S. N.	4 (3 on 20 000; 1 on 80 000)		30	8,379	55 422	1 511	983	
Aransas Pass, Texas	E. M. Hughes, U. S. N.	1	10 000	7	1,566	10 526	113½	10	
Coast of California, Ragged Point to Coopers Point.	D. Delehanaty, U. S. N.	3	20 000	11	4,264	4 711	314½	118	
Von Helm Rock, California	D. Delehanaty, U. S. N.	Add'l.	20 000	2	94	117	1½		Plotted on sheet 2022.
Coos Bay, Oregon	Asst. E. F. Dickens	3	10 000	9	2,345	14 511	138	12	
Willapa Bay, Washington, season of 1890.	J. M. Helm, U. S. N.	3	20 000	24	8,782	38 543	769	90	
Willapa Bay, Washington, previous to July 1, 1891.	J. M. Helm, U. S. N.			18	6,179	31 417	482½	37	
Boundary Bay and Skagit Bay, Washington, season of 1890.	J. N. Jordan, U. S. N.	2	20 000	19	7,834	19 798	854½	84	
Gulf of Georgia, Washington, previous to July 1, 1891.	J. N. Jordan, U. S. N.	1	20 000	5	2,708	6 996	505½	146	
Lynn Canal and Stephens Passage, Southeast Alaska.	H. B. Mansfield, U. S. N.	9	Various	21	17,896	17 306	2 359	703	Six of these sheets contain also the topographical survey of the localities covered by the hydrography.
Lynn Canal and Stephens Passage, Southeast Alaska (topographical survey).	H. B. Mansfield, U. S. N.	3	80 000						
Grand total		51	Various.	253	93 413	415 721	11,881	2,486	

COAST PILOT DIVISION.

The work of this Division was under my charge until March 18th, when I relieved Commander Charles M. Thomas, U. S. N., as Hydrographic Inspector. During the remainder of the fiscal year there was no officer in charge of this Division, but I exercised a general supervision of the work. I was assisted by Ensign E. A. Anderson, U. S. N., and Mr. John Ross, and the work of bringing forward Parts I and II of the Atlantic Coast Pilot progressed as rapidly as possible. The manuscript of these parts having been prepared at the office, the party embarked on the steamer *Endeavor*, and the ground covered by this work was carefully gone over for verification and correction. Every harbor of importance was visited, and the sailing lines and buoys verified.

After returning to the office in October the manuscript was placed in the hands of the printer as soon as the many necessary corrections could be made, and it was earnestly hoped that this volume could be given to the public before the summer of 1891, but on account of lack of funds it was not received for issue until the season had nearly expired.

HYDROGRAPHIC DIVISION.

The Hydrographic Division of this office has been under the charge of Lieut. R. T. Jasper, U. S. N., during the year.

The numerous duties of this Division have been most carefully and intelligently carried out, and I would earnestly call your attention to the recommendations made by Lieut. Jasper in his report, which is forwarded herewith.

REPAIRS AND MAINTENANCE OF VESSELS.

The vessels on the Pacific Coast have received slight repairs, being only those due to the ordinary wear of service. Lieut. Delehanty, U. S. N., commanding the *Hassler*, was authorized to have built for that vessel a new steam cutter, but the parties who contracted to build it failed to finish it at the proper time; and when it was finished, it was not in accordance with the agreement, and was rejected by Lieut. Delehanty.

The *Hassler* was also furnished with a new steam capstan windlass, which was built at Providence, R. I., and delivered at San Francisco by the builder for much less than it could be built on the Pacific Coast.

On the Atlantic Coast the principal repairs were made to the *Blake* and *Endeavor*. The former was taken to the Navy Yard, New York, and the forward half of the spar deck lifted, the timbers replaced where necessary, and new deck laid, covered, and painted. This work was entirely done by men of the Coast Survey vessels under the direction of Carpenter W. W. Richardson, U. S. N.

During the winter the steamer *Endeavor* was sent to Baltimore, Md., where a new steel boiler was put in her, and other necessary repairs made to her top sides.

The steamer *Bache* received very slight repairs.

The schooner *Eagre* was supplied with a new foremast, foretopmast, main boom, new suit of sails, and new gig and whaleboat, in addition to numerous other repairs.

In addition to this, numerous small repairs were made to the *Daisy*, *Quick*, *Transit*, *Spy*, *Hitchcock*, and *Scoresby*.

I would respectfully recommend that the steamers *Hitchcock* and *Daisy* be sold out of the Survey. The former is now at Morgan City, La., and is in such a condition that it would not be in the interest of economy to repair her. She is perfectly unseaworthy, and her engines can at best only propel her about four knots.

The last season's work on Nantucket Shoals about finished the boilers of the *Daisy*, and her hull is now so rotten that she is not worth repairing. She was, at her best, an old vessel turned over by the Light-House Department to the Coast Survey. Her quarters are very limited and her consumption of coal very large.

All the steamers of the Coast Survey are now old except the *Patterson*, and she is now seven years old, and within the next three years will require new boilers and, it may be, extensive repairs to her hull.

Of the others all are more than seventeen years old and require greater annual repairs than they have been receiving to keep them in good running order. The *Hassler* and *Bache* will both require new boilers during the coming year, and these alone will absorb more than one-half of the entire annual appropriation that has been allowed for the past few years. I would, therefore, recommend that at least \$30 000 be asked for in place of \$25 000, the amount of this year's appropriation.

I will here repeat what I have before communicated to you verbally, viz: the great necessity for a new steam vessel for this coast to take the place of the *Gedney* sent to the Pacific. Such a vessel as we now require could be built for about \$75 000. She should be of iron, with twin screws, not over 8 feet draught, able to keep the sea in any weather, and to carry twenty days' coal.

The duties of Clerk to the Hydrographic Inspector have been satisfactorily performed by Mr. J. H. Roeth.

Very respectfully,

DR. T. C. MENDENHALL,
Supt. U. S. Coast and Geodetic Survey.

S. M. ACKLEY,
Lieut. Commander, U. S. N.,
Hydrographic Inspector Coast and Geodetic Survey.

REPORT IN REGARD TO THE COAST PILOT DIVISION FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

COAST SURVEY OFFICE,
Washington, October 1, 1891.

This report is usually made by the Officer in charge of the Coast Pilot Division to the Hydrographic Inspector, but in the present instance, there being no officer in charge, and the Hydrographic Inspector having filled that office for a greater part of the year, this report is made by him.

At the beginning of the fiscal year the manuscript of the Atlantic Coast Pilot, Part VI, Chesapeake Bay and Tributaries, was still in the hands of the Public Printer, and the proofs were being sent for correction only at long intervals. A number of months passed before the book was finally ready for issue, having been in press for more than a year.

The manuscript for a new Coast Pilot volume covering the coast of Maine, New Hampshire, and Massachusetts as far as Cape Ann having been finished, the party consisting of Ensign E. A. Anderson, U. S. N., Mr. John Ross, and myself were on board the steamer *Endeavor* at New Bedford, Mass., making necessary repairs, at the beginning of the fiscal year.

As soon as these repairs were completed the party proceeded to Eastport, Me., where a hydrographic survey of a part of Eastport Harbor was made. The statistics of work consist of—

40 miles of sounding lines.
804 angles.
2,059 soundings.

In addition to this a reported rock was developed in Mistake Harbor, Me.; also a shoal at the entrance to Sullivan Harbor, Me.

In addition to a number of other examinations for chart corrections, all the important navigable harbors within the limits of the work were visited, the sailing lines tested, and descriptive matter verified. As soon as this was completed the party returned to the Coast Survey Office, where the corrected manuscript and views were prepared for the printer without

loss of time, with the hope that this volume could be made ready for publication by the opening of the following summer season, at which time these books are in the greatest demand. Unfortunately the work on it had to be stopped before the end of the fiscal year on account of a lack of funds.

In addition to the above enumerated work there has been prepared, with the exception of a very small part, the manuscript of Atlantic Coast Pilot, Part III, covering the coast from Cape Ann to Point Judith. This was completed with the exception of the eastern entrance of Nantucket Sound and Nantucket Shoals, where new surveys were being made.

Ensign E. A. Anderson, U. S. N., was detached from the Coast Pilot party at Portland, Me., and ordered to resume his naval duties. He was a most intelligent and conscientious officer, and zealous in the performance of his duties.

Mr. John Ross has been employed in this Division, at the office and in the field, during the entire year. He has been engaged in compiling data and in routine office work of the Division. He has had experience as a recorder and observer of a hydrographic party, and this, combined with an excellent knowledge of the Atlantic Coast and most willing attention to duty, makes his services most valuable to this Division. His severing his connection with the Coast Survey in the near future is greatly to be regretted.

The clerical work of the Division was performed most satisfactorily by Miss Alice F. Carlisle until she was taken into the Superintendent's Office, and afterward by Mr. Talbot Pulizzi.

Very respectfully,

S. M. ACKLEY,
Lieutenant Commander, U. S. N.,
Hydrographic Inspector, Coast and Geodetic Survey.

REPORT OF THE HYDROGRAPHIC DIVISION FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, D. C., July 1, 1891.

SIR: I have the honor to submit the following report of the work done in this Division during the fiscal year 1890-'91.

The personnel has remained unchanged, Messrs. E. Willenbücher, W. C. Willenbücher, and F. C. Donn being the draughtsmen, and upon them falls the entire work of plotting and verifying all hydrographic sheets sent in from the field, verifying the hydrography on drawings for new charts, etc. The fact that they have during the year plotted 43 original sheets, corrected 146 reduced drawings and proofs, and have done a vast amount of miscellaneous draughting and work on proofs of charts for publication, as shown in the monthly reports of the Division, is an evidence of the industry they have displayed.

Each has performed his duties to my entire satisfaction, but frequently during the year the necessity for another draughtsman became apparent by the accumulation of work. I earnestly recommend that this addition be made, but before the person selected is assigned to office work here, I would suggest the importance of detailing him for hydrographic work in the field for one or two seasons, in order that he may have a practical experience that is essential to efficiency in the duties he will be called upon to perform in the office.

Mr. E. H. Wyvill still continues to perform, in a highly satisfactory manner, the varied duties of draughtsman and clerk in the Office of the Chief of Division. I cannot too strongly urge the propriety and justice of his again being appointed as draughtsman, and his present pay increased.

Upon the subject of chart publication, I beg to renew a suggestion, often verbally made, that there be issued preliminary charts of all localities of importance where surveys have been made, as soon as the data received from the field can be put in shape and drawings pre-

pared for lithography. These charts, designed principally for purposes of navigation, would require only the shoreline, with prominent objects shown, and the hydrographic features, with aids to navigation indicated. A large sum of money is expended yearly by the Government in surveys of the Coast and Harbors, and the results of these surveys should be within reach of the public at the earliest practicable moment.

The present arrangement with the Light-House Board, by which this Office is promptly informed of changes in aids to navigation, has been in existence long enough to show that it is productive of great usefulness in keeping the charts corrected to date in that respect. It is to be hoped that a similar arrangement may be made with the U. S. Engineers engaged in the improvements of our harbors, and water-ways generally, in order that all important changes in depths, new channels, jetty constructions, etc., may be indicated on the charts at as early a date as possible.

The Alaska Coast Pilot, soon to be issued, contains the results of the Coast Survey work in the interior waters of the Territory to the year 1889, inclusive. The valuable report of Lieut. Commander H. B. Mansfield, U. S. N., commanding the Coast Survey steamer *Patterson*, on the season's work of 1890, suggests the necessity of publishing, in pamphlet form, the successive yearly reports, until a new edition of the Coast Pilot is compiled. Otherwise the information contained in these reports, always of importance to those navigating the waters concerned, will be simply filed in the Archives for an indefinite time. The expense of such publications would be trifling compared with the benefits that would result.

Your attention is invited to the series of Coast Charts, recently prepared in this Division, on which are shown the limits of all hydrographic sheets of the Atlantic Coast now on file. It is intended to make a similar series for the Gulf and the Pacific Coasts, and when these are finished, all the hydrographic work done by the Coast Survey will be simply and clearly shown on these charts. A similar set, incomplete and on a much smaller scale, has been in existence heretofore, but the increasing number of hydrographic sheets called for the work on a larger scale.

Very respectfully,

ROBT. T. JASPER,
Lieutenant, U. S. N.,
Chief of Hydrographic Division.

Lieut. Commander S. M. ACKLEY, U. S. N.,
Hydrographic Inspector, U. S. Coast and Geodetic Survey.

List of Naval Officers attached to the U. S. Coast and Geodetic Survey during the fiscal year ending June 30, 1891.

Name.	Date attached.	Date detached.	Remarks.	Name.	Date attached.	Date detached.	Remarks.
COMMANDERS.				ENSIGNS.—continued.			
Charles M. Thomas	Jan. 10, 1887 Reattached July 1, 1889	Mar. 17, 1891		W. L. Howard	Feb. 23, 1891		Still in service.
LIEUTENANT-COMMANDERS.				E. A. Anderson	Apr. 24, 1888	Sept. 25, 1890	
H. E. Nichols	Nov. 1887 Oct. 2, 1889	Jan. 6, 1891		J. M. Poyer	Sept. 15, 1890		Still in service.
S. M. Ackley	Reattached Mar. 18, 1891		Still in service.	Chas. P. Eaton	June 23, 1890		Still in service.
H. B. Mansfield	May 15, 1888		Still in service.	Harry George	May 2, 1890		Still in service.
LIEUTENANTS.				F. L. Chapin	Feb. 17, 1891		Still in service.
J. E. Pillsbury	July 13, 1882	Jan. 10, 1891		W. B. Hoggatt	Feb. 14, 1891		Still in service.
D. Delehanty	Mar. 20, 1889		Still in service.	G. R. Slocum	Aug. 7, 1887	Nov. 10, 1890	
J. F. Moser	Jan. 29, 1884	July 15, 1890		W. G. Miller	Feb. 20, 1891		Still in service.
Robt. T. Jasper	Dec. 9, 1889		Still in service.	J. P. McGuinness	Aug. 9, 1887	Oct. 7, 1890	
D. H. Mahan	Nov. 15, 1888	Oct. 2, 1890		Jos. Strauss	July 16, 1887	Nov. 10, 1890	
E. M. Hughes	June 28, 1890		Still in service.	C. S. Stanworth	July 15, 1887	July 19, 1890	
Chas. E. Vreeland	Oct. 25, 1889		Still in service.	H. A. Biepham	July 13, 1887	July 16, 1890	
W. P. Ray	Nov. 5, 1890		Still in service.	J. E. Shindel	July 13, 1887	Sept. 8, 1890	
Wm. P. Elliott	Mar. 19, 1889		Still in service.	Benj. Wright	Feb. 20, 1891		Still in service.
W. Winder	July 18, 1890	Dec. 12, 1890		W. H. G. Bullard	July 8, 1888	Aug. 15, 1890	
E. J. Donn	Apr. 1, 1889		Still in service.	P. Andrews	July 4, 1888	May 23, 1891	
J. M. Helm	Sept. 4, 1888		Still in service.	W. H. Faust	Aug. 1, 1888		Still in service.
L. K. Reynolds	July 26, 1880		Still in service.	W. L. Dodd	July 14, 1888	June 13, 1891	
LIEUTENANTS—JUNIOR GRADE.				R. D. Tisdale	July 8, 1888	July 17, 1890	
Chas. A. Gove	Apr. 9, 1888	Mar. 27, 1891		S. M. Strite	July 11, 1888	Aug. 16, 1890	
J. N. Jordan	June 13, 1889		Still in service.	F. W. Jenkins	Feb. 8, 1889	Mar. 13, 1891	
A. L. Hall	Aug. 21, 1889	Nov. 29, 1890		E. T. Witherspoon	May 31, 1891		Still in service.
J. H. L. Holcombe	Aug. 4, 1889	Jan. 13, 1891		L. C. Bertolette	July 2, 1889	Dec. 10, 1890	
W. L. Burdick	Aug. 17, 1890		Still in service.	E. Moale, jr.	Aug. 9, 1889		Still in service.
Harry Kimmell	Dec. 18, 1888		Still in service.	S. R. Hurlbut	July 25, 1889	June 13, 1891	
A. L. Rogers	Mar. 7, 1890	Apr. 1, 1891		E. H. Burell	July 11, 1889	Dec. 10, 1890	
T. W. Ryan	Mar. 21, 1891		Still in service.	F. H. Brown	July 1, 1889	May 25, 1891	
J. B. Blish	Nov. 5, 1890		Still in service.	SURGEON.			
R. P. Schwerin	Sept. 27, 1890	Feb. 18, 1891		Thos. Owens	July 23, 1888	Nov. 11, 1890	
ENSIGNS.				PASSED ASSISTANT SURGEONS.			
John Gibson	Mar. 18, 1891		Still in service.	N. H. Drake	Dec. 26, 1888	Sept. 12, 1890	
J. H. Gibbons	Aug. 23, 1890		Still in service.	John M. Steele	Mar. 30, 1888	Apr. 2, 1891	
H. C. Poundstone	Feb. 5, 1890		Still in service.	H. T. Percy	Mar. 10, 1889		Still in service.
W. C. P. Muir	July 27, 1890		Still in service.	T. A. Berryhill	Sept. 12, 1890	Apr. 26, 1891	
J. H. Rohrbacher	July 17, 1890		Still in service.	ASSISTANT SURGEONS.			
W. W. Buchanan	Aug. 5, 1890		Still in service.	P. H. Bryant	Dec. 13, 1889		Still in service.
A. N. Mayer	July 30, 1890		Still in service.	E. S. Bogert	Nov. 10, 1890		Still in service.
John F. Luby	Dec. 14, 1888		Still in service.	PAYMASTERS.			
Hugh Rodman	Apr. 1, 1891		Still in service.	H. T. Wright	Oct. 22, 1890		Still in service.
H. B. Wilson	Oct. 6, 1890		Still in service.	Geo. A. Deering	Oct. 15, 1889	Died Oct. 16, 1890.	
G. W. Brown	Apr. 20, 1890	Dec. 13, 1890		ASSISTANT ENGINEERS.			
A. L. Key	Sept. 15, 1890		Still in service.	E. H. Scribner	July 9, 1889		Still in service.
				Thos F. Carter	Mar. 25, 1890		Still in service.
				W. W. White	Dec. 19, 1888		Still in service.
				J. C. Leonard	Jan. 21, 1889		Still in service.
				CAPRENTER.			
				W. W. Richardson	Oct. 27, 1888	May 7, 1891	

RECAPITULATION.

Commanders	1
Lieutenant Commanders	3
Lieutenants	13
Lieutenants (Junior Grade)	10
Ensigns	40
Surgeon	1
Passed Assistant Surgeons	4
Assistant Surgeons	2
Paymasters	2
Assistant Engineers	4
Carpenter	1

NOTE.—From the statement immediately following it appears that of the 81 officers above named 46 were on duty in the Survey at the close of the fiscal year.

List of Naval Officers attached to the U. S. Coast and Geodetic Survey, June 30, 1891.

COAST AND GEODETIC SURVEY OFFICE.

Lieut. Commander S. M. Ackley.

Lieut. Robert T. Jasper.

Paymaster H. T. Wright.

ATLANTIC COAST.

Steamer Bache (Atlantic Coast).—Lieut. E. M. Hughes, commanding; Lieut. W. L. Burdick; Ensign W. W. Buchanan; Ensign J. F. Luby; Ensign W. B. Hoggatt; Assistant Engineer E. H. Scribner.

Steamer Blake (Atlantic Coast).—Lieut. C. E. Vreeland, commanding; Lieut. H. Kemmell; Ensign Benj. Wright; Ensign W. C. P. Muir; Ensign J. H. Rohrbucher; Assistant Surgeon E. S. Bogert; Assistant Engineer W. W. White.

Steamer Endeavor (Atlantic Coast).—Lieut. L. K. Reynolds, commanding; Lieut. T. W. Ryan; Ensign John Gibson; Ensign Hugh Rodman.

Schooner Eagle (Atlantic Coast).—Lieut. Wm. P. Elliott, commanding; Ensign Charles P. Eaton; Ensign E. T. Witherspoon.

PACIFIC COAST.

Steamer Patterson (Pacific Coast).—Lieut. Commander H. B. Mansfield, commanding; Lieut. E. J. Donn; Ensign F. L. Chapin; Ensign W. G. Miller; Ensign W. L. Howard; Ensign H. C. Poundstone; Ensign W. H. Faust; Passed Assistant Surgeon H. T. Percy; Assistant Engineer Thos. F. Carter.

Steamer Hassler (Pacific Coast).—Lieut. D. Delehanty, commanding; Ensign J. B. Blish; Ensign H. B. Wilson.

Steamer McArthur (Pacific Coast).—Lieut. W. P. Ray, commanding; Ensign A. L. Key; Ensign E. Moale, jr.; Ensign Harry George; Assistant Engineer J. C. Leonard.

Steamer Gedney (Pacific Coast).—Lieut. J. M. Helm, commanding; Ensign J. H. Gibbons; Ensign A. N. Mayer; Ensign J. M. Poyer; Assistant Surgeon P. H. Bryant.

Schooner Earnest (Pacific Coast).—Lieut. J. N. Jordan, commanding.

Names of Vessels, their tonnage, etc., in the service of the U. S. Coast and Geodetic Survey during the fiscal year ending June 30, 1891.

No.	Name of vessel.	Tonnage.	Complement of—	
			Officers.	Men.
1	Steamer Patterson	453	12	46
2	Steamer Hassler	243	10	34
3	Steamer Blake	218	10	38
4	Steamer Bache	186	10	38
5	Steamer Gedney	133	8	29
6	Steamer McArthur	112	7	30
7	Steamer Endeavor	105	7	23
8	Steamer Hitchcock	83	5	14
9	Steamer Cosmos	25	3	7
10	Steamer Daisy	44	3	14
1	Schooner Eagle	202	6	26
2	Schooner Drift	87	5	14
3	Schooner Earnest	80	5	18
4	Schooner Ready	80	5	14
5	Schooner Yukon	78	6	14
6	Schooner Scoresby	72	5	14
7	Schooner Matchless		5	14
8	Schooner Quick	38	4	12
9	Schooner Transit	43	3	9
10	Schooner Spy	35	3	9
1	Barge Beauty	28		1

RECAPITULATION.

Steamers	10
Schooners	10
Barge	1
Total	21

OFFICE REPORT NO. 3.—1891.

REPORT OF THE DISBURSING AGENT FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

U. S. COAST AND GEODETIC SURVEY,
OFFICE OF THE DISBURSING AGENT,
Washington, D. C., November 25, 1891.

SIR: I have the honor to submit herewith the report of the Disbursing Office for the fiscal year ending June 30, 1891.

During the year the progress made in the audit and adjustment of the accounts of the Survey, of which large arrearages were brought over from the prior fiscal year, as explained in my last report, was quite satisfactory, and a very perceptible increase of promptness was attained in making final settlements with field parties. As time passes, and new methods suggest themselves, I hope to reach the point where, with competent aid, I shall be able to audit, adjust and settle all accounts rendered within a few days of their receipt.

On July 1, 1890, a radical change in the system of rendering accounts to the Accounting Officers of the Treasury was inaugurated which, so far, has proven very satisfactory. Prior to that date, the accounts of the Survey had been rendered to the Department to accord with the month in which the expenditure was actually incurred in the field, but to do this satisfactorily it was necessary to hold open the Monthly Abstracts of the Disbursing Agent for several months after their original dates in order to include therein all vouchers properly pertaining thereto. This resulted in a delay in their rendition to the Department and the consequent accumulation of vouchers in this office, when it would have been much safer for them to have been filed in the hands of the Accounting Officers. The present system closes out and balances all accounts on the last day of each and every month, and within ten days thereafter they are usually on file in the Department. By a systematic arrangement of the files of vouchers retained for reference in this office, the possibility of a duplicated account passing without detection is reduced to a minimum.

During the latter part of the month of January and for a portion of the month of February, 1891, an Examining Committee, appointed by the Secretary of the Treasury, was engaged in an investigation of the books, accounts and vouchers of the office. The Committee was very thorough in its work and proved every item of expenditure and checked every balance. The final result was a complete adjustment of the assets and liabilities of the office and the Committee so reported to the Secretary.

The Annual Report of Expenditures of the Coast and Geodetic Survey for the fiscal year ending June 30, 1890, was completed on February 25, 1891, and on the same date was transmitted to Congress, through the Secretary of the Treasury.

The aggregate of advances to chiefs of the field parties during the year was \$174 344.83. The total disbursements on adjusted accounts, for the same period, were \$488 034.28. The number of vouchers, bills, etc., adjusted and paid, was 18 690. Additional statistics of the work accomplished will be found in the files of the office.

The relations of the office with the Accounting Officers of the Treasury have been very satisfactory during the year. Explanations as to various items in the accounts have been duly submitted by me, whenever called for, with satisfactory results. It has been, and will continue to be, my aim to supply the Department with all necessary data upon which to base a fair and equitable adjustment of the accounts of the Survey.

During the year I have had the assistance of the following named persons, for the periods named:

Mr. Wm. H. Lanman, clerk, until January 27, 1891, when he resigned.

Miss Paula E. Smith, writer, for the year.

Mr. A. B. Simons, clerk, from January 2 to April 15, 1891, on which date he was detailed for duty in the Office of the First Comptroller by request of the Assistant Secretary of the Treasury.

Miss Alice F. Carlisle, from October 30, 1890, occasional service during intervals of relief from her duties as confidential typewriter to the Superintendent.

Mr. N. G. Henry, from March 21, 1891, upon which date he took the oath of office as Confidential Clerk and Cashier to the Disbursing Agent.

All have rendered intelligent and capable service in the execution of the various office details assigned to them. Mr. Henry's prior service for many years in field parties gives him peculiar qualifications for duty in the audit and adjustment of accounts.

The Annual Report of Expenditures for the fiscal year just ended will be submitted at an early date. As heretofore, I beg to ask that it may be considered as forming a part of this report.

Respectfully yours,

JOHN W. PARSONS,
Disbursing Agent, U. S. Coast and Geodetic Survey.

The SUPERINTENDENT,
U. S. Coast and Geodetic Survey.

[House Ex. Doc. No. 151, Fifty-second Congress, first session.]

EXPENDITURES, COAST AND GEODETIC SURVEY, 1891.

Letter from the Acting Secretary of the Treasury, transmitting a statement of expenditures on account of the Coast and Geodetic Survey for the fiscal year ended June 30, 1891.

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., March 1, 1892.

SIR: In compliance with section 264 of the Revised Statutes, I have the honor to transmit herewith a statement of the expenditures made on account of the Coast and Geodetic Survey for the fiscal year ending June 30, 1891.

Respectfully yours,

O. L. SPAULDING,
Acting Secretary.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

STATEMENT OF THE EXPENDITURES OF THE UNITED STATES COAST AND GEODETIC SURVEY FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

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

Salaries—Pay of field officers.

To whom paid.	Time employed.	Amount.
SUPERINTENDENT.		
Thomas C. Mendenhall	One year	\$6 000-00
ASSISTANTS.		
George Davidson	One year	4 000-00
Charles A. Schott	do	4 000-00
Benjamin A. Colonna	do	3 600-00
Augustus F. Rodgers	do	3 200-00
Charles S. Peirce	do	3 000-00
George A. Fairfield	do	3 000-00
Alonso T. Mosman	do	3 000-00
Robert S. Woodward	Eleven months thirty days	2 991-87

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Salaries—Pay of field officers—Continued.

To whom paid.	Time employed.	Amount.
ASSISTANTS—continued.		
William H. Dennis.....	One year.....	\$2 800-00
Cleveland Rockwell.....	One year (waiting instructions three months twenty-seven days).....	2 390-46
John W. Donn.....	One year.....	2 600-00
William Eimbeck.....	do.....	2 400-00
Henry L. Whiting.....	do.....	2 400-00
Edward Goodfellow.....	do.....	2 400-00
James S. Lawson.....	do.....	2 400-00
Herbert C. Ogden.....	do.....	2 400-00
Otto H. Titmann.....	do.....	2 400-00
Richard M. Bache.....	do.....	2 200-00
Charles H. Boyd.....	do.....	2 200-00
John J. Gilbert.....	do.....	2 200-00
Henry L. Mariudin.....	do.....	2 200-00
Andrew Braid.....	do.....	2 000-00
Gershom Bradford.....	do.....	2 000-00
Frank Walley Perkins.....	do.....	2 000-00
Spencer C. McCorkle.....	do.....	2 000-00
Frank D. Granger.....	Ten months.....	1 663-58
Edwin Smith.....	One year.....	2 000-00
Richard E. Halter.....	do.....	1 800-00
Stehman Forney.....	do.....	1 800-00
Edmund F. Dickens.....	do.....	1 800-00
Joseph Hergesheimer.....	do.....	1 800-00
John F. Pratt.....	Six months (waiting instructions two months ten days).....	813-75
Cephas H. Sinclair.....	One year.....	1 800-00
Dallas B. Wainwright.....	do.....	1 800-00
William C. Hodgkins.....	do.....	1 800-00
Erasmus D. Preston.....	do.....	1 800-00
Charles T. Iardella.....	do.....	1 600-00
Washington Irving Vinal.....	One year (waiting instructions one month fifteen days).....	1 550-00
James B. Baylor.....	One year.....	1 600-00
Charles H. Van Orden.....	do.....	1 600-00
Robert A. Marr.....	Three months.....	400-00
John E. McGrath.....	Ten months two days.....	1 339-10
Francis H. Parsons.....	One month twenty-nine days.....	244-61
Isaac Winston.....	Four months twenty-four days.....	644-47
SUB-ASSISTANTS.		
John E. McGrath.....	One month twenty-nine days.....	228-23
Isaac Winston.....	Seven months four days.....	836-16
John Henry Turner.....	One year.....	1 400-00
Philip A. Welker.....	do.....	1 400-00
Fremont Morse.....	do.....	1 400-00
John A. Flemer.....	do.....	1 400-00
John Nelson.....	do.....	1 200-00
Walter B. Fairfield.....	Nine months twenty-two days.....	971-74
AIDS.		
Fred. A. Young.....	Nine months twenty-two days.....	728-80
George R. Putnam.....	Three months.....	225-00
John S. Siebert.....	Eight months.....	479-40
James H. Gore.....	Thirteen days.....	32-14
Expenditures.....		\$109 939-31
Appropriation.....		119 600-00
Expenditures.....		109 939-31
Unexpended balance.....		9 660-69

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Salaries—Pay of office force.

To whom paid.	Time employed.	Amount.
DISBURSING AGENT.		
John W. Parsons	Ten months two days	\$1 841.36
ACCOUNTANTS.		
John W. Parsons	One month twenty-nine days	293.45
Eugene B. Wills	do	293.45
Roger C. Glascock	do	228.23
GENERAL OFFICE ASSISTANT.		
Marshall W. Wines	One year	2 200.00
CHIEF OF DIVISION OF LIBRARY AND ARCHIVES.		
Francis H. Parsons	Ten months two days	1 506.58
CLERK TO SUPERINTENDENT.		
Martin Hensel	Nine months four days	913.04
CLERK TO ASSISTANT IN CHARGE OF OFFICE.		
Adelbert B. Simons	Eight months twenty-nine days	744.60
CLERKS.		
William B. French	One year	1 650.00
William B. Chilton	do	1 625.58
John H. Smoot	do	1 400.00
William C. Maupin	Ten months two days	1 171.81
Artemas Martin	do	1 171.81
Freeman R. Green	One year	1 195.91
Eugene B. Wills	Ten months two days	1 004.32
William H. Lanman	Six months twenty-seven days	690.00
Nicholas G. Henry	Three months eleven days	336.67
Roger C. Glascock	Two months fourteen days	244.55
Frank A. Cook	Seven months sixteen days	753.27
John W. Whitaker	One year	1 200.00
John Henry Roeth	do	1 000.00
James M. Dueberry	One month twenty-nine days	163.00
Frank W. Edmonds	One year	983.75
RECEIVING AND FORWARDING CLERK.		
William C. Maupin	One month twenty-nine days	224.08
LIBRARIAN.		
Artemas Martin	One month twenty-nine days	293.45
CHART-CORRECTORS.		
James H. Barker	Ten months two days	1 004.32
Edward H. Wyvill	do	1 004.33
Archie Upperman	do	753.28
WRITERS.		
Lily A. Mapes	Nine months twenty-eight days	701.39
Fannie B. Bailey	One month twenty-nine days	146.72
Virginia Harrison	One year	819.83
Mary E. Nesbit	Eleven months one day	741.33
Paula E. Smith	Ten months twenty-one days	641.79
Ida M. Peck	One year	666.66
Alice G. Reville	Nine months twenty-seven days	592.88
Fannie Cadel	One month twenty-nine days	117.34
Kate Lawn	do	117.24
Jennie H. Fitch	do	117.34
Sophie S. Hein	do	117.34
Alice F. Carlisle	Eight months two days	483.31
COPYIST.		
Rollo S. Jackson	Twenty-seven days	53.41

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Salaries—Pay of office force—Continued.

To whom paid.	Time employed.	Amount.
STENOGRAPHERS AND TYPEWRITERS.		
Fannie B. Bailey	Two months two days	\$154.08
Eugene Rhodes	Three months sixteen days	176.67
BUOY COLORISTS.		
Jennie H. Fitch	Ten months two days	602.66
Sophie S. Hein	Nine months eighteen days	573.31
Creed W. Childs	Ten months two days	602.66
MAP-COLORIST.		
Creed W. Childs	One month twenty-nine days	117.34
TYPEWRITERS.		
Fannie Cadel	Ten months two days	602.66
Kate Lawn	do	602.66
DRAFTSMEN.		
Adolph Lindenkohl	One year	2 400.00
Henry Lindenkohl	do	2 200.00
Eugene Willenbacher	do	2 000.00
Edwin H. Fowler	do	2 000.00
Ferdinand Westdahl	do	1 800.00
Ernest J. Sommer	do	1 800.00
William C. Willenbacher	do	1 800.00
Frank C. Donu	do	1 400.00
David M. Hildreth	do	1 351.19
James H. Barker	One month twenty-nine days	216.81
Charles H. Deetz	One year	1 151.04
George F. Pohlers	do	1 151.04
Edward H. Wyvill	One month twenty-nine days	195.67
Charles Mahon	One year	1 042.62
Paul Erichsen	do	1 065.26
Edwin J. Pond	Eight months seventeen days	640.78
Everett S. Mitchell	Seven months seven days	642.92
Emil Molkow	Two months twenty-nine days	301.63
Edmund P. Ellis	Three months twenty-one days	277.50
Archie Upperman	One month twenty-nine days	146.72
COMPUTERS.		
Alexander S. Christie	Ten months two days	1 673.89
Edward H. Courtenay	Eleven months twenty days	1 945.66
Myrick H. Doolittle	One year	2 000.00
John B. Bontelle	Ten months two days	1 339.11
Leland P. Shidy	do	1 339.10
Henry Farquhar	One year	1 400.00
Louis A. Bauer	do	1 383.76
Charles H. Kummell	do	1 200.00
Frank M. Little	Eleven months twenty-two and a half days	1 165.98
John F. Hayford	Ten months two days	1 004.32
James Page	One year	983.75
Rollin A. Harris	Eleven months twenty-seven days	939.13
TIDAL COMPUTERS.		
Alexander S. Christie	One month twenty-nine days	326.11
Leland P. Shidy	do	244.61
John F. Hayford	do	203.81
COPPER-PLATE ENGRAVERS.		
Henry M. Knight	Ten months	1 673.87
William A. Thompson	do	1 673.89
John G. Thompson	do	1 673.87
August Petersen	do	1 506.55
Theodore Wasserbach	do	1 506.55

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Salaries—Pay of office force—Continued.

To whom paid.	Time employed.	Amount.
COPPER-PLATE ENGRAVERS—continued.		
Edward J. Enthoffer	Five months thirteen days	\$810-00
Edward H. Sipe	Ten months two days	1 339-10
William H. Davis	do	1 339-10
Rudolph F. Bartle, jr	Nine months twenty-one days	908-07
Henry L. Thompson	Ten months two days	837-03
William F. Peabody	Six months ten days	474-46
Alfred H. Sefton	Ten months two days	502-26
William A. Van Doran	do	502-26
Emil A. Kubel	Eight months twenty-nine days	446-74
George Hergeshelmer	Ten months two days	323-86
John M. Williams	Eight months twenty-four days	175-45
Harry R. McCabe	Ten months two days	180-58
Francis Gilbert Dawson	Nine months eight days	92-61
Edward H. Smith	One month twenty-three days	17-60
ENGRAVERS.		
Henry M. Knight	One month twenty-nine days	385-84
William A. Thompson	do	326-11
John G. Thompson	do	319-56
August Petersen	do	293-45
Theodore Wasserbach	do	293-45
Edward H. Sipe	do	265-12
William H. Davis	do	244-61
Rudolph F. Bartle, jr	do	195-67
Henry L. Thompson	do	146-72
Alfred H. Sefton	do	77-42
William A. Van Doran	do	77-42
Emil A. Kubel	Nineteen days	24-52
Harry R. McCabe	One month twenty-nine days	19-56
INSTRUMENT MAKERS.		
Ernst G. Fischer	Ten months two days	1 506-56
Otto Storm	do	1 004-32
Stephen A. Kearney	do	837-03
William R. Whitman	do	837-03
Clarence E. Regennas	do	837-00
William Gaertner	do	837-00
Michael Lauxmann, jr.	do	585-80
CHIEF MECHANICIAN.		
Ernst G. Fischer	One month twenty-nine days	293-45
MECHANICIANS.		
Otto Storm	One month twenty-nine days	216-81
Stephen A. Kearney	do	191-59
William R. Whitman	do	146-72
Clarence E. Regennas	do	163-00
William Gaertner	do	163-00
Michael Lauxmann, jr.	do	88-85
ELECTROTYPY AND PHOTOGRAPHER.		
Daniel C. Chapman	One year	1 800-00
CARPENTERS.		
Horace O. French	One year	1 594-22
George W. Clarvoe	do	883-73
Charles N. Darnall	Ten months two days	583-80
PLATE PRINTERS.		
Frank Moore	Ten months two days	1 339-10
Dickerson N. Hoover	Twenty-eight days	76-08
Charles J. Harlow	Eight months thirty days	747-32

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Salaries—Pay of office force—Continued.

To whom paid.	Time employed.	Amount.
PLATE PRINTERS—continued.		
George B. Craufurd	Two months	\$165.83
Thomas A. Sullivan	Eight months twelve days	698.41
James Beck	One month eight days	103.33
Richard S. Bright	Six months twenty-six days	570.65
COPPER-PLATE PRINTERS.		
Frank Moore	One month twenty-nine days	277.17
Dickerson N. Hoover	do	216.81
George B. Craufurd	do	203.81
James Beck	do	216.81
PLATE PRINTER'S HELPERS.		
Lynn H. Troutman	Six months sixteen days	331.16
James F. Dickson	Four months twenty-five days	283.91
John M. Williams	Three months seven days	188.32
Eberhard Fordan	Eight months fourteen days	492.63
JANITOR.		
William M. Long	One year	1 200.00
SKILLED LABORER.		
Robert T. Bassett	Ten months	837.03
MAP MOUNTER.		
Robert T. Bassett	One month twenty-nine days	166.28
ELECTROTYPY.		
Louis P. Keyser	Ten months two days	753.29
APPRENTICE TO PHOTOGRAPHER.		
Louis P. Keyser	One month twenty-nine days	81.50
HELPER TO PHOTOGRAPHER.		
Charles N. Darnall	One month twenty-nine days	81.50
WATCHMEN.		
David Parker	One year	880.00
William H. Keith	do	880.00
MESSENGERS.		
William H. Butler	One year	880.00
Charles Over	do	820.00
Vicente Denis	do	820.00
Neil Bryant	do	820.00
Sandy Bruce	do	820.00
Charles H. Jones	Ten months two days	686.38
William R. McLane	do	636.45
William Savoy	Eleven months twenty-eight days	634.78
Peter Sage	One year	640.00
William West	do	640.00
John F. Grinage	Eight months	366.20
PACKERS AND FOLDERS.		
Attrell Richardson	One year	630.00
Charles H. Jones	One month twenty-nine days	133.62
DRIVER.		
William R. McLane	One month twenty-nine days	118.73
LABORERS.		
John W. Reed	One year	630.00
George Newman	do	630.00
John H. Brown	do	550.00
William Young	do	550.00
Hans Bowdwin	do	366.00
Sarah E. Flynn	do	304.01

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Salaries—Pay of office force—Continued.

To whom paid.	On what account.	Amount.
FIREMEN.		
Horace Dyer.....	Ten months two days.....	\$527.43
Harrison Murray.....	do.....	460.36
CARPENTER AND FIREMAN.		
Horace Dyer.....	One month twenty-nine days.....	92.97
NIGHT FIREMAN.		
Harrison Murray.....	One month twenty-nine days.....	89.64
Expenditures.....		\$130 279.48
Appropriation.....		136 461.65
Expenditures.....		130 279.48
Unexpended balance.....		6 182.17

SUMMARY.

Pay of field officers.....	\$109 939.31
Pay of office force.....	130 279.48
Total expenditures.....	240 218.79
Total sum appropriated for salaries.....	256 061.65
Total sum expended for salaries.....	240 218.79
Unexpended balance.....	15 842.86

Party expenses, 1891.

COAST OF MAINE.

To whom paid.	On what account.	Amount.
S. H. Calligan.....	Storage.....	\$6.51
J. A. Flemer.....	Topography and hydrography.....	1 391.75
W. F. Grant.....	Storage.....	60.00
Joseph Hergesheimer.....	Topography and hydrography.....	1 315.83
Horace Kellogg.....	Storage.....	16.00
Expenditures.....		\$2 790.09
Appropriation.....		3 500.00
Less 20 per cent transferred to Gravity Experiments.....	\$700.00	
Expenditures.....	2 790.00	3 490.00
Unexpended balance.....		9.91

RESURVEYS—VINEYARD SOUND, ETC.

To whom paid.	On what account.	Amount.
Bureau of Equipment and Recruiting, Navy Department.	Water, steamer Bache.....	\$0.56
Bureau of Provisions and Clothing, Navy Department.	Soap, schooner Eagle.....	28.2
John W. Donn.....	Topography.....	975.18
Delaware and Hudson Canal Co.....	Coal, steamer Bache.....	444.84
Wm. P. Elliott, U. S. Navy.....	Hydrography, steamer Eagle.....	3 491.39
E. E. Haskell.....	Hydrography.....	1 148.53
Wm. C. Hodgkins.....	Topography.....	1 054.90
E. M. Hughes, U. S. Navy.....	Hydrography, steamer Bache.....	1 640.52
C. T. Iardella.....	Hydrography.....	2 026.87

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

RESURVEYS—VINEYARD SOUND, ETC.—Continued.

To whom paid.	On what account.	Amount.
Lehigh Valley Coal Co	Coal, schooner Eagle	\$94.00
Walter O. Luscombe	Storage	20.00
Philadelphia and Reading Coal and Iron Co.	Coal, schooner Eagle, and launches and steamer Bache	728.15
W. Irving Vinal	Topography and hydrography	1 780.91
D. B. Wainwright	Topography	1 419.70
Henry L. Whiting	do	112.30
Expenditures		\$14 940.76
Appropriation		10 000.00
Add 13 per cent from Florida—West Coast		650.00
Add 20 per cent from Peridido Bay, etc.		800.00
Add 15 per cent from Hydrography—California, etc.		1 350.00
Add 11 per cent from Topography—California		880.00
Add 10 per cent from Triangulation—California		1 300.00
Expenditures		14 980.00
Expenditures		14 940.76
Unexpended balance		39.24

DELAWARE RIVER.

To whom paid.	On what account.	Amount.
R. M. Bachs	Triangulation and topography	\$965.26
John J. Beckett	Storage	41.33
Expenditures		1 006.99
Appropriation		1 000.00
Add 1.50 per cent from Reported Dangers		7.50
Expenditures		1 007.50
Expenditures		1 006.99
Unexpended balance		.51

TRIANGULATION—ALABAMA.

To whom paid.	On what account.	Amount.
F. Walley Perkins	Triangulation	\$3 652.11
Appropriation		3 500.00
Add 2 per cent from Topography—California		160.00
Expenditures		3 660.00
Expenditures		3 652.11
Unexpended balance		7.89

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

FLORIDA—WEST COAST.

To whom paid.	On what account.	Amount.
Gas Engine and Power Co.....	Naphtha launches.....	\$2 624.25
Joseph Hergesheimer.....	Combined operations.....	1 687.52
Expenditures.....		4 311.77
Appropriation.....		5 000.00
Less 13 per cent transferred to Resurveys—Vineyard Sound, etc.....	\$650.00	
Expenditures.....	4 311.77	4 961.77
Unexpended balance.....		38.23

PERDIDO BAY, ETC.

To whom paid.	On what account.	Amount.
Stehman Forney.....	Combined operations.....	\$3 050.01
Appropriation.....		4 000.00
Less 20 per cent transferred to Resurveys—Vineyard Sound, etc.....	\$800.00	
Expenditures.....	3 050.01	3 850.01
Unexpended balance.....		149.99

COAST OF LOUISIANA.

To whom paid.	On what account.	Amount.
Bureau of Equipment and Recruiting, Navy Department.	Coal, steamer <i>Bache</i>	\$122.90
E. M. Hughes, U. S. Navy.....	Hydrography, steamer <i>Bache</i>	3 254.91
F. Walley Perkins.....	Triangulation.....	2 081.17
Expenditures.....		\$5 458.98
Appropriation.....		6 500.00
Less 15 per cent transferred to Transcontinental Work.....	\$975.00	
Expenditures.....	5 458.98	6 433.98
Unexpended balance.....		66.02

OFFSHORE SOUNDINGS, ETC.

To whom paid.	On what account.	Amount.
J. H. Bunnell & Co.....	Battery.....	\$6.57
John Chatillon & Sons.....	Springs.....	39.00
E. E. Haskell.....	Traveling expenses and services.....	315.28
Tate & Co.....	Covering table.....	32.60
The Okonite Co.....	Okonite wire.....	18.48
C. E. Vreeland, U. S. Navy.....	Hydrography, steamer <i>Blake</i>	7 443.03
Expenditures.....		\$7 845.96
Appropriation.....		8 000.00
Expenditures.....		7 845.96
Unexpended balance.....		154.04

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

HYDROGRAPHY—CALIFORNIA, ETC.

To whom paid.	On what account.	Amount.
D. Delchanty, U. S. Navy	Hydrography, steamer <i>Hastler</i>	\$7 000 00
Aug. F. Rodgers	Triangulation	590 66
Expenditures		7 590 66
Appropriation		9 000 00
Less 15 per cent transferred to Resurveys—Vineyard Sound, etc	\$1 350 00	
Expenditures	7 590 66	8 940 66
Unexpended balance		59 34

TOPOGRAPHY—CALIFORNIA.

To whom paid.	On what account.	Amount.
Aug. F. Rodgers	Triangulation and topography	\$5 838 99
Amount disbursed		5 838 99
Railroad accounts referred for settlement		194 86
Expenditures		6 033 85
Appropriation		8 000 00
Less 11 per cent transferred to Resurveys—Vineyard Sound, etc	\$880 00	
Less 2 per cent transferred to Triangulation—Alabama	160 00	
Less 3 per cent transferred to Magnetism—Atlantic and Gulf	240 00	
Expenditures	6 033 85	7 313 85
Unexpended balance		686 15

TRIANGULATION—CALIFORNIA.

To whom paid.	On what account.	Amount.
George Davidson	Triangulation	\$7 595 05
E. F. Dickens	do	1 431 83
Amount disbursed		9 026 88
Railroad accounts referred for settlement		260 20
Expenditures		9 287 08
Appropriation		13 000 00
Less 10 per cent transferred to Resurveys—Vineyard Sound, etc	\$1 300 00	
Less 10 per cent transferred to Objects not named	1 300 00	
Expenditures	9 287 08	11 887 08
Unexpended balance		1 112 92

COAST OF OREGON.

To whom paid.	On what account.	Amount.
E. F. Dickens	Combined operations	\$2 170 74
J. M. Helm, U. S. Navy	Hydrography, steamer <i>Goitney</i>	1 673 92
J. H. Leo Holcombe, U. S. Navy	Hydrography, steamer <i>McArthur</i>	323 13
D. H. Mahan, U. S. Navy	do	986 15
W. P. Ray, U. S. Navy	do	1 034 03
Cleveland Rockwell	Combined operations	1 901 17
Expenditures		8 089 14
Appropriation		\$10 000 00
Less 18 per cent transferred to Transcontinental Work	\$1 800 00	
Expenditures	8 089 14	9 889 14
Unexpended balance		110 86

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

COAST OF WASHINGTON.

To whom paid.	On what account.	Amount.
J. J. Gilbert.....	Triangulation and topography.....	\$123.50
Geo. W. Hendry, executor of Chas. J. Hendry, deceased.	Outfit, steamer <i>Gedney</i>	246.35
J. M. Helm, U. S. Navy.....	Hydrography, steamer <i>Gedney</i>	3 375.83
J. N. Jordan, U. S. Navy.....	Hydrography, schooner <i>Earned</i>	2 330.08
J. F. Pratt.....	Topography.....	306.04
Amount disbursed.....		6 381.80
Railroad accounts referred for settlement.....		44.68
Expenditures.....		6 426.48
Appropriation.....		\$8 000.00 *
Less 18 per cent transferred to Transcontinental Work.....	\$1 440.00	
Expenditures.....	6 426.48	7 866.48
Unexpended balance.....		133.52

ALASKA EXPLORATIONS.

To whom paid.	On what account.	Amount.
Bureau of Equipment and Recruiting, Navy • Department.	Outfit, steamer <i>Patterson</i>	\$34.30
John Bliss & Co.....	Sounding machine.....	191.00
H. B. Mansfield, U. S. Navy.....	Hydrography, steamer <i>Patterson</i>	9 222.83
Amount disbursed.....		9 448.17
Railroad accounts referred for settlement.....		59.44
Expenditures.....		9 507.61
Appropriation.....		\$10 000.00
Less 4 per cent transferred to Transcontinental Work.....	\$400.00	
Expenditures.....	9 507.61	9 907.61
Unexpended balance.....		92.39

PHYSICAL HYDROGRAPHY.

To whom paid.	On what account.	Amount.
Henry L. Marindin.....	Physical surveys.....	\$4 877.62
Homer P. Ritter.....	Services.....	900.00
Expenditures.....		5 777.62
Appropriation.....		\$6 000.00
Less 3 per cent transferred to Transcontinental Work.....	\$180.00	
Expenditures.....	5 777.62	5 957.62
Unexpended balance.....		42.38

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

REPORTED DANGERS.

To whom paid.	On what account.	Amount.
L. K. Reynolds, U. S. Navy	Hydrography, steamer <i>Endeavor</i>	\$243.39
C. E. Vreeland, U. S. Navy	Hydrography, steamer <i>Blake</i>	156.00
Expenditures		399.39
Appropriation		500.00
Less 1.50 per cent transferred to Delaware River	\$7.50	
Expenditures	399.39	
		406.89
Unexpended balance		93.11

MAGNETICS—ATLANTIC AND GULF.

To whom paid.	On what account.	Amount.
James B. Baylor	Magnetics	\$922.19
Appropriation		700.00
Add 3 per cent from Topography—California		240.00
		940.00
Expenditures		922.19
Unexpended balance		17.81

MAGNETICS—PACIFIC, ETC.

To whom paid.	On what account.	Amount.
George Davidson	Magnetics	\$17.65
R. E. Halter	do	1 398.61
Fred. A. Schmidt	Ferro-prussiate paper	12.00
Expenditures		1 428.26
Appropriation		1 500.00
Less than 1.50 per cent transferred to Gravity Experiments	\$22.50	
Expenditures	1 428.26	
		1 450.76
Unexpended balance		49.24

EXACT LEVELING.

To whom paid.	On what account.	Amount.
Isaac Winston	Precise leveling	\$3 197.92
Appropriation		4 000.00
Less 20 per cent transferred to Transcontinental Work	\$800.00	
Expenditures	3 197.92	
		3 997.92
Unexpended balance		2.08

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

TIDES—PACIFIC, ETC.

To whom paid.	On what account.	Amount.
George Davidson	Alaska, Sausalito, and Kadiak tidal	\$1 945.88
Jas. S. Lawson	Sausalito tidal	186.20
Expenditures		2 132.08
Appropriation		2 500.00
Less 12 per cent transferred to Transcontinental Work	\$300.00	
Expenditures	2 132.08	2 452.08
Unexpended balance		67.92

TIDES—ATLANTIC.

To whom paid.	On what account.	Amount.
Frances S. Patton	Rent of cottage	\$24.00
J. G. Spaulding	Services and contingencies	953.48
Eugene Veith	do	933.75
Expenditures		1 911.23
Appropriation		2 100.00
Less 8 per cent transferred to Transcontinental Work	\$168.00	
Expenditures	1 911.23	2 079.23
Unexpended balance		20.77

GRAVITY EXPERIMENTS.

To whom paid.	On what account.	Amount.
T. C. Mendenhall	Pendulum observations	\$804.86
T. S. & J. D. Negus	Chronometers	770.00
E. D. Preston	Pendulum observations	1 303.18
G. R. Putnam	Services	234.19
Wells, Fargo & Co	Expressage	8.40
Amount disbursed		3 120.63
Railroad accounts referred for settlement		100.00
Expenditures		3 220.63
Appropriation		2 500.00
Add 20 per cent from Coast of Maine		700.00
Add 1.50 per cent from Magnetism—Pacific, etc		22.50
Expenditures		3 222.50
Unexpended balance		3 220.63
		1.87

STATE SURVEYS.

To whom paid.	On what account.	Where expended.	Amount.
E. A. Bowser	Triangulation	New Jersey	\$439.94
C. H. Boyd	Reconnaissance	Michigan	189.27
A. H. Buchanan	Triangulation	Tennessee	1 613.60
Wm. Conkle	Storage	Wisconsin	9.00
M. G. Copeland & Co	Tent flies	Tennessee	28.00
John E. Davis	Triangulation	Wisconsin	1 291.13

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

STATE SURVEYS—Continued.

To whom paid.	On what account.	Where expended.	Amount.
Stehman Forney.....	Reconnaissance.....	Texas.....	\$2 956.37
W. R. Hoag.....	Triangulation.....	Minnesota.....	1 029.31
C. H. Sinclair.....	Astronomical work.....	Missouri.....	270.41
Wm. H. Wiun.....	Pasturage.....	Texas.....	36.00
Expenditures.....			7 863.03
Appropriation.....			\$9 500.00
Less 10 per cent transferred to Transcontinental Work.....		\$950.00	
Expenditures.....		7 863.03	
			8 813.03
Unexpended balance.....			686.97

GEOGRAPHICAL POSITIONS.

To whom paid.	On what account.	Amount.
M. G. Copeland & Co.....	Tents and flies.....	\$248.88
E. E. Jackson & Co.....	Stationary and chronometer boxes.....	43.00
R. A. Marr.....	Longitudes.....	574.00
Royce & Mareau.....	Electrical supplies.....	13.35
C. H. Sinclair.....	Longitudes.....	1 155.19
G. R. Putnam.....	do.....	460.21
Amount disbursed.....		2 494.57
Railroad accounts referred for settlement.....		128.19
Expenditures.....		2 722.76
Appropriation.....		3 000.00
Expenditures.....		2 722.76
Unexpended balance.....		377.24

TRANSCONTINENTAL WORK.

To whom paid.	On what account.	Where expended.	Amount.
Geo. W. Alley.....	Storage.....	Indiana.....	\$9.00
William Eimbeck.....	Triangulation.....	Utah.....	9 858.94
George A. Fairfield.....	do.....	Indiana.....	1 029.30
W. B. Fairfield.....	Reconnaissance.....	West Virginia, Ohio, and Kentucky.....	336.52
John D. Farr.....	Storage.....	Kansas.....	24.00
F. D. Granger.....	Triangulation.....	do.....	4 536.82
Harrison Safety Boiler Works.....	Ice breaker.....	Indiana.....	10.00
A. T. Mosman.....	Base measurement.....	do.....	6 928.80
F. O'Reilly & Co.....	Board of horses.....	Kansas.....	48.00
F. Walley Perkins.....	Triangulation.....	do.....	2 413.30
John S. Siebert.....	Services.....	Indiana.....	34.84
P. A. Walker.....	Traveling expenses.....	Utah.....	34.20
R. S. Woodward.....	Contingencies.....	Indiana.....	56.70
Amount disbursed.....			\$26 220.48
Railroad accounts referred for settlement.....			643.43
Expenditures.....			26 868.91
Appropriation.....			20 000.00
Add 15 per cent from Coast of Louisiana.....			375.00
Add 18 per cent from Coast of Oregon.....			1 800.00
Add 18 per cent from Coast of Washington.....			1 440.00
Add 4 per cent from Alaska Explorations.....			400.00
Add 3 per cent from Physical Hydrography.....			180.00

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

TRANSCONTINENTAL WORK—Continued.

	Amount.
Add 20 per cent from Exact Leveling	\$800.00
Add 12 per cent from Tides—Pacific, etc.	300.00
Add 8 per cent from Tides—Atlantic	168.00
Add 10 per cent from State Surveys	950.00
Add 7 per cent from Transportation (Navy), etc	245.00
	\$27 258.00
Expenditures	26 868.91
Unexpended balance	389.00

COAST PILOT.

To whom paid.	On what account.	Amount.
S. M. Ackley, U. S. Navy	Hydrography steamer <i>Endeavor</i>	\$571.82
Alice F. Carlisle	Services	196.77
Talbot Pulizzi	do	150.00
A. L. Hall, U. S. Navy	Hydrography, steamer <i>Endeavor</i>	86.00
N. G. Henry	Services and traveling expenses	416.50
L. K. Reynolds, U. S. Navy	Hydrography, steamer <i>Endeavor</i>	87.10
John Ross	Services and traveling expenses	1 501.45
Expenditures		\$3 009.64
Appropriation		4 500.00
Expenditures		3 009.64
Unexpended balance		1 490.36

TRANSPORTATION (NAVY), ETC.

To whom paid.	On what account.	Amount.
S. M. Ackley, U. S. Navy	Mileage	\$170.56
J. B. Blish, U. S. Navy	do	261.44
Wilson W. Buchanan, U. S. Navy	do	69.36
W. L. Burdick, U. S. Navy	do	147.20
F. L. Chapin, U. S. Navy	do	225.92
Walter S. Crosby, U. S. Navy	Traveling expenses	9.55
Nelson H. Drake, U. S. Navy	Mileage	2.48
Charles P. Eaton, U. S. Navy	do	8.24
Wm. P. Elliott, U. S. Navy	Mileage, etc	39.73
J. H. Gibbons, U. S. Navy	Mileage	66.56
W. B. Hoggatt, U. S. Navy	do	88.80
E. M. Hughes, U. S. Navy	do	130.86
A. L. Key, U. S. Navy	do	331.28
A. N. Mayer, U. S. Navy	do	269.12
W. G. Miller, U. S. Navy	do	258.08
W. C. P. Muir, U. S. Navy	do	28.96
J. E. Pillsbury, U. S. Navy	do	15.52
J. M. Poyer, U. S. Navy	do	261.28
W. P. Ray, U. S. Navy	do	200.48
L. K. Reynolds, U. S. Navy	do	30.16
W. N. Richardson, U. S. Navy	do	15.12
Hugh Rodman, U. S. Navy	do	51.04
T. W. Ryan, U. S. Navy	do	55.84
R. P. Schwerin, U. S. Navy	do	9.04
Chas. M. Thomas, U. S. Navy	do	81.12
J. McC. Tiffany, U. S. Navy	Traveling expenses	9.00
H. B. Wilson, U. S. Navy	Mileage	254.24

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

TRANSPORTATION (NAVY), ETC.—Continued.

To whom paid.	On what account.	Amount.
W. Winder, U. S. Navy.....	Mileage.....	\$33.44
E. T. Witherspoon, U. S. Navy.....	do.....	27.76
Benjamin Wright, U. S. Navy.....	do.....	80.08
Expenditures.....		\$3 232.26
Appropriation.....		3 500.00
Less 7 per cent transferred to Transcontinental Work.....	\$245.00	
Expenditures.....	3,232.26	3 477.26
Unexpended balance.....		22.74

OBJECTS NOT NAMED.

To whom paid.	On what account.	Amount.
John Conroy & Co.....	Supplies, schooner <i>Ready</i>	\$20.75
Chas. S. Crosby.....	Supplies, schooner <i>Searesby</i>	30.83
J. H. Dawson.....	Supplies, schooner <i>Ready</i>	15.00
John W. Donn.....	Topography, hydrography, inspection, etc.....	565.12
Wm. P. Elliott, U. S. Navy.....	Hydrography, schooner <i>Eagre</i>	229.31
Stehman Forney.....	Survey, Kennebec River.....	1 281.05
F. L. Grow.....	Coal-oil, schooner <i>Yukon</i>	1.35
Wm. C. Hodgkins.....	Triangulation, North Carolina coast.....	42.30
E. M. Hughes, U. S. Navy.....	Survey Arkansas Pass, steamer <i>Bache</i>	149.40
F. Kressel, jr.....	Supplies, schooner <i>Ready</i>	11.75
R. A. Marr.....	Hydrography at Cape May, N. J.....	24.95
Spencer C. McCorkle.....	Observing tides at Philadelphia.....	56.04
T. C. Mendenhall.....	Traveling expenses, inspection, etc.....	246.35
F. Walley Perkins.....	Storage.....	12.00
L. K. Reynolds, U. S. Navy.....	Hydrography, steamer <i>Endeavor</i> , Chesapeake Bay.....	1 537.89
C. H. Sinclair.....	Work for Geological Survey.....	962.11
Edwin Smith.....	Astronomical work.....	141.44
United States Fuel Co.....	Stove coal, schooner <i>Eagre</i>	8.75
P. A. Welker.....	Survey of Pensacola Bay, etc.....	2 303.69
Henry L. Whiting.....	Traveling expenses.....	116.15
Amount disbursed.....		7 756.23
Railroad accounts referred for settlement.....		41.48
Annual contribution to the International Geodetic Association.....		385.56
Expenditures.....		\$8 183.32
Appropriation.....		7 000.00
Add 10 per cent from Triangulation—California.....		1 300.00
Expenditures.....		8 300.00
Unexpended balance.....		8 183.32
		116.68

RECAPITULATION.

[Showing expenditures in gross (by sub-items) on account of the appropriation for Party Expenses, 1891.]

	Amount.
Coast of Maine.....	\$2 790.09
Resurveys—Vineyard Sound, etc.....	14 940.76
Delaware River.....	1 006.99
Triangulation—Alabama.....	3 652.11
Florida—West Coast.....	4 311.77
Perdido Bay, etc.....	3 050.01
Coast of Louisiana.....	5 458.98

UNITED STATES COAST AND GEODETIC SURVEY.

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EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Party expenses, 1891—Continued.

RECAPITULATION—Continued.

	Amount.
Offshore Soundings, etc.....	\$7 845.96
Hydrography—California, etc.....	7 590.66
Topography—California.....	5 838.99
Triangulation—California.....	8 626.88
Coast of Oregon.....	8 089.14
Coast of Washington.....	6 381.80
Alaska Explorations.....	9 448.17
Physical Hydrography.....	5 777.62
Reported Dangers.....	399.89
Magnetics—Atlantic and Gulf.....	922.19
Magnetics—Pacific, etc.....	1 428.26
Exact Leveling.....	3 197.92
Tides—Pacific, etc.....	2 132.08
Tides—Atlantic.....	1 911.23
Gravity Experiments.....	3 120.63
State Surveys.....	7 863.03
Geographical Positions.....	2 494.57
Transcontinental Work.....	26 220.48
Coast Pilot.....	3 009.64
Transportation (Navy) etc.....	3 252.26
Objects not named.....	7 756.28
Amount disbursed.....	\$158 897.89
Railroad accounts referred to accounting officers for settlement.....	1 477.28
Annual contribution to the International Geodetic Association.....	385.56
Total expenditures.....	\$160 760.73
Total amount appropriated for Party Expenses, 1891.....	166 800.00
Total amount expended for Party Expenses, 1891.....	160 760.73
* Unexpended balance.....	\$6 039.27

* This balance will be slightly reduced by outstanding railroad accounts not yet received for adjustment.

CLASSIFICATION OF EXPENDITURES FOR PARTY EXPENSES.

On what account.	Amount.
Triangulation.....	\$24 602.50
Topography.....	15 417.00
Hydrography.....	60 768.81
Transcontinental Geodetic Work.....	26 868.91
Points for State Surveys.....	7 863.03
Coast Pilot.....	3 009.64
Leveling.....	3 197.92
Magnetics.....	2 350.45
Physical Hydrography.....	5 777.62
Geographical Positions (longitudes).....	2 622.76
Tidal Operations.....	4 099.35
Gravity Experiments.....	3 220.63
Geological Survey Work.....	962.11
Total.....	\$160 760.73

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Alaska boundary survey.

[From July 1, 1890, to January 31, 1892.]

To whom paid.	On what account.	Amount.
Alaska Commercial Co	Supplies, etc	\$4 824.86
George Davidson	Moon culminations	11.87
Forbes Lithograph Manufacturing Co.	Printing charts	61.00
Chas. Junken	Services	3 032.07
John E. McGrath	Boundary survey	17 639.91
Mount Holly Paper Co	Chart paper	65.20
Norris Peters Co	Printing charts	121.00
J. Henry Turner	Boundary survey	18 299.36
Amount disbursed		44 055.27
Railroad accounts referred for settlement ..		40.00
Expenditures		\$44 095.27
Unexpended balance on hand July 1, 1890 ..		19 934.95
Appropriation—Sundry civil act August 30, 1890 ..		15 000.00
Appropriation—Sundry civil act March 3, 1891 ..		10 000.00
		44 934.95
Expenditures		44 095.27
Unexpended balance on February 1, 1892* ..		839.68

* Outstanding obligations amounting to about \$24 000 not yet adjusted.

Repairs of vessels, 1891.

To whom paid.	On what account.	Amount.
S. M. Ackley, U. S. Navy	Steamer <i>Endeavor</i>	\$177.75
American Ship Windlass Co	Steamer <i>Hassler</i> and schooner <i>Eagle</i> ..	1 327.63
P. H. Conlin	Schooner <i>Transit</i>	2.00
Jas. Clarke & Co.	Steamer <i>Endeavor</i>	4 854.19
John Dalton	Steamer <i>Hitchcock</i>	228.00
D. Delehanty, U. S. Navy	Steamer <i>Hassler</i>	1 550.00
Wm. P. Elliott, U. S. Navy	Schooner <i>Eagle</i> and steamer <i>Daisy</i> ..	3 097.70
Robert Frost	Launch <i>Terry-not</i>	4.00
J. J. Gilbert	Launch <i>Helena</i>	117.09
J. M. Helm, U. S. Navy	Steamer <i>Gedney</i>	988.34
George W. Hendry, executor Chas. J. Hendry, deceased.	do	32.96
Joseph Hergesheimer	Schooner <i>Spy</i>	210.36
Herreshoff Manufacturing Co.	Steamer <i>Gedney</i>	43.00
E. M. Hughes, U. S. Navy	Steamer <i>Bache</i>	702.77
J. N. Jordan, U. S. Navy	Schooner <i>Earnest</i>	200.00
F. Kressel, jr.	Schooner <i>Ready</i>	23.20
H. B. Mansfield, U. S. Navy	Steamer <i>Patterson</i>	2 722.07
W. C. Marden	Schooner <i>Scoreby</i>	1.00
McKensie, Oertling & Co.	Schooner <i>Transit</i>	23.46
Wm. H. Peirce	Schooner <i>Spy</i>	93.85
L. K. Reynolds, U. S. Navy	Steamer <i>Endeavor</i>	881.23
Thomas Shannon	Steamer <i>Hitchcock</i>	9.75
Chas. M. Thomas, U. S. Navy	Schooner <i>Transit</i> and Launch No. 4 ..	76.06
Philip Vicente	Launch <i>Terry-not</i>	2.00
O. E. Vreeland, U. S. Navy	Steamer <i>Blake</i>	2 296.64
P. A. Welker	Schooner <i>Quick</i>	169.11
G. J. Wilde	Schooner <i>Drift</i>	4.50
Carl Wilson	Schooner <i>Transit</i>	8.00
Wm. E. Woodall & Co.	Steamer <i>Bache</i>	4 974.19
Woodward, Wight & Co. (limited)	Schooner <i>Spy</i>	40.59
Expenditures		\$24 862.44
Appropriation		25 000.00
Expenditures		24 862.44
Unexpended balance		137.56

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Repairs of vessels, 1891—Continued.

CLASSIFICATION OF EXPENDITURES FOR REPAIRS OF VESSELS.

Name of vessel.	Amount.	Name of vessel.	Amount.
Steamer <i>Dachs</i>	\$5 676.96	Schooner <i>Quick</i>	\$159.11
Steamer <i>Blake</i>	2 373.64	Schooner <i>Ready</i>	23.20
Steamer <i>Endeavor</i>	5 913.17	Schooner <i>Scoreby</i>	1.00
Steamer <i>Godney</i>	1 064.20	Schooner <i>Spy</i>	353.80
Steamer <i>Hassler</i>	2 500.00	Schooner <i>Transit</i>	49.96
Steamer <i>Hitchcock</i>	237.75	Launch <i>Helen</i>	117.09
Steamer <i>Patterson</i>	2 722.07	Launch No. 4	59.56
Schooner <i>Drift</i>	4.50	Launch <i>Tarry-not</i>	6.00
Schooner <i>Eagle</i>	3 400.33	Total	\$24 862.44
Schooner <i>Earnest</i>	200.00		

Publishing observations, 1891.

To whom paid.	On what account.	Amount.
John B. Boytelle	Services as computer, one month twenty-nine days	\$380.89
William Ferrel	Examination and correction of publications	100.00
J. H. Gore	Indexing publications	450.00
Lily A. Mapes	Services as copyist, one month twenty-nine days	117.34
Alice G. Reville	Services as copyist, one month twenty-nine days	117.34
Expenditures		1 045.57
Appropriation		\$1 618.08
Expenditures		1 045.57
Unexpended balance		572.51

General Expenses, 1891.

INSTRUMENTS, INSTRUMENT SHOP, CARPENTER SHOP, DRAWING DIVISION, BOOKS, MAPS, CHARTS, AND SUBSCRIPTIONS.

To whom paid.	On what account.	Amount.
Aluminum Brass and Bronze Co.	Instrument shop	\$110.81
American Journal of Mathematics	Subscriptions	5.00
American Journal of Science	do	6.00
Astronomical Journal	Books	5.00
William Ballantyne & Sons	Books, instrument and carpenter shops	81.60
D. Ballauf	Instrument shop	335.45
Barber & Ross	Instrument and carpenter shops	3.96
Charles Becker	Carpenter shop	16.16
Benedict & Burnham Manufacturing Co.	Instrument shop	168.98
Hugo Bilgram	do	556.39
John Bliss & Co.	Charts	1.00
A. C. Both	Instrument shop	12.00
R. B. Bowker	Subscriptions	5.00
Andrew Boyd	Books	20.00
W. L. Brown & Co.	Instrument shop and drawing division	12.88
Brown & Sharpe Manufacturing Co.	Instrument shop	89.73
E. W. Bullinger	Subscriptions	6.00
Bullock & Crenshaw	Instrument shop	.89
J. H. Bunnell & Co.	do	57.00
L. P. Casella	Instruments	756.18
J. B. Chamberlain	Instrument shop	65.88
Jas. J. Chapman	Books	77.26
Chatillon & Sons	Instrument shop	6.50
Chas. L. Condit	Books	15.00

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

General expenses, 1891—Continued.

INSTRUMENTS, INSTRUMENT SHOP, CARPENTER SHOP, DRAWING DIVISION, ETC.—Continued.

To whom paid.	On what account.	Amount.
Albert M. Cowell	Instrument shop	\$30.00
Darling, Brown & Sharpe	do	69.00
George Davidson	Books, instrument, and carpenter shops and subscriptions	536.15
John E. Davies	Instrument shop	5.00
Edison General Electric Co	do	69.54
Eimer & Amend	do	31.15
Felt & Tarrant	Instruments	125.00
N. M. Forney	Subscriptions	3.00
Stehman Forney	Instrument shop	2.25
Frank E. Clement Co	Carpenter shop	126.00
Frederick Crane Chemical Co	Instrument shop	34.80
W. T. Galliher & Bro	Carpenter shop	68.47
Geological Publishing Co	Subscriptions	3.50
Z. D. Gilman	Instrument shop	77.01
Gopsill's Directory	Books	5.00
Henry J. Green	Instrument shop	184.75
R. E. Halter	do	1.00
Harris & Shearer	do	68.01
Harrison Safety Boiler Works	do	10.00
E. E. Haskell	do	1.75
Heller & Brightly	do	24.80
W. R. Hoag	Instruments	9.00
James M. Hodges	Instrument and carpenter shops	28.00
N. D. C. Hodges	Subscriptions	3.50
H. Hoffa	Instrument shop	14.50
Hooe, Bro. & Co	Instrument and carpenter shops	23.06
E. M. Hughes, U. S. Navy	Instrument shop	6.25
A. Hurlimann	Instruments	639.80
Johns Hopkins Press	Books	5.00
Jones & Laughlins	Instrument shop	1.25
Journal of the Association of Engineering Soci- eties	Books	10.90
M. E. Kahler	Instrument shop	104.70
J. Karr	do	47.25
Ads. Keppelmann	do	4.50
Keuffel & Esser Co	Instrument shop and instruments	118.58
Kingsley Bros. Creamery Co	Carpenter shop	.48
Julius Lansburgh	Instrument and carpenter shops	7.50
James S. Lawson	Instrument shop	6.45
Libbey, Bittinger & Miller	Carpenter shop	445.79
Library Bureau	Books	11.50
Mellville Lindsay	Instrument shop	13.76
Geo. E. Littlefield	Books	3.00
W. H. Lowdermilk & Co	do	55.49
M. Lukanitsch, Jr.	Instrument shop	5.88
Maine Historical Society	Books	3.50
Manhattan Brass Co	Instrument shop	127.70
F. P. May & Co	Carpenter shop	108.36
McFadden Co	Instrument shop	137.84
W. H. Mehler	do	10.75
T. C. Mendenhall	do	10.00
W. H. Mildrum	do	18.00
Edward Miller	Subscriptions	12.00
Francis Miller	Instrument and carpenter shops	7.87
E. Morrison	Instrument shop	.76
Munn & Co	Subscriptions	7.00
T. S. & J. D. Negus	Instrument shop	32.00
New Haven Clock Co	do	90.00
Norton Emery Wheel Co	do	12.11
Wm. Owens	do	7.00

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

General expenses, 1891—Continued.

INSTRUMENTS, INSTRUMENT SHOP, CARPENTER SHOP, DRAWING DIVISION, ETC.—Continued.

To whom paid.	On what account.	Amount.
John C. Parker.....	Books.....	\$25.40
Patapsco Oil and Grease Co.....	Instrument shop.....	11.00
Pitney & Shannon.....	do.....	13.13
Chas. S. Platt.....	do.....	43.50
Pratt & Whitney Co.....	do.....	210.00
Publishers' Weekly.....	Books.....	2.50
James W. Queen & Co.....	Instruments and instrument shop.....	533.97
Riggs & Co.....	Instruments.....	9.88
E. S. Ritchie & Sons.....	Instrument shop.....	136.50
Cleveland Rockwell.....	do.....	16.00
Aug. F. Rodgers.....	do.....	3.00
Henry Romeike.....	Subscriptions.....	4.85
Royce & Mearns.....	Instrument shop.....	63.96
Geo. Rynaal, jr.....	Instrument and carpenter shops.....	223.61
Fred. A. Schmidt.....	Instrument shop and drawing division.....	245.81
L. H. Schneider's Son.....	Instrument and carpenter shops.....	119.56
Scottish Geographical Magazine.....	Subscriptions.....	1.00
Seaboard.....	do.....	1.30
Sideraal Messenger.....	do.....	3.00
J. L. Smith.....	Maps.....	13.00
Smith Wheel Manufacturing Co.....	Instrument shop.....	30.50
L. S. Starrett.....	do.....	16.10
Gustav E. Stechert.....	Books.....	688.88
B. F. Stevens.....	Subscriptions.....	26.60
Ormand Stone.....	Books.....	3.13
Susfeld Lorsch & Co.....	Instrument shop.....	238.50
S. Thaxter & Sons.....	Books.....	.70
Tice & Lynch.....	Instruments.....	627.66
United States Naval Institute.....	Subscriptions.....	3.50
John W. Walker.....	Instrument shop.....	3.90
B. Westermann & Co.....	Books and subscriptions.....	49.01
Stillman White.....	Instrument shop.....	20.87
Richard H. Willet.....	Carpenter shop.....	228.79
A. H. Williams.....	Books.....	1.00
Isaac Winston.....	Instrument shop.....	3.50
Woodward & Lothrop.....	Instrument and carpenter shops.....	39.37
W. D. Wyvill.....	Instrument shop.....	30.00
Zucker & Levett Chemical Co.....	do.....	1.14
Expenditures.....		9 734.97
Appropriation—Sundry civil act August 30, 1890.....	\$9 000.00	
Appropriation—Deficiency act March 3, 1891.....	727.55	
Received from United States Light-House Board in payment for instruments furnished.....		9 727.55
Expenditures.....		\$10 134.74
* Unexpended balance.....		9 734.97

* This balance will be partly absorbed in payment of obligations incurred before the close of the fiscal year.

COPPER PLATES, CHART PAPER, PRINTING INK, COPPER, ZINC, AND CHEMICALS FOR ELECTROTYPING AND PHOTOGRAPHING, ENGRAVING, PRINTING, PHOTOGRAPHING, AND ELECTROTYPING SUPPLIES, EXTRA ENGRAVING AND DRAWING, PHOTO-LITHOGRAPHING, AND PRINTING FOR IMMEDIATE USE.

To whom paid.	On what account.	Amount.
Jas. F. Anderson.....	Photographing and electrotyping supplies.....	\$39.20
Jas. L. Barbour & Son.....	Printing supplies.....	.90
B. F. Bartle.....	Engraving supplies.....	20.00
Chas. Becker.....	Printing and electrotyping supplies.....	108.37
M. W. Beveridge.....	Electrotyping supplies.....	1.50
Julius Bien & Co.....	Photolithographing.....	1 058.62
A. Brown.....	Printing from stone.....	26.00

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

General expenses, 1891—Continued.

COPPER PLATES, CHART PAPER, PRINTING INK, COPPER, ZINC, ETC.—Continued.

To whom paid.	On what account.	Amount.
Bureau of Engraving and Printing	Printing supplies	\$750.68
E. F. Campbell	Printing from copper	240.02
John Christman	Printing supplies	4.00
Clendenin Bros	Copper for electrotyping	1 020.91
Elizabeth Cox	Engraving supplies	19.39
E. F. Dickins	Photographing supplies	8.40
Jas. F. Dickson	Printing from copper	147.98
E. J. Enthoffer	Extra engraving	31.60
Evans & Bartle	do	1 361.91
H. C. Evans	do	49.82
Eberhard Fordan	Printing from copper	166.06
Franklin & Co.	Engraving supplies	2.00
Isaac Friedenwald Co.	Photolithographing	468.67
Henry R. Garland	Extra drawing	657.80
C. D. Gildersleeve	Printing supplies	60.00
Z. D. Gilman	Engraving, electrotyping, and printing supplies	319.14
Andrew B. Graham	Printing from stone	20.00
E. N. Gray & Co.	Printing supplies	121.04
Mary L. Handlase	Extra drawing	104.00
Chas. J. Harlow	Printing from copper	11.68
George Hergesheimer	Extra engraving	58.06
A. Hoen & Co.	Photolithographing	291.20
H. Hoffa	Engraving supplies	148.80
Hoe, Bro. & Co.	Printing and engraving supplies	80.76
Charles Eneu Johnson & Co.	Printing supplies	5.00
Ernst Kubel	Copper plates	659.95
Julius Lansburgh	Engraving supplies	4.80
Jas. S. Lawson	Photographing supplies	2.15
Melville Lindsay	Electrotyping supplies	32.06
Charles F. Locraft	Printing from copper	13.60
Matthiessen & Hegeler Zinc Co.	Electrotyping supplies	226.13
Robt. W. Maupin	Printing from copper	13.60
Robt. C. Mayer	Photolithographing	9.00
F. P. May & Co.	Engraving, printing, and electrotyping supplies	5.26
McFadden Co.	Engraving supplies	3.65
W. H. Mehler	Electrotyping and printing supplies	30.66
Francis Miller	Engraving and printing supplies	12.70
E. Morrison	Printing supplies	33.30
Mount Holly Paper Co.	Chart paper	5 862.02
New York Belting and Packing Co.	Electrotyping supplies	5.00
New York Steel and Copper Plate Co.	Copper plates	45.00
Norris Peters Co.	Photolithographing	617.60
Vincente L. Ourdan	Engraving supplies	85.00
John C. Parker	Printing supplies	16.80
Philadelphia Blue Print Co.	Photographing supplies	8.25
E. J. Pullman	do	4.00
Geo. Ryneal, Jr.	Printing, engraving, and electrotyping supplies	88.36
Schindler Bros.	Photographing supplies	3.60
Fred. A. Schmidt	do	22.61
E. H. Schneider's Son	Engraving and electrotyping supplies	10.59
L. G. Soltmann	Electrotyping supplies	2.93
Wm. H. Waddington	Printing from copper	127.45
Ernst Winter & Son	Engraving supplies	112.00
Woodward & Lothrop	Engraving and printing supplies	35.78
Expenditures		\$15 683.48
Appropriation—Sundry civil act, August 30, 1890	\$15 500.00	
Appropriation—Deficiency act, March 3, 1891	• 125.00	
Received for electrotyping done for the Hydrographic Office, Navy Department		15 625.00
		524.98
Expenditures		16 549.98
		15 683.48
Unexpended balance		866.50

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

General expenses, 1891—Continued.

STATIONERY, TRANSPORTATION OF INSTRUMENTS AND SUPPLIES, OFFICE WAGON AND HORSES, FUEL, GAS, TELEGRAMS, ICE, AND WASHING.

To whom paid.	On what account.	Amount.
Adams Express Co	Transportation	\$162.00
Alaska Commercial Co	Stationery	3.82
Wm. Ballantyne & Son	do	14.50
J. Baumgarten & Son	do	55.50
James Connor	Office horses	30.00
George Davidson	Stationery, transportation, and washing	28.42
E. F. Dickins	Stationery	.60
Z. D. Gilman	Stationery and office horses	9.60
Great Falls Ice Co.	Ice	65.13
Harriet E. Harrod	Washing	99.59
W. E. Hoag	Stationery	3.00
Hygienic Ice Co.	Ice	233.14
Inland and Seaboard Coasting Co	Transportation	.80
Geo. W. Knox	do	101.54
Jas. S. Lawson	Washing and stationery	1.35
Lutz & Bro	Office horses and wagon	9.75
Walter H. Marlow	Fuel	149.15
John Miller	do	1 055.70
E. Morrison	Stationery	17.63
Office Specialty Manufacturing Co	do	4.80
John C. Parker	do	49.12
People's Despatch and Transfer Co.	Transportation	16.49
F. Walley Perkins	Stationery	1.20
Pitt & Scott	Transportation	6.75
Fred. A. Schmidt	Stationery	165.16
B. F. Shaw	Office horses and wagon	245.25
Smithsonian Institution	Transportation	23.85
Stationery Division, Treasury Department	Stationery	1 363.67
Stephenson's Express	Transportation	34.78
Tice & Lynch	do	33.29
United States Express Co	do	276.10
C. E. Vreeland, U. S. Navy	Stationery	1.00
Wm. Walter's Son	Office wagon	50.00
Washington Gas Light Co	Gas	1 146.91
Woodward & Lorthrop	Stationery	63.63
Wyckoff, Seaman & Benedict	do	14.70
Amount disbursed		\$5 537.92
Railroad accounts referred for settlement		12.50
Expenditures		5 550.42
Appropriation		6 000.00
Expenditures		5 550.42
Unexpended balance		449.58

MISCELLANEOUS EXPENSES, CONTINGENCIES OF ALL KINDS, OFFICE FURNITURE, REPAIRS, EXTRA LABOR, AND TRAVELING EXPENSES (OFFICE).

To whom paid.	On what account.	Amount.
Advertising Newspaper Co	Advertising	\$5.63
American Machinist Publishing Co	do	7.80
James F. Anderson	Plumbing	77.40
Albert A. Ashe	Extra labor	70.00
Baltimore American	Advertising	2.81
Jas. L. Barbour & Son	General office supplies	18.79
J. Baumgarten & Son	Numbering and dating machine and repairing stamps	38.50
Chas. Becker	Lime	1.75

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

General expenses, 1891—Continued.

MISCELLANEOUS EXPENSES, CONTINGENCIES OF ALL KINDS, ETC.—Continued.

To whom paid.	On what account.	Amount.
M. W. Beveridge.....	Office furniture.....	\$32.35
Boston Journal.....	Advertising.....	5.25
J. W. Boteler & Son.....	General office supplies.....	12.60
C. T. Bride.....	Plumbing.....	127.00
Edward Brown.....	Extra labor.....	34.38
J. B. Bryan & Bro.....	General office supplies.....	33.26
Henry Burrell.....	Extra labor.....	8.75
J. L. Campbell.....	Packing and boxing.....	1.40
Chesapeake and Potomac Telephone Co.....	Exchange rental.....	100.00
Chicago Tribune Co.....	Advertising.....	12.00
Cleveland Leader.....	do.....	2.40
Columbia Phonograph Co.....	Rent of graphophones.....	133.89
Commercial Gazette Co.....	Advertising.....	9.00
M. G. Copeland & Co.....	Office furniture.....	22.88
Daily News.....	Advertising.....	5.97
George Davidson.....	Suboffice expenses.....	127.40
Dispatch Publishing Co.....	Advertising.....	8.33
John F. Doyle.....	Tin.....	1.08
Samuel L. Eubank.....	Extra labor.....	290.63
Evening Star Newspaper Co.....	Advertising.....	28.69
E. G. Fischer.....	Traveling expenses.....	14.15
James Flynn.....	Extra labor.....	111.00
Frank Freeman.....	do.....	36.45
Z. D. Gilman.....	General office supplies.....	6.70
Globe Printing Co.....	Advertising.....	10.50
E. N. Gray & Co.....	Grate bars.....	57.40
Israel Green.....	Extra labor.....	22.00
Mary L. Handlan.....	do.....	594.19
Herald Publishing Co.....	Advertising.....	3.37
Edward Herbert.....	Extra labor.....	2.50
Hoe, Bro. & Co.....	Office furniture.....	106.94
Inter Ocean Publishing Co.....	Advertising.....	14.28
W. S. Jenks & Co.....	Tin tubes.....	50.00
Johnson & Morris.....	Repairs.....	74.09
B. C. Keubling.....	Extra labor.....	.75
Julius Lansburgh.....	Office furniture.....	83.80
Jas. S. Lawson.....	Sub-office expenses.....	8.80
Libbey, Bittinger & Miller.....	Map rollers.....	199.80
Library Bureau.....	Index cards.....	3.00
Libbie Ludgate.....	Extra labor.....	172.07
Lutz & Bro.....	General office supplies.....	8.50
Mail and Express.....	Advertising.....	10.80
Matthews & Kirkland.....	Extra labor.....	1.45
F. P. May & Co.....	General office supplies.....	15.13
Alex McKie.....	Repairs.....	14.55
W. H. Mehler.....	General office supplies.....	30.95
I. H. Mills & Co.....	Ink rollers.....	1.00
Mobile Register.....	Advertising.....	6.60
W. C. Morey.....	Extra labor.....	29.89
W. B. Moses & Sons.....	Office furniture.....	323.11
Chas. A. Muddiman.....	Water hose.....	2.00
John A. Mulloy.....	Extra labor.....	89.38
Munn & Co.....	Advertising.....	13.50
National View.....	do.....	1.50
New York Herald.....	do.....	7.80
New York Press Co., limited.....	do.....	8.70
New York Tribune.....	do.....	5.40
Newman & Sons.....	Repairs to caligraph.....	2.00
Nicholson & Co.....	Advertising.....	14.40

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

General expenses, 1891—Continued.

MISCELLANEOUS EXPENSES, CONTINGENCIES OF ALL KINDS, ETC.—Continued.

To whom paid.	On what account.	Amount.
John C. Parker.....	Typewriting supplies.....	\$27.25
Wm. C. Peake.....	Glazing.....	23.55
Pittsburg Commercial-Gazette.....	Advertising.....	13.97
Post Publishing Co.....	do.....	6.60
Press Co., limited.....	do.....	8.40
Lewis T. Raley.....	Extra labor.....	24.00
Royce & Marcan.....	Electrical supplies.....	3.05
Geo. Byneal, jr.....	General office supplies.....	2.87
Fred A. Schmidt.....	do.....	.10
L. H. Schneider's Son.....	do.....	1.25
Scientific American.....	Advertising.....	4.50
The Sentinel.....	do.....	2.00
Jas. E. Sierra.....	Extra labor.....	21.25
Sunday Gazette.....	Advertising.....	3.83
Sunday Herald.....	do.....	11.47
Sunday Republic.....	do.....	2.76
Superintendent's office, Treasury Department.....	Office furniture.....	338.81
William Thomas.....	Extra labor.....	98.12
J. Q. Thompson & Co.....	Advertising.....	10.50
Smith Thompson.....	File holders.....	53.75
Times-Democrat.....	Advertising.....	6.00
Traveller Newspaper Co.....	do.....	1.75
Tribune Association.....	do.....	16.20
J. Henry Turner.....	Extra labor.....	3.00
Washington City post-office.....	Post-office box rent.....	16.00
Washington Critic Co.....	Advertising.....	10.25
Washington Post Co.....	do.....	20.86
Washington Sentinel.....	do.....	5.50
Dennis E. White.....	Extra labor.....	93.33
J. H. Wilkerson.....	Inspecting boilers.....	10.00
Wilmarth & Edmonston.....	General office supplies.....	25.74
Woodward & Lothrop.....	do.....	68.03
Wyckoff, Seamans & Benedict.....	Typewriter and repairs.....	121.35
Expenditures.....		4 432.53
Appropriation—Sundry civil act August 30, 1890.....	\$4 500.00	
Appropriation—Deficiency act March 3, 1861.....	5.00	
Expenditures.....		\$4 556.00
*Unexpended balance.....		4 432.53
		117.47

*This balance will be partly absorbed in payment of obligations incurred before the close of the fiscal year.

RENT OF BUILDINGS FOR OFFICES, WORKROOMS, AND WORKSHOPS.

To whom paid.	On what account.	Amount.
C. C. Coleman and Francis E. Richards.....	Rent of buildings.....	\$1 312.50
Alfred Richards.....	do.....	1 312.50
Alfred Richards and Sarah Ann Richards, executrix.....	do.....	7 875.00
Expenditures.....		\$10 500.00
Appropriation.....		10 500.00
Expenditures.....		10 500.00

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

General expenses, 1891—Continued.

RENT OF FIRE-PROOF BUILDING.

To whom paid.	On what account.	Amount.
Benj. F. Butler.....	Rent of building.....	\$4 500.00
Appropriation		6 000.00
Expenditures.....		4 500.00
Unexpended balance.....		1 500.00

RECAPITULATION.

[Showing expenditures in gross (by sub-items) on account of the appropriation for General Expenses, 1891.]

Instruments, instrument shop, carpenter shop, drawing division, books, maps, charts, and subscriptions	\$9 734.97
Copper plates, chart paper, printing ink, copper, zinc, and chemicals, for electrotyping and photographing; engraving, printing, photographing, and electrotyping supplies; extra engraving and drawing; photolithographing and printing for immediate use	15 683.48
Stationery, transportation of instruments and supplies, office, wagon and horses, fuel, gas, telegrams, ice, and washing	5 537.92
Miscellaneous expenses, contingencies of all kinds, office furniture, repairs, extra labor, and traveling expenses (office)	4 432.53
Rent of buildings for offices, workrooms, and workshops	10 500.00
Rent of fire-proof building.....	4 500.00
Amount disbursed	50 388.90
Railroad accounts referred to accounting officers for settlement	22.50
Total expenditures.....	\$50 401.40
Total amount appropriated for General Expenses, 1891:	
Sundry civil act August 30, 1890	\$51,500.00
Deficiency act March 3, 1891	902.55
Received for instruments furnished the U. S. Light-House Board.....	52 402.55
Received for electrotyping done for the Hydrographic Office, Navy Department.....	407.19
	924.98
	53 734.72
Total amount expended for General Expenses, 1891.....	50 401.40
* Unexpended balance	\$3 333.32

* This balance will be partly absorbed in payment of outstanding obligations. See footnotes under sub-items.

CLASSIFICATION OF EXPENDITURES FOR GENERAL EXPENSES, 1891.

On what account.	Amount.	On what account.	Amount.
Instruments.....	\$2 516.50	Office wagon and horses	\$344.60
Instrument shop.....	4 676.36	Fuel.....	1 204.85
Carpenter shop.....	1 326.19	Gas	1 146.91
Drawing division	52.25	Ice.....	298.27
Books, maps, and charts	1 047.26	Washing	109.36
Subscriptions	116.41	Miscellaneous expenses and contingencies of all kinds	1 433.26
Copper plates.....	704.95	Office furniture	907.99
Chart paper.....	5 862.02	Repairs.....	373.99
Engraving, printing, photographing, and electrotyping supplies	3 452.31	Extra labor.....	1 703.24
Extra engraving.....	1 701.39	Traveling expenses (office).....	14.15
Extra drawing.....	761.80	Rent of buildings for offices, workrooms, and workshops	10 500.00
Photolithographing.....	2 434.89	Rent of fireproof building	4 500.00
Printing for immediate use.....	766.12	Total.....	\$50 401.40
Stationery.....	1 768.33		
Transportation of instruments and supplies	678.10		

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Salaries—Standard weights and measures, 1891.

To whom paid.	Time employed.	Amount.
ADJUSTER.		
Louis A. Fischer	One year	\$1 500 '00
MECHANICIANS.		
Walter H. Bullock	Five months	415 '80
Jacob Schwarz	Three months twenty-five days	399 '30
WATCHMEN.		
Adelbert B. Simons	Three months two days	183 '91
Sayles J. Bowen	One month thirteen days	69 '04
David Somerville	Five months eighteen days	334 '00
Expenditures		2 902 '05
Appropriation		\$3 470 '00
Expenditures		2 902 '05
Unexpended balance		567 '95

Contingent expenses—Standard weights and measures, 1891.

MATERIALS AND INCIDENTAL EXPENSES.

To whom paid.	On what account.	Amount.
Brown & Sharpe Manufacturing Co	Micrometer caliper, etc	\$46 '80
John Chatillon & Sons	Balance	3 '25
Darling, Brown & Sharpe	Steel bars	35 '30
Eimer & Amend	Materials and funnels	23 '48
Z. D. Gilman	Materials	42 '00
Harrison Safety Boiler Works	Ice breakers	5 '00
H. Hoffa	Sapphirine	'50
Hoe, Bro. & Co	White velvet and millinet	9 '59
M. E. Kahler	Materials	72 '20
Melville Lindsay	Round belting	1 '26
Lutz & Bro	Leather handle	'75
W. H. Mehler	Materials	23 '00
Francis Miller	Oil barrel	1 '00
James W. Queen & Co	Quartz plate, filter pump, etc	26 '22
Royce & Marcan	Electrical supplies	48 '39
Geo. Ryneal, jr	Plate glass, etc	5 '58
L. H. Schneider's Son	Hardware	4 '10
O. H. Tittmann	Traveling expenses, etc	106 '95
United States Mint, Philadelphia, Pa.	Plate of pure gold	138 '85
Expenditures		\$593 '92

MATERIALS AND INCIDENTAL EXPENSES—Continued.

	Amount.
Appropriation—Legislative act July 11, 1890	\$500 '50
Appropriation—Deficiency act March 3, 1891	475 '00
Received from United States Commissioner of Customs for expenses of special investigations	\$975 '50
Expenditures	1 068 '45
*Unexpended balance	593 '92
	474 '53

* This balance will be partly absorbed in payment of obligations incurred before the close of the fiscal year.

UNITED STATES COAST AND GEODETIC SURVEY.

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

Contingent expenses—Standard weights and measures, 1891—Continued.

STANDARD GALLONS.

To whom paid.	On what account.	Amount.
Eagle Lock Co.	Lock	\$10.00
W. T. Galliber & Bro.	Lumber	25.25
Hooe, Bro. & Co.	Velvet	31.45
Philipp Kropp.	Constructing boxes	267.75
F. P. May & Co.	Brass butts, etc.	7.07
Geo. Ryneal, jr.	Glass	15.75
Henry Troemner	Liquid measures	760.00
Expenditures		1 117.07
Appropriation		\$1 500.00
Expenditures		1 117.07
Unexpended balance		382.93

BALANCE OF PRECISION.

To whom paid.	On what account.	Amount.
Johnson, Matthey & Co.	Weights	\$130.91
Riggs & Co.	Exchange, London	.09
Expenditures		131.00
Appropriation		\$1 200.00
Expenditures		131.00
* Unexpended balance		1 069.00

* This amount will be practically exhausted in payment for the Balance of Precision ordered in Europe upon the appropriation becoming available, but not yet delivered.

RECAPITULATION.

[Showing expenditures in gross (by sub-items) on account of the appropriation for Contingent Expenses—Standard weights and measures, 1891.]

	Amount.
Materials and incidental expenses	\$593.92
Standard gallons	1 117.07
Balance of precision	131.00
Total expenditures	1 841.99
Total amount appropriated for Contingent Expenses—Standard weights and measures, 1891:	
Legislative act July 11, 1890	\$3 200.00
Deficiency act March 3, 1891	475.50
	3 675.50
Received from United States Commissioner of Customs for expenses of special investigations	92.95
	3 768.45
Total amount expended for Contingent Expenses—Standard weights and measures, 1891	1 841.99
* Unexpended balance	\$1 926.46

* This balance will be partly absorbed in payment of outstanding obligations. (See foot notes under sub-items.)

EXPENDITURES COAST AND GEODETIC SURVEY, 1891—Continued.

RECAPITULATION.

[Showing appropriations, expenditures, and balances for the fiscal year ending June 30, 1891; also unexpended balance available on Alaska boundary survey from prior fiscal year and amounts received from other Government bureaus.]

Name of appropriation.	Appropriated.	Expended.	Balances.
Salaries—Pay of field officers.....	\$119 600·00	\$109 939·31	\$9 660·69
Salaries—Pay of office force.....	136 461·65	130 279·48	6 182·17
Party expenses*.....	166 800·00	160 760·73	6 039·27
Alaska Boundary survey : *			
Sundry civil act August 30, 1890.....	\$15 000·00		
Sundry civil act March 3, 1891.....	10 000·00		
Unexpended balance June 30, 1890.....	19 934·95		
	44 934·95	44 085·27	839·68
Repairs of vessels.....	25 000·00	24 862·44	137·56
Publishing observations.....	1 618·08	1 045·57	572·51
General expenses : *			
Sundry civil act August 30, 1890.....	\$51 500·00		
Deficiency act March 3, 1891.....	902·55		
Received from U. S. Light-House Board.....	407·19		
Received from Hydrographic Office, Navy Department.....	924·98		
	53 734·72	50 401·40	3 333·32
Salaries—Weights and Measures.....	3 470·00	2 902·05	567·95
Contingent Expenses—Weights and Measures : *			
Legislative act July 11, 1890.....	\$3 200·00		
Deficiency act March 3, 1891.....	475·50		
Received from United States Commissioner of Customs.....	92·95		
	3 768·45	1 841·99	1 926·46
Totals.....	555 387·85	526 128·24	29 259·61
Amounts appropriated and available as follows :			
Appropriations for Coast and Geodetic Survey proper for fiscal year ending June 30, 1891, including \$15 000 for Alaska Boundary survey, sundry civil act August 30, 1890.....			\$515 530·00
Appropriations for Office of Standard Weights and Measures, legislative act July 11, 1890.....			6 670·00
Received from other Government bureaus for materials and work.....			1 425·12
Increase by Treasury Department, under terms of joint resolutions of June 30, 1890, and subsequent dates.....			449·73
Appropriations to meet deficiencies on account of duty on imported instruments deficiency act March 3, 1891.....			1 378·05
Unexpended balance available on Alaska Boundary survey from prior fiscal year, and amount appropriated by sundry civil act March 3, 1891.....			29 934·95
Amounts expended as follows :			555 387·85
For Coast and Geodetic Survey.....	\$492 288·93		
For Standard Weights and Measures.....	4 741·04		
For Alaska Boundary survey.....	29 095·27		
			526 128·24
Total unexpended balance*.....			\$29 259·61

* The balances on these appropriations are subject to reduction on account of outstanding obligations, for details of which see footnotes under the different main headings of the tabulated statements of expenditures. The total unexpended balance will be correspondingly modified.

EXPENDITURES SINCE LAST REPORT ON ACCOUNT OF THE APPROPRIATIONS FOR THE SERVICE OF THE FISCAL YEAR ENDING JUNE 30, 1889.

Party expenses, 1889.

TRANSFER—STEAMER GEDNEY.

To whom paid.	On what account.	Amount.
J. M. Helm, U. S. Navy.....	Transfer—steamer <i>Gedney</i>	\$2 041·45
Appropriation—Deficiency act, September 30, 1890.....		2 041·45
Expenditures.....		2 041·45

TRANSCONTINENTAL WORK.

To whom paid.	On what account.	Amount.
William Kimbeck.....	Triangulation—Utah and Nevada.....	\$423·76
Appropriation—Deficiency act, September 30, 1890.....		423·76
Expenditures.....		423·76

EXPENDITURES SINCE LAST REPORT ON ACCOUNT OF THE APPROPRIATIONS FOR THE SERVICE
OF THE FISCAL YEAR ENDING JUNE 30, 1889—Continued.

General expenses, 1889.

STATIONERY, TRANSPORTATION OF INSTRUMENTS AND SUPPLIES, OFFICE WAGON AND HORSES, FUEL, GAS, TELEGRAMS,
ICE, AND WASHING AND TELEPHONE.

To whom paid.	On what account.	Amount.
Chesapeake and Potomac Telephone Co	Exchange rental	\$25.00
Stephenson's Express	Transportation	27.29
Western Union Telegraph Co	Telegrams	65.42
Expenditures		117.71
Appropriation—Deficiency act, September 30, 1890		117.71
Expenditures		117.71

EXPENDITURES SINCE LAST REPORT ON ACCOUNT OF THE APPROPRIATIONS FOR THE SERVICE
OF THE FISCAL YEAR ENDING JUNE 30, 1890.

Salaries—pay of field officers,

To whom paid.	Time employed.	Amount.
John E. McGrath	One year	\$1 400.00
John Henry Turner	do	1 300.00
Expenditures		2 700.00
Balance on hand—Report for 1890		13 663.80
Expended since, as above		2 700.00
Present unexpended balance*		\$10 963.80

*Adding to this sum the balance on pay of office forces for 1890, makes the total unexpended balance on salaries, 1890, amount to \$14 008.79.

Party expenses, 1890.

OBJECTS NOT NAMED.

To whom paid.	On what account.	Amount.
George Davidson	Expenses as delegate	\$51.28
Appropriation—Deficiency act March 3, 1891		51.28
Expenditures		51.28

Repairs of vessels, 1890.

To whom paid.	On what account.	Amount.
Huntington Hopkins Co	Steamer <i>McArthur</i>	\$164.12
Balance on hand—Report for 1890		101.44
Appropriation—Deficiency act March 3, 1891		62.68
Amount disallowed by Comptroller		.10
Expenditures		164.22
Present unexpended balance		164.12
		.10

General expenses, 1890.

Balance on hand—Report for 1890	\$126.33
Expended—J. H. Hickcox, for subscriptions	5.00
Present unexpended balance	121.33

U. S. COAST AND GEODETIC SURVEY,
OFFICE OF THE DISBURSING AGENT,
Washington, D. C., February, 25, 1892.

I certify that the foregoing statement is a complete exhibit in detail of the expenditures of the U. S. Coast and Geodetic Survey and of the Office of Standard Weights and Measures for the service of the fiscal year ending June 30, 1891, and prior years, as shown by the books, records, and accounts now on file in this office.

JOHN W. PARSONS,
Disbursing Agent,
U. S. Coast and Geodetic Survey.

Approved:

T. C. MENDENHALL,
Superintendent, U. S. Coast and Geodetic Survey.

OFFICE REPORT No. 4---1891.

REPORT OF THE ASSISTANT IN CHARGE OF THE OFFICE OF STANDARD WEIGHTS AND MEASURES FOR THE FISCAL YEAR ENDED JUNE 30, 1891.

UNITED STATES COAST AND GEODETIC SURVEY,
OFFICE OF STANDARD WEIGHTS AND MEASURES,
Washington, D. C., Nov. 14, 1891.

SIR: This report on the conduct of the Office of Standard Weights and Measures during the fiscal year ending June 30, 1891, is herewith respectfully submitted:

On July 14, 1890, National Prototype Metre, No. 21, and Kilogramme, No. 4, together with the certificates relating to these and to the other Metre and Kilogramme, were brought by me to Washington from Paris, and on July 18, they were formally deposited in the Standards Room.

On July 19, I resumed charge of the Office, relieving Assistant F. H. Parsons, who was altogether detached from this Office on September 8.

The duties of mechanic and watchman are accounted for in the reports of the Instrument and Miscellaneous Divisions respectively.

Mr. L. A. Fischer, Adjuster, during the year performed the varied duties of his office with skill and ability. Besides making verifications and adjustments of Standards, he gilded numerous weights, and assisted in the determination of the expansion co-efficients of the five-metre rods 13 and 14, and in polariscopic work.

Mr. John F. Hayford was assigned to duty on December 15, and continued attached to this Office throughout the remainder of the year. His duties related chiefly to weighing and to the determination of densities of weights intended to be used as the reference and working standards of subsidiary weights. The pressing calls on this Office from outside sources for comparisons of weights interfered continually with the plan of confining him to the particular duty of correlating all the office weights of different denominations, by reference to the Prototype Kilogramme. The speedy consummation of this plan is urgently needed in the interest of economy. A register of final results was begun by Mr. Hayford, containing systematic entries of results and detailed description of the office weights. Systematic schemes of weighing were formulated by him for office use. In June he made a determination of the corrections at five points of the scale of each, of 128 Balling Saccharometers, for the U. S. Internal Revenue Bureau.

STANDARD WEIGHTS.

The reception of Prototype Kilogramme, No. 4, has been referred to.

In October a set of twenty platinum iridium weights from fifty grammes downward was secured from Johnson, Matthey & Co., of London, the same firm who prepared the alloy for the International Kilogrammes. Mr. Matthey stated to me that these weights were of the same alloy as the International Standards. The densities of the larger of these weights were carefully determined by hydrostatic weighings; their relative masses were found by intercomparison, and their absolute values by reference to the Arago platinum Kilogramme. They are now the Standard subsidiary weights of this Office.

As the old metric star weights of this Office are hollow and not gilded, it was deemed important to have a more perfect set, and such a one was constructed by the Instrument shop from drawings and dimensions furnished by Mr. Fischer, Adjuster. The set was made from a single bar of wrought brass in June and July, 1890. They were electro-gilded by Mr. Fischer and their volumes were determined by Mr. Hayford. As soon as practicable their masses will be determined.

For the purpose of electro-gilding weights a gold plate was purchased from the United States Mint, through the courtesy of the Director, Mr. E. Leech.

STANDARDS OF LENGTH.

In regard to these nothing is to be noted except the reception of National Prototype Metre, No. 21, already referred to. A steel bar of H cross-section and intended to be converted into a working standard metric scale was acquired during the year, and also a 10-foot steel bar to be used in the graduation and comparison of long Bench or Mural Standards. These bars, for lack of time, have not yet been graduated.

STANDARD CAPACITY MEASURES.

The stock of customary capacity measures for use of the States having become exhausted, ten sets were ordered in September from Henry Troemner, of Philadelphia, to be constructed according to specifications furnished by this Office. They were promptly supplied by the maker in January. The final adjustment of each set will be deferred until it is needed.

STANDARDS FURNISHED TO STATES.

On September 30, 1890, a complete set of customary and metric weights and measures, with the exception of the Standard End Metre, was furnished to the State of Washington.

The State of Massachusetts was supplied with a set of avoirdupois and ounce weights on December 20th.

Numerous comparisons of weights were made for the District of Columbia, and a balance was loaned to it at the request of the Commissioners.

ELECTRICAL STANDARDS.

On April 9, 1891, a standard legal Ohm was received through the State Department from Dr. René Benoit, Director of the International Bureau of Weights and Measures, by whom it was presented to this Office. In regard to it Dr. Benoit in a letter dated March 21, says:

"This copy (No. 10) was compared by my colleague Dr. Guillaume with three of my standards and by two absolutely different methods. Thus six values were obtained, all very accordant, the mean of which gave

Ohm (legal)

No. 10 = 1.00003 at zero.

"The extreme errors of the individual results with reference to this mean do not exceed ± 1 unit in the last place. I believe therefore that one may consider the above value as certain within 1 unit in the last place. (one hundred thousandth of an Ohm.)"

Thus this Office owes the possession of its first electrical standard of precision to the liberality of Dr. Benoit.

A description of this standard and the manner in which its prototypes were determined will be found in a pamphlet entitled "Construction des Étalons Prototypes de Résistance Électrique du Ministère des Postes et des Télégraphes par M. J. René Benoit, Paris, 1885."

Besides the current work of the Office already referred to, other matters engaged the time and attention of this Office. Among the most important of these was the request from Assistant Secretary Spaulding, made September 20, that this Office should undertake an examination of the standards for testing sugars, in use in the Custom-houses at Boston, Philadelphia, and New York. Having been designated by you to make the examination,

ANNUAL REPORT OF THE ASSISTANT IN CHARGE OF THE OFFICE OF STANDARD WEIGHTS AND MEASURES, FOR THE FISCAL YEAR ENDED JUNE 30, 1891.—Continued.

those ports were visited by me, and a careful examination was made between November, 18 and December 4. This examination was followed by a determination of the sugar values of a quartz plate used by me for comparing the relative values of the quartz plates in use in Philadelphia and New York. The results were embodied in a detailed report submitted December 31.

On March 11, I was designated by you to represent this Office on a Commission organized by the Hon. John W. Mason, Commissioner of Internal Revenue, for the purpose of recommending standards and methods to be used in the analysis, by the optical method, of sugars on which bounty is paid, and on this Commission I served until the completion of its labors. Since this Commission submitted its recommendations, this Office has graduated all the sugar flasks and verified the sugar weights and lengths of polariscope tubes used in the Internal Revenue Bureau. In addition, at the request of the Commissioner, a large number of Balling Saccharometers have been standardized.

This Office has endeavored to meet the demands upon it with promptness, but its means are inadequate. More room and more assistance is required.

When the sacred obligation of the Government to be just, is considered, and that lack of uniformity in the weights and measures which enter into nearly all the dealings of the Government with the people surely involves injustice, it need hardly be pointed out that the office charged with the preservation of the ultimate standards should be furnished with adequate means to perform the duties which tend to secure uniformity, and which necessarily fall to it.

Yours, very respectfully,

O. H. TITTMANN,

Assistant in charge

of the Office of Standard Weights and Measures.

Dr. T. C. MENDENHALL,

Superintendent U. S. C. and G. Survey,

and of Standard Weights and Measures.

OFFICE OF STANDARD WEIGHTS AND MEASURES.

ABSTRACT OF VERIFICATIONS OF WEIGHTS AND MEASURES MADE DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

Date.	Name.	Service.
1890		
July	Tagliabue, G., New York	Thermometers compared.
	City Engineer, Sandusky, Ohio	Tape compared.
	Wilkening, G., Houston, Texas	Weights compared.
	Sikes, F. C. & C. R., Buffalo	Tape compared.
August	District of Columbia	Weights compared.
	Coast and Geodetic Survey	Avoirdupois pound No. 26 furnished.
	Coast and Geodetic Survey	Thermometers compared.
	Adjuster, San Francisco Mint	Weights compared.
	Tagliabue, G., New York	Thermometers compared.
	District of Columbia	Ounce weights compared and furnished.
	Queen & Co., Philadelphia	Chain compared.
	Trantwine, J. C., Philadelphia	Information furnished.
	Clapp Ammonia Co., Cincinnati	Information furnished.
	District of Columbia	Medium sized balance loaned.
September	Lucas, Geo. F., Castile, New York	Tape compared.
	Lucas, Geo. F., Castile, New York	Tape compared.
	U. S. Internal Revenue	Capacity measures adjusted.
	Rogers, A. W.	Thermometers compared.
October	State of Washington	Standard weights and measures furnished.
	Coast and Geodetic Survey	Tape compared.
	Quickberner, C. A. J., Washington	Weights compared.
November	District of Columbia	Weights compared.
	Coast and Geodetic Survey	Pendulums weighed.
	Coast and Geodetic Survey	Thermometers compared.
December	Aloe, A. S., St. Louis	Tape compared.
	Dean, Seth, Iowa	Tape compared.
	Proprietors Locks and Canals, Massachusetts	Tape compared.
	State of Massachusetts	Weights compared and furnished.
	U. S. Mint	Weights furnished.
1891		
January	Brown, W. R., Wichita	Tape compared.
	U. S. Internal Revenue	Capacity measures verified.
	Harvard College Laboratory	Weights compared.
	Varney, J. D., Cleveland	Tape compared.
	Winslow, Lieut., U. S. N.	Densities determined.
	Treasury Department	Quartz plates determined.
	State Geologist, Arkansas	Thermometer compared.
February	Coast and Geodetic Survey	Thermometer compared.
March	Harvard College Laboratory, Massachusetts	Weights compared.
April	Coast and Geodetic Survey	Coefficients of bronze determined.
	Fairbanks & Co., Vermont	Weights compared.
	Becker Bros., New York	Yard compared.
	Chase, C. F., Providence	Tape compared.
	Farsell, H. V., New York	Tape compared.
	Becker Bros., New York	Weights compared.
	Coast and Geodetic Survey	Weighing of inertia ring.
May	Coast and Geodetic Survey	Thermometers compared and numbered.
	Hell Chemical Co., Kansas	Weights compared.
	Case School, Cleveland	Metre compared.
	U. S. Geological Survey	Tape compared.
	U. S. Internal Revenue	Sugar standards verified.
	U. S. Internal Revenue	Weight compared.
	U. S. Internal Revenue	Sugar standards verified.
	U. S. Internal Revenue	Capacity measures verified.
	U. S. Coast and Geodetic Survey	Coefficients of expansion determined.
	U. S. Geological Survey	1000-foot tape compared.
June	U. S. Internal Revenue	128 hydrometers verified.
	District of Columbia	Tape verified.
	Gray, W. C., Rochester	Tape verified.
	U. S. Internal Revenue	237 flasks graduated.

U. S. COAST AND GEODETIC SURVEY REPORT FOR 1891.

PART I.

PROGRESS SKETCHES.

- No. 1. Sketch of general progress (eastern sheet).
- No. 2. Sketch of general progress (western sheet).
- No. 3. General chart of Alaska.
- No. 4. Map showing longitude stations and connections determined by the electric telegraph between 1846 and June 30, 1891.
- No. 5. Map showing positions of magnetic stations occupied between 1844 and June 30, 1891.
- No. 6. Map showing lines of geodetic leveling run, and positions of gravity stations to June 30, 1891.
- No. 7. Progress of the surveys and resurveys between the St. Croix and Hudson rivers (with sub-sketeh).
- No. 8. Triangulation between the Atlantic Coast and the Ohio River.
- No. 9. Triangulation between the Ohio and Mississippi rivers.
- No. 10. Triangulation between the Mississippi River and eastern Colorado.
- No. 11. Triangulation between eastern Colorado and Utah.
- No. 12. Triangulation between Utah and western Nevada.
- No. 13. Triangulation between western Nevada and the Pacific Coast.
- No. 14. Sketch showing the connection of the triangulations of Kentucky, Tennessee, Georgia, and Alabama, with extension of triangulation in Alabama towards the Gulf Coast.
- No. 15. Progress of the survey on the coasts of Florida, Alabama, Mississippi, and Louisiana.
- No. 16. Triangulation in Wisconsin and Minnesota.
- No. 17. Progress on the coast of California between San Diego and Point Sal.
- No. 18. Progress on the coast of California between Point Sal and Tomales Bay with sub-sketch, Tomales Bay to Mendocino Bay.
- No. 19. Progress on the coasts of California and Oregon from Cape Mendocino to Umpquah River.
- No. 20. Progress of the survey on the coasts of Oregon and Washington from Tillamook Bay to the Boundary.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

Please Note:

This project currently includes the imaging of the full text of each volume up to the "List of Sketches" (maps) at the end. Future online links, by the National Ocean Service, located on the Historical Map and Chart Project webpage (<http://historicals.nod.noaa.gov/historical/histmap.asp>) will include these images.

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