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, 1887.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1889.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

The annual report of the Superintendent of the U. S. Coast and Geodetic Survey.

DECEMBER 13, 1887.—Laid on the table and ordered to be printed.

TREASURY DEPARTMENT, *December* 12, 1887.

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 F. M. Thorn, Superintendent of the Coast and Geodetic Survey, showing the progress made in that work during the fiscal year ended June 30, 1887, and accompanied by charts illustrating the general advance in the operations of the Survey up to that date.

Respectfully, yours,

C. S. FAIRCHILD,
Secretary.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

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REPORT.

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, December 12, 1887.

SIR: The report of progress made in the work of the Coast and Geodetic Survey for the fiscal year ended June 30, 1887, which I have the honor to submit herewith, in accordance with law and with the regulations of the Treasury Department, shows that every branch of the Survey has been actively prosecuted during the year to a degree commensurate with the means afforded by Congress. Estimates approved by the Department having been largely reduced, field operations were necessarily restricted, and I would again urge the importance of obtaining, for the proper development and economical conduct of the work, appropriations to the full amount of the approved estimates.

A careful analysis of the appropriations made in the Sundry Civil Expenses Act for the present fiscal year shows that for objects and purposes depending upon or related to the care and maintenance of the country and the Government, there was appropriated by that Act the sum of $16,468,526, and for those relating to or dependent upon their growth and development, the sum of $5,918,015, or about 36 per cent.

That the Coast and Geodetic Survey, in its appliances, methods, purposes, and results, is essentially a work bearing a close relation to the growth and development of the country can hardly be denied. For its service for the fiscal year 1887–'88, the amount estimated ($560,765) was less than one-tenth of the sum allotted to the needs of growth and development, and for the fiscal year 1888–'89, an aggregate somewhat less is submitted* for the approval of the Treasury Department.

In its general form and in the arrangement of its parts, this report follows those published since and including the year 1882. A systematic arrangement was then introduced into Part I, which included statements of general progress in field-work, office-work, and special scientific work; this was continued in the reports for 1883 and 1884, and enlarged in 1885 by a list of the Notices to Mariners published during the fiscal year.

The summary statements of general progress given in Part I are amplified in Part II, and are arranged in tabular form and in a geographical order in Appendix No. 1, Part III. Other appendices which have place in Part III are those giving the statistics of the field and office work of the Survey for the fiscal year (Appendix No. 2), a table of the information furnished to Departments of the Government in reply to special requests and to individuals upon application (Appendix No. 3), and the annual reports of the Assistant in charge of Office and Topography and of the Hydrographic Inspector for the fiscal year (Appendices Nos. 4 and 5). The appendices which follow these are referred to under the heading "Special Scientific Work" in Part I. They contain reports or discussions of the methods and results of the Survey which have been deemed worthy of publication.

In the map of general progress (Sketches Nos. 1 and 2), which accompanies this report, the advance made in the several operations of the Survey up to June 30, 1887, is exhibited graphically. A separate map (Sketch No. 12), shows the progress of the work in Alaska to the same date.

The index maps which are appended show the limits of the several classes of charts published by the Survey for the Atlantic, Gulf, and Pacific coasts of the United States.

* See Statement of Estimates at close of Part I.

PART I.

During the past fiscal year, field operations, including triangulation and topography, astronomical and magnetic work, were carried on within the limits or on the coasts of twenty-seven States and three Territories, and in the District of Columbia. Hydrographic surveys were prosecuted in the waters or off the coasts of seventeen States and two Territories.

Effort was concentrated in pushing to completion important surveys already in progress, and in beginning those imperatively demanded by the interests of commerce and navigation. Special attention was given to the study of the physical changes in Monomoy and its shoals; to the completion of the resurveys of Long Island Sound and of New York Harbor and its approaches; to the formation and movement of ice and of shoals in Delaware River and Bay; to the investigation of the currents of the Gulf Stream, and to resurveys of the harbors of San Francisco and San Diego.

Advance was made in the special triangulation begun in 1884 at the request of the Commissioners of the topographical survey of the State of Massachusetts; the surveys asked for by the Harbor Board of Baltimore to define port-warden lines in that harbor, and to connect them with the triangulation, were made; the boundary line between the States of Virginia and North Carolina was determined at the request of the Commissioners of those States; hydrographic resurveys and examinations were made at New Inlet, North Carolina, Saint Simon's Sound, Georgia, and Atchafalaya Bay, Louisiana. A special examination was made in Charleston Harbor to determine any changes of depth due to the effects of the earthquake. On the coasts of California and Oregon, of Washington Territory and of Alaska, surveys were in active progress.

The basis for accurate National and State surveys afforded by the transcontinental triangulation authorized by act of Congress March 3, 1871, and intended to connect the work on the Atlantic and Pacific coasts, has been extended by the continuation of geodetic operations in the States of Pennsylvania, New Jersey, Tennessee, Indiana, and Wisconsin, and by a survey begun towards the close of the fiscal year in the State of Minnesota, the only State which had made requisite provision for its own topographical and geological surveys, as provided in the act just referred to, and in which points had not been already furnished.

The general statements of progress which follow are classified under the heads of "Field-Work," "Office-Work," "Discoveries and Developments," and "Special Scientific Work."

GENERAL STATEMENT OF PROGRESS.

I.—FIELD-WORK.

ATLANTIC COAST.—During the fiscal year ended June 30, 1887, the following operations were included in the work of the Survey upon the coasts and within the borders of the New England States: Triangulation in the vicinity of Calais, Me., to connect with the Northeastern Boundary Survey; hydrographic survey begun in the Saint Croix River, Maine; triangulation and topography in Cobscook Bay and vicinity, and topography from Moose Cove to Quoddy Head, coast of Maine; hydrographic survey of the coast of Maine from Machias Bay Entrance to Quoddy Head, and hydrographic examinations in Penobscot River, Maine; continuation of the tidal record from the self-registering tide-gauge at Pulpit Cove, North Haven Island, Penobscot Bay; detached hydrographic examinations on the coasts of Maine and Massachusetts; continuation of the special triangulation for the topographical survey of the State of Massachusetts; triangulation and topography upon the coast of Massachusetts between Chatham and Monomoy Point; hydrographic survey from Chatham to Monomoy; investigations of the tides, currents, and movements of the sands at the entrance to Vineyard Sound; hydrographic examinations for the Coast Pilot on the coasts of Massachusetts and Rhode Island; completion of a topographical survey of the new opening in Cotamy Beach, Martha's Vineyard; hydrographic examinations in Vineyard Sound and approaches; completion of the topographical resurvey of Block Island; triangulation at the eastern entrance to Long Island Sound; topographic resurvey in the vicinity of Stonington, Conn.; hydrographic resurveys in Long Island Sound, between Falkner's Island and Execution Rocks; topographic resurvey on the north shore of Long Island Sound in the vicinity of Clinton and Madison, Conn.; also from Woodmont, Conn., to the eastward, and from Woodmont westward to East Bridgeport, and completion of the interior topographical resurvey near the north shore of Long Island Sound from Norwalk River to Throg's Neck.

Field operations upon the coasts and within the limits of the States of New York, New Jersey, Pennsylvania, and Delaware, included hydrographic examinations and observations of currents off Race Rock, towards Little Gull Island; hydrographic examinations for the Coast Pilot of harbors in Long Island Sound, Gardiner's Bay, and Fisher's Island Sound; topographic resurveys on the south shore of Long Island Sound; inshore hydrography of the south shore of Long Island Sound, from Smithtown Bay to Oyster Bay Harbor; hydrographic resurveys in the western part of Long Island Sound; special hydrography for the determination of tidal levels in Little Neck, Flushing and Newark Bays, and in East River, Harlem and Hudson Rivers, New York; physical hydrography in New York Bay and Harbor, including observations of currents; geodesic leveling from Willets Point to Corlear's Hook, New York; topographic resurveys on the shores of the Harlem and Hudson Rivers, New York; triangulation in Newark Bay and topographic resurveys of the shore lines of Newark Bay, Bergen Neck, etc.; topographic resurveys of the Staten Island shore of New York Bay from Stapleton south and southwestward, and of the shore lines of Raritan and Sandy Hook Bays; examination of the Swash Channel, New York Harbor; hydrographic resurvey of New York Lower Bay; record continued from self-registering tidal station at Sandy Hook, New Jersey; continuation of geodetic operations in the State of Pennsylvania; physical hydrography of Delaware River, with observations of the formation and movement of ice in that river; continuation of geodetic operations in the State of New Jersey; connection of triangulations on the coast of New Jersey; completion of the topographical resurvey of that coast, and hydrographic work off shore from Cape May towards Cape Charles.

Within the District of Columbia and the State of West Virginia, and upon the coasts and within the boundaries of the States of Maryland, Virginia, North and South Carolina, and Georgia, field operations included a special triangulation for defining port-warden lines in Baltimore Harbor, with a topographical and hydrographical resurvey of that harbor; magnetic determinations at Washington, D. C.; continuation of the detailed topographical survey of the District of Columbia; magnetic observations and establishment of a meridian line at Charlottesville, Va.; magnetic observations at Williamsburgh and at Cape Henry, Virginia; triangulation and topography on the Virginia coast in the vicinity of Cape Charles; off-shore soundings between Cape Charles and Cape May; survey of the boundary line between Virginia and North Carolina; special survey for the State of North Carolina to define the location and limits of oyster-beds; magnetic observations at stations in that State, and triangulation and topography upon its coast; hydrographic resurvey at New Inlet, North Carolina; special hydrographic examination in Charleston Harbor, South Carolina; magnetic observations at stations in Georgia, and hydrographic examinations in Saint Simon's Sound, Georgia.

Upon the east and west coasts of Florida, in the approaches to these coasts, in the interior of Florida, and upon the coasts and within the limits of the Gulf States, the following operations were in progress or completed: Occupation of stations in Florida for magnetic observations; continuation of observations of currents in the Gulf Stream; triangulation and topography on the west coast of Florida from Cape Sable to Pavilion Key; hydrographic surveys on that coast from Estero Bay southward, and from Saint Joseph's Bay (or Anclote Sound) northward; reconnaissance and triangulation in northern and central Alabama carried towards the Gulf coast; lines of geodesic leveling run in Alabama and Mississippi; triangulation and topography on the coast of Louisiana between Grande Isle and Raccoon Point, and soundings of the dredged channel in Atchafalaya Bay.

PACIFIC COAST.—Field operations in progress or completed upon the coasts and within the boundaries of the States of California and Oregon, of Washington Territory and of Alaska, included resurveys of San Diego and San Pedro Bays, California; triangulation and topography in the vicinity of San Juan Capistrano; continuation of observations at the self-registering magnetic station, Los Angeles, Cal.; examinations for the Pacific Coast Pilot in the vicinity of the Santa Barbara Islands; topographical survey from Piedras Blancas to Point Sur; topographical and hydrographical resurveys in San Francisco Bay and in San Pablo and Suisun Bays; observations continued at the self-registering tide-gauge station at Saucelito, San Francisco Bay; occupation of the San Francisco station for the determination of longitudes by telegraphic exchanges of signals with Salt Lake City and Ogden, Utah; topographic survey between Koos Bay and Umpquah River and completion of the hydrography of the Umpquah River and Bar; topographical reconnaissance of the coast of Oregon from the Umpquah River to the Yaquina River and from the Yaquina River to Tillamook Bay, with examinations of sites proposed for light-houses at Cape Lookout and Cape Meares; hydrographic surveys on the Oregon coast between the Umpquah River and Tillamook Bay, with hydrography of Nestucca Bay and Nehalem River; hydrography continued in the Columbia and Willamette Rivers; station for latitude, longitude, and magnetic observations occupied at Portland, Oregon; reconnaissance, triangulation, and topography from Shoalwater Bay to Gray's Harbor, Washington Territory; special triangulation and topography at Tacoma and Seattle; reconnaissance from Gray's Harbor to Cape Flattery, Washington Territory; hydrographic surveys continued in Puget Sound; triangulation and topography of Port Susan, Stillaguamish River, and Saratoga Passage, Washington Territory; triangulation and topography of Rosario Strait and vicinity; continuation of the record from the self-registering tidal station at Saint Paul, Kadiak Island, Alaska, and hydrographic surveys of harbors, straits, etc., in southeastern Alaska.

INTERIOR STATES.—In the States between the Atlantic and Pacific coasts, field-work included the extension westward of the primary triangulation and reconnaissance near the thirty-ninth parallel in Kentucky and Ohio; reconnaissance for additional stations in the same States and in Indiana; geodetic operations continued in the State of Tennessee; extension to the eastward of the transcontinental triangulation near the thirty-ninth parallel in the State of Indiana, and continuation of geodetic operations in that State and in the State of Wisconsin; transcontinental triangulation in Missouri and Kansas carried to the westward; station for magnetic observations occupied at Saint Louis, Mo.; geodetic operations begun in the State of Minnesota; stations for the determination of latitudes, and of longitudes by telegraphic exchanges of signals occupied at Colorado Springs, Gunnison, and Grand Junction, Colo., and at Salt Lake City and Ogden, Utah, and continuation of the primary triangulation and reconnaissance to the eastward from stations in central Utah.

SPECIAL OPERATIONS during the year included the testing and adjustment at the United States Mint in Philadelphia of a new set of standard weights for the use of the San Francisco Mint, and the detail of an officer of the Survey to execute special surveys desired by the Hawaiian Government.

II.—OFFICE-WORK.

In the Coast and Geodetic Survey Office, which is charged with the duty of making the results of field-work accessible to the people and to the Government by the speediest and most economical methods, the efforts of the Assistant in charge were heartily seconded by the chiefs of the several office divisions, and the annual report of that officer (Appendix No. 4) indicates increased efficiency and economy of administration.

A more detailed notice of office operations is given towards the close of Part II of this volume. They are here briefly summarized.

During the fiscal year there were published twenty-four new charts and nine new editions of charts, ten new charts and four new editions being from engraved plates; fourteen new charts and five new editions from photolithographs. There were printed thirty-five thousand one hundred and thirty charts, of which number twenty-nine thousand eight hundred and fifty-two were from engraved plates and five thousand two hundred and seventy-eight from stone. Distribution was made of thirty-four thousand and sixteen copies of charts. Of this number eight thousand eight hundred and twenty-four were for the use of the Executive Departments, two thousand five hundred and fifteen for Congress, and twenty-one thousand and ten were sent to agents for sale.

Twelve Notices to Mariners were issued during the year, and twelve thousand copies of these Notices were printed for distribution.

Tide-Tables, predicting for 1888 the times and heights of the tide on the Atlantic and Pacific coasts, were in preparation and are now published. Upwards of four hundred and eighty copies of the third edition of Subdivision No. 13, Atlantic Local Coast Pilot, including the south coast of Long Island, New York Bay, and Hudson River, were printed. The manuscript of a new edition (the fourth) of the Pacific Coast Pilot, was nearly completed for publication.

Of the Annual Reports for various years, two thousand eight hundred and one copies were distributed.

III.—DISCOVERIES AND DEVELOPMENTS.

Reference was made in the last annual report to the beginning of a series of Notices to Mariners which should be published quarterly, and should contain a list of all corrections made to the charts of the Survey during each quarter of the fiscal year; also lists of charts canceled, new charts issued or in preparation, and the more essential parts of the special Notices which are from time to time published announcing dangers to navigation, changes in lights, buoys, and depths in channels, etc. The value of this quarterly series soon became so manifest that the Hydrographic Inspector, at whose instance it had been begun, recommended a monthly issue, and towards the close of the fiscal year arrangements had been perfected for carrying this recommendation into effect. For part of the information incorporated in this series of Notices, the Survey is indebted to the Light-House Board and to the Bureau of Engineers.

Following is an abstract of the Notices issued during the fiscal year:

No. 77 (September 30, 1886). Coast of the United States. Chart corrections during the quarter ending September 30, 1886.

No. 78 (October 13, 1886). Atlantic coast. Velocity and direction of the Gulf Stream between Fowey Rocks, Florida, and Gun Cay, Bahamas.

No. 79 (October 15, 1886). Atlantic coast. Development of shoals off False Cape, Virginia.

No. 80 (October 23, 1886). Ledges developed in the resurvey of Long Island Sound.

No. 81 (November 8, 1886). Coast of the United States. Correction of an error in Notice to Mariners No. 77.

No. 82 (December 1, 1886). Atlantic coast. Ledge developed in East River, New York.

No. 83 (December 31, 1886). Coast of the United States. Chart corrections during the quarter ending December 31, 1886.

No. 84 (January 8, 1887). Atlantic coast. Obstruction to navigation in the Gulf Stream.

No. 85 (March 31, 1887). Chart corrections during the quarter ending March 31, 1887.

No. 86 (April 16, 1887). Dangerous sunken wreck in Long Island Sound.

No. 87 (June 9, 1887). Shoal spot on rocky ledge off Eaton's Point, Long Island Sound, New York.

No. 88 (June 30, 1887). Chart corrections during the quarter ending June 30, 1887.

IV.—SPECIAL SCIENTIFIC WORK.

HEIGHTS FROM SPIRIT-LEVELING OF PRECISION BETWEEN MOBILE, ALA., AND CARROLLTON (NEW ORLEANS), LA.

In Appendix No. 9, Assistant Schott discusses the methods and results of the lines of geodesic leveling which were run by Assistant Weir between Mobile and New Orleans in 1885–'86.

The geodesic micrometer levels used in this work are described and illustrated, and the modes of using them explained, in Appendix No. 15, 1879, and in No. 11, 1880. Assistant Weir's methods were the same, with the important exception that instead of running a simultaneous double line of levels with reversal of direction for alternate sections, he secured two independent measures by running a single line in one direction, followed by a single line in the opposite direction. As the reversal of direction took place either about the middle of the same day, or on different days, according to circumstances, the conditions of the instrument and of the atmosphere were different for the two measures, and the results should therefore be of greater value than by the method previously followed.

From a discussion of probable errors, Mr. Schott finds that the measure from Mobile to Carrollton (New Orleans) is one of great accuracy. By a comparison of his results with those of the Mississippi River Commission, referred to the tide-gauge and bench-mark of that Commission at Biloxi, Miss., he determines the heights of the bench-marks at Mobile and Carrollton above the average Gulf level, and at the close of his elaborate paper gives a table of the resulting heights of the permanent bench-marks between Biloxi and Mobile above the average or half-tide level of the Gulf.

A feature of the report which will have special interest for geodesists is the inquiry into the magnitude of the deflection of the vertical depending upon the disturbing influence of the differential attraction of the sun and moon, the conclusion reached being that this disturbing influence is of so minute an order that it is masked entirely by the probable uncertainties of the measure itself.

ON THE MOVEMENTS OF THE SANDS AT THE ENTRANCE TO VINEYARD SOUND.

A question of practical interest relative to the movements of the sands at the eastern entrance to Vineyard Sound is discussed by Assistant Henry Mitchell in a paper published as Appendix No. 6 to this volume. What are the dangers to commerce which are threatened by these movements and by the changes which they involve in the shoals?

The report on Monomoy and its Shoals, which was published as Appendix No. 8 to the Annual Report for 1886, was a strictly historical sketch, nor was anything more contemplated at that time; but the discovery of the influence of *stage* in the recent physical survey of New York Harbor gave new meaning to the tidal and current observations made by Mr. Mitchell's party thirty years ago in the Vineyard Sound and its approaches, and it was therefore determined to recompute them so as to bring out their relations to the deposits and their movements.

By reason of the higher *stage* the current that flows southward along the Monomoy peninsula and westward through Butler's Hole not only carries a larger volume of water but at a greater velocity than the reverse tide. "The sands from the north press into the Vineyard Sound, not simply because it offers a dead angle or pocket, but also because there is a *draught* through to the southwestward."

Studies from comparative surveys and observations of currents and waves give some grounds for apprehending that this entrance to the Sound may close.

FLUCTUATIONS IN THE LEVEL OF LAKE CHAMPLAIN AND AVERAGE HEIGHT OF ITS SURFACE ABOVE THE SEA.

In connection with the systematic survey of Lake Champlain which was made part of the duty of the Coast Survey by Congress in 1870, it became necessary to decide upon some plane of reference to which the soundings of the lake, taken in different months and years, should be reduced as a standard, and as bearing a close relation to this inquiry was the collection of data and observations to determine the average elevation of the lake above the half-tide or mean level of the sea.

The irregular, periodic, and secular variations in the lake level are discussed by Assistant Schott in a paper which appears as Appendix No. 7 to this volume. Certain anomalies in the monthly fluctuations of level as derived from observations made between 1871 and 1882, led Mr. Schott to compare the fluctuations in the level of Lake Champlain with those of Lake Ontario. For Lake Ontario he obtained monthly means from observations between the years 1859 and 1881, and was thereby enabled to deduce laws of change which show the need of a longer series of observations at a station on Lake Champlain.

Authorities were found to differ considerably as to the average elevation of the lake above the ocean, and to differ largely in regard to its greatest depth, the figures for depth ranging from 282 to 600 feet. Mr. Schott gives as a result of his investigations 402 feet for the greatest depth and 97.2 feet for the height of the average lake level above the mean level of the sea. He finds also from the observations made between 1871 and 1882 an extreme fluctuation of level of 7.99 feet, the highest stage of water observed during that period being 5.21 feet above the average level, and the lowest stage 2.78 feet below it.

ABSTRACT OF THE RESULTS OF THE ASTRONOMICAL AND MAGNETIC OBSERVATIONS MADE BY THE INTERNATIONAL POLAR EXPEDITION TO LADY FRANKLIN BAY IN 1881–1884, UNDER COMMAND OF LIEUT. A. W. GREELY, U. S. ARMY, AND IN ACCORDANCE WITH SPECIAL DIRECTION GIVEN BY THE COAST AND GEODETIC SURVEY.

The co-operation of the Coast and Geodetic Survey in the organization of the scientific work of the International Polar Expedition to Lady Franklin Bay, 1881–1884, under the command of Lieut. A. W. Greely, U. S. Army, has become well known through the history of that expedition published by its leader.

In Appendix No. 10 to this volume, Assistant Schott presents an abstract of the results deduced by him from the astronomical and magnetic observations made at the International Polar station, Fort Conger, the records of which were placed in his hands for discussion and for preparation for the press. The high northern latitude (81° 44′) of this station; the length of time during which the magnetic observations were kept up; the care taken to make them conform in arrangement to the general international programme, and the steady persistence and faithfulness of the observer, will give special value to the results and amply repay the very laborious work of computation, when it shall be possible to compare them with those of other expeditions organized during the same period.

Mr. Schott's paper embodying the record and full discussion of the observations was communicated by direction of the Superintendent to Lieutenant Greely, and published by him as Appendix No. 139 to the second volume of his report.*

The abstract referred to in this notice gives a summary of the chief additions to our knowledge of terrestrial magnetism as derived from the Fort Conger observations, and concludes with a statement urging the importance of a new determination of the American Pole of Dip.

GULF STREAM EXPLORATIONS. OBSERVATIONS OF CURRENTS, 1887.

Lieut. J. E. Pillsbury, U. S. N., Assistant Coast and Geodetic Survey, presents in Appendix No. 8 to this volume a full report of his observations of the currents of the Gulf Stream in the winter and spring of 1887, together with a summary of results obtained and a comparison of these with the results of the two seasons preceding.

In Appendices No. 14 of 1885 and No. 11 of 1886, Lieutenant Pillsbury described the apparatus which he has devised for this work and the methods adopted for it. The expeditions of those years were devoted to an investigation of the currents of that part of the Stream between Fowey Rocks and Gun Cay, its narrowest part, with the object of ascertaining the laws governing the flow. In 1887, the current stations occupied crossed the Stream in three sections, one between Cape San Antonio, Cuba, and Cape Catoche, Yucatan; a second, between Rebecca Shoal, Florida, and Havana, Cuba, and a third, normal to the coast off Cape Hatteras.

All of these sections were of much greater depth than any before attempted for observations of currents, and not the least gratifying feature of the season's work was the ability to anchor the steamer safely and expeditiously in these depths. The greatest was off Hatteras, in 1,852 fathoms, and that, too, with a surface current of over four knots. A most interesting result of the observations off Hatteras was the discovery by direct evidence of the existence of tidal action and of a polar counter-current underneath the Gulf Stream water.

After an account of certain improvements made in the apparatus, the report discusses the general characteristics and limits of the Stream at each cross-section; its daily variation; its axis; its depth, and velocity at different depths; and finally compares the results obtained from the sev-

* Report of the International Expedition to Lady Franklin Bay, Grinnell Land, by First Lieut. A. W. Greely, Fifth Cavalry, U. S. Army, Acting Signal Officer and Assistant.

eral sections, recapitulating their points of similarity or dissimilarity, and giving a summary of the conclusions arrived at.

The report is accompanied by diagrams in which the observations are represented graphically, and by a project of lines for the further development of the Gulf Stream current. Lieutenant Pillsbury observes that, having investigated the currents of the Stream on two sections where they flow north and on one where they flow east, it becomes of importance to have observations made where the flow is westward or contrary to the direction of the earth's rotation, as in the passages between the Windward Islands through which the Stream enters the Caribbean Sea.

THE UNDER-RUN OF THE HUDSON RIVER, ITS RELATION TO NEW YORK BAR, AND THE COURSES OF THE HUDSON TIDES THROUGH NEW YORK HARBOR.

There appears in Appendix No. 15 to this volume a paper on the "Results of the Physical Surveys of New York Harbor," in which Assistant Henry Mitchell presents some of his latest studies respecting this harbor, with special reference to the courses of the Hudson tides through it, and to the *under-run* of the Hudson as related to New York Bar.

Preceding the discussion of the physical hydrography of the harbor under these heads, it will be remembered that there was published a paper (Appendix 13, 1886) in which Mr. Mitchell announced the discovery of a *resultant* or net discharge through the harbor from Long Island Sound to the ocean, the effect of which is to keep the port open in winter and to sweep the sand from its threshold.

The term *under-run* he applies distinctively to the current that predominates along the bed of the channel, carrying salt water and probably sewer waters to interior basins during the dry season, when the *head* of the river falls below that which is necessary to counterbalance the heavier waters of the sea.

The proposition to improve Gedney's Channel by dredging, raised the question as to the limit of the natural scouring power of currents, and whether the *under-run* might not offset the *resultant* from the Sound when greater depth should be reached; but Mr. Mitchell found from the observations of past years that the *neutral plane* (at which flood and ebb would be equal) lay below the present level of the bar. Details of observations are given in the report, which is illustrated by diagrams and accompanied by a table of densities of the water at different depths at the Narrows, in the East River at Nineteenth street, in the Hudson River at Thirty-ninth street, and at Dobbs Ferry.

In the second part of his report Mr. Mitchell furnishes tables showing the slopes of the Hudson and the East Rivers for each hour between successive transits of the moon, with statements of the tidal conditions at these hours, to confirm his conclusion that the Hudson has two outlets for its commerce, but only one for its waters.

V.—DESCRIPTIVE REPORTS TO ACCOMPANY ORIGINAL TOPOGRAPHICAL AND HYDROGRAPHICAL SHEETS.

While the annual reports of operations required by the regulations of the Survey from each chief of a field party have not unfrequently contained valuable statements descriptive of the general character and prominent physical and geological features of the area included in the survey, if on land, and of the aspect of the coast on approaching from sea, of landfalls, harbor improvements, etc., if on water, there had been until the present year no systematic formulation of "what to observe," and no uniform method of placing upon record varied results of observation directed to specified objects.

In April, 1887, at the instance of the Superintendent, a board of officers was convened, to whom the subject was referred, with instructions to consider and recommend a schedule of topics, topographical, physical, hydrographical, and statistical, which might properly come under the notice of field officers, and from which they should select points of inquiry to be reported upon.

The members of this board were: Assistant C. O. Boutelle (chairman), Assistants B. A. Colonna and Henry Mitchell, Lieut. Commander W. H. Brownson, U. S. N., Hydrographic Inspector, and Assistants E. Hergesheimer and H. G. Ogden.

Suggestions were received from Assistants George Davidson, A. F. Rodgers, J. S. Lawson, and from Lieuts. J. M. Hawley and G. H. Peters, U. S. N.

The schedule of topics adopted by the board after full consideration of the subject was printed for distribution to field-officers. It is published also as Appendix No. 11 to this volume. Each report, when received at the office, is to be sent to the archives for a register number, which must always be the same as the topographical and hydrographical sheet to which it refers, and the sheet must bear a reference to the report by number and date.

VI.—GENERAL INDEX TO THE PROGRESS SKETCHES AND ILLUSTRATIONS, MAPS, AND CHARTS PUBLISHED IN THE ANNUAL REPORTS OF THE U. S. COAST SURVEY AND U. S. COAST AND GEODETIC SURVEY FROM 1844 TO 1885, INCLUSIVE.

In the Annual Report of the U. S. Coast Survey for 1854, pages 280 to 285, was published a consolidated index to the sketches embraced in the ten preceding reports from 1844 to 1853, inclusive. A similar index to the sketches published in the annual reports from 1854 to 1863, inclusive, appeared in the Report for 1864, pages 309 to 315. These indexes were preliminary in their character, no classification of the sketches, progress diagrams, charts, or illustrations having been attempted, and no alphabetical arrangement of titles adopted. This was doubtless not needed in 1854, but it would have been desirable ten years later.

The need of a general classified index* to these sketches, charts, and illustrations for the entire series of reports is now recognized, and the work of preparing it has been undertaken by Assistant Edward Goodfellow. Its arrangement is under the following heads:

I. General progress sketches, showing the progress of the survey on the Atlantic, Gulf of Mexico, and Pacific coasts of the United States.

II. Sketches showing progress in sections or portions of the coast and interior.

III. Maps and charts.

IV. Diagrams, drawings, and miscellaneous sketches, illustrating the methods and results of the survey.

Under I, the order is that of the years of the reports. Under II and III, a geographical order will be observed, beginning at Passamaquoddy Bay and ending at the Rio Grande for the Atlantic and Gulf coasts; beginning at San Diego and ending at the Aleutian Islands for the Pacific coast, and for the interior States, extending westward from the eightieth meridian. Under the subheadings of III, which will include successive portions of the coast, the maps and charts relating thereto will be arranged alphabetically for convenience of reference. Under IV, the diagrams, drawings, and miscellaneous sketches, illustrating the methods and results of the survey, will be indexed under subject heads in an alphabetical order.

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* See Appendix No. 12.

EXPLANATION OF ESTIMATES.

The estimates submitted to the Department for the fiscal year 1888–'89 were accompanied by the following statement:

"U. S. COAST AND GEODETIC SURVEY OFFICE,
"*Washington, October* 6, 1887.

"SIR: In transmitting for your approval the estimates of the appropriations required for the U. S. Coast and Geodetic Survey for the fiscal year ending June 30, 1889, I have the honor to submit the following explanation:

"Exclusive of the estimates for printing and binding, which are the same each year, the aggregate of the estimates ($559,885) is slightly less than the aggregate of the estimates for the current year ($560,765). All items of field-work, to which has been added the item for 'Repairs of vessels,' are included under the classification of 'Party expenses,' and they comprise only kinds of work which have had the annual sanction of Congress and the example of nearly all civilized countries for many years. They are selected as being the most urgent of a much larger number of items whose importance is asserted by the most competent opinion in both the civilian and naval arms of the service. They provide for the prosecution of operations on the uncompleted portions of the coast-work at as rapid a rate as is practicable, and they contemplate for purposes of hydrography all that the Hydrographic Inspector has requested or can profitably use. They are adjusted in amount with reference to the longest practicable maintenance of parties in the field, the importance of which to the economical prosecution and completion of work was discussed in my letter transmitting the estimates for the fiscal year ending June 30, 1888 (page 291 Appendix G g), to which I respectfully refer.

"The estimate for 'Party expenses' covers the pay of those temporarily employed as recorders, signal-men, hands, cooks, drivers, or boatmen, or in any other capacity in connection with field-work except as field-officers or members of the permanent or normal force; the commutation (or subsistence) of the chiefs and employés of parties; traveling expenses to and from the field, and local transportation in the vicinity of field-work or in connection with it; the transportation of instruments, tents, stationery, materials, outfit, and equipage to the field and in the field, and the purchase of all requisite materials, supplies, tents, boats, stationery, and camp equipage for use in connection with field-work, and all other necessary expenses properly incident to the prosecution of field-work.

"I have included an estimate for the amount of the annual contribution by this Government ($450) to the expenses of the International Geodetic Association for the Measurement of the Earth, and also the amount ($550), or so much as may be necessary, to defray the expenses of the attendance of a delegate from this Government at the General Conference of said Association in 1889 or 1890, the American delegate being expected to attend the conference once in three years at its place of meeting in Europe or America. The sums mentioned are made payable out of the preceding item, 'For objects not hereinbefore named,' so that there is no increase in the aggregate estimate. Their expenditure is also made conditional upon this Government becoming a member of the International Geodetic Association by signifying its adhesion to the Convention of said Association of October, 1886, in pursuance of the very urgent invitation from the German Government transmitted in February last. Inasmuch as such adhesion involves an obligation which can only be fulfilled by the annual contribution aforesaid and by the triennial attendance of a delegate (who should be selected by the National Academy of Sciences), the honorable Secretary of State will probably await an appropriation by Congress before signifying such adhesion. Without prolonging this communication by a detailed exposition of the purpose of such Association, it is believed that a sufficient argument in behalf of the small appropriation mentioned is to be found in the urgent invitation extended by the German Government for us to unite with an Association embracing the Government of every enlightened nation of Europe, and in the earnest and emphatic indorsement of the purpose of such Association and of our adhesion thereto, by the most eminent geodesists of America and Europe.

"The estimates contemplate a reduction of four from the number of field-officers provided for by the appropriation for the current year. They contemplate also an increase in the pay of three assistants in charge, respectively, of the Engraving, Drawing, and Instrument Divisions, which increase is but a just compensation of services, a partial re-imbursement for a reduction of former compensation by the abolishment of their subsistence allowance, and is intended to continue only while they remain, respectively, in charge of the divisions mentioned.

"The estimate for 'Pay of office-force' provides for $500 additional compensation to the disbursing clerk, Treasury Department, which was approved by the honorable Secretary of the Treasury last year (Appendix F f, page 291, Estimates for fiscal year 1888). It provides also for a few deserved promotions, aggregating $720, and for an increase, the urgency of which was mentioned in my letter transmitting the estimates for the current year, and which has been found to be indispensable, in the Computing, Drawing, and Engraving Divisions, to the working up of data which were accumulated but unused under all the former Superintendents, and to the prompt (and therefore adequately useful) publication of the current results of the work in the form of charts, chart corrections, comparative surveys and hydrography, tide-tables, tidal and current data, and compilations for replies to requests from other bureaus or private individuals for information, drawings, tracings, etc. Very much of the value of the work of the Survey depends upon such prompt publication of its results, especially in the form of new charts and new editions of old charts, which adequately prompt publication is absolutely impossible without the requested increase in the force of computers, tidal computers, draughtsmen, and engravers. An appropriation in the form suggested—$4,500 for additional draughtsmen at not exceeding $900 per year each, $2,700 for additional computers at not exceeding $900 per year each, and $2,700 for additional engravers at not exceeding $900 per year each—would enable us to employ, on trial for six months, and at much less than $900 per year each, a large number of comparatively young and promising computers, draughtsmen, and engravers, from whom to select for retention those who demonstrate their superiority by such competition. It is a method which has heretofore been tried in the selection of incumbents for the mentioned positions, which demand the one qualification of demonstrated fitness."

The law making separate appropriations for printing for this Bureau having been operative but a little more than two months, and having no data indicating the propriety of a modification, the estimates for printing (which, pursuant to the act making appropriation for sundry civil expenses for the fiscal year ending June 30, 1887, are made 'separately and in detail') ask for the same amounts which were estimated for the current year.

Respectfully, yours,

F. M. THORN,
Superintendent.

The SECRETARY OF THE TREASURY.

ESTIMATES.

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 coasts and throughout the Gulf Stream and Japan Stream flowing off the said coasts; tidal observations; the necessary resurveys; 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:

PARTY EXPENSES, COAST AND GEODETIC SURVEY:

For triangulation, topography, and hydrography of the coast of Maine in Cobscook Bay and Saint Croix River and to the international boundary monument, and for off-shore soundings (all new work)	$9,000
For resurveys: For triangulation, topography, and hydrography in the vicinity of the east end of Long Island, Block Island, Nantucket, Nantucket Shoals and approaches, and including Vineyard Sound and Connecticut River to Hartford, Conn., and Hudson River to Troy, N. Y	13,000
For physical surveys of New York Harbor, to continue observations and reductions.	3,000
For physical survey of Delaware Bay and River, including observations, comparisons, and reductions	4,000
For observing the movement, lodgment of, and obstructions by ice in the Delaware River, and noting the changes caused thereby in Cherry Island Flats, etc	200
To correct to date former surveys of the Delaware and Schuylkill Rivers for use on a new large-scale chart of the same in the vicinity of Philadelphia and up the Delaware River to Trenton	3,000
For physical survey of Monomoy Shoals and entrance to Vineyard Sound, observations and reductions	6,000
For the hydrography of the outside waters and bars south of Absecon Light; for necessary triangulation and for continuing the topography and inside hydrography along the Atlantic coast of New Jersey (some of the hydrography is new work, and the topography is virtually so because of the great changes)	4,000
For an examination for changes along the shores of the Potomac River from its mouth to Washington, D. C., and for a hydrographic examination of same	500
For hydrographic examination at Cape Lookout and at Beaufort Inlet, North Carolina	500
To complete the surveys in the vicinity of Charleston, S. C., and up the Cooper and Ashley Rivers to the head of navigation; and to continue the astronomical latitude and azimuth (which is new) work, and in connection therewith, the recovery and re-marking of old triangulation stations for their preservation (this work was not reached during fiscal year 1888)	3,000
To continue the primary triangulation from Atlanta towards Mobile	3,000
For a geodetic junction of Fernandina with Cedar Keys, including a line of precise levels	5,000
For continuing the survey of the western coast of Florida from Cape Sable north to Cape Romano, and for hydrography off the same coast, being all new work.	12,000
For the survey of the tributaries of Pensacola Bay	2,000
For the triangulation, topography, and hydrography of Perdido Bay and its connection with the coast triangulation and for resurvey of Mobile Bay entrance.	3,000
For triangulation, topography, and hydrography of Lakes Pontchartrain and Maurepas in Louisiana	4,000
For continuing the survey of the coast of Louisiana west of the Mississippi Delta and between Barataria Bay and Sabine Pass	7,000
To make off-shore soundings along the Atlantic coast, and current and temperature observations in the Gulf Stream	8,000
For off-shore current observations	5,000
For hydrography, coast of California	5,000
For continuing the topographic survey of the coast of southern California, including necessary tertiary triangulation	10,000

PARTY EXPENSES—Continued.

For continuing the primary triangulation of southern California, and for connecting the same at Mount Conness with the transcontinental arc, and for a primary base-line in the vicinity of Los Angeles	$10,000
For continuing the resurvey of San Francisco, San Pablo, and Suisun Bays, the examination of San Francisco entrance and the bar and approaches	7,000
For continuing the survey of the coast of Oregon, including off-shore hydrography; and to continue the survey of the Columbia River from the mouth of the Willamette toward the Cascades, triangulation, topography, and hydrography	9,000
For continuing the survey of the coast of Washington Territory	9,000
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 between Sitka and the southern end of the Territory	12,000
For continuing the researches in physical hydrography relating to harbors and bars, including computations and plotting	3,000
For examinations into reported dangers on the Atlantic, Gulf, and Pacific coasts	1,000
To continue magnetic observations on the Atlantic and Gulf slopes	1,200
For continuing magnetic observations on the Pacific coast and at Los Angeles Magnetic Observatory	1,200
To remove the Magnetic Observatory from Los Angeles and to re-establish it at either Seattle or Port Townsend, Wash. Ter., or at Austin or San Antonio, Tex.	1,800
For running an exact line of levels from Boston or Salem, Mass., to Blue Hill, Mount Monadnock, Mount Washington, Mount Independence, and Lake Champlain	2,000
For continuing the exact line of levels from Cairo southward to Okolona, Miss	3,000
For continuing tide observations on the Pacific coast, viz, at Kadiak, in Alaska, and at Saucelito, near San Francisco, in California	2,500
For one season's series of tide observations at Sitka, or vicinity, and at Unalaska, or vicinity, in the Aleutian Islands, Alaska	1,200
To continue tidal observations on the Atlantic coast at Pulpit Harbor, Maine, and at Sandy Hook, New Jersey, and to begin observations at Savannah, Ga	2,100
To establish a self-registering tide-gauge at Savannah, Ga., or vicinity	1,200
For a self-registering gauge at Willets Point, Long Island, New York, to co-operate with the gauge at Sandy Hook, New Jersey, in securing data for the more complete study of the tides and tidal currents of East River and New York Harbor.	1,000
For furnishing points to State surveys, to be applied, as far as practicable, in States where points have not been furnished	10,000
For determinations of geographical positions, longitude parties	5,000
For continuing the transcontinental geodetic work on the line between the Atlantic and Pacific Oceans	22,000
To continue the compilation of the Coast Pilot, and to make special hydrographic examinations for the same	4,000
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	3,000
For repairs and maintenance of the complement of vessels used in the Coast and Geodetic Survey	25,000
For objects not hereinbefore named that may be deemed urgent	5,000

And 10 per centum of the foregoing amounts shall be available, interchangeably, for expenditure on the objects named.

International Geodetic Association.—Contribution to the "International Geodetic Association for the Measurement of the Earth," or so much thereof as may be necessary	450

PARTY EXPENSES—Continued.

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," and after the adhesion by the Government of the United States to the Convention of October, 1886, of the International Geodetic Association aforesaid.	
Total party expenses, including repairs of vessels	$252,400

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, the unexpended balance of the appropriation therefor for the fiscal year ending June 30, 1888.

PAY OF FIELD OFFICERS:

Pay of Superintendent	$6,000
Pay of two Assistants, at $4,000 each	8,000
Pay of one Assistant	3,600
Pay of one Assistant	3,200
Pay of two Assistants, at $3,000 each	6,000
Pay of two Assistants, at $2,800 each	5,600
Pay of three Assistants, at $2,700 each	8,100
Pay of three Assistants, at $2,400 each	7,200
Pay of three Assistants, at $2,300 each	6,900
Pay of five Assistants, at $2,200 each	11,000
Pay of six Assistants, at $2,000 each	12,000
Pay of nine Assistants, at $1,800 each	16,200
Pay of nine Assistants, at $1,500 each	13,500
Pay of three Subassistants, at $1,400 each	4,200
Pay of two Subassistants, at $1,300 each	2,600
Pay of four Subassistants, at $1,100 each	4,400
Pay of three Aids, at $900 each	2,700
Total pay in the field	$121,200

Provided, That no new appointment shall be made to the above force until the whole number of Assistants, Subassistants, and Aids shall be reduced to fifty-two.

PAY OF OFFICE FORCE:

Additional compensation to the Disbursing Clerk of the Treasury Department for the disbursement of the appropriations for the Coast and Geodetic Survey	$500
For one Accountant	1,800
For one Accountant	1,400
For one General Office Assistant	2,200
For one Draughtsman	2,350
For one Draughtsman	2,100
For two Draughtsmen, at $2,000 each	4,000
For three Draughtsmen, at $1,800 each	5,400
For three Draughtsmen, at $1,400 each	4,200
For one Draughtsman	1,330
For one Draughtsman	1,260
For two Draughtsmen, at $1,200 each	2,400

PAY OF OFFICE FORCE—Continued.

For one Draughtsman	$1,100
For one Draughtsman	1,000
For additional Draughtsmen, at not exceeding $900 per annum each	4,500
For two Computers, at $2,000 each	4,000
For one Computer	1,420
For one Computer	1,400
For one Computer	1,200
For one Computer	1,100
For additional Computers, at not exceeding $900 per year each	2,700
For one Tidal Computer	2,000
For one Tidal Computer	1,250
For one Engraver	2,060
For one Engraver	2,000
For one Engraver	1,960
For two Engravers, at $1,800 each	3,600
For two Engravers, at $1,600 each	3,200
For one Engraver	1,200
For one Engraver	900
For additional Engravers, at not exceeding $900 per annum each	2,700
For one Contract Engraver, contract not to exceed $2,400 per annum	2,400
For one Contract Engraver, contract not to exceed $2,100 per annum	2,100
For one Contract Engraver, contract not to exceed $1,800 per annum	1,800
For one Contract Engraver, contract not to exceed $800 per annum	800
For one Electrotypist and Photographer	1,800
For one Electrotypist's Helper	500
For one Apprentice to Electrotypist and Photographer	500
For one Copper-plate Printer	1,700
For two Copper-plate Printers, at $1,330 each	2,660
For one Copper-plate Printer	1,250
For two Plate-Printers' Helpers, at $700 each	1,400
For one Chief Mechanician	1,800
For one Mechanician	1,565
For one Mechanician	1,330
For one Mechanician	1,250
For one Mechanician	1,200
For one Mechanician	1,000
For one Mechanician	545
For one Carpenter	1,565
For one Carpenter	800
For one Carpenter and Fireman	570
For one Night Fireman	550
For one Map-mounter	1,020
For one Librarian	1,800
For one Clerk	1,650
For two Clerks, at $1,500 each	3,000
For one Clerk	1,400
For one Clerk	1,350
For two Clerks, at $1,200 each	2,400
For two Clerks, at $1,000 each	2,000
For one Clerk	900
For one Clerk	1,175
For one Map colorist	720
For one Writer	900

PAY OF OFFICE FORCE—Continued.

For one Writer	$840
For six Writers, at $720 each	4,320
For one Writer	600
For one Messenger	875
For one Messenger	840
For three Messengers, at $820 each	2,460
For three Messengers, at $640 each	1,920
For one Driver	730
For one Packer and Folder	820
For one Packer and Folder	630
For two Laborers, at $630 each	1,260
For two Laborers, at $550 each	1,100
For one Laborer	315
For one Laborer	365
For one Janitor	1,200
For two Watchmen	1,760
Total for pay of office force	$135,725

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, printers' ink, copper, zinc, and chemicals for electrotyping and photographing; engraving, printing, photographing, and electrotyping supplies; for extra engraving; and for photolithographing charts and printing from stone for immediate use	10,000
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	6,000
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	3,500

And 10 per centum of the foregoing amounts for office expenses shall be available interchangeably for expenditures on the objects named.

Total general expenses of office	$28,500

FOR RENT OF OFFICE BUILDINGS:

For rent of buildings for offices, work-rooms, and work-shops in Washington	$10,500
For rent of fire-proof building No. 205 New Jersey avenue, including rooms for standard weights and measures; for the safe-keeping and preservation of the original astronomical, magnetic, hydrographic, and other records, of the original topographical and hydrographic maps and charts, of instruments, engraved plates, and other valuable property of the Coast and Geodetic Survey	6,000
Total	$16,500

PUBLISHING OBSERVATIONS:

For one Computer, $1,800; one Computer, $1,600; and three Copyists, at $720 each, in all	$5,560

That no part of the money herein appropriated for the Coast and Geodetic Survey shall be available for allowances to civilian or other officers for subsistence while on duty in the office at Washington, or to officers of the Navy attached to the Survey; nor shall there hereafter be made any allowance for subsistence to officers of the Navy attached to the Coast and Geodetic Survey.

PRINTING AND BINDING, COAST AND GEODETIC SURVEY:

For all printing and lithographing, photolithographing, 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)..	$10,435
For 4,900 copies of the Annual Report of the Superintendent (including regular edition of 1,900 copies for Congress), viz: For composition, stereotyping, press-work, folding, inserting plates, binding, material, etc.........................	8,000
For photolithographing, lithographing, photo-engraving, and all forms of illustration by the Public Printer for the Annual Report*.........................	2,500
Total..	$20,935
Total Coast and Geodetic Survey (exclusive of printing) for the fiscal year 1888–'89	$559,885

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, October 7, 1887.

SIR: Herewith I have the honor to transmit the estimates of appropriations required for the Office of Construction of Standard Weights and Measures for the fiscal year ending June 30, 1889.

The only changes contemplated by these estimates, as compared with the estimates and appropriations for the current year, consist in the substitution of annual in place of *per diem* or monthly salaries (involving an aggregate reduction of $67) and the omission of the words 'while actually employed' from the clause appropriating for salaries.

The omitted words tend to produce an unjust discrimination against the three mentioned employés in the matter of leaves of absence and of pay on days when the Departments are closed by Executive order. Their employment is continuous, substantially identical with that of the Coast Survey employés, being performed side by side with them, and there is no reason for the retention of the phrase "while actually employed" in their cases, which would not also apply with equal force and propriety to any other permanent employés of the Government.

Existing laws have provided for supplying States and Territories with standard weights and measures. No provision, however, has heretofore been made for repairs and adjustments to the standards so supplied, but which have become valueless by fire or other accident. The standards having been supplied by the Office of Standard Weights and Measures, no reason is apparent why, having been injured, their value or utility should remain permanently destroyed for want of authority, at the sole repository of standards, to repair and re-adjust them.

Such authority, without increased appropriation, is contemplated by the proviso attached to the item for "Contingent Expenses."

Very respectfully,

F. M. THORN,
Superintendent.

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

LEGISLATIVE BILL.

OFFICE OF CONSTRUCTION OF STANDARD WEIGHTS AND MEASURES:

Salaries of Standard Weights and Measures.—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 in Washington, District of Columbia, the following, namely: One adjuster, at $1,500 per annum; one mechanician, at $1,250 per annum; one watchman, $720 per annum; in all	$3,470

* No engraving is done by the Public Printer for the Coast and Geodetic Survey. In explanation of estimate see Appendix.

OFFICE OF CONSTRUCTION OF STANDARD WEIGHTS AND MEASURES—Continued.

Contingent Expenses, Office of Standard Weights and Measures.—For purchase of materials, and apparatus, and incidental expenses $500

Provided, That such necessary repairs and adjustments shall be made to the standards furnished to the several States and Territories as may be requested by the Governors thereof, and also to standard weights and measures that have been or may hereafter be supplied to United States Custom-Houses and other offices of the United States under act of Congress, when requested by the Secretary of the Treasury.

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 20, 1875, the sum of $600, or so much thereof as may be necessary 600

PART II.

The abstracts of reports of field operations which appear in this part of the Annual Report, arranged in a geographical order, include references to the localities of the work, the time of its execution, and the names of the officers engaged in it, which are essential to a complete history of the progress of the Survey. A statement of office operations condensed from the annual report of the Assistant in charge of the Office (Appendix No. 4) follows, and also a notice of the suboffices at Philadelphia and at San Francisco.

Among the several branches of work begun, completed, or in progress during the year, mention may be made here of the following, which have special practical or scientific value: The continuation of the special triangulation in aid of the topographical survey of the State of Massachusetts; the investigations intended to ascertain the mode of formation of the shoals at the entrance to Vineyard Sound, and what means should be adopted to preserve the navigable channels into that Sound; conclusions deduced from the physical survey of New York Harbor in regard to the circulation of the sea through that harbor; redetermination of a part of the boundary line between the States of Virginia and North Carolina; hydrographic examination in Charleston Harbor to determine any changes that might be due to the earthquake; conclusions reached in the progress of the investigations of the currents of the Gulf Stream; resurveys of San Diego and San Pedro Bays, and of San Francisco, San Pablo, and Suisun Bays, California, and progress made towards a junction of the transcontinental triangulations advancing westward from the Atlantic coast and eastward from the Pacific.

In Appendix No. 2 is given a tabular statement of the progress made in field and office work during the year, as shown by statistics, and in Appendix No. 3 a list of data furnished to Departments of the Government in reply to official calls, and to individuals upon application.

The assignment of Lieut. Commander W. H. Brownson, U. S. N., to duty as Hydrographic Inspector of the Coast and Geodetic Survey was continued throughout the year. In Appendix No. 5 is published the annual report of this officer, in which his efficient discharge of important and responsible service is fully made manifest.

Beginning with a summarized statement of hydrographic work and of the condition of the vessels of the Survey, the report refers to the work of the Coast Pilot Division, which, under the general direction of the Hydrographic Inspector, is carried on under the immediate charge of Lieut. George H. Peters, U. S. N., Assistant Coast and Geodetic Survey, who has submitted a special report of progress. Lieutenant-Commander Brownson's report concludes with a notice of the work of the Hydrographic Division of his office, which was in immediate charge of Lieut. J. F. Moser, U. S. N., from the beginning of the fiscal year to November 10; then of Lieut. J. M. Hawley, U. S. N., until April 27, 1887, when he was relieved by Lieut. M. L. Wood, U. S. N., whose report is appended.

For copies of the Atlantic Local Coast Pilot there is a steady and increasing demand among sea-faring men. New editions of four of the subdivisions have been called for. Forms of questions devised to obtain special information from the best local authorities with regard to ports and harbors have been widely circulated, and with excellent results. A volume of the Coast Pilot, to include the entire Atlantic coast, is in preparation upon a plan intended to present only such details as are absolutely essential to the navigator.

It is hoped also to have ready for publication in the course of a few months the manuscript of a new and greatly enlarged edition of the Pacific Coast Pilot, prepared by Assistant George Davidson.

Lieutenant-Commander Brownson refers to the numerous and exacting duties connected with the Hydrographic Division, consisting of the planning and preparation of projections for hydrographic work, the examination and verification of hydrographic sheets as they come in from the field, the preparation of corrections to charts, and the prompt notification to navigators of changes and corrections on charts, and of the development of all dangers to navigation.

Messrs. Eugene Willenbucher, W. C. Willenbucher, and F. C. Donn continued on duty as hydrographic draughtsmen in this division during the fiscal year. Tabular statements of their work accompany the report.

Mr. George J. Vestner remained on duty as clerk to the Hydrographic Inspector.

SECTION I.

MAINE, NEW HAMPSHIRE, VERMONT, MASSACHUSETTS, AND RHODE ISLAND, INCLUDING COAST AND SEA-PORTS, BAYS AND RIVERS. (SKETCHES Nos. 1, 3, 16, and 17.)

Topographical survey in the vicinity of Machias, and triangulation of Cobscook Bay, Maine.—At as early a date as practicable after the passage of the annual appropriation act, Assistant C. H. Boyd was directed to organize a party for the completion of the topography in the vicinity of Machias, Me., and for the triangulation of Cobscook Bay.

Beginning work about the middle of August, he completed the Machias topographical sheet by the addition of enough topography to develop the first range of hills surrounding the town, and then took up the triangulation of Cobscook Bay, starting from the base Trescott Rock–Porcupine. Field-work in this vicinity was closed October 29, a sufficient number of points having been determined by that time for the projections laid out to cover the south side of Cobscook Bay. Mr. Boyd then returned to Machias, where he was occupied in some topographical examinations until November 7, at which date field operations were finally closed.

Assistant Gershom Bradford joined the party at the beginning of the season and rendered most acceptable service until October 24, when he was detached for duty which will be referred to under a subsequent heading in this section.

A summary of the work accomplished is given in the following statistics:

Miles of road surveyed	7
Miles of creeks surveyed	1
Area surveyed in square miles	5
Number of stations occupied in triangulation	14
Number of angles measured (second order)	118
Number of angles measured (third order)	96
Geographical positions determined	26

During the winter and until near the end of April, 1887, Mr. Boyd was occupied in office duty, and upon his detachment from the office was instructed to continue the triangulation of Cobscook Bay. This work he took up from the line Carr–Little of 1886, and he was engaged in carrying it along the north side of the bay at the close of the fiscal year. Mention of its further progress will be made in the next annual report.

Following are the statistics reported for the work of 1887:

Number of angles measured	174
Number of geographical positions determined	24

Hydrographic survey of the Saint Croix River begun, and hydrographic examinations made in the Penobscot River, Maine.—Under instructions bearing date of May 16, 1887, Lieut. F. H. Crosby, U. S. N., Assistant Coast and Geodetic Survey, left New York with his party on board the steamer *Gedney*, and proceeding to the coast of Maine took up some hydrographic examinations required in the Penobscot River from Sears Island to Adams Ledge.

Lieutenant Crosby reports that he was unable to find an eighteen-feet spot which had been reported to the southward of Fort Point Ledge, and the local authorities whom he consulted doubted its existence. In the vicinity of Adams Ledge he found the river bottom very much changed, and was informed by pilots and fishermen that the changes higher up the river since the former survey are greater. Enough soundings were taken to show fully the changes in the locality of the Ledge.

Just above Sandy Point, and about half a mile from shore, Lieutenant Crosby developed a rocky ledge to which his attention was called by local pilots, who seemed to be unanimous in the opinion that a buoy should be placed there. The Penobscot River work was finished June 15, and on June 30 the *Gedney* was at Eastport, where the survey of the Saint Croix River was begun in the steam launch *Sagadahoc*.

Further account of the progress of this work will appear in the next annual report. Hydrographic examinations made and additional soundings taken in Long Island Sound at the outset of the season by Lieutenant Crosby are referred to under the heading of Section II.

Ensigns A. W. Dodd and N. J. L. T. Halpine, U. S. N., were attached to the party.

Following are the statistics reported of the work on the coast of Maine:

Miles run in sounding	48
Angles measured	832
Number of soundings	2, 938

Topographical survey of the coast of Maine from Moose Cove to Quoddy Head, and of the western shore-line of Cobscook Bay and shore-line of Denbow's Neck.—In continuation of the topography of the coast of Maine, Assistant Eugene Ellicott was directed in August, 1886, to organize a party for work in the towns of Trescott and Lubec. With a projection on a scale of 1-10000, he took the field, and being favored by exceptionally fine weather completed the survey on November 9 to the limits of his sheet, from Moose Cove to and around Quoddy Head.

The statistics reported are:

Miles of shore-line surveyed	27
Miles of roads surveyed	19
Area surveyed in square miles	16

After inking his topographical sheet and forwarding it to the office, Mr. Ellicott was directed to report for office duty at Washington, and was assigned to service under the direction of Assistant Henry Mitchell. Upon being detached he was instructed, in April, 1887, to begin the topography of the shores of Cobscook Bay, and was engaged in this work at the close of the fiscal year. At that date he had surveyed the western shore-line of the bay and carried his survey around Denbow's Neck and the coast immediately to the westward.

For the fiscal year the statistics reported are, miles of shore-line surveyed	70
Miles of roads	20
Area surveyed in square miles	17

Topographical survey of the south branch of Cobscook Bay, Maine.—Mr. J. H. Gray, Aid, has reported briefly upon the results of the topographical survey of the south branch of Cobscook Bay, Maine, assigned to him under instructions bearing date of May 11, 1887.

The character of the topography was chiefly shore-line and its immediate vicinity, and the statistics reported to the close of the fiscal year are as follows:

Number of miles of shore-line surveyed	23
Number of miles of railroads and other roads	3
Approximate area surveyed in square statute miles	1

Additional progress in field operations will be referred to in the next annual report.

Hydrographic survey of the coast of Maine from Machias Bay Entrance to Quoddy Head, and hydrographic examinations on the coasts of Maine and Massachusetts.—Reference was made in the last annual report to the organization of a hydrographic party by Lieut. John M. Hawley, U. S. N., Assistant Coast Survey, commanding the steamer *Bache*, and to examinations made by him under instructions in Casco Passage and York Narrows, coast of Maine, while on his way with the *Bache* to a field of work further to the eastward. The results of these examinations were presented in a special report in which Lieutenant Hawley recommended that Casco Passage should be buoyed, it being quite as wide as York Narrows, and straighter, while the least water found was three fathoms. These examinations were made June 28, 29, and 30, 1886, and since then Casco Passage has been buoyed, five buoys having been placed to mark the ledges on either side of the channel. In York Narrows a new ledge was developed to the westward of Hawley's Ledge; ranges for finding Hawley's Ledge were reported, and also bearings for the new ledge, which has but ten and a half feet on its shoalest part at mean low water.

Upon the completion of this work, Lieutenant Hawley proceeded directly to Machiasport, Me., and after putting in a new boiler into the launch *Sagadahoc*, which had been laid up at that port, took up the regular work of the season, a hydrographic survey of the coast of Maine and included harbors from Libby Island to Quoddy Head, and off-shore soundings between the same limits to within three miles of the British possessions.

For the inshore hydrography, four projections were furnished by the Office on a scale of 1-10000, the first including Machias Bay Entrance; the second, Little Machias Bay and to the eastward; the third to the eastward of Little River, and the fourth to the eastward of Bailey's Mistake. A fifth projection, scale 1-40000, was supplied for the hydrography of Grand Manan Channel.

All soundings on the hydrographic sheet which included Machias Bay Entrance with Cross Island Narrows were reduced from observations of the tide made at Starboard Creek on a gauge put up there by Lieutenant Heald in 1885.

On the second, third, and fifth projections the soundings were reduced to a plane of reference found by continuous observations of low water for one month and observations at intervals for two months on a gauge established August 3, at Cutter, Washington County, Me.

The soundings on the fourth hydrographic sheet, Bailey's Mistake to Quoddy Head, were reduced from observations of the tide made at Carrying Place Cove, West Quoddy Head, and the plane of reference was found by transferring the mean low water of the gauge at Cutter.

Lieutenant Hawley reports the weather during the season as unusually favorable, there being but little fog and no gales. As heretofore he took every opportunity to obtain information respecting shoals and ledges from fishermen and pilots in the vicinity, and made a large number of soundings for the development of shoals. For the survey of Little River, lines were run closer than usual, it being a harbor of refuge much used by coasters in bad or foggy weather.

Upon the completion of the regular work of the season, October 6, the steam-launch was laid up at Eastport, and Lieutenant Hawley proceeded in the *Bache* to New York, stopping en route to make special examinations and surveys at the following-named localities:

(1) Examination of a ledge in Moos-a-bec Reach, Maine, upon which the least water was found to be seven and a half feet instead of twelve feet as shown on the charts. (2) Additional soundings needed to locate all the curves of depth, and clear up doubtful spots in Pleasant River above Reef Point. (3) Examination of Tibbett's Rock and Jackson Ledge, lying to the eastward of Petit Manan Light-house for least depths of water, and to fix ranges for finding these ledges. (4) Additional soundings at entrance of Southwest Harbor, Mount Desert Island, between Cranberry Ledge and Flynn's Ledge. (5) Search for a shoal spot of three fathoms to the southward and eastward of Boon Island Light. The result of a careful search convinced Lieutenant Hawley that no shoal existed as reported.

These examinations finished, the *Bache* proceeded, towards the end of October, to Edgartown Harbor, Massachusetts, instructions having been given to her commander to execute work in that vicinity. Reference to this will be made under a later heading in this section.

The officers attached to the party during the season were Ensigns Edward E. Wright, John E. Craven, Reuben O. Bitler, and Harry A. Field, U. S. N. Of their efficiency and zeal in the performance of all duty intrusted to them Lieutenant Hawley speaks in high terms.

For the work on the coast of Maine, including special examinations, the statistics reported are:

Miles run in sounding	1,005
Angles measured	11,531
Number of soundings	26,421

Series of tidal observations with automatic tide-gauge continued at Pulpit Cove, North Haven Island, Penobscot Bay, Maine.—The record from the automatic tide-gauge which was established in 1870 at Pulpit Cove, North Haven Island, Penobscot Bay, was kept up throughout the year by the observer, Mr. J. G. Spaulding. During the prevalence of low temperatures in the winter, the water in the float tube is heated by an apparatus devised for the purpose, and no interruption is allowed to occur in the record, which is for the past year almost absolutely unbroken. It will be very desirable to continue the observations at this station until a lunar cycle shall have been completed.

Co-operation with the Commission for the Topographical Survey of the State of Massachusetts.—Reference is made under this and other headings in this section to the service of Assistant Henry L. Whiting as one of the Commissioners of the Topographical Survey of the State of Massachusetts, under special assignment, with the approval of the Secretary of the Treasury.

For the first seven weeks of the fiscal year Mr. Whiting was engaged in completing a resurvey of Cotamy Beach, Martha's Vineyard, mention of which is made under a separate heading. On October 1, 1886, he reported for duty at the Coast and Geodetic Survey Office in pursuance of instructions. During the winter he made three visits to Massachusetts on the service of the State Commission, and while there prepared plans showing the exterior lines in tide-water of the State. Reference in detail to these plans is made under a separate heading.

In the execution of his duties at the Office of the Survey, in addition to minor subjects referred to him for examination, Mr. Whiting prepared a project, illustrated by maps and diagrams, for a new series of charts for Long Island Sound; a project for a series of field topographical sheets of the coast of Maine and so much of the territory of the British Provinces as would include the approaches to our own waters, and also a project with maps and diagrams for a series of field topographical sheets for the resurvey of Nantucket and Vineyard Sounds.

On April 1, 1887, he left the Office, under instructions to make arrangements for the field operations of the triangulation parties of Assistant Bradford and Subassistant Van Orden, who had been assigned to the duty of furnishing points for the State survey of Massachusetts and for the determination of the boundary lines of cities and towns in the State under his general supervision.

Mr. Whiting has included a brief notice of Mr. Bradford's work in his own report, but as a more detailed report has been made by Mr. Bradford, an abstract of this is given under a separate heading. The locality of his work was at Wareham, Mass.

Mr. Van Orden reported for duty April 26, and established his headquarters at Provincetown. The field assigned to him was the peninsula of Cape Cod. The character of the country is fairly open and accessible. Up to June 30, 1887, the statistics of his work are:

Number of points of boundary lines determined in geographical position	26
Number of other points determined	69
Number of boundary points partly determined	11

In addition to the triangulation, Mr. Van Orden ran a line of geodesic leveling through part of the area of his work, beginning at Wellfleet and running south and west. The length of this line up to June 30 was eleven miles.

During the closing months of the fiscal year, Mr. Whiting supervised the field-work just referred to; completed the plans showing the external lines in tide-water and the boundary lines between cities and towns in the State bordering on the sea, and made preliminary arrangements for beginning the topographical resurvey of the shores of Vineyard and Nantucket Sounds.

In the arrangement under which the State of Massachusetts avails herself of the services of officers of the Coast and Geodetic Survey, it is provided that their subsistence shall be paid by the State.

Preliminary determination of the boundary lines in tide-water of cities and towns in Massachusetts bordering on the sea.—In connection with the work of determining by triangulation the boundary lines on land of cities and towns in Massachusetts, in which the Coast and Geodetic Survey has taken part, the State Commission, of which Assistant H. L. Whiting is authorized to serve as a member, has deemed it desirable to have made, under his personal direction and supervision, copies of the official plans of the Harbor and Land Commission, which were prepared by him by authority of the Commission. These plans show the exterior line in tide-water of the State, and the boundary lines in tide-water of cities and towns bordering on the sea, and on arms of the sea from the shore-line out to the exterior line, which, as defined by statute, extends one marine league from the sea-shore at low-water mark.

This marine league is taken as equal in length to three nautical miles, or 5,559.6 meters.

Mr. Whiting has already prepared, with the approval of the Superintendent, plans showing the lines referred to in Bristol, Dukes, Nantucket, and parts of Barnstable and Plymouth Counties. The main plan is composed of selected sheets of the three coast charts, on the scale of 1-80000, extending from Monomoy to Block Island, joined and backed so as to form a continuous sheet, showing thereon the territorial limits of the Commonwealth as defined by the statute just referred to, and giving the geographical positions of the initial points marking the angles and intersections of the town boundary lines in tide-water. This plan, Mr. Whiting observes, is preliminary in its character, for while it establishes these points with sufficient accuracy for illustration and practical purposes of definition, yet when the work of determining by triangulation the boundary lines of cities and towns of the State on land has been completed, the Commissioners intend to restate the positions of the points, and to redescribe the lines of exterior and subdivisional jurisdiction, so that the geographical position of each point in these lines shall conform to the system of final adjustment of all the other points in Massachusetts based on the Clarke spheroid.

Two subplans have also been prepared, one on the harbor chart of Wood's Holl, on a scale of 1-20000, showing on this larger scale the more intricate boundary line between Falmouth and Gosnold, and one on a manuscript tracing from original topographical sheets, on a scale of 1-10000, of the still more intricate boundary line in the headwaters of Buzzard's Bay, between the towns of Wareham and Sandwich.

Disputed questions of fishing rights and the previously undefined jurisdiction over the valuable oyster beds in these waters gave rise to the State legislation which determined the boundaries and defined the jurisdiction in tide-water of each town, respectively. To the main plan, and to each subplan, have been attached printed copies of the reports of the Harbor and Land Commissioners of Massachusetts, under whose authority this work was done, giving all needed information in regard to these town boundaries. The value of such plans, based on accurate surveys and delineated on trustworthy charts, is manifest. Already in Massachusetts these determined boundaries have led to the settlement of questions of conflicting jurisdiction relating to fishing interests. They also define judicial jurisdiction in cases of crime committed on the water.

At the request of the Harbor and Land Commissioners of Massachusetts, Mr. Whiting has transmitted to this Office a plan of part of Boston Harbor, specially prepared by that Board for the use of the Survey, showing improvements made in its channels by the United States and by the State. This plan accompanies the report of the Commissioners for 1883, and has been corrected by them to show the condition of the channels on January 1, 1887.

Triangulation in aid of the topographical survey of the State of Massachusetts.—For the determination of points for the use of the topographical survey of the State of Massachusetts, Assistant Gershom Bradford was directed towards the end of October, 1886, to report to Assistant H. L. Whiting, one of the Commissioners of that survey, by special assignment of the Superintendent at the request of the Governor of the State.

After consultation with Mr. Whiting, Mr. Bradford proceeded to Plymouth, Mass., and having recovered the old stations, Monk's Hill and Manomet, started his triangulation with this line as a base, and continued it over the townships of Plymouth, Carver, Plympton, and Kingston, an area of about one hundred and fifty square miles, until December 4, when a heavy snow storm set in, which made the further prosecution of the work inadvisable.

The statistics reported are:

Number of stations occupied	10
Number of horizontal directions observed	61
Number of geographical positions determined	17
Area in square miles covered by the triangulation	151

After returning from the field, Mr. Bradford was engaged in completing the records and computations of his work. Two copies were required, one for the State of Massachusetts, which was transmitted to Mr. Whiting, and one for the archives of the Survey. In January Mr. Bradford was directed to report to the Assistant in charge of the Office, and was assigned to the division of physical hydrography under the direction of Assistant Henry Mitchell. Upon being detached from the Office at the end of March he proceeded under instructions to Boston, where he reported to Assistant H. L. Whiting for triangulation work in aid of the survey of the State of Massachusetts.

Reference was made in the last annual report to that branch of the work in Massachusetts which involved the determination by triangulation of the boundary lines of cities and towns in the Commonwealth, and to its progress under Mr. Whiting's general direction. At his instance Mr. Bradford took up this work in the town of Wareham, at the head of Buzzard's Bay, April 21, 1887, and was still engaged in it at the close of the fiscal year. The location of the boundary marks defining the angles in the several town lines presented obstacles only to be overcome by special devices. Not unfrequently the marks were found in remote and almost inaccessible places, sometimes in low land and in the dense forest. The country about Wareham offers few commanding heights for observation, and fewer still that are free from obstructing woods. High tripod and scaffold signals were impracticable on account of the great expense attending their erection; hence church steeples and other artificial elevations were used as much as possible, and flags placed in trees near the boundary stones, carefully-checked compass bearings and distances being taken from the flag-poles or steeples to the stones.

By June 30, 1887, the northwestern corner of Wareham had been partially triangulated; also the western side of Wareham and the western side of Marion township.

Mr. Bradford reports the following statistics:

Stations recovered	7
Stations occupied for horizontal direction observations	25
Stations occupied for observation of elevations	11
Horizontal directions observed	142
Vertical angles observed	68
Boundary stones located	11

Resurvey of the shore-line of Cape Cod peninsula, between Nausett and Monomoy.—Additional resurveys being required to obtain data for the study of the changes of shore-line on the Massachusetts coast between Nausett and Monomoy, Assistant John B. Weir was instructed, towards the close of August, 1886, to proceed to Chatham, Mass., and make a topographical resurvey from Nausett to connect with the resurvey made in June preceding by Assistants Boyd and Van Orden in the vicinity of Monomoy. The work being intended to be done in connection with studies in physical hydrography under the direction of Assistant Henry Mitchell, Mr. Weir was directed to confer with Mr. Mitchell in regard to details of execution, and after these officers had gone together over a large part of the ground the survey was begun early in September.

The plan adopted for the work required a determination of shore-line, both high and low water, from Nausett to a point about a mile and a half north of Monomoy Point Light, and a representation of the bluff-line wherever clear definition could be obtained. In addition to this, lines of levels along the base and crest-line of the bluffs, and offsets a short distance back from the crest over territory likely to cave in, were required. Two tide-gauges were desired for reference, one within Harding's Beach and one on the outside of the beach in front of Chatham. These gauges were to be observed so as to compare high and low water at their respective localities.

The topographical work was assigned to Mr. G. F. Bird, Aid, who reported for duty September 2, and carried out in detail Assistant Mitchell's suggestions. The points needed for the topography were determined by Mr. Weir, who obtained also the tide-gauge comparisons, and ran lines of levels along the crest-line and base of the bluffs, establishing temporary bench-marks from fifty to two hundred meters apart. The positions of these temporary marks were determined by the plane-table and plotted on the topographical sheet. Angles of elevation were taken every ten or twenty meters, or as often as was necessary to delineate the profile of the bluffs. Offsets were run back from the crest of the bluffs to furnish data to compute the areas which might, in future, be washed away, and lines of levels were run at a number of points down the face of the bluffs to determine the angles of natural slope.

Five permanent bench-marks were established and connected with the levels, the plane of reference for which was mean low water of the gauge outside of the main beach in front of Chatham. This plane of reference was secured by a permanent bench-mark on Chatham North Light.

Field operations were closed November 11, after which Mr. Weir was instructed to proceed to Washington, and subsequently to organize a party for geodesic leveling in Alabama and Mississippi. Mention of this duty will be further made under the heading of Section VIII.

Following are the statistics reported of work on the coast of Massachusetts:

Number of stations occupied in triangulation	10
Number of miles of shore-line surveyed	144

Mr. Weir commends highly the energy and skill of his aid, Mr. Bird.

Physical hydrography.—Movements of the sands at the entrance to Vineyard Sound.—In addition to other researches in physical hydrography, the study of the changes in Monomoy and its shoals was continued during the year by Assistant Henry Mitchell.

In Appendix No. 8 to the last annual report, Mr. Mitchell gave the physical history of those changes; in Appendix No. 6 to this volume he submits a continuation of that paper, in which he discusses the movement of the sands at the entrance to Vineyard Sound, and presents tables showing the resultant effect of tidal currents in that locality.

Mr. Mitchell prefers the title "Entrance to Vineyard Sound," because, as he states, the title "Nantucket Sound" (first given by Lieut. Charles Henry Davis) has never been adopted by the commercial world, and because the theme of his discussion involves the entire water space sheltered by the islands of Nantucket and Martha's Vineyard, and he adopts, therefore, the name in use that is the most comprehensive.

In a paper which forms part of his annual report, Mr. Mitchell offers some notes on physical surveys in progress, and maintains that the seaward approaches to great cities, and the sounds through which the fleets of commerce must pass, can never cease to be fields of survey; they must be watched as carefully as the great railways or rivers of interior communication.

Recommendations made by him in this paper for a survey of the seaward face of that portion of the Cape Cod peninsula from which shoal-building material appears to be derived, and for a hydrographic survey off Chatham and to the southward, have been carried into effect.

Other recommendations relating to the physical survey of New York Bay and Harbor will be referred to, with a notice of the progress of that survey, under the heading of Section II.

Special hydrography on the coast of Massachusetts from Powder Hole, Monomoy, to a point northward of Chatham River.—In connection with the study of the movements of the sands at the eastern entrance to Vineyard Sound, to which much time has been given by Assistant Henry Mitchell, and in accordance with suggestions made by him, instructions were given at the close of August, 1886, to Lieut. J. E. Pillsbury, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Blake*, to make special examinations on the Massachusetts coast from a point off Chatham towards Monomoy.

This survey was begun September 22. Lines of sounding normal to the shore were run at distances varying from two hundred and sixty to six hundred feet, with cross-lines at distances apart of from four hundred to six hundred feet. These normals were mostly run on ranges placed by the party. While the boats were engaged in sounding, Lieutenant Pillsbury anchored the vessel at a number of stations and observed currents with the Pillsbury current-meter. He desired to ascertain whether there were any subcurrents setting contrary to the surface currents which would account for the difference in time existing between high water and the flood current, or low water and the ebb, which is about three hours. These observations were taken between Handkerchief and Shovelful Shoals, and in the deep water of Butler's Hole, but the subcurrents were always found to be setting nearly true with those at the surface and with about the same velocity.

The shoal on the Shovelful was observed to make great changes during the progress of the work, extending or reducing its length, changing its direction, and altering its profile continually. At this point the sea seems to meet from opposite directions. Sometimes the top of the shoal would be flat and at other times curved. At first it was nearly a regular curve in contour, and then the eastern end became bifurcated.

Monomoy Point was observed to make great changes in a westerly gale. The sand was washed up, apparently building the Point towards the southward and eastward to an elevation of four or five feet at high-water mark and about two feet at low water.

Assistant Mitchell, in a note to this, observes that sometimes the elevation changes eleven feet, but that there is no permanent change due to storms in the long run.

Lieutenant Pillsbury presents the following statistics of the survey, which was completed November 8:

Miles run in sounding	258
Angles measured	3,370
Number of soundings	20,820

Hydrographic examinations for the Coast Pilot on the coasts of Massachusetts, Rhode Island, and New York.—In pursuance of instructions bearing date of December 4, 1886, Ensign W. J. Maxwell, U. S. N., attached to the Coast and Geodetic Survey, visited a number of localities upon the New England coast and in New York to make examinations for the use of the Coast Pilot with regard to improvements in harbors, quarantine regulations, bridges, uncharted dangers, buoys, new shore-lines, and weather signals.

The terminal points of the Cape Cod Ship Canal, now in course of construction, were visited and notes made of such information as would be useful. At Boston and New Bedford Mr. Maxwell tested sailing lines and ranges for entering and leaving these ports. This he was accorded facilities for doing by the courtesy of the Harbor-master of Boston and the Collector of the Port at New Bedford. While at Boston he visited the office of the State Harbor Commissioners, and there obtained the results of the latest harbor improvements in that port. These have since been transferred to the charts of the Survey.

Other ports at which examinations were made were Monument, Sandwich, and Fall River, Mass.; Wickford, Newport, Providence, Warren, and Bristol, R. I.; and New York, N. Y.

Routes by water were selected, whenever possible, in order to obtain such information as could be given by captains of steamers, and to make notes on the courses followed.

Mr. Maxwell completed his examinations and returned to Washington December 28.

Completion of a topographical survey of a new opening in Cotamy Beach, forming an inlet into Edgartown Harbor, Martha's Vineyard.—The duty of determining the exact location, extent, and character of the opening made in Cotamy Beach by the storm of January 9, 1886, having been assigned to Assistant Henry L. Whiting, as stated in the last annual report, he took up the work with as little delay as practicable, and in September, 1886, submitted a full report of its results, with special reference to the changes which had occurred at different periods since the first surveys were made forty years ago.

This paper was accompanied by a map showing changes in Cotamy Beach from surveys made by Mr. Whiting in 1846, 1856, 1871, and 1886, and was published as Appendix No. 9 to the last annual report. The opening of 1846 was similar in position and extent to that shown by Des Barres in 1776. The easterly point of the present opening is farther within the Bay, northward, than at any previous time, and, contrary to the usual action of the inlets and openings of previous years, the resultants of its moving sands have had a westward movement. The movement in this direction Mr. Whiting thinks will probably prove to be but a temporary one, and eventually the opening will work eastward as all former ones have done, though certain conditions of the beach may retard it. Soon after the opening was made, its width by estimation was three hundred feet; on July 1, by actual survey, it was twelve hundred feet.

Upon application made by the Board of Harbor and Land Commissioners of the State of Massachusetts, a copy of Mr. Whiting's report was furnished for the use of the board.

Hydrographic examinations in Edgartown Harbor and approaches.—In accordance with instructions issued in October, 1886, Lieut. John M. Hawley, U. S. N., Assistant Coast Survey, commanding the steamer *Bache*, on his way from duty on the coast of Maine, made an examination of the channel into Edgartown Harbor and of the new inlet into Cotamy Bay, taking also current observations in mid-channel between Chappaquiddick Point and Edgartown.

Arriving at Edgartown November 5, Lieutenant Hawley put up a tide-gauge on the wharf near where the old gauge had stood, and reduced his soundings to the plane of reference furnished by the Office from former observations. Several channel lines of soundings were run through the inlet at Cotamy Bay, and the line of breakers located on each side of the channel. Fishermen familiar with the locality stated that the channel through the inlet changed in direction and depth with every strong gale, and gave it as their opinion that the inlet was likely to close up at any time.

Lines of soundings about fifty meters apart were run across the channel into Edgartown from the outside red buoy to a point nearly a mile south of the town, a sufficient number being taken to develop any changes that might have taken place in the channel.

Continuous observations of the tidal current were taken for twenty-eight consecutive hours, and would have been kept up longer but for a heavy gale.

Ensigns E. E. Wright, John E. Craven, R. O. Bitler, and H. A. Field, U. S. N., aided in the work. The statistics are:

Miles run in sounding	10
Angles measured	238
Number of soundings	1,722

This duty performed, Lieutenant Hawley proceeded in the *Bache* to New York, where he arrived November 10. Soon after he was assigned to service in the office of the Hydrographic Inspector.

Completion of the topographical resurvey of Block Island, Rhode Island.—Reference was made in the last annual report to the progress of the topographical resurvey of Block Island, this resurvey being required as a part of the general resurvey of Long Island Sound, with the islands included in it and adjacent to it. Assistant W. H. Dennis, to whom had been assigned the charge of this work, had finished upwards of half of it by the beginning of the fiscal year, and completed it on the 9th of August, 1886.

Mr. Dennis has incorporated in his report some statements of much interest respecting the topographical and geological features of the island, extracts from which are as follows:

"The work on Block Island was of such a character as to require a very minute survey to represent properly its peculiar features; the surface is very irregular, or billowy, the highest point being some two hundred and twelve feet above tide-water.

"It is very nearly divided by Great Salt Pond, the pond being separated on the east and west sides from the ocean by narrow strips of sand. The northern part of the island, known as the Neck, is on the western side mostly sand and sand dunes, while the eastern is highly cultivated land; its highest point is about one hundred and forty feet; the bluffs along this part of the Neck, known as Clay Head, are from twenty to one hundred and fifteen feet above tide.

"The southern part of the island is nearly all under cultivation. On the eastern side, which is the most thickly settled, are the artificial harbor and breakwater built by the Government, and most of the large summer hotels. The eastern and southern shores of the island are steep bluffs, in places one hundred and seventy feet high. At the feet of these is a narrow sand and cobble beach, with large bowlders scattered profusely along, which serve as a breakwater, preventing the wash of the bluffs by the sea.

"Dotted over the whole island are innumerable ponds of all sizes and shapes, the waters of which are from a few feet to upwards of one hundred feet above tide. There is no evidence of these ponds being supplied by springs; they are simply catch-basins, which, from the nature of the soil, hold the water.

"The surface soil is of granitic origin; no rocks are found in place, but numerous bowlders of granite are scattered over the island. The substratum on which the whole rests is a deposit of Tertiary blue clay, destitute of any remains of marine shells, and containing layers of white sand and imbedded masses of gravelly bog-iron ore."

After finishing the resurvey of Block Island, Mr. Dennis took up, under instructions, the filling in of a gap in topography on the coast of Rhode Island, from Watch Hill, about five miles to the eastward, and extending inland between three and a half and four and a quarter miles, to a little beyond the line of the Providence and Stonington Railroad.

Upon the completion of this survey, October 31, field operations were closed for the season, and Mr. Dennis was ordered to duty at the Office. During the winter he was occupied for the greater part of the time in inking his topographical sheet of Block Island in such a manner that it could be reproduced by photolithography.

Between December 13 and January 2 he was placed in charge of the Instrument Division during the temporary absence of its chief.

Having finished the inking of the Block Island sheet the last of March, Mr. Dennis soon after received instructions to complete some unfinished portions of topography on or near the north coast of Long Island Sound. Mention of this service will be made under the heading of Section II, where also will be given the statistics of field-work executed by him during the fiscal year.

SECTION II.

CONNECTICUT, NEW YORK, NEW JERSEY, PENNSYLVANIA, AND DELAWARE, INCLUDING COAST, BAYS, AND RIVERS. (SKETCHES Nos. 1, 3, 4, 16, and 17.)

Triangulation at the eastern end of Long Island Sound.—In continuation of the resurvey of Long Island Sound, certain additional triangulation was found to be needed between Saybrook, Conn., and Watch Hill, R. I. For the execution of this work instructions were issued towards the end of August, 1886, to Subassistant C. H. Van Orden, who took the field on the 24th of that month, and at once began a general reconnaissance of the coast for the recovery of old points and the building of signals. The points determined are included in a stretch of coast on the Connecticut shore of the Sound from the Connecticut River eastwardly, and extend a short distance into Rhode Island.

Observations were begun September 11, and, the weather being unusually favorable, were finished October 5.

Mr. Van Orden reports the following statistics:

Number of signals built	10
Number of stations occupied	15
Number of horizontal directions measured	2,186
Number of micrometer readings	8,744
Number of geographical positions determined	12

Upon the completion of this survey Mr. Van Orden was directed to report to the Assistant in charge of the Office.

Towards the end of March, 1887, he received instructions to proceed to Boston, Mass., and report to Assistant Whiting for duty in aid of the topographical survey of the State of Massachusetts. Mention of this service will be found under the heading of Section I.

Topographical resurvey of the north shore of Long Island Sound between Stonington and Pequonnock, Conn.—In accordance with instructions dated July 28, 1886, Subassistant W. C. Hodgkins organized his party early in the following month to continue the topographical resurvey of the north shore of Long Island Sound. The work of the season, which began August 9, consisted in a survey of the country lying back from the shore between Stonington and Pequonnock, Conn., to include the principal country roads along and near the shore, and as far in the interior as the line of the New Haven, New London and Stonington Railroad.

The area surveyed, Mr. Hodgkins observes, is quite well settled, and includes the considerable villages of Mystic River and Mystic Bridge. The village of Noank and the borough of Stonington had been previously surveyed in connection with the survey of the shore-line in 1882 and 1883. The surface rises nowhere to a great height, but is rugged and broken, and quite well wooded a little back from the coast.

At the close of the season the new Light-house on Latimer's Reef was determined by triangulation.

Following are the statistics of the season, which closed towards the end of November:

Miles of shore-line surveyed	5
Miles of creeks and ponds	12
Miles of roads and railroads	47
Area surveyed, in square miles	14
Number of horizontal angles measured	12

After a term of duty at the Office, Mr. Hodgkins was instructed in January, 1887, to join the party of Assistant F. W. Perkins for service on the coast of Louisiana.

His work in that locality will be referred to under the heading of Section VIII.

Hydrographic examinations and observations of currents in Long Island Sound.—Lieut. C. P. Perkins, U. S. N., Assistant Coast and Geodetic Survey, commanding the schooner Eagre, reports that the work of his party executed prior to June 30, 1887, under instructions dated in March of that year, consisted of hydrographic re-examinations off Lawrence Point, in Oyster Bay, off Eaton's Neck, and off Larchmont and Mamaroneck, Long Island Sound, and also of the occupation of seven stations for a full series of observations of currents at each station.

His party arrived at the working-ground April 11 and completed the work June 17.

The statistics reported are:

Miles of soundings run	59
Number of soundings	6,520

Special hydrography executed by Lieutenant Perkins in New York Harbor and approaches is referred to under another heading in this section.

Hydrographic resurvey of Long Island Sound from Faulkner's Island to Execution Rocks.—The lines of soundings referred to in the last annual report, as needed to fill up parts of the surveys made in Long Island Sound in 1884 between Hammonasset Point and New Haven, which had been unavoidably left incomplete, were finished before the middle of July, 1886, by Lieut. F. H. Crosby, U. S. N., Assistant Coast Survey, commanding the steamer *Gedney*.

Lieutenant Crosby then took up, under instructions dated in June, 1886, the regular work of the season, which was laid out on four projections as follows: The first from Faulkner's Island to Stratford Shoal, scale 1–40000, for steamer work in the Sound, and for boat work along the north shore of Long Island from Roanoke Point to Mount Misery; the second, a projection, scale 1–40000, for steamer work to connect with the work of Lieutenant Paine in 1885, with that by Lieutenant Crosby on the north, and with that by the party in the steamer *Arago* on the south side of the Sound; and the third a projection, scale 1–20000, from Eaton's Neck to Execution Rocks for similar work, connecting with that done by the parties in the *Palinurus* and *Arago*, and including boat work along the Long Island shore from Oak Neck to a little west of Matinicock Point.

There was also one projection, scale 1–10000, covering Port Jefferson and Stony Brook Harbors and the adjacent coast.

To obtain a plane of reference for the soundings on the two sheets first named, Lieutenant Crosby erected a box gauge at Stratford Shoal Light, and kept up tidal observations there for about four months. Simultaneously with it, at different times, tides were observed on gauges at Southwest Ledge, entrance to New Haven Harbor, Money Island, Faulkner's Island, Port Jefferson (entrance and head of harbor), Stony Brook Harbor, and Stamford Light. Other gauges were established at Setauket Harbor, Wilson's Point in Sheffield Island Harbor, Constable Point, and Execution Rocks.

Lieutenant Crosby observes that there is a gradual increase of rise and fall in the tide from east to west in the Sound until its narrow point is reached at Eaton's Neck, beyond which point there is little change.

Just before the close of the season three current stations were occupied, one west of Execution Rocks, one off Matinicock Point, and one off Eaton's Neck. At the first-named station a full series of current observations was taken for twenty-six hours under favorable circumstances; at the second station for but twenty hours, during thirteen of which the conditions were favorable;

at the third station a twenty-six hour series was obtained, but under conditions which were not wholly favorable. All of the observations on these three stations have been sent to the Office.

Sailing directions prepared by Lieutenant Crosby for those parts of the Sound included within the limits of his survey have been referred to Lieutenant Peters in charge of the Coast Pilot work.

In the course of the work a rocky shoal of considerable extent was developed, having a least depth of fourteen feet over it, and lying about three-quarters of a mile to the northeastward of Stratford Shoal Light-house. Several other shoal patches and rocky heads were found off that Light-house, at distances varying from one-half to three-quarters of a mile, and having from sixteen to twenty-one feet of water over them. To warn navigators of these dangers, a Notice to Mariners (No. 80) bearing date of October 23, 1886, was issued. Vessels passing to the northward of Stratford Shoal were advised to give the light house a berth of at least a mile.

Ensigns A. W. Dodd, J. S. Watters, G. W. Street, C. E. Sweeting and C. M. Fahs, U. S. N., were attached to the *Gedney* during the season.

Lieutenant Crosby reports the following statistics of his work, which was brought to a close about the middle of November:

Miles run in sounding	1,655
Angles measured	12,456
Number of soundings	58,223

During the winter and until about April 1 the steamer was undergoing repairs at Baltimore and at the navy-yard, New York. Early in April Lieutenant Crosby reorganized his party, under instructions, aboard the *Gedney*, and proceeded to Long Island Sound to make certain examinations and run additional lines of soundings in Five Mile River; near Stamford, Conn.; off Stratford Point, and off Guilford, Conn.

This done, he left the Sound, and under instructions bearing date of May 12, made an examination in the Swash Channel, off Dry Romer Beacon, New York Lower Bay, to locate the spot where the steamer *Fulda* grounded.

Upon the completion of this duty, Lieutenant Crosby left New York May 30, and proceeded to the coast of Maine, to take up the regular work of the season. Reference to his service on that coast is made under the heading of Section I.

For the hydrography executed at the outset of the season, the following are the statistics reported:

Miles run in sounding	121
Angles measured	1,784
Number of soundings	9,623

Ensigns A. W. Dodd and N. J. L. T. Halpine, U. S. N., were attached to the party on the *Gedney*.

Topographical resurveys on or near the north shore of Long Island Sound, to complete resurveys previously made.—In order to fill certain gaps in topographical resurveys on or near the north shore of Long Island Sound, Assistant W. H. Dennis organized his party under instructions on the 1st of May, 1887, taking up the topography near Stonington where he had left off the preceding season, and working westwardly until on May 19 he had made a junction with the topography executed by Subassistant Hodgkins. He then moved to New London and extended the topography back from the narrow margin along the shore already surveyed so as to include the line of the New Haven, New London and Stonington Railroad on both the Niantic and New London sheets. Finishing this on June 16, the party was transferred to Saybrook, Conn., where a similar piece of work was done, covering a small area, and again moved June 22 to Clinton, Conn., where on the 30th was finished all that was required on the Guilford sheet.

For the fiscal year ending June 30, 1887, Mr. Dennis reports the following statistics:

Miles of shore-line surveyed	34
Miles of creeks and ponds	47
Miles of roads	179
Area surveyed, in square miles	32

Detailed topographical resurvey of the north shore of Long Island Sound, from East Bridgeport, Conn., to the eastward.—A shore-line resurvey of the north coast of Long Island Sound from East Bridgeport to Woodmont, Conn., was completed in 1884–'85 by the party in charge of Subassistant W. C. Hodgkins. In order to fill in the details of the belt of topography extending back from the shore to the line of the New York, New Haven and Hartford Railroad, Assistant W. I. Vinal was instructed to organize a party early in August, 1886. This resurvey was carried on till November 20, when field operations were closed.

After inking his topographical sheet, Mr. Vinal reported for duty at the Office in Washington, where he was occupied until the end of March. In April he was engaged in service at Baltimore, Md., which is reported under the heading of Section III, and on May 1, 1887, he resumed his topographical work in Connecticut from the limits of the previous season and brought it to completion by the end of the fiscal year.

With regard to the geological features of the country covered by the survey between East Bridgeport and West Haven, Conn., Mr. Vinal observes that they are neither bold nor striking. The rocks are mostly of secondary formation and sedimentary, with many drift bowlders. Limestone abounds, and slate rock suitable for flagging and foundations occurs extensively. In the eastern part of Milford township is a quarry, now neglected, of marble, which is susceptible of high polish. The Naugatuck Railroad, which runs along the east side of the Housatonic River, passes through an extensive cutting of micaceous gneiss rock immediately on leaving the bridge.

The streams shown on this survey are all shallow. Light-draught steamers and canal-boats pass the bridges on the Housatonic River, but nothing larger than a sail-boat can reach Milford on the Wepowage River. At the latter place the Government has constructed a short breakwater out from Indian Point towards Charles Island. It does not appear, as Mr. Vinal remarks, to have benefited the channel, but affords a convenient and safe anchorage below the town for small vessels. Mr. Vinal's report refers to a number of facts of historical interest relating to the towns and villages included in his survey, mentioning among others the Indian name of Milford, which was Wepowage, a name yet retained by the little river which runs through the center of the town. It may be observed here that the name is sometimes spelled Wepawang.

For the fiscal year the statistics of work on the Long Island coast are as follows:

Miles of shore-line surveyed	3
Miles of creeks surveyed	37
Miles of ponds surveyed	7
Miles of ditches surveyed	3
Miles of railroad surveyed	10
Miles of roads and streets	105
Area (approximate) surveyed, in square miles	17

Topographical resurvey of the shore-line of New York Bay, Newark Bay, Kill van Kull, and Arthur Kill.—Topographical resurvey from Woodmont to the eastward.—Mr. E. L. Taney, Aid, has made a very brief report of the operations of his party, organized under instructions dated in August, 1886, for a topographical resurvey of part of the shore-line of New York Bay, and of the shore-lines of Newark Bay, Kill van Kull, and Arthur Kill.

This resurvey was begun August 16 and finished November 15, when field-work closed.

From that date till March 31, 1887, Mr. Taney was employed on office-work, first in inking his topographical sheets and then on duty in the Coast Pilot Division. Upon being relieved from the Office, he was ordered to service in the harbor of Baltimore, mention of which is made under the heading of Section III.

On May 1 he proceeded under instructions to West Haven, Conn., and took up a topographical resurvey from Woodmont to the eastward. He reports the following statistics:

Approximate number of miles of shore-line surveyed	66
Approximate number of miles of creeks	13
Approximate number of miles of railroads and other roads	19
Approximate area surveyed, in square miles	6

Hydrographic examinations for the Atlantic Coast Pilot in Long Island Sound and on the coast to the eastward.—For the purpose of obtaining fresh data and material to be used in the compilation of the Atlantic Coast Pilot and its subdivisions, Lieut. George H. Peters, U. S. N., Assistant Coast and Geodetic Survey, under instructions issued April 12, 1887, took command of the steamer *Daisy*, and after having refitted her at the navy-yard, New York, began hydrographic examinations in the East River.

On May 11 an examination was made of Southeast Point Deep Reef, off the southern end of City Island, at the western entrance to Long Island Sound, and the result reported to the Office.

Between June 6 and 9, Lieutenant Peters was at New Haven, Conn., on special service under the direction of the Hydrographic Inspector, and upon its completion he resumed the regular work of his party, making examinations in Fisher's Island Sound, Gardiner's Bay, Shelter Island Sound, and in the harbors adjacent.

On June 16 he proceeded to Narragansett Bay, and was occupied in that bay and its harbors till June 26. Much delay was caused during this period by fog and unfavorable weather. On June 28, in accordance with instructions, the *Daisy* was turned over to Lieut. C. P. Perkins, U. S. N., Assistant Coast and Geodetic Survey, commanding the schooner *Eagre*, and the Coast Pilot party proceeded to New York and joined the steamer *Endeavor* June 29, under orders to proceed to the eastern coast.

Lieutenant Peters reports the results accomplished at the close of the fiscal year as gratifying, and takes occasion to attribute this in great measure to the skill and energy of the officers associated with him in the work: Ensign E. H. Tillman, U. S. N., who served till June 13, and Ensign W. J. Maxwell after that date. Also Mr. John Ross, who served throughout the season.

Care was taken to collect from local authorities, harbor-masters, pilots, and others, all information that would be of practical use to mariners.

Resurvey of the shore-lines of Hempstead Harbor, Long Island, and of the south shores of Long Island Sound from Setauket Harbor to Eaton's Neck.—Under instructions bearing date early in July, 1886, Assistant C. T. Iardella took the field in continuation of the topographical resurvey of the south shores of Long Island Sound. Beginning with a resurvey of the shore-line of Hempstead Harbor, Long Island, he finished that work August 11, and then took up the resurvey of the north coast of Long Island from Setauket Harbor to Stony Brook Harbor, and thence to Eaton's Neck. Upon the east, this survey (scale 1-10000) connects with the work of Assistant Vinal in 1885, and upon the west with that of Assistant Hodgkins in the same year.

Field operations were closed October 22. Mr. J. H. Gray served acceptably as Aid in the party. The statistics reported are:

Miles of shore-line surveyed	92
Miles of low-water line surveyed	83
Miles of roads surveyed	22
Miles of marsh-line surveyed	33
Miles of creeks and wharf lines	12
Area surveyed, in square miles	15

During the rest of the autumn and part of the winter Mr. Iardella was engaged in Office-work, and in January, 1887, received orders for duty, reference to which will be made under the heading of Section VIII.

Completion of the shore-line and interior topographical resurvey of the north coast of Long Island Sound from the Norwalk River to Rye Neck.—In continuation of his work of the previous season on the north shore of Long Island Sound, Assistant Charles Hosmer was occupied under instructions between June 1 and November 8, 1886, in filling in the details of topography from the shore of the Sound and vicinity, back to the line of the New York and New Haven Railroad between the Norwalk River and Rye Neck. This work is included in four topographical sheets, scale 1-10000; the last sheet, which extended to Davenport's Neck and New Rochelle, could not be finished, owing to the exhaustion of the amount available to keep the party in the field; the work closed, therefore, for the season at Rye Neck.

Mr. Hosmer states that the details of topography in the region surveyed were quite intricate and progress necessarily slow. He reports the following statistics:

Miles of shore-line surveyed	10
Miles of roads surveyed	104
Miles of creeks	2
Area surveyed, in square miles	20

During the winter and early spring Mr. Hosmer was engaged upon office duty at his home, and in April, 1887, was instructed to resume the topography from the limits of his work of the previous season in the vicinity of New Rochelle, and carry it inland as far as the line of the New York, New Haven and Hartford Railroad east of that town, and to the west of it to Hutchinson's River, keeping the belt of topography about of an equal width.

This work was finished June 30, previous to which Mr. Hosmer had received instructions for topographical inspection duty on the coast of Maine.

The statistics for May and June, 1887, which he reports, are as follows:

Miles of shore-line surveyed	6
Miles of roads	70
Miles of creeks	2
Area surveyed, in square miles	8

Resurvey of Long Island Sound.—Continuation of inshore hydrography between Sheffield Island Light and Execution Rocks.—Hydrographic survey of Hempstead Harbor.—Reference was made in the last annual report to the progress made up to the close of the fiscal year by Lieut D. D. V. Stuart, U. S. N., Assistant Coast Survey, commanding the schooner *Palinurus*, in the hydrographic resurvey of the western portion of Long Island Sound. His work was laid out upon four projections, scale 1–10000, the first three including the inshore hydrography from Sheffield Island Light to Execution Rocks, and the last covering the area of Hempstead Harbor.

With the exception of some slight revisions of lines of soundings, the hydrography was finished by November 3. These revisions were then completed, and the *Palinurus* returned to New York November 13. The statistics are:

Miles run in sounding	627
Angles measured	7,357
Number of soundings	31,441

Lieut. W. G. Hannum, U. S. N., and Ensigns Marbury Johnston, W. O. Hulme, and H. E. Parmenter were attached to the party on board the *Palinurus*.

In December, 1886, Lieutenant Stuart was transferred to the command of the steamer *Endeavor*, and organized his party on board of her for service on the Gulf coast, reference to which will be made under the heading of Section VIII.

Resurvey of Long Island Sound.—Inshore hydrographic surveys on the north coast of Long Island.—Early in July, 1886, detailed instructions for hydrographic work in continuation of the resurvey of Long Island Sound were issued to Lieut. F. S. Carter, U. S. N., Assistant Coast Survey, commanding the steamer *Arago*. He received at the same time two projections, one upon a scale of 1–20000, including the western part of the Sound from Eaton's Neck to Execution Rocks; the other upon a scale of 1–10000, including Oyster Bay and vicinity.

Leaving New York July 17, the *Arago* arrived at Oyster Bay on the 19th, and on the following day began running lines of soundings. The shore-line in this vicinity had been recently resurveyed, and as the signals were still standing and their positions plotted on the projection, this survey, which included Cold Spring Harbor, Oyster Bay Harbor, and Oyster Bay and approaches, was speedily pushed to completion. Work was then taken up on the sheet of the western part of the Sound, but this sheet was subsequently transferred to Lieutenant Crosby, commanding the *Gedney*, by whom it was finished.

Two more projections having been received from the Office, one including Huntington and Northport Bays, the other Smithtown Bay, work upon them was taken up in due course. During its progress orders were received October 19 detaching Lieutenant Carter from the survey, and the command of the *Arago* and charge of the party were transferred to Ensign W. J. Sears,

U. S. N. By November 15 the hydrography embraced in these projections was finished, and on November 16 and 17 the party was engaged in taking observations of currents at Station No. 3 in the Sound, distant seven miles and four-tenths on a course N. 109° W. of Stratford Shoal Light. Current observations were again taken November 21 and 22, the station occupied on those days being No. 1, distant two and a half miles from Stratford Shoal Light on a course N. 3° W. These observations were the best that could be obtained at this season, it being difficult to get twenty-six consecutive hours of favorable weather in the Sound late in November.

Ensign Sears has transmitted with his report navigation notes and sailing directions, which will afford valuable data in the compilation of a new edition of the Coast Pilot.

The officers attached to the party were Lieut. F. S. Carter, U. S. N., commanding, until October 19, when he was succeeded by Ensign W. J. Sears, U. S. N., who had joined the *Arago* September 21; Ensigns A. W. Dodd and Roger Welles, jr., U. S. N. Ensign Dodd was detached October 4.

For the season the statistics are:

Miles run in sounding	498
Angles measured	6,323
Number of soundings	22,318

Tidal examinations and comparisons in the Hudson, Harlem, and East Rivers, and in Flushing, Little Neck, and Newark Bays.—For the purpose of obtaining data to aid in an investigation of the interference tides in New York Bay and Harbor, Lieut. C. P. Perkins, U. S. N., Assistant Coast Survey, commanding the schooner *Eagre*, acting under special instructions from the Hydrographic Inspector, established a series of tidal stations in the Hudson, Harlem, and East Rivers, and in Newark Bay, and took such tidal observations and soundings as would be of service in ascertaining the several tidal levels produced by the Long Island Sound and ocean tides.

Lieutenant Perkins organized his party and began operations in May, 1886, as stated in the last annual report. For convenience of reference and survey he divided his work into several sections, and determined the mean low-water reading for each section from a suitably-located tide-gauge.

His first division or section was from One hundred and twenty-fifth street on the Hudson River up to King's Bridge. For this division the tide reductions were taken from the tide-gauge at the dock at One hundred and fifty-fifth street. The mean low-water reading of this gauge was determined from observations extending through one lunar month, and the plane of reference thus derived was carried up to a tide-staff at the mouth of Spuyten Duyvil Creek, and used for the upper part of the river and for the creek.

The second division extended from King's Bridge through the Harlem River to Ward's Island, and the tide reductions were taken from the gauge at Randall's Island boat-house, its mean low-water reading being determined from observations of the tide for one lunar month. This gauge was used for the work as far up as High Bridge, and from a tide-staff set at High Bridge for the remainder of the work to King's Bridge.

The third division extended from Ward's Island around through Hell Gate to Lawrence Point, and the mean low-water plane was assumed the same as at Randall's Island; that is, the mean low-water reading was obtained by comparing several high and low waters, and following the method given in the General Instructions for Hydrographic Work, using the tide-staff at Pot Cove, Astoria.

The fourth division was from Lawrence Point to Clauson's and College Points, including Flushing Bay, the tide reductions being taken from the gauge at College Point. Mean low water for this gauge was determined from observations through one lunar month.

Work in Little Neck Bay and between College Point and Willets Point, comprising the fifth division, was also reduced from the College Point gauge. A tide-staff was set up at North Brother Island, and one at Willets Point, and the run of the tide at these two positions found to be the same.

The sixth division included the upper part of Newark Bay, and the tide reductions were taken from three gauges, one at the end of the jetty in Newark Bay, one midway in the Passaic River work, and one midway in the Hackensack River work, the mean low-water reading being determined by a twenty-four hour comparison with a gauge at Elizabethport, N. J., observed by Lieutenant Hanus.

From careful comparisons of several simultaneous readings of tides, Lieutenant Perkins reports that the plane of mean low water at Randall's Island is the mean of the planes at One hundred and fifty-fifth street, Hudson River, at Bellevue Hospital (foot of Twenty-eighth street, East River), and at College Point. For that reason the Harlem River and Hell Gate work has been reduced to that plane, the Hudson River work to a plane about 0.5 foot higher, and Flushing Bay to a plane one foot lower.

Few changes were found to be needed in sailing directions for the localities under survey. Special reports and tracings of such changes for the channels between North and South Brother Islands, between South Brother Island and Lawrence Point, and between Lawrence Point and the Sunken Meadow were transmitted to the Office.

It having been reported, through the Hydrographic Office of the Navy Department, that there existed an uncharted ledge between Lawrence Point and the Middle Ground (Sunken Meadow Shoal) buoy, Lieutenant Perkins was directed to examine the locality, and found an abrupt, narrow, and dangerous ledge, over which the soundings were very irregular, and having over it a least depth of thirteen feet water. The bearings of this ledge from well-known points in the locality, with directions for avoiding it, were given in Notice to Mariners No. 82, bearing date December 1, 1886.

Operations afloat were closed for the season November 17. The statistics reported are:

Miles run in sounding	370
Number of soundings	40,057

Ensigns W. B. Fletcher and W. E. Parmenter were attached to the party aboard the *Eagre*.

In March, 1887, Lieutenant Perkins was instructed to reorganize his party on board the *Eagre*, and to make current observations and hydrographic examinations in the eastern part of Long Island Sound. Reference to this work has been made under a previous heading in this section.

Physical hydrography.—The circulation of the sea through New York Harbor.—Conclusions, recommendations, and suggestions derived from studies of the resurvey of the harbor.—In the report on the circulation of the sea through New York Harbor, which is now in press as Appendix No. 13 to the annual report for 1886, Assistant Henry Mitchell, in charge of the physical survey of that bay and harbor, states as a proposition the existence of a *resultant* or net movement through New York Harbor from the Sound to the ocean. This proposition he demonstrates, first from a theoretical and then from an inductive point of view.

There are so many variables that enter into tidal currents, and it is so difficult to continue the observations long enough to eliminate these, that no conclusion could have been safely based upon the inequalities of ebb and flood. Fortunately a comparison of computed curves, so adjusted as to represent the tidal profiles of the Sound and harbor as given in the general tide-tables, revealed the inevitable presence of this net movement before it was discovered that current observations made as far back as 1871 told the same story.

The best work, however, in the way of current observations was done in 1885 by the party in charge of Assistant H. L. Marindin. They gauged the East River from side to side and from top to bottom, at Nineteenth street and at Old Ferry, sections some ten miles apart. The observations were continued thirty-six hours at each section, so as to eliminate the diurnal inequality, and the results were 342 and 448 millions of cubic feet, respectively, as the *net* discharge westward for each twelve hours.

"It is this circulation which keeps the port open in winter and sweeps the sand from its threshold."

In a later paper, forming part of his annual report, Mr. Mitchell submits recommendations and suggestions having an important bearing on schemes of future work. The general purport of these is as follows:

Hitherto the surveys for the development of the physical hydrography of the harbor have all been carried on in the dry season, July, August, and September, when the rivers run low, and while the subcurrent of sea-water is pouring into the Tappan Sea and the bed of the Hudson. Observations ought to be made at two other seasons—when the rivers are frozen and when they are in flood, *i.e.*, in February and April—winter and spring.

In concert with the automatic tidal record kept up at Sandy Hook, a similar record should be kept at Willets Point, in order that the variations of level which induce the scour of the harbor and its channels may be known, whether these variations are due to influences of the sun and moon or to meteorological causes.

It would be very desirable also to have observations made in New York Bay, and in other great bays and sounds, of the variations of temperature and specific weights of sea-water. Few comprehend how very gradually the sea chills as winter comes on, and how orderly the variations appear when plotted on profile paper. Mr. Mitchell is of opinion that where no river waters change the densities, the date at which the danger point for freezing is reached could be predicted in the almanac, and the actual closing of the port announced by the Weather Bureau.

Reference is made under the heading of Section I to other investigations in physical hydrography which have occupied Mr. Mitchell's attention, and under a subsequent heading in this section to his connection with the work in Delaware River and Bay.

Continuation of surveys for the development of the physical hydrography of New York Bay and Harbor.—In response to an urgent call for the continuation of the important physical surveys in New York Bay and Harbor, instructions were given towards the end of August, 1886, to Assistant H. L. Marindin to proceed from Philadelphia to New York in the schooner *Ready* with the party in his charge which since the opening of the fiscal year had been engaged in making observations of currents and in locating pier lines along the water front of Philadelphia.

After detention by adverse winds at the Delaware Breakwater, the *Ready* arrived at New York September 12, and two days later, work in the harbor was begun by the erection of tide-gauges. The plan of operations, as devised by Assistant Mitchell, and set forth in the programme issued from the Office, contemplated the occupation of numerous tide-stations, where simultaneous observations were to be recorded, in order to get data for determining the relative elevation of the different tidal reservoirs which pour their waters into and out of the harbor. For this purpose tide-staffs were erected at Willets Point, College Point, Port Norris, Polhemus Dock, Pot Cove, foot of Eighty-fourth street, Ravenswood, Hunter's Point, and Corlear's Hook in the East River; also at Governor's Island, Forty-second street, Hudson River; Constable's Hook, Bay Ridge, and at Quarantine Dock for the Upper Bay; and for the Lower Bay, Sandy Hook, Bath, Great Kills, South Amboy, Port Monmouth, and Conaskonk Point. For Newark Bay and the Kills the tide stations were Elizabethport, Elm Park, and Hackensack River Bridge. The tide station at Dobbs Ferry, nineteen miles above New York, on the Hudson River, was also occupied as being at the entrance of the Tappan Sea.

While tide observations were in progress, a number of current stations were occupied simultaneously between October 4 and 7 by the vessels of the Coast and Geodetic Survey then in the harbor; Lieutenant Hanus, U. S. N., with the *Endeavor* occupying a station on the bar at Sandy Hook; the steamer *Daisy*, attached to his party, occupying one in the Narrows; and Lieutenant Perkins, U. S. N., with the schooner *Eagre* occupying one at Old Ferry Point, while Mr. Marindin's party, with the schooner *Ready*, occupied a station off Twenty-third street, East River. At the close of these observations the naval vessels returned to their season's work.

Toward the end of the season, in order to reduce expenditures, Mr. Marindin at his own request was directed to lay up the vessel and with a reduced party to continue the connection of the tidal stations by lines of geodesic leveling. Subassistant J. E. McGrath, who had joined the party in July, was detached to go on with this work, and upon November 1 he was placed in sole charge of it, Mr. Homer P. Ritter being assigned to aid him. Mention in detail of this service will be made under a following heading in this section.

Mr. Marindin acknowledges the kindness of Professor Ricketts, of Columbia College, in obtaining for him the services of a number of the graduates and undergraduates of that institution as tide-observers. With the aid of these young men a very satisfactory series of observations at the tidal stations was secured.

A summary of the statistics of the season which closed in November, 1886, is as follows:

Number of tide-gauges observed	25
Number of tidal observations recorded	29,151
Number of observations of currents	308

During part of the winter Mr. Marindin was on duty with the United States Advisory Commission for the Port of Philadelphia. Having completed the drawings for this Commission, he reported for Office duty at Washington January 31, and from that date till towards the end of May, 1887, he was attached to the Division of Physical Hydrography under Assistant Henry Mitchell.

The work assigned to him was the computation of the differences of elevation of the water surface in the bays and streams surrounding New York for specified times following the moon's transit, and the preparation of diagrams showing these differences graphically.

In May, 1887, he was detached from the Office and instructed to take charge of parties on the schooners *Ready* and *Palinurus*, with steam-launches attached, and to continue the investigation of the movements of the currents on Sandy Hook Bar, New York Harbor.

The parties on the schooner *Ready* and steam-launch, having been fitted out, Mr. Marindin began field-work June 1 by rating the telegraphic current meters to be used during the season. A week later the *Palinurus* joined the party.

For this rating the requisite conditions of slack water, sufficient depth, and shelter from wind were obtained at Factory Pond, on Staten Island, and upon its completion, June 10, the parties proceeded to Bath Beach, New York Lower Bay, where the principal tide-station and the headquarters for the schooners and steam-launches were to be established.

A self-registering tide-gauge was placed on the steam-boat wharf at Bath Beach and maintained in operation during the entire season. It was referred to the bench-mark established some years before by Lieutenant Hanus, U. S. N.

At the first opportunity current observations were begun in accordance with memoranda prepared by Assistant Mitchell.

Each channel, beginning with the most northerly one, was occupied by the schooners and launches to obtain cross-sections of current velocities at as many points as could be observed simultaneously. From four to five points were thus occupied for thirteen consecutive hours, with observations every fifteen minutes; then an interval of six hours was allowed to elapse, after which a set of observations for seven consecutive hours was begun.

The velocities were taken at different depths, and with special care near the bottoms of the channels, and specimens of the bottom were obtained and preserved.

Mr. Marindin found the steam-launches to be of great service throughout the season. He expresses himself as much indebted to the Hydrographic Inspector, Lieutenant-Commander Brownson, for his efforts in supplying the new launch at an early date.

For the work of June, 1887, the following statistics are reported:

Number of soundings on cross-sections	170
Number of stations occupied for observations of currents	14
Number of observations of currents	1,093
Number of directions of bottom velocities observed	63
Number of hydrometric observations	79

In acknowledgment of faithful services rendered by numbers of his party, special mention is made by Mr. Marindin of Messrs. E. E. Haskell, H. P. Ritter, G. E. Kent, E. H. Wedekind, W. H. Given, A. R. Hasson, R. G. G. Moldenke, and James A. Connor.

At the close of the fiscal year the work was still in progress, and further mention of it will be made in the next annual report.

Physical hydrography of New York Bay and Harbor.—Zeros of tide-gauges in the East River connected by geodesic leveling.—For the study of the phenomena of the successive tidal levels in the East River caused by the two tidal waves, one from the Sound and the other from the ocean, which meet or pass into each other in Hell Gate, Assistant H. L. Marindin, acting under the general direction of Assistant Henry Mitchell, had established tide-gauges and bench-marks at

Hunter's Point, Ravenswood, Eighty-fourth street, Pot Cove, Polhemus Dock, College Point, and Willets Point. To connect the zeros of these tide-gauges and their bench-marks, lines of geodesic leveling were run, beginning October 16, from Pot Cove to Polhemus Dock; from Eighty-fourth street to Pot Cove (crossing the East River at the head of Blackwell's Island), and from an intermediate point on this line to Ravenswood and Hunter's Point. The old bench-mark of 1857 at Ravenswood was recovered and connected with the bench-mark of 1886.

After the difference of absolute heights between the zeros of the Pot Cove and Eighty-fourth street gauges had been determined by the geodesic level, a discrepancy was found between this result and that obtained from observation of the mean sea-levels determined by the readings of the tide-gauges; this discrepancy appeared also when the two determinations for the difference of level of the zeros of the gauges at Pot Cove and at Polhemus Dock were compared.

Hence, as a means of precaution, the line between Eighty-fourth street and Pot Cove was again run, but by a different route, and a result obtained for difference of level almost identical with that from the first line.

On November 1 Subassistant J. E. McGrath was directed to take up the leveling work in accordance with an approved scheme which had been submitted by Assistant Marindin, and in pursuance of which a check line of levels of precision was run from Hunter's Point directly to Polhemus Dock, and Willets Point and College Point were connected with Hunter's Point. The connection of Hunter's Point and Ravenswood with Polhemus Dock having been established independently of the bench-marks at the foot of Eighty-fourth street and at Pot Cove, a new line was also run from Hunter's Point to a temporary bench-mark on the Long Island Railroad, making the lines from Hunter's Point to College Point and to Willets Point entirely independent of the lines between Hunter's Point and the bench-marks around Astoria.

In the geodesic leveling the method of two simultaneous parallel lines was adopted. The number of miles of double lines run was twenty-eight.

Mr. McGrath has accompanied his report by a summary of the heights of the zeros of the tide-gauges and bench-marks referred to the zeros of the Ravenswood tide-gauge and bench-mark of 1886. He acknowledges the valuable service rendered by Mr. Homer P. Ritter as recorder in his party.

In April, 1887, Assistant J. B. Weir was directed to organize a geodesic leveling party to continue the connection of the tide-gauges and bench-marks in and near New York Bay and Harbor. Subassistant J. E. McGrath and Extra Observer W. B. Fairfield were assigned to Mr. Weir's party, each of these officers being trained and skillful in the many details of observation with geodesic levels.

The method of working was the same as that followed by Mr. Weir in connecting Citronelle, Ala., with Quitman, Miss., by leveling of precision during the winter preceding.

Field operations were begun April 19. Owing to the crowded condition of the streets it was necessary to keep away from the water-front and select those streets which were least used by heavy wagons. A compromise route was therefore selected, though not without much labor; one that would afford, as nearly as possible, the shortest horizontal distance, the fewest vertical changes, the least disturbance by heavy teams, and that would at the same time keep as close as practicable to the river and bay fronts. As a main or base line such a line was run from Hunter's Point to Fort Hamilton, and offsets were run from this main line whenever it was necessary to connect on a tide-gauge. These offsets were to the tide-gauges at Corlear's Hook, New York, Governor's Island, Bay Ridge between Gowanus Bay and Fort Hamilton, and Bath on Gravesend Bay.

In order to reach the gauge at Corlear's Hook it was necessary to cross East River, which was done from the gas-house wharf, Brooklyn (the first wharf below the navy-yard), by means of simultaneous observations on both sides of the river, each observer occupying alternately the north and south banks of the river during four days. The sights were five hundred and twenty-one and five hundred and thirty-four meters in length, but owing to the unfavorable weather it was necessary to take a great many observations in order to get an accurate crossing.

The same method was used in crossing Buttermilk Channel from Atlantic Dock, Brooklyn, to Governor's Island.

For the crossing at the Narrows the instruments were mounted, one on the ramparts of Fort Lafayette and the other on the terrace at Fort Wadsworth, Staten Island. The sights being about one thousand four hundred meters in length, very favorable weather was required to obtain satisfactory results. This part of the work had not been completed when Mr. Weir, having been relieved from duty at his own request, turned over the charge of the party, June 7, to Mr. McGrath. But the line of levels had been continued from Fort Wadsworth up the bay, and up Kill van Kull to Elm Park tide-gauge, with an offset to Quarantine tide-gauge.

Mr. W. B. Fairfield was detached from the party May 12, and Mr. John Nelson, Aid, assigned to take his place.

The statistics of the work of 1887, as reported by Mr. Weir, are as follows:

Miles run of geodesic leveling	31
Tide-gauges connected and referred to permanent bench-marks	8
Permanent bench-marks established and connected with lines of geodesic leveling	21

The further progress of this work until its completion by Subassistant McGrath will be stated in the next annual report.

Topographical resurvey of shore-lines of New York Bay and Harbor and vicinity continued.—Reference was made in the last annual report to the resumption in May, 1886, by the party of Assistant D. B. Wainwright, of the topographical resurvey of the shore-lines of New York Bay and Harbor and vicinity.

This resurvey included the shore-line of the Harlem River from Randall's Island to and including Spuyten Duyvil Creek; also both shores of the Hudson River between that creek and Seventy-ninth street. This part of the work was finished November 1, and Mr. Wainwright then took up the resurvey of the shore-line of the Lower Bay, connecting at Keyport, N. J., with the topography executed by Assistant R. M. Bache, and extending the shore-line resurvey to Sandy Hook.

Certain details of the work requiring re-examination, Mr. Wainwright was occupied in this duty from December 20 till about the beginning of January, 1887. Some triangulation of an approximate character with the plane table was needed for the determination of additional points.

Subsequently Mr. Wainwright was employed on office duty, and early in March he left for Wilmington, N. C., to organize a party for service which is referred to under the heading of Section IV.

Determination by triangulation of additional stations in Newark Bay and vicinity.—Certain additional triangulation having been found necessary to strengthen the determinations in geographical position of some plane-table stations in Newark Bay and vicinity, Assistant A. T. Mosman was charged with this duty by instructions issued in February, 1887.

After a general reconnaissance of Newark Bay and an examination of stations for occupation in the towns of Elizabeth and Bergen, N. J., on Staten Island and in New York City, Mr. Mosman began his observations March 8, having mounted his theodolite on the outside of the spire of the First Presbyterian Church in Elizabeth. Other stations successively occupied were the top of the tower of the Reformed Dutch Church, Bergen, N. J.; the top of the tower of the Produce Exchange, New York, and station Bogart, N. J.

As all of these stations were in very exposed positions, and as no tent could be used over the instrument owing to their peculiar location, the work was prosecuted under many difficulties, owing to stormy weather and the frequency of high, cold winds, against which the observer had no protection. When strong winds were not blowing, the smoke from numerous chimneys at Bergen Point, Newark, Elizabethport, Jersey City, and New York so obscured the atmosphere that no signals could be seen.

Field operations were completed March 24. The statistics are:

Number of stations occupied	4
Number of geographical positions determined	28
Number of observations of horizontal angles	727

After finishing the computations relating to this work, Mr. Mosman began in April to prepare for resuming the transcontinental triangulation in Ohio and Kentucky. A report of this service will be found under the heading of Section XIV.

Continuation of the resurvey of New York Harbor and approaches by a shore-line survey of the south coast of Staten Island from New Creek to Tottenville, and of the New Jersey shore from Perth Amboy by way of South Amboy to Keyport.—Reference was made in the last annual report to the progress of the topographical resurvey of the shore-line of Staten Island from Tompkinsville to the southward and westward under the direction of Assistant R. M. Bache. With the shore line, the work included a strip of topography of moderate and varying width just back of it, and by the close of the season had been completed around Ward's Point up both shores of Arthur Kill for about three and a half miles, and thence around Raritan River entrance by way of South Amboy to Keyport, N. J.

Mr. Bache reports that the difficulties of the work were largely increased by the loss of triangulation points, both on the Staten Island and New Jersey shores, so that it was frequently necessary, after a vain search for subsoil and other marks, to supplement with the plane table the deficiencies of the triangulation. Just short of Keyport the work was brought to a close, the plane-table development of the triangulation having there been pushed to the extreme limit permissible to such development. Between June 12 and November 11, the date of suspending field operations, the statistics of the resurvey, which was executed on a scale of 1–10000, are as follows

Miles of shore-line surveyed	34
Miles of railroad and other roads	25
Miles of creeks	23
Area surveyed, in square miles	12

Continuation of the hydrographic resurvey of New York Bay and Harbor.—At the beginning of the fiscal year Lieut. G. C. Hanus, U. S. N., Assistant Coast Survey, commanding the steamer *Endeavor*, was actively engaged in the continuation of that part of the resurvey of New York Bay and Harbor which had been assigned to him by instructions dated early in June, 1886. The steamer *Daisy* and a steam-launch having been added to the party equipment, Lieutenant Hanus was enabled, during most of the season, to keep two parties constantly at work, and at times he had two parties engaged in building and determining signals, while a third party was taking soundings. He was thereby enabled to finish a hydrographic survey which was laid out upon nine projections, covering the following-named localities: Off Sandy Hook (scale 1–20000); Raritan and Sandy Hook Bays (1–20000); vicinity of East Channel (1–10000); the Narrows (1–5000); Arthur Kill and Staten Island Sound, four projections on a scale of 1–5000 each; and Newark Bay (1–10000).

Repeated examinations of the bar in the East Channel were made, so as to obtain a complete survey of the bar at each examination; a number of spots requiring additional soundings were also developed in different parts of the harbor.

During several days the entire party was engaged in observations of currents.

Three wrecks were located during the season: One off Elm Tree Beacon; one to the eastward of the wharves at South Amboy, and the third near Chelsea Landing, Arthur Kill. Descriptions and positions of these wrecks were communicated to the Office, and their exact locations were marked upon the hydrographic sheets.

All work with reference to the tides was, as heretofore, placed under the direction of Ensign G. R. French, U. S. N. The standard tide-gauge, with which all other gauges put up during the season were compared, was the box gauge which had been established by Lieutenant Hanus in May, 1885, on the steam boat wharf at Bath, Gravesend Bay, Long Island.

On July 2, 6, and 7, tides were observed at the gauge of the United States Engineers at Government wharf, Sandy Hook. The mean low water given by the engineer in charge of the gauge was found to agree to a tenth of a foot with the one found by comparison with the Bath Beach gauge. A careful examination made in 1885 developed the fact (which was referred to in last year's report) that high water occurs at Bath but ten minutes later than at Sandy Hook, and that there is no practical difference between these two places in the rise and fall of the tide. The comparison taken this year agreed with that of last year, although last year the comparison was made with mean low water as given by the Coast and Geodetic Survey gauge, and this year with that given by the United States Engineer gauge.

The other tide-gauges established during the season to obtain planes of reference for the soundings were at the steam-boat wharf, San Lorato Orphan Asylum landing, Princess Bay; at

Rutan's marine railway, Tottenville, S. I.; at the wharf at the Sewaren Hotel, Arthur Kill; at the steam-boat wharf at Rossville, Arthur Kill; and at the dry-dock wharf, Elizabethport, N. J. Care was taken as usual to refer a known mark on each gauge to a well-secured bench-mark.

Early in November, the season's work having been accomplished, operations afloat were suspended, and the party took up office-work.

The following-named officers were attached to the *Endeavor:* Ensigns C. S. Ripley, E. F. Leiper, G. R. French, and H. P. Jones, U. S. N.

Lieutenant Hanus reports statistics for the season as follows:

Miles run in sounding	1,524
Angles measured	18,115
Number of soundings	105,927

In January Lieutenant Hanus was detached from the Survey. Arrangements had been made previously for the transfer of the *Endeavor* to the command of Lieut. D. D. V. Stuart, U. S. N., Assistant Coast and Geodetic Survey, and for her fitting out for service on the Gulf coast.

Hydrographic examination of the Swash Channel, New York Bay.—A shoal spot in the Swash Channel, New York Bay, having been reported in a letter from Mr. Nash, secretary of the Board of Pilot Commissioners of New York, Lieut. F. H. Crosby, U. S. N., Assistant Coast and Geodetic Survey, was instructed in May, 1887, to make search for the supposed obstruction.

Before proceeding with the work, Lieutenant Crosby had a conference with Mr. Nash and with the pilot who had charge of the steamer *Illinois* when she grounded May 11. From the latter he learned that it was too foggy at the time to see the ranges; that coming in from sea he sounded on the starboard, finding twenty-three feet, but did not sound on the port; that he took a careful bearing of the Romer Beacon, and estimated its distance; that he had no other means of getting his position.

Lieutenant Crosby reports as the result of his examination his conviction that the pilot was considerably out in estimating his distance from the beacon, and that the soundings as given on the latest chart show actual depths.

Series of tidal observations with automatic tide-gauge at Sandy Hook, New Jersey.—Reference was made in the last annual report to the detail of an officer of the Survey to select a suitable place or places at Sandy Hook, New Jersey, for the erection of permanent automatic tide-gauges, the old location having been found to be unsuitable. The structure then begun for this purpose was finished early in the fiscal year, and it was decided to put up two automatic tide-gauges, the slight additional expense, which is merely that of the paper on which the tidal curve is traced, being more than compensated by the safeguard afforded against breaks in the record due to the occasional and almost unavoidable stoppages in this greatly exposed locality.

The tides of Willets Point should be observed in concert with those of Sandy Hook, in order (adopting Assistant Mitchell's phraseology) that the variations of level that induce the scour of the harbor of New York and its channels, whether due to processes of sun and moon or to meteorological causes, may be recorded.

Geodetic operations.—Continuation of the triangulation in eastern Pennsylvania towards the northern boundary of the State.—Instructions having been received by Assistant William Eimbeck, towards the end of August, 1886, directing him to report for duty in the party of Prof. Mansfield Merriman, engaged in geodetic operations in the State of Pennsylvania, and to relieve Professor Merriman in the charge of the party when so requested by him, Mr. Eimbeck left Washington August 28, and on the 31st reported to Professor Merriman near Ashland, Pa. Next day, as previously arranged, he took charge of Professor Merriman's work at Barry station.

The observations at Barry station had been partly completed when Mr. Eimbeck took charge, and were finished by him September 13. The next station to be occupied was Catawissa, about three miles to the southeastward of the town of that name on the Susquehanna River. Owing to delay occasioned by the heliotropers, who were students at the Lehigh University, being obliged to leave the party to resume their studies, Mr. Eimbeck was not able to complete all his arrangements for observing at this station till October 2.

From that date until December 6, when the observations were finished, the closest application to the work failed to secure satisfactory progress, owing to the almost constant prevalence of an atmosphere charged with dense smoke. The provisional occupation of Line Mountain and Montour stations was next undertaken in order to determine the position of Little Mahanoy, a second-order point, the geographical co ordinates of which had been applied for by Professor Ashburner, of the State Geological Survey.

Snow had fallen by this time and had accumulated considerably in the uplands of the mountains of that section of the Susquehanna basin. Some delays were thus occasioned, but finally enough observations were secured at the two stations named, and on December 15 field operations were closed. They were confined this season to measures of horizontal and vertical angles or double-zenith distances.

Having reported for duty at the Office, Mr. Eimbeck devoted his time mainly to the completion of the records and results of his field-work. He determined also the instrumental constants of the Repsold Vertical Circle, No. 76, and those of the Coast and Geodetic Survey magnetometer, No. 15, an instrument of Russian pattern and construction. He made also a special report with a view to the reconsideration of the location of a primary base-line in Utah, the result of which was the adoption of a line near Salt Lake, instead of the Juab base previously adopted.

About the middle of April Mr. Eimbeck was instructed to resume as early as practicable his field-work in Utah, and left Washington for this purpose April 24. Reference to this service is made under the heading of Section XVI.

Physical hydrography.—Observations of currents in Delaware River and Bay.—At the opening of the fiscal year the party of Assistant H. L. Marindin, on board the schooner *Ready*, had been engaged since early in May, 1886, in making observations of currents in the Delaware River above the city of Philadelphia. These observations, which were undertaken to enable the United States Advisory Board for the port of Philadelphia to determine and locate pier-lines along the water-front of the city, were completed about the middle of July.

Just before this time, in pursuance of a suggestion from Assistant Henry Mitchell, in general charge of physical hydrographic surveys, Mr. Marindin was directed to continue the observations of currents towards the Capes of the Delaware, with the view of ascertaining the rate of progress of the time of maximum strength of currents, additional observations being deemed desirable with reference to the rule for currents in Delaware Bay and River, given by Mr. Mitchell in Appendix No. 18, Report for 1881. The confirmation of this rule, or its application by more strictly defined geographical limits, was desired.

Series of current observations were made at three principal points, one within the harbor of Philadelphia, at the foot of Petty's Island; one at the Bight of New Castle, and lastly, one on a line between Capes May and Henlopen, about three and a half miles from the latt.

Owing to the exposed position of the station off Cape Henlopen the series was interrupted by bad weather, so that the vessel had to seek refuge behind the Breakwater. As the weather continued unfavorable and the necessity for resuming the New York Harbor work became urgent, Mr. Marindin was instructed to proceed to that port towards the end of August.

For July and August, 1886, the statistics are:

Number of cross-sections on which currents were observed	8
Number of observations of currents on cross-sections	516
Number of soundings on cross-sections	1,083
Number of single stations for currents	3
Number of observations of currents on single stations	2,622
Number of tidal stations occupied	7

Reference to Mr. Marindin's work in New York Harbor, and to Mr. Mitchell's deductions from it, has been made under a previous heading in this section.

After the close of his operations in that harbor, Mr. Marindin was authorized to assist the United States Advisory Commission for the port of Philadelphia. Having completed the drawings for this Commission, he reported, January 31, at Washington, under instructions for office duty.

Physical hydrography.—Observations of the formation and movement of ice in Delaware River and Bay during the winter of 1886–'87.—Under instructions issued in November, 1886, Assistant S. C. McCorkle began preparations in that month for resuming observations of the formation and movement of ice in Delaware River and Bay.

Mr. McCorkle has submitted a full report of his observations, containing facts of much interest to all navigators frequenting the port of Philadelphia. Ice began to form in the river early in December, a month sooner than usual.

The plan of work involved, in addition to observations by Mr. McCorkle personally, observations by the keepers of twelve light-houses on the river and bay; by the masters of six steamers of the Winsor Line (Philadelphia and Boston), and by the masters of twelve steam-colliers in the service of the Philadelphia and Reading Railroad. Also a series of observations at Delaware Breakwater by Mr. S. P. Allmond, of the Philadelphia Maritime Exchange. Mr. Allmond noted the temperature and density of the water in the bay during the season beginning November 28, 1886, and ending February 28, 1887, as well as the ice movement.

Ice formed in the river December 4, and practically disappeared January 31.

Its formation and movements are discussed by Mr. McCorkle with reference to three sections of the distance from Philadelphia to the Capes; the first from Philadelphia to Chester, the second from Chester to New Castle, and the third from New Castle to the Capes. In each of these sections he notes a diminution of the dangers and obstructions due to ice as compared with conditions existing in previous years, and reports that during the winter the port of Philadelphia was not closed a single day by reason of ice. Reasons are given for this improved state of things, and recommendations made for hydrographic surveys of the channel at Cherry Island Flats, over Fort Mifflin Bar, and of Goose Island Bar, above Fort Delaware. Also that a tide-gauge should be established and observations kept up during the winter at Edgemoor, on the river, near Cherry Island Flats.

Mr. McCorkle acknowledges the kind co-operation of Capt. George B. White, U. S. N., Light-House Inspector Fourth District, of Messrs. Henry Winsor & Co., agents Philadelphia and Boston Steamship Line, and of Capt. J. B. Gallagher, superintendent of the steam-colliers of the Philadelphia and Reading Railroad Company. The masters of these vessels rendered a gratuitous service which was very creditably performed. He expresses also his obligations to the Philadelphia Maritime Exchange for uniform courtesy and permission to employ one of its observers, and to the Director of Public Works of the city of Philadelphia for facilities of access to the city records.

Reference to duty in charge of the suboffice at Philadelphia, with which Mr. McCorkle was charged during the fiscal year, is made towards the conclusion of Part II of this volume.

Geodetic operations.—Extension of the triangulation and reconnaissance in southern New Jersey towards Delaware River and Bay.—Upon resuming field-work in the southern part of the State of New Jersey, in May, 1886, under instructions to carry the triangulation and reconnaissance to the westward and southward, Prof. E. A. Bowser began the erection of tripod and scaffold observing signals at stations Newfield and Richland, the former in Gloucester and the latter in Atlantic County. These signals, each forty-three and a half feet in height, were finished early in June, when the allotment for the work having been exhausted, field operations were suspended, pending action upon the appropriation for State surveys.

In September, work was resumed by the occupation of Hammonton station in the vicinity of the town of that name in Atlantic County. Some observations had been made at Hammonton in 1885, but the series was incomplete, Newfield and Richland not being then in readiness to be observed upon. The season of 1886 proved to be very unfavorable to rapid progress owing to a very smoky condition of the atmosphere, caused by forest fires. By November 22 the observations were completed, and on the next day the reconnaissance was resumed, the first step taken being to carry out the recommendation of Assistant C. O. Boutelle, in special charge of State surveys, and endeavor to establish a connection with stations Jocelyn and Pine of the old primary series. Signals were built ninety and one-half feet in height at Jocelyn and one hundred and five feet in height at Pine Mountain, and some days were spent in trying to see these high signals from the scaffolds at Newfield and Richland, but without success, owing to tall timber on the intervening ridges.

The reconnaissance was then continued from the point where it had been closed in December, 1885, and the intervisibility of the line Newfield–Bridgeton was satisfactorily determined. Bridgeton was therefore selected as a primary station to connect with Newfield and Kellogg. On December 10, field-work was closed for the season. The total number of observations was four hundred and forty-four, of which four hundred and twenty were upon primary stations.

Upon taking the field, under instructions, early in May, 1887, Professor Bowser resumed his reconnaissance, directing it specially to the selection of a station twelve or sixteen miles to the westward of Newfield, from which could be seen Bridgeton, Newfield, and Williamstown, and at which could be obtained a good view of the country to the north, west, and south of it. Tripods were erected at a number of points; the country being flat and in many places heavily timbered, the trees often growing to heights of ninety and one hundred feet, the tripods ranged in height from ninety-five to one hundred and twenty feet.

Without completing this reconnaissance, Professor Bowser deemed it advisable to devote the summer months to observations of horizontal angles, and accordingly on June 2 he began the occupation of station Richland.

The party was still engaged in observations at this point at the close of the fiscal year. The station point had been carefully marked by a granite monument four feet long, dressed six inches square at top and for a length of six inches, with the letters U. S. cut in each of the four faces, and a triangle cut on top. It is set in hydraulic cement.

Connection of old with new triangulation in the vicinity of Absecon Light, coast of New Jersey.—In order that the triangulation of 1884 near Absecon Light, on the New Jersey coast, might be extended so as to form a connection with one of the sides of the old triangulation to the northeastward of that point, Assistant Joseph Hergesheimer was directed towards the end of August, 1886, to make search for such of the points of the old triangulation as would serve as a base for effecting the connection desired.

This he accomplished by using for a base and azimuth the line Absecon Light to Leeds Point. From this base he determined in geographical position the new Light-house which had been built at Little Egg Harbor, and carried a triangulation towards Cape May to the line Grove–Linwood of the triangulation of 1884. The statistics of this work, which was begun September 6 and finished October 28, are as follows:

Number of points occupied	6
Number of angles measured	19
Number of observations	480

In November Mr. Hergesheimer was directed to organize a party for continuing the survey of the west coast of Florida. Reference to this will be made under the heading of Section VI.

Completion of the topographic resurvey of the coast of New Jersey.—Having resumed, under instructions, the topographical resurvey of the coast of New Jersey from a point about one mile north of Corson's Inlet, Assistant C. M. Bache, using the barge *Beauty* for the accommodation of his party, carried the topography from two to four miles inland, and along shore to a point about one mile north of South Atlantic City on Absecon Beach.

This work, which was executed between June 11 and November 26, 1886, completed the topographical resurvey of the New Jersey coast. The following statistics of the season are reported:

Miles of outside shore-line surveyed	9
Miles of creeks, ditches, etc. (inner shore-line)	215
Miles of fast land-line (inner)	40
Miles of roads, streets, etc	72
Miles of fencing	50
Area surveyed in square miles	32

During the winter and part of the spring Mr. Bache was engaged in Office work, and in June, 1887, was assigned to special duty at the suboffice, Philadelphia.

Deep-sea soundings to develop the one-hundred-fathom curve between Cape Henlopen and Cape Henry, and off-shore hydrography north of Cape May and south of Cape Henlopen.—As soon after the beginning of the fiscal year as the steamer *Blake* could be prepared for the summer season's work, her commander, Lieut. J. E. Pillsbury, U. S. N., Assistant Coast and Geodetic Survey, left Boston for Hampton Roads under instructions to run lines of deep sea soundings to develop the one-hundred-fathom curve from Cape Henry to Cape Henlopen.

This work was finished August 15. Its statistics are:

Miles run of soundings	1,019
Number of soundings	526
Number of observations taken	111
Area developed in square miles	6,000
Number of fixed positions	63
Length in miles of shore-line adjacent to soundings	124

The party then took up certain off-shore hydrography south of Cape Henlopen and north of Cape May, including in the latter the development of shoals near the shore.

On September 16 this survey was completed. Following are the statistics:

Number of miles of soundings run	725
Number of soundings	10,575
Number of angles	1,479
Area developed in square miles	525
Length in miles of shore-line adjacent to soundings	35

Lieutenant Pillsbury then proceeded to the vicinity of Chatham and Monomoy, Mass., and began a special hydrographic survey, reference to which is made under the heading of Section I.

SECTION III.

MARYLAND, DISTRICT OF COLUMBIA, VIRGINIA, AND WEST VIRGINIA, INCLUDING BAYS, SEA-PORTS, AND RIVERS. (SKETCHES Nos. 1, 4, 14, 16, and 17.)

The port-warden lines of the city of Baltimore traced out on the ground and connected with the triangulation of Baltimore Harbor.—In 1876 an accurate topographic survey was made of the wharf and harbor lines of the city of Baltimore and a hydrographic survey of the harbor, at the instance of the local authorities and under the direction of a board authorized by the President of the United States. With the concurrence of this board, consisting of C. P. Patterson, Superintendent of the Coast Survey, General A. A. Humphreys, Chief of Engineers, and Maj. W. P. Craighill, U. S. Engineers, the execution of the work was assigned to Assistant J. W. Donn, of the Coast Survey.

Copies of the original topographic sheets of this special survey, filed in the Coast Survey archives, are in possession of the Harbor Board of Baltimore, and upon these copies were laid down the port-warden lines for the harbor. Mention was made in the last annual report of the detail in June, 1886, of Assistant O. H. Tittmann to confer with Maj. N. H. Hutton, engineer of the Baltimore Harbor Board; and in pursuance of their request, to trace these lines on the ground and connect them with the triangulation in such a way that they can be reproduced by reference to ground-marks.

In conformity with Major Hutton's suggestion, Mr. Tittmann confined his work to tracing the pier-head line around the harbor, but the bulkhead line in certain places only.

The method pursued was to transfer the port-warden lines to the original sheets; these sheets were then taken into the field, and in general the points of deflection of these lines were identified by means of the plane table. They were then referred by distance measurements and deflection angles to stones planted by Mr. Tittmann in the streets or sidewalks of the city, except where no streets had been opened, as along the Middle Branch of Patapsco River, where the stones were set along the high-water line. The stones were all connected with the triangulation and their locations were accurately described in the records.

As a base for the needful triangulation, Mr. Tittmann adopted the same line, Bay View–Monument, as had been used in 1876, and as the progress of the measurements between the reference stones in the streets disclosed a want of accord between the distances determined by these measurements and those deduced from the triangulation, it was deemed advisable to strengthen and check the triangulation by connecting it with some of the primary stations.

Finally, however, on account of the difficulties of recovering the stations proposed and the expense attending their occupation, it was decided to obtain the desired check by the measurement of a base and its introduction into the triangulation.

A site of about a mile in length having been selected on Fort avenue, the measurement was made with the four-meter contact-slide base apparatus, and a correction found and applied to the previously accepted distance, Bay View–Monument.

By the field-work, which closed November 20, one hundred and seven geographical positions were determined, of which all but eleven were new. Assistant Tittmann was aided in the work by Mr. J. Henry Turner, whose efficient service he acknowledges in his report.

The records, sketches, and computations of the work have been filed in the archives, and its results have been communicated to Major Hutton for the use of the Baltimore Harbor Board.

Other duty assigned to Mr. Tittmann is referred to under the heading of Section VIII in this report.

Soundings in Baltimore Harbor, and measurements along the harbor front.—Maj. N. H. Hutton, engineer of the Baltimore Harbor Board, having applied for the services of an officer of the Survey to execute certain work supplementary to that accomplished by Assistant Tittmann, and referred to under the heading just preceding, Subassistant W. I. Vinal was instructed, towards the end of March, 1887, to proceed to Baltimore, and in conjunction with Mr. Hutton to make a hydrographic survey of such portions of the harbor as had been agreed upon in conference between Mr. Hutton and the Assistant in charge of the Office.

Mr. E. L. Taney, Aid, was assigned to the party. In connection with the soundings, some miscellaneous measurements of streets and wharves along the harbor front were made. This duty occupied Messrs. Vinal and Taney during the month of April. Upon its completion they were each instructed to organize parties for a resumption of topographical work on the north shore of Long Island Sound. Reference to this service is made under the heading of Section II.

Annual determination of the magnetic declination, dip, and intensity at the station on Capitol Hill, Washington.—Necessity for the selection of a new station reported.—On the 14th, 15th, and 16th of June, 1887, Assistant Charles A. Schott made the usual annual determination of the magnetic elements at Washington, D. C.

Two stations were occupied, first the one in use since 1877 on First street, Capitol Hill; and then, as this station was found to be affected by local attraction, a station about forty-one feet west of it.

Since the observations of 1886 were made, a two-story brick building, used as an instrument-shop, had been erected within six feet of the magnetic observatory. The second station was selected to avoid the influence of the iron contained in this building, but the results obtained show that here the needle is affected by a two-inch vertical cast-iron pipe in a neighboring house, about thirty feet off.

Mr. Schott recommends, therefore, the abandonment of this locality altogether and the selection of a new station, which should be far enough away from the Capitol to be unaffected by its massive iron dome.

At the old station the normal declination was found to be increased by fifteen minutes of arc, and, at the second one occupied, diminished by forty-eight minutes; the dip and horizontal and total intensities were affected likewise, and in a manner indicating the special causes mentioned.

Continuation of the detailed topographical survey of the District of Columbia.—At the beginning of the fiscal year, the operations of the party of Assistant John W. Donn, in charge of the detailed topographical survey of the District of Columbia, had advanced the work to the Distributing Reservoir; thence along the Conduit road to a point one-quarter of a mile from the northwestern boundary of the District; thence by an irregular line in a northeasterly direction through Tennallytown to Rock Creek Valley, a half mile below the Military road.

During the following summer and autumn, the survey of the country lying between the Conduit road and the river, and the open country lying between the irregular line above mentioned and the northwest boundary as far to the north as the Bell road, was finished. The difficult work through the rough and wooded region from Tennallytown to Rock Creek, and all of the small areas not touched during the summer, because impracticable, were completed during the winter, excepting that immediately about the receiving reservoir, known as the Government farm.

At the opening in the spring of the season for field operations, at the request of Capt. Eugene Griffin, Assistant Engineer Commissioner of the District, Mr. Donn began work upon sheet No. 1, Eastern Division, which covers the lines of the Baltimore and Ohio Railroad at their entrance into Washington. Field-work was continued until May 8, when the exhaustion of the appropriation for the survey made a suspension of the work necessary for the remainder of the fiscal year. On account of this suspension, which kept the party out of the field nearly two months, the area covered during the year scarcely equals the usual amount, but the standard of accuracy established at the beginning was carefully maintained.

Magnetic observations; establishment of a meridian line and marking of a station at Charlottesville, Va.—Assistant C. H. Sinclair having been authorized by instructions issued October 23, 1886, to mark permanently the astronomical and trigonometric station of the Survey at the McCormick Observatory, near the University of Virginia, and to establish at the magnetic station at Charlottesville a meridian line, took the field early in November for these purposes.

The station point near the observatory was marked by a granite post twenty-one inches long and eight inches square, dressed down one inch from the top, with a hole one and a quarter inches in diameter on the upper face, inside of which a quarter-inch hole was drilled. For an underground mark, a hole eighteen inches below the surface was drilled in the bed-rock.

Azimuth was determined at the magnetic station, Charlottesville, by forty-two observations on Polaris, time being furnished by the Western Union Telegraph Company. The ends of the meridian line were marked by two meridian stones, four hundred feet apart, each one of James River granite, and with dimensions and markings similar to the stone just described, except in length, the meridian stones being each forty inches long.

These stones were furnished by the county of Albemarle, and were set without any expense to the Coast and Geodetic Survey.

Instructions for other duty received by Mr. Sinclair led to the postponement of the magnetic observations till April, 1887, when they were made jointly by himself and by Mr. John Nelson, Aid, on the 5th, 6th, and 7th of that month.

Reference is made under the headings of Sections IV, X, XI, XV, and XVI to service elsewhere assigned to Mr. Sinclair.

Magnetic observations at stations in Virginia.—The occupation of two stations in Virginia for the determination of the magnetic elements was included in the plan of field-work assigned to Assistant James B. Baylor by instructions issued January 6, 1887.

At Williamsburgh, Va., the station of 1874 in the grounds of William and Mary College was re occupied. The declination was determined by observations for three days, the dip and intensity on two days, and the azimuth of the magnetic meridian by observations of the sun on one day.

At Cape Henry, Virginia, the station of 1874, near the old light-house, was re-occupied. The declination was determined on three days, the dip and intensity on two days, and the direction of the magnetic meridian by observations of the sun on one day.

Other stations occupied by Mr. Baylor during the season are referred to under the headings of Sections IV, V, VI, and VII.

Reconnaissance and triangulation in the vicinity of Cape Charles, Virginia.—In pursuance of instructions issued in April, 1887, subassistant R. A. Marr, having been detached from duty in the Computing Division of the Office, proceeded to Cape Charles, Virginia, to make a secondary triangulation in sufficient detail to furnish points for a topographical resurvey of the outer shore-line in that vicinity from station Rosemary on the Bay side about fifteen miles north of the Cape, around the Cape and up to Sand Shoal Inlet. He was directed, moreover, to give particular attention to a scheme which should extend from Costin station, on the Chesapeake shore, about three and a half miles from Cape Charles, around by Cape Charles Light-house, and northeastward along the Atlantic shore about ten miles, keeping in mind the necessity of so locating the stations and building the signals that they would serve the uses of a hydrographic party soon to follow.

At the close of the fiscal year this work was approaching completion, and about two weeks later was finished.

Mr. Marr reports the following statistics:

Number of signals erected	22
Number of stations occupied	11
Number of points determined	19
Number of horizontal angles measured	128
Number of observations for horizontal angles	524
Number of micrometer readings	1,913

Until October, 1886, Mr. Marr performed duty on the Pacific coast and in the interior, mention of which is made under headings of Sections X and XVI.

Re-establishment of that part of the boundary line between the States of Virginia and North Carolina extending from the Atlantic coast westward to the Nottoway River.—In pursuance of authority granted by the Secretary of the Treasury in response to a request from the Governor of Virginia, Assistant C. H. Sinclair, in November, 1886, was assigned to duty in connection with a Commission for re-establishing that part of the boundary line between the States of Virginia and North Carolina which extends from the Atlantic coast westward to the Nottoway River, a distance of sixty miles.

Maj. Conway R. Howard, on the part of the State of Virginia, and Hon. W. D. Pruden, on the part of the State of North Carolina, constituted the Commission. Mr. John Nelson, Aid, was assigned to duty with Mr. Sinclair.

The line was originally surveyed by Commissioners from England, and later by Colonel Byrd, in 1728. After a meeting had been held with the Commission a definite plan of operations was outlined. This plan involved the occupation of five latitude stations and the determination of azimuth at each, as well as at any intermediate point deemed necessary. The tracing of the line, opening of vistas, etc., it was arranged, should be done by the surveyor of the Commission.

The first station selected was at the supposed boundary stone on the Dismal Swamp Canal, that being the only known stone on the boundary. Mr. Sinclair states that it is quite evident, from the latitude observations both east and west of this point, that the stone was over six hundred feet north of the boundary. According to tradition this stone was set about the year 1800, more than seventy years after the line had been run by Colonel Byrd. This station is nearly midway between the Atlantic Ocean and the Nottoway River.

The second station was near the Norfolk and Southern Railroad, about a mile south of Northwest Depot and ten miles east of the Dismal Swamp Canal. The third was on Knott's Island, about three miles from the sea; the fourth on land of Dr. Hines, about ten miles west of the canal; the fifth and last was on the west side of Nottoway River, very near the old boundary running west from that point, and about half a mile south of the boundary east of the Blackwater River.

These five stations divided the distance into four sections. Polygonal lines starting on a tangent in the prime vertical of the azimuth point connected the stations. Deflections to the north were made, as a rule, at every five thousand feet. At each station the magnetic elements were determined by observations on three days.

The statistics of the work are:

Number of stations occupied for latitude	5
Number of observations for latitude	251
Number of stations occupied for azimuth	6
Number of observations for azimuth	168
Number of magnetic stations	5

Duplicates of the field-notes of the survey and a tracing of the map of the line will be deposited, as soon as completed, in the archives of this Office.

Most of the magnetic observations were made by Mr. Nelson. His cordial co-operation in the work is acknowledged by Mr. Sinclair in his report.

SECTION IV.

NORTH CAROLINA, INCLUDING COAST, SOUNDS, SEA-PORTS, AND RIVERS. (SKETCHES Nos. 1, 5, 16, and 17.)

Re-establishment of that part of the boundary line between the States of North Carolina and Virginia which extends from the Atlantic Ocean to the Nottoway River.—Under the heading of the preceding section, full reference was made to the detail of Assistant C. H. Sinclair to act in concert with a Commission for the re-establishment of part of the boundary line between the States of North Carolina and Virginia.

This boundary line, of about sixty miles in length, extends from the Atlantic Ocean to Nottoway River, and having been originally marked in the early part of the last century, the monuments or stones had all been lost, with the exception of one, which Mr. Sinclair found to be quite out of position.

Details of the mode of procedure adopted by Mr. Sinclair after conference with the members of the Commission are given under the preceding heading.

Special hydrography.—Surveys and examinations undertaken in connection with the investigation of oyster-beds for the State of North Carolina.—Reference was made in the last annual report to the detail of Lieut. Francis Winslow, U. S. N., Assistant Coast and Geodetic Survey, for special service at the request of the authorities of the State of North Carolina, and to the progress of the hydrographic surveys and examinations required in connection with the investigation of the oyster-beds of the State.

In order to determine the areas suitable for oyster culture, the State authorities desired the location of the natural and artificial oyster-beds, and a general examination of the Sounds. The field of work was limited by nature to those bodies of water lying to the southward of Albemarle Sound, and included Croatan, Roanoke, Pamplico, Core, and Bogue Sounds and their tributaries. To get the data needed in the least time and in the most economical manner, this area had to be treated as a whole, and not investigated by piecemeal. For instance, in the exposed portions of Pamplico Sound, work could only be done in the summer season, and consequently the investigation of the bays, rivers, and creeks was left for the winter. Also the determinations of the general specific gravity could be made to a great extent during necessary passages to and from ports.

For these and other reasons Lieutenant Winslow reports at the close of the fiscal year that although the examination of but few localities has been entirely completed, the work is nevertheless well advanced as a whole, and all of the necessary data will be collected in the course of a few months. Upon its completion he will submit a full report of the work, similar in character to those published in Appendix No. 11 to the annual report for 1881, on the oyster-beds of James River and Tangier and Pocomoke Sounds.

The party was organized on board the schooner *Scoresby*. Among the various difficulties incident to the work and the obstacles encountered in it causing delay, Lieutenant Winslow mentions shoal water, foggy and stormy weather, much sickness among the men, and the want of experienced assistants.

In Core Sound, the examination of which was completed in September, 1886, the water was too shoal to permit the passage of the schooner through the Sound, or even the approach nearer than from ten to twenty miles to the working ground of the party. It became necessary, therefore, to establish camps on shore for the use of small detached parties, working in light-draught skiffs.

The weather during the year was unusually bad. In July and August, 1886, strong southwesters prevailed about Beaufort and Core Sounds, which made it almost impossible for boats to live. On August 23, in the passage from Beaufort to Ocracoke Inlet, a severe cyclonic gale was encountered, in which every sail of the vessel was split and one of the boats lost. During the winter months the *Scoresby* usually rode with both anchors down, and at times was unable for a week to lower a boat.

Sickness also interfered with the progress of the party, and it was not an infrequent experience to have one-third of the working force on the sick-list. These obstacles, together with the necessity for going from one to two hundred miles for all supplies, have not only retarded the completion of the work, but made it of an extremely arduous nature for both officers and men.

As at first organized, Lieutenant Winslow's party consisted, besides himself, of two naval officers, Lieut. B. T. Walling and Ensign J. C. Drake, and a recorder. Lieutenant Walling was detached in July, and no one was detailed in his place until December, when Ensign C. M. Fahs was assigned. This officer was detached, however, on May 9, after a service of about four months. Hence, with the exception of about five months, the conduct of the work rested upon Lieutenant Winslow and Ensign Drake, and it was only by training some of the crew holding the higher rates so as to utilize them as observers, or place them in charge of boats, that field operations could be continued.

Lieutenant Winslow mentions Messrs. John D. Battle, J. W. Stearns, E. C. Robinson, and W. F. Hill as having rendered effective service, but expresses his special indebtedness to Ensign Drake, whose good judgment and careful management contributed largely to the success of the party.

Magnetic observations at stations in North Carolina.—In the course of the season's work executed by Assistant James B. Baylor under instructions issued in January, 1887, four stations in North Carolina were occupied for the determination of the magnetic elements.

At Smithville, near the mouth of the Cape Fear River, the station of 1874 at Fort Johnston was re-occupied. Declination, dip, and intensity were determined on two days, and time and azimuth by observations on the sun on one day.

At New Berne the station of 1874 in the grounds of the National Cemetery was re-occupied, the three elements of the earth's magnetism being determined on two days, and azimuth and time on one day.

Similar observations were made at Raleigh, the station of 1854 in the grounds of the State Capitol being re-occupied. At Weldon the station of 1875 in the grounds of the Methodist Church was re-occupied. But two days' observations were made at this station, the declination, dip, and intensity being determined on one day, and the time and azimuth on another.

Valuable additions to our knowledge of the secular changes in the elements of the earth's magnetism may be expected by careful repetitions of observations at the same stations at periods ranging from ten to twenty-five years.

Other stations occupied by Mr. Baylor between January and April, 1887, are referred to under headings in Sections III, V, VI, and VII.

Connection of old with new triangulation near the mouth of Cape Fear River, North Carolina; topographical resurvey of New Inlet, and soundings in Masonboro Inlet, North Carolina.—In pursuance of instructions issued towards the close of February, 1887, Assistant D. B. Wainwright left Washington March 2, and having organized his party at Wilmington, N. C., took up the connection between the triangulation in that vicinity and that on the sea-coast in the neighborhood of Wrightsville and Masonboro.

In order to accomplish this, it was necessary to recover two of the stations of the former coast triangulation, and after much labor, Money Point and Berry, on the inside shore, between Masonboro and Old Topsail Inlets, were found. A scheme of work was then laid out, consisting partly of triangulation and partly of wire measure, and prosecuted till April 4, when its execution was temporarily suspended to take up the topographical resurvey of New Inlet. This was done in order to have in readiness all points that might be needed by a hydrographic party. High winds prevailed during April, retarding the work and subjecting the party to great exposure.

On May 11, the triangulation and topography having been finished, the party was transferred to Wrightsville, where observations were made for azimuth. Masonboro Inlet was also sounded, with the two principal channels leading into it.

Field operations were brought to a close June 20. The statistics are as follows:

For the work at the mouth of Cape Fear River:	
Number of miles of shore-line surveyed	33
Area of topography, in square miles	6
Number of points determined in geographical position	11
For the work in the vicinity of Masonboro Inlet:	
Number of miles of wire measure	6
Number of miles of shore-line surveyed	10
Number of miles of soundings run	8

The whole number of stations of the triangulation occupied during the season was eighteen, and the number of azimuth stations two. Descriptive reports accompany the topographic and hydrographic sheets showing the results of the survey.

Duty assigned to Mr. Wainwright earlier in the fiscal year is referred to under the heading of Section II.

Observations of currents off Cape Hatteras.—Hydrographic survey off New Inlet, North Carolina.—Reference in detail will be found under the heading of Section VI to the observations of currents made by Lieut. J. E. Pillsbury, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Blake*, during the winter and spring of 1887, in continuation of his explorations of the Gulf Stream.

His current stations crossed the stream in three sections, one between the west end of Cuba and the peninsula of Yucatan; a second between Rebecca Shoal, Florida, and Havana, Cuba, and a third normal to the coast off Cape Hatteras. Upon all of the sections, the steamer was anchored at much greater depths than before attempted, the greatest being off Cape Hatteras in 1,852 fathoms. Lieutenant Pillsbury reports that one of the most interesting results of the observations off Cape Hatteras was the discovery by direct evidence of the existence of tidal action and of a polar counter-current underneath the Gulf Stream water.

Upon completing his current observations Lieutenant Pillsbury took up under instructions a hydrographic resurvey off New Inlet, North Carolina. Of this resurvey the following statistics are reported:

Miles of soundings run	68
Angles measured	1,400
Number of soundings	5,447
Area of survey, in square miles	5
Length of shore-line adjacent to soundings	7

This work done, the *Blake* proceeded north, and arrived June 6, 1887, at Boston, where she was refitted for a summer cruise. Reference to hydrography executed by her commander off Chatham and Monomoy, Mass., is made under the heading of Section I.

The following-named naval officers were attached to the party on board the *Blake* during the fiscal year or parts of it: Ensign (now Lieutenant) T. D. Griffin, U. S. N.; Ensigns R. M. Hughes, A. G. Rogers, J. H. Hetherington, W. J. Sears, F. R. Brainard, Franklin Swift, J. K. Seymour, U. S. N.

The recorders were Passed Assistant Surgeon W. H. Rush, U. S. N. (when the vessel was engaged on current or deep-sea work); Pay Yeoman N. G. Henry, and Ship's Writer W. W. Appelget. Master-at-Arms Jens Petersen contributed largely to the success of the party.

Lieutenant Pillsbury gives in his annual report the following summary of statistics for the fiscal year:

Number of miles of soundings run	2,069
Number of angles measured	6,249
Number of soundings	37,368
Area developed, in square miles	6,550
Length of adjacent shore-line	177
Number of current stations occupied	37
Number of current observations with the current meter	2,509
Number of surface observations with a current pole	2,521

SECTION V.

SOUTH CAROLINA AND GEORGIA, INCLUDING COAST, SEA-WATER CHANNELS, SOUNDS, HARBORS, AND RIVERS. (SKETCHES Nos. 1, 5, 16, and 17.)

Special hydrographic examination in Charleston Harbor.—In order to ascertain definitely whether the earthquake of August 31, 1886, which was so disastrous in its effects in the city of Charleston, had produced any changes of importance in the harbor and approaches, Assistant C. O. Boutelle, whose knowledge of the locality by many years' service in that section was known to be minute and thorough, was instructed in September to proceed to Charleston and make such examinations of the bar and channels as would be sufficient to decide upon reported changes.

Mr. Boutelle arrived in Charleston September 10. By direction of the Secretary of the Treasury, the Collector of the Port had placed the revenue steamer *Hugh McCulloch* at his service for the examinations required. After an interview with Lieut. F. V. Abbot, U. S. Engineers, in regard to the tidal observer at Fort Sumter, who had also observed for Lieutenant Hanus, U. S. N., Assistant Coast Survey, in his hydrographic survey of the bar and channels executed in April and May, 1886, Mr. Boutelle proceeded at once to Fort Sumter in the *McCulloch* and started tidal observations. By noon of the same day he began lines of soundings in the northernmost or "Pumpkin Hill" Channel. By 3 p. m., the sea having risen with the tide and the coming in of the sea-breeze, he stopped sounding and ran out five miles to the Rattlesnake Shoal Light-ship to obtain her master's account of the effect of the earthquake upon his vessel, which is anchored in thirty feet of water, about five miles east of the "Swash" or Jetty Channel. The master of the Light-ship reported that a little before ten o'clock on the night of August 31, as he was sitting in his cabin, he felt a shock as though a vessel had struck the Light-ship and was dragging by them, jarring the ship severely. The shock was accompanied by a heavy rumbling sound. Springing to the deck he found the ship shaking in every part, but not vibrating. Masts and lamps were severely jarred, but nothing was broken and the lamps were not extinguished. The first and severest shock lasted forty-five seconds. Four others were felt that night, and lighter ones had occurred every day since.

At the time of the first shock there was a gentle, long-rolling swell setting in from the sea. It was not changed in character or volume by the shock. The ship was riding with head to tide. She did not change her direction, nor was there any strain upon the vessel's moorings as there would have been if any wave from seaward had accompanied the earthquake.

The next day Mr. Boutelle ran all lines needed to determine whether any changes had taken place in the South Channel, the one now chiefly used. The sea was much heavier than on the day before and interfered with the work greatly, but sufficient data were obtained to establish the fact that no serious changes had occurred in either of the principal channels used for vessels of heavy draught, and that all changes that had taken place were for the better.

Having telegraphed this result to the Office, he went the day after to Fort Sumter, obtained the record of tides observed during all times of sounding upon the bar, and arranged with the observer to continue the observation of each high and low tide until notified to stop. United States Assistant Engineer Allen accompanied him to Fort Sumter and verified by leveling the relation of the zero of the tide-gauge to the bench-mark upon the Fort. He found it to be the same as before the earthquake and the same as when Lieutenant Hanus made his survey. The soundings taken by Mr. Boutelle will, therefore, when reduced to the plane of reference used by Lieutenant Hanus, become a direct means of ascertaining any changes upon the bar caused by the earthquake, or by any local causes, such as are continually acting upon all channels into the harbors of the South Atlantic.

The statistics of the examination are:

Number of lines of soundings run	13
Number of miles run in sounding	18
Number of miles run by steamer in addition to sounding lines	59
Number of soundings	637

Mr. Boutelle concludes his report by expressing his obligations to the officers of the revenue-steamer *McCulloch* for ready and zealous assistance given him throughout the whole of his stay. To Lieut. Commanding Frederick M. Munger, Lieut. and Executive Officer George W. McConnell; Lieut. J. J. Sill, and Pilot Edward Dennis he was specially indebted for assistance which contributed greatly to the rapid execution of the work. Other duty assigned to Mr. Boutelle during the fiscal year is reported under the heading of Section XV. See also "Special operations."

Magnetic observations at stations in Georgia.—The following-named stations in the State of Georgia were occupied by Assistant James B. Baylor for the determination of the magnetic elements, under instructions issued in January, 1887.

At Way Cross, Ware County, a station was established northwest of the Grand Central Hotel.

Observations for magnetic declination, dip, and intensity were made on one day, time and azimuth were determined on one day, and latitude on two days by observations of the sun.

At Brunswick, a station was established in the open square on Gloucester street near the Custom-house. The magnetic elements were determined on one day, and time, latitude, and azimuth on one day by the observations of the sun.

Similar observations were made at Jesup, Wayne County, where a station was established in the garden in the rear of the Altamaha Hotel.

At Milledgeville, the station of 1875 in the Old Capitol grounds was re-occupied. Declination, dip, and intensity were determined by observations on two days, and time and azimuth by observations of the sun on one day.

Other stations occupied by Mr. Baylor for determining the elements of the earth's magnetism are referred to under the headings of Sections III, IV, VI, and VII.

Hydrographic survey off the bar of St. Simon's Sound, Georgia.—On the way north from work off the Florida coast, which is reported under the heading of Section VI, Lieut. J. E. Pillsbury, U. S. N., Assistant Coast and Geodetic Survey, in pursuance of instructions, made a hydrographic survey off St. Simon's Bar, Georgia.

No triangulation points could be found, except the foundation of the old Light-house, so that it became necessary to measure a base, establish its azimuth, and make a local triangulation. This done, the soundings desired were quickly obtained, and the *Blake* proceeded to New Inlet, North Carolina, where hydrographic work was executed which is referred to under the heading of Section IV. The work off St. Simon's was finished about the middle of May, 1887. Its statistics are:

Miles (nautical) of soundings run	32
Angles measured	367
Number of soundings	2,255

SECTION VI.

PENINSULA OF FLORIDA, FROM ST. MARY'S RIVER ON THE EAST COAST TO AND INCLUDING THE ANCLOTE KEYS ON THE WEST COAST, WITH THE COAST APPROACHES, REEFS, KEYS, SEA-PORTS, AND RIVERS. (SKETCHES NOS. 1, 6, 16, and 17.)

Magnetic observations at stations in Florida.—In the course of a magnetic tour through the Atlantic and Gulf States from Virginia southward, undertaken in pursuance of instructions issued in January, 1887, Assistant James B. Baylor determined the elements of the earth's magnetism at five stations in the State of Florida.

At Baldwin, Duval County, a station was established near the corner of Drew and Center streets. One day was occupied in determining the magnetic declination, dip, and intensity, and one day in observations on the sun for time, latitude, and azimuth.

At Tampa, Hillsborough County, a station was established in the Court-house square, and a set of observations made similar to those at Baldwin.

At Key West the station of 1879 in the grounds of the Army Hospital was re-occupied; the magnetic elements were determined on two days, and the time and azimuth on one day by observations of the sun.

At Cedar Keys, a station was established in the open square east of the Suwanee Hotel; the magnetic elements were determined on one day, and time and azimuth on one day by observations of the sun.

Similar observations, with the addition of a determination of latitude, were made at Gainesville, Alachua County, where a station was established on East Main street, in the rear of the Methodist Church.

Other stations occupied by Mr. Baylor are referred to under headings in Sections III, IV, and V.

Physical hydrography.—Gulf Stream explorations.—Observations of currents, 1887.—In continuation of the investigation of the Gulf Stream currents, Lieut. J. E. Pillsbury, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Blake*, having organized his party aboard that vessel, left New York January 11, 1887, and after a stormy passage reached Key West. Work on the cross-sections previously adopted for the further development of the currents in the Stream was immediately taken up.

The very full and comprehensive report made by Lieutenant Pillsbury of this elaborate physical survey appears as Appendix 8 to this volume. It is accompanied by diagrams in which the observations are graphically represented, and by the aid of which his deductions are enforced. An abstract of his report is here given.

Experience gained in preceding seasons had led to some alterations in the anchoring gear in order to secure quicker action and better control over the machinery, and it was found advisable also to use a wire rope of less diameter for the current meter. The registers of velocity for the meters were renewed and their graduation improved so that the readings could be made more easily and with fewer chances of error.

Referring to the connection between the work of the two preceding seasons and that of this season, Lieutenant Pillsbury thinks that viewing the latter with the light of the former, an interpretation of the record can be made with considerable certainty.

The sections occupied this season were three in number, one between Rebecca Shoal and Cuba (C C); one between Cape San Antonio, Cuba, and Yucatan (D D); and one from Cape Hatteras Shoal in a direction about southeast. All of these sections are of much greater depth than ever before attempted, and not the least gratifying feature of the season's work was the readiness with which the steamer was safely anchored in these depths. The greatest was off Cape Hatteras in 1,852 fathoms, and that, too, with a surface current of over four knots.

Lieutenant Pillsbury discusses the several subjects involved in his investigations under the following heads:

(1) General characteristics and limit of the Stream at each cross-section.
(2) Daily variation.
(3) Axis of the Stream.
(4) Depth, and velocity at different depths.
(5) Results obtained at various sections, with comparison of the same.

For the details of this discussion and the conclusions which Lieutenant Pillsbury arrives at, the reader is referred to the report.

In closing his report he observes with reference to his project showing the lines proposed for the further development of the Gulf Stream current:

"The sections drawn between the islands of the West Indies are for the purpose of ascertaining the relation between the times and velocities of the current entering the Caribbean and passing into the Gulf of Mexico. Reasoning upon temperatures and depths found in these passages and in the Gulf of Mexico, it has been stated that the water entering the latter comes through the Windward and Mona Island Passages. Many of the principal islands are separated by depths through which most of the water flowing out of the Straits of Florida could pass. We have investigated currents flowing north at two sections and one flowing east. The only place where opposite conditions can be found (and within the province of the Coast Survey to investigate), that is, where the Stream is flowing west, or contrary to the direction of the earth's rotation, is in the passages between the Windward Islands.

"On the observations now completed the conclusion would be arrived at that in all ocean currents flowing north the axis is west of the middle and the current extends to about a constant depth.

"When flowing east, the axis coincides with the middle of the current, and the flow is deepest at that point. To ascertain the characteristics of the current flowing west will be of the greatest importance to science as well as commerce, and will enable us to define the fixed laws governing the currents of the world with a degree of certainty which, without these data, would be very incomplete."

The officers attached to the *Blake* were as follows: Ensign R. M. Hughes, U. S. N., executive officer and navigator; Ensigns A. G. Rogers, W. J. Sears, F. Swift, and J. K. Seymour, U. S. N., observers; Passed Assistant Engineer George W. Cowie, jr., and Passed Assistant Surgeon W. H. Rush, U. S. N., who acted as recorders. Pay Yeoman N. G. Henry and Ship's Writer W. W. Appelget served also as recorders.

Reference to other duty assigned to Lieutenant Pillsbury is made under the headings of Sections I, II, IV, and V.

Completion of the triangulation on the west coast of Florida from Pavilion Key to Cape Sable.—In continuation of his work of previous seasons on the west coast of Florida, Assistant Joseph Hergesheimer, having organized his party on board the schooner *Quick*, in pursuance of instructions issued in November, 1886, and having made extensive repairs which it was found were much needed by the vessel, reached his working ground off Pavilion Key January 9, 1887, and on the next day began a triangulation intended to be carried down the coast to Cape Sable.

This triangulation began from the line Freeland–Pavilion Key, and by April 27 had been completed to the primary base-line on Cape Sable, the ends of which had been recovered and the line re-established by Mr. Hergesheimer in 1886. It was intended to make the connection of the coast triangulation with the line West Base–East Base, and this involved the opening of the line East Base to Sandy Key. It was found impracticable to accomplish this, as the line passes through a heavily wooded swamp, and after two days' cutting the men were forced to give up work on account of the mosquitoes. A shorter line, West Base–Middle Base, was accordingly selected, but still of sufficient length to test fully the triangulation resting on the base, Caximbas to Cape Romano, which was measured with beach tapes during the preceding season.

This test was quite satisfactory in latitude, azimuth, and distance. The length West Base to Middle Base, as measured with the primary base apparatus by Superintendent Bache in 1855, was 3,215.8 meters, and as determined by Mr. Hergesheimer by beach measurement and by triangulation carried down the coast for eighty miles, it was 3,216.1 meters, a difference of but 0.3 of a meter, or 11.8 inches.

With regard to the coast-line between Cape Romano and Cape Sable, Mr. Hergesheimer observes that it is a succession of heavily-wooded islands, for the most part low and wet, but a few high and dry. They vary in size greatly, some being of a few acres in area, others several miles in length. The Gulf shores of many of the islands are rocky; the formations being coral, in color dark-brown, some smooth, and others rough and broken.

Attention is called to a tidal phenomenon on this coast which deserves investigation, the large rise and fall of tides, at times as much as five feet between Cape Romano and Cape Sable. A very strong current is also reported by Mr. Hergesheimer, running along the coast on both the flood and ebb tide. The flood tide makes from the Gulf, and flows south along the coast towards and to the eastward of Cape Sable; hence vessels running between Key West and Cape Sable should allow for this current, especially at night.

Having finished his season's work, Mr. Hergesheimer supplied data needed by the hydrographic party on board the steamer *Bache*, and early in May laid up his schooner in Manatee River, proceeding thence north under instructions for office duty.

He commends the services of the very competent aids assigned to him during the season, Mr. George F. Bird and Mr. J. H. Gray.

The statistics reported are:

Number of signals erected	24
Number of points determined	24
Number of stations occupied	19
Number of angles measured	117
Number of observations	1,547

Field duty assigned to Mr. Hergesheimer earlier in the fiscal year is referred to under the heading Section II.

Hydrographic survey on the west coast of Florida from Cape Romano to the southward.—On the 8th of April, 1887, Lieut. J. F. Moser, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Bache*, began a hydrographic survey on the west coast of Florida from Cape Romano southward. His party had just completed a survey in the vicinity of Cedar Keys, begun at the outset of the season. An abstract of the report of this work will be found under the heading of Section VII.

The survey from Cape Romano southward consisted in executing the inshore and offshore hydrography from Cape Romano to Cape Sable to the ten-fathom curve, this being the only gap in coast hydrography then remaining to be filled between Eastport, Me., and the Delta of the Mississippi.

In carrying a hydrographic survey along a coast the limits of which were marked by a network of islands, it was found impracticable to run the lines of soundings between and around the fringing islands as had been at first intended, on account of the great delays that would be involved. As soon as the outer shore-line is passed, the dense mangroves cut off the signals, so that a new set of signals would have been needed had the original scheme been adhered to. But the lines were always carried in as far as possible, and from island to island, so that the depths at the entrances, which were seldom more than a few feet, could readily be seen.

Lieutenant Moser observes that should it ever become desirable to ascertain the depths between the thousands of islands that fringe this coast, it can readily be done after the topography is finished, by a small party in a light-draught vessel.

Continuous observations of high and low waters made day and night at a tide-gauge established on one of the outlying keys gave a mean rise and fall of tides above the plane of reference of 3.34 feet. The greatest rise above this plane was 4.3 feet, and the greatest fall below it 1.15 feet. The tides as plotted are regular, but show a marked inequality in range of the two daily tides. Like those of Cedar Keys, they are largely influenced by the wind. The tidal current on and around Cape Romano shoal is strong, particularly during spring tides and on the seaward side of the shoal, and the flood current was found setting to the southward and the ebb current to the northward.

With regard to the general character of this coast and of the country adjacent, Lieutenant Moser observes that it is dreary, desolate, and uninhabited, and visited only by turtle-hunters and plume-catchers, who sail in craft of light draught and need no guide. The islands which fringe the coast are generally mud lumps and thickly covered with mangrove; they are small in size, mostly awash at high water, and protected by a belt of oysters which have taken for holding ground the roots of the mangroves and also the overhanging limbs as they droop in the water. It is here that oysters may be seen growing on trees, for the spawn that has clung to the overhanging branches at high water is developed into oysters that are suspended at low water from the tree tops.

Lieutenant Moser's report contains much information of interest to navigators, naturalists, and geologists, but the abstract given must suffice here. His survey was completed May 21, soon after which the *Bache* proceeded to Key West and thence north.

The officers attached to his party, to whom, and also to the crew, he expresses his thanks for their hearty co-operation in the season's work, were Ensigns E. E. Wright, H. A. Field, W. O. Hulme, H. E. Parmenter, and H. P. Jones, U. S. N.; Passed Assistant Surgeon F. B. Stephenson, U. S. N.; and Assistant Engineer S. H. Leonard, U. S. N. Messrs. George R. Jones and J. L. Dunn served as recorders.

Following are the statistics reported:

Number of miles (nautical) run in sounding	1,258
Number of angles taken	4,007
Number of soundings	36,860

SECTION VII.

PENINSULA OF FLORIDA, WEST COAST, FROM ANCLOTE KEYS TO PERDIDO BAY, INCLUDING COAST APPROACHES, BAYS, AND RIVERS. (SKETCHES Nos. 1, 6, 16, and 17.)

Magnetic observations at stations in Florida.—Reference was made under the heading of the preceding section to the five magnetic stations occupied in Florida by Assistant James B. Baylor in January and February, 1887. Two of these stations, Cedar Keys and Gainesville, fall within the limits of Section VII, but as the observations made at them were all of the same character, and at stations in the same State, all were noticed under the one heading.

Other magnetic stations occupied by Mr. Baylor are reported under headings in Sections III, IV, and V.

Inshore and offshore hydrography of the west coast of Florida from Cedar Keys to the Chassahowitzka River.—In continuation and with a view to the completion of the hydrography of the west coast of Florida, Lieut. J. F. Moser, U. S. N., Assistant Coast and Geodetic Survey, having organized his party aboard the steamer *Bache*, in pursuance of instructions received towards the close of November, 1886, reached Key West, Fla., December 27, and after a detention in that port for some days by a heavy norther, arrived at Cedar Keys January 5, 1887.

The first work assigned to his party was the execution of the inshore and offshore hydrography from Cedar Keys southward to a point off the Chassahowitzka River, thus connecting the survey upon which the *Bache* was employed the previous winter with the several surveys finished many years ago and centering at Cedar Keys.

At the outset, Lieutenant Moser reports that the work gave rather meager results for the time and energy employed, and the reasons for this were that the area was very large, the water very shallow, the shore-line without distinguishing features, and the triangulation on which the work was to be based having been executed more than thirty years ago, many of the station marks had disappeared.

It was found that the screw-piles which had been adopted at that time for marking the station points were far more suitable for permanent markings than stone or terra cotta, which has been used of late years. Some of the piles had gone, used possibly for boat anchors, and in one instance that came to Lieutenant Moser's notice, for a Fourth of July celebration, the hollow iron stem making a fair substitute for a cannon. But in all inaccessible places they remained, and on oyster reefs had become firmly fixed by the adhesion of the oysters to the stem and flanges, and on the shell beaches the flanges were packed solid as a rock by deposits of carbonate of lime brought up by the tide from the many marine organisms which secrete that substance. Stones when used are frequently carried off as boat anchors, and terra-cotta pipes for station points are rendered worthless by a slight blow.

The scheme of the hydrography, as carried out, consisted in developing the three-fathom curve with lines normal to the coast, and from one-third to two-fifths of a mile apart, and such development additional to this as was deemed necessary. The ten-fathom curve was developed with lines from one and one-half to two miles apart. About fifteen miles from shore the three-fathom curve is reached, and from there the depth increases with great regularity to the ten-fathom curve, which is about forty-three miles off shore.

To determine a plane of reference for the soundings, a staff-gauge was established near the end of the wharf leading from Faber's Cedar Mill on Depot Key. At this gauge, which was well exposed to the tidal movement, continuous observations of high and low water were made from February 1 to April 6. Before February 1 occasional observations had been made at intervals. It would have been desirable to have had the gauge located nearer the center of the work, but no suitable location could be found, the shore for the greater part being fringed with oyster reefs, uncovered at low water, and back of these are marsh islands or mud flats, bare at low water, which extend from the shore for a long distance. Comparison gauges were used with the Cedar Keys gauge on all parts of the work. Full details in regard to all of the tide-gauges observed and bench-marks established are given in Lieutenant Moser's report. He observes that the tides in that locality are easily affected by winds, which cause great irregularity in their range, stand, and time of movement. The lowest "norther" tides fall as much as two and a half feet below the plane of reference, while winds from the southward and westward back the water up along the coast. During the hurricane of September 10 and 11, 1882, the highest tide known at the station occurred, the water rising to a height of twelve feet above the plane of reference.

The experience and close observation of Lieutenant Moser, both in field and office duty, lead him to urge in his report the need of parties specially organized for the investigation of currents, the short intervals of time available in hydrographic parties for this purpose being quite inadequate to obtaining accurate results. This he found to be peculiarly the case off the Florida coast, where the set of the current, as apparent from the few observations that could be made, was not unfrequently misleading and the results contradictory.

Work in the vicinity of Cedar Keys was finished April 3, and preparations were at once made for carrying out instructions for a hydrographic survey from Cape Romano to Cape Sable. An abstract of the report of this survey appears under the heading of Section VI. The statistics there given are for that part of the work. For the work of the season they are:

Number of miles (nautical) run in sounding	2,945
Number of angles taken	8,887
Number of soundings	89,255

SECTION VIII.

ALABAMA, MISSISSIPPI, LOUISIANA, AND ARKANSAS, INCLUDING GULF COASTS, PORTS, AND RIVERS.

(SKETCHES NOS. 1, 5, 7, 16, and 17.)

Occupation of stations of the triangulation in Alabama for extending the measurement of the oblique arc of the meridian from Atlanta towards Mobile.—The value for geodesy of the oblique arc of the meridian along the Atlantic coast, extending from Calais, Me., to Atlanta, Ga., a distance of some twelve hundred statute miles, will, it is known, be much increased by its extension to Mobile Point. The Atlantic and Gulf coast triangulations will be united and an oblique arc of twenty-two degrees be obtained.

For the continuation of the triangulation directed to this object, Assistant O. H. Tittmann took the field in northern and central Alabama early in January, 1887, under instructions issued towards the close of the month preceding. Five primary stations were occupied in the course of the season—Wornock, Alpine, Horn, Kahatchee, and Laurel. These stations are included in an area limited by the parallels of 33° and 34° north latitude, and 86° and 87° west longitude. At each station, horizontal and vertical angles were observed, pointings being made on such hill and mountain tops as seemed notable, and a number of churches and other prominent buildings being determined in the towns of Talladega and Childersburgh, Talladega County.

Field operations were completed towards the end of May. Mr. Tittmann commends the services of his aid, Mr. J. Henry Turner. Mr. Turner was relieved May 21 and ordered to duty on the transcontinental triangulation.

In concluding his report, Mr. Tittmann recommends that latitude and azimuth observations should be made at station Weogufka when the work is again taken up, this being the last of the mountain stations of the oblique arc, so that there is a probability of a change of station errors on proceeding southward.

Under the heading of Section III, reference is made to other service assigned to Mr. Tittmann.

Lines of geodesic leveling carried from Citronelle, Ala., to Quitman, Miss.—By successive steps, the line of precise leveling which is intended to connect a point on the Gulf of Mexico with the transcontinental line of geodesic leveling is approaching completion.

With the exception of a gap between Citronelle, Ala., and Quitman, Miss., lines of precise leveling were continuous in January, 1887, between New Orleans by way of Biloxi, Miss., and Mobile, Ala., to Okolona, Miss. To fill this gap Assistant J. B. Weir organized a party under instructions dated January 6, and in March reached Quitman. From Okolona, in order to connect with the transcontinental line of geodesic leveling, the work must be carried to Villa Ridge, Ill., about sixteen miles north of Cairo.

In the organization of his party for the work of 1887, Mr. Weir had the advantage of the aid of an experienced observer, Subassistant John E. McGrath, and was enabled thereby to run separate lines of levels which should be entirely independent of each other.

Mr. Weir, using geodesic micrometer level No. 3, ran the lines from south to north, and Mr. McGrath, with geodesic micrometer level No. 2, ran the lines north to south, the lines going over the same ground. The leveling-rods only were common to the two operations, hence as nearly perfect a system of checks was secured as practicable.

The country passed through was generally low, flat, sandy, and wooded with pine, broken here and there by small sand-hills, affording on the whole a good foundation for instruments and plates to rest on.

During the season seventy-seven miles of levels, forward and backward, were run, and eleven permanent bench-marks were established. The total discrepancy between the two lines at Quitman was 4.9 millimeters, or about two-tenths of an inch.

Mr. Weir expresses his appreciation of the care and skill with which Mr. McGrath performed his duties. He commends also the good service rendered by Extra Observer W. B. Fairfield, who acted as recorder in the party, and in Mr. Weir's absence took his place as observer.

Field operations were closed March 24. Other service assigned to Mr. Weir is referred to under headings in Sections I and II.

Triangulation and topography upon the coast of Louisiana, between Grande Isle and Raccoon Point.—In continuation of the survey of the southwest coast of Louisiana, Assistant F. W. Perkins organized his party on board the steamer *Hitchcock* at New Orleans early in February, 1887, and after some detention by head wind and sea off the bar of Grand Pass, began the triangulation and topography of that portion of the coast which is included between Grande Isle and Raccoon Point.

The coast-line in this locality is formed by a cordon of sand-faced marsh, pierced at intervals by inlets with unknown bars at their mouths and a doubtful depth of water inside. The only harbors of refuge of which anything was known were at Grand Pass and Raccoon Point, nearly seventy miles apart. But in the course of a reconnaissance on February 7, Subassistant W. C. Hodgkins, who was attached to the party, upon sounding Chinière Pass, found a narrow bar carrying seven feet, with a good anchorage inside in twelve feet, soft bottom. This unexpected discovery of so good an entrance and harbor within the limits of the work was very gratifying. Reconnaissance, building of signals, and the sounding out of bars were at once begun, and all hands working with a will, the party had, by the end of the month, notwithstanding the great amount of fog, completed the outer line of signals for the triangulation as far as Cat Island Pass, erected the greater part of the inner line of signals, and assured themselves of the practicability of the entrances and harbors at Pass Fourchon, and Timballier and Cat Island Passes, besides finishing many miles of topography and quite a number of observations of horizontal angles.

Mr. Perkins observes that Pass Fourchon has had its present depth of five feet only since the hurricane of 1886, which washed it out.

For the extension of the triangulation westward and southwestward from Grande Isle, a base was selected which formed a good connecting line with the old work. From this line, Tambour–Southwest base, points were established in Tambour Bay, and as much triangulation and topography done as could be readily reached from the vessel's anchorage. Afterwards the *Hitchcock* was taken outside, while the work of all descriptions was being completed as far as West Timballier Pass, which was entered with seven feet of water on April 16.

Timballier Bay is about twelve miles wide from east to west, and if Lakes Chien, Felicity, etc., with which it is closely connected, are included, it is about twenty-four miles from north to south. Grande du Chien, Point Jean, Charles, and Terrebonne Bayous empty into it, and it is connected by canal with Bayous Blue and La Fourche. There is a sparse population on the islands, but the main marsh is believed to be for the most part too soft and too low for reclamation.

Terrebonne Bay, separated from Timballier Bay by the narrow tongue of land through the center of which Bayou Terrebonne runs, is only about half as large, and receives its waters mainly from Little Caillou Bayou. There were no inhabitants near the southern end, but wooded islands and occasional houses were visible from Smith's Island. There are two entrances to Terrebonne Bay, Vine Island Pass, with not less than seven feet at the western end of the island of that name, and Cat Island Pass, between Vine Island and Caillou Island.

Other details of local interest are given by Mr. Perkins in his report, which bears internal evidence to the ability and energy with which he directed the labors of his party.

He had the aid during the season of Assistant C. T. Iardella, a topographer of long experience, and of Subassistant Hodgkins, whose name has already been mentioned in connection with this work. Mr. Iardella's unflagging industry is highly commended by his chief. The work in which Mr. Hodgkins was occupied was various in its character, calling for the application of exceptional methods, not unfrequently in regions difficult of access, but his ready appreciation of the requirements of the survey enabled him to overcome all difficulties and obtain satisfactory results.

On the 23d of June the triangulation and topography had been so far completed as to furnish data sufficient for the hydrographic surveys of the outer coast of Louisiana and its inlets from Grande Isle to Raccoon Point, at the western end of Isle Dernière, and the *Hitchcock* was soon after laid up at New Orleans and the party disbanded.

Following are the statistics of the season:

Number of stations occupied in triangulation	28
Number of points determined in geographical position	50
Number of miles of shore-line surveyed	203
Number of miles of shore-line of creeks and bayous	117
Number of miles of marsh-line	79
Area surveyed, in square miles	103

Other service performed by Mr. Perkins is referred to under the heading of Section XIV.

Hydrographic surveys on the coast of Louisiana.—Brief reports of surveys executed on the coast of Louisiana early in 1887 have been received from Lieut. D. D. V. Stuart, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Endeavor*. He has sent to the Office a tracing which shows the channel crossing the bar near Southwest Pass and entering Vermilion Bay, and also the records of work done in the survey of the dredged channel into Atchafalaya Bay. These surveys were made under instructions dated in December, 1886, and in April, 1887, and were finished soon after the middle of May of that year.

The statistics are:

Miles run of soundings	904
Angles measured	1,786
Number of soundings	28,412

Other hydrographic work executed by Lieutenant Stuart is referred to under the heading of Section II.

SECTION X.

CALIFORNIA, INCLUDING THE COAST, BAYS, HARBORS, AND RIVERS. (SKETCHES Nos. 2, 8, 9, 15, 16, and 17.)

Triangulation begun for the examination of changes along the shore of San Diego Bay and vicinity.—Upon the receipt of instructions early in June, 1887, Assistant A. F. Rodgers, who had been engaged in a resurvey of San Francisco Bay entrance, made arrangements to proceed to San Diego, to begin there a triangulation which should determine the geographical positions and shore-line needed for the examination of changes along the shore of San Diego Bay and vicinity.

Arriving at San Diego on June 11, Mr. Rodgers, with the aid of Subassistant Isaac Winston, had determined, by the close of the fiscal year, a sufficient number of points for the projection of the topographical sheets, and reports that the examination of changes on the shore of the bay will be carried forward as rapidly as possible.

The trigonometrical determinations included the principal buildings in the city of San Diego, and in National City and the town of Coronado, opposite San Diego. Also the only objects available in South San Diego, all the beacons and channel buoys in San Diego Bay, the three bar buoys, and the hydrographic signals erected and used by the United States Engineers in a recent hydrographic survey. A number of directions were observed also upon the Coronados Islands, twenty miles south of the entrance to the bay.

Mr. Rodgers refers in his report to the cordial and steady support given him in both field and office work by Mr. Winston.

The statistics of the San Diego work are:

Number of stations selected and signals erected	18
Number of stations occupied	24
Number of observations of horizontal directions	934
Number of geographical positions determined	80

Continuation of the triangulation and topography of the south coast of California.—Preparations had been made early in August, 1886, by Assistant A. F. Rodgers to take the field in continuation of the triangulation and topography of the south coast of California, and as soon as the appropriation for the work became available the party was sent forward by steamer to San Pedro, and thence by rail and wagons to San Juan Capistrano. Subassistant Isaac Winston, attached to Mr. Rodgers's party, reached Capistrano August 16, and moved the camp stored there to San Onofre, twelve miles south, where the tents were pitched.

Field-work was begun immediately upon Mr. Rodgers's arrival by the erection of signals and the occupation of stations needed to obtain a base from which to carry the topography south from Point San Mateo, that being the southern limit of the work of the previous season. Fifteen stations having been occupied trigonometrically, the topography was taken up and continued until November 25, when the amount of funds remaining on hand made it necessary to close field operations on this part of the coast.

The statistics reported are:

Number of stations selected and signals put up	17
Number of horizontal angles observed	2,208
Number of pointings made	4,416
Number of geographical positions determined	22
Number of miles of roads surveyed	10
Number of miles of creeks surveyed	5
Number of miles of shore-line surveyed	14
Area surveyed, in square miles	12

Having stored his instruments and camp equipage at Capistrano, in default of a safe storage place farther south, Mr. Rodgers proceeded under instructions to San Francisco, where he was employed in office-work at the suboffice until the middle of April, when he was directed to organize a party for the resurvey and examination of San Francisco Bay entrance. Subassistant Winston, who had been temporarily detached and directed to report to Assistant Davidson for duty, was re-assigned to Mr. Rodgers's party.

Reference to this duty and to service executed by Mr. Rodgers in San Diego Bay is made under other headings in this section.

Series of magnetic observations with self-registering magnetic apparatus continued at Los Angeles, Cal.—From the beginning of the fiscal year until February 1, 1887, the charge of the magnetic observatory at Los Angeles, Cal., was continued with Subassistant Carlisle Terry, except for a short period in July, 1886, when Subassistant R. A. Marr was in charge.

In accordance with arrangements previously made, Assistant R. E. Halter reported for duty at the observatory September 7, and began at once to familiarize himself with the methods of obtaining a continuous photographic record from the Adie magnetographs. On February 1 he relieved Mr. Terry, who, on account of failing health, had been instructed to proceed to his home and take up office-work.

This change of duty seemed for a time to be beneficial, but the hope of Mr. Terry's recovery entertained by his friends and associates on the Survey proved to be a delusive one.

His death took place at his father's residence in Columbus, Ga., March 10, 1887.

Mr. Halter has submitted his annual report of the work of the observatory. The photographic traces giving the record of differential measurements have been continuous, with but little exception; the absolute measures of the magnetic declination, dip, and intensity were made regularly on the 14th, 15th, and 16th of each month.

In the routine work he had the assistance of Mr. W. P. Miles. The statistics for the period of Mr. Halter's charge are as follows:

Number of observations for time	156
Number of observations for temperature	1,885
Number of unifilar hourly scale readings	3,564
Number of bifilar hourly scale readings	3,574
Number of vertical-force readings	3,574
Number of observations for absolute declination	780
Number of observations for absolute dip	1,560
Number of observations for absolute intensity	885
Number of observations for scale values of bifilar and vertical-force magnets	324

Topographical surveys on the coast of California in the vicinity of San Simeon Bay.—The topographical survey on the California coast, which was referred to in the last annual report as in course of execution by Assistant Stehman Forney in June, 1886, was continued by Mr. Forney until October 15, 1886, at which date the survey of the shore-line from Villa Creek to Pico Creek was finished, and a connection made with the shore-line surveyed by Assistant Rockwell in 1871–1872. He completed also a detailed topographical survey, including the country one and a half statute miles back from the coast (taking in the town of Cambria) to the mouth of Santa Rosa Creek.

During the period following the close of field operations and until early in May, 1887, Mr. Forney was engaged at the suboffice, San Francisco, in completing his field records and inking and making tracings of his topographical sheets.

On May 11, having received instructions to resume his topographical survey, he proceeded to Cambria, San Luis Obispo County, where he organized his party and established his camp on the eastern end of Hearst's Ranch. Taking up the survey from the mouth of Santa Rosa Creek westward, he had but a few days' work at the close of the fiscal year to complete it to a junction with Assistant Rockwell's work at San Simeon Bay.

From this locality to the mouth of Villa Creek, the country included in the topographical survey has for its chief features rolling hills and small valleys divided into dairy farms. For vessels approaching this part of the coast, the Cambria Pines and the Pico Pines are prominent landmarks, being isolated clumps of pines which are the only trees immediately on the coast between San Diego and Monterey. The Cambria Pines stand on both sides of Santa Rosa Creek, extending one and one-half statute miles to the southward and eastward of its mouth, and to the westward one statute mile. The Pico Pines are two and a half statute miles west of the Cambria Pines.

San Simeon Bay, Mr. Forney observes, is a good southwest lee and a safe anchorage during the summer months. At this point there is a good wharf eight hundred and sixty feet long, and a large warehouse, built and owned by Mr. George Hearst (now a Senator from California), whose landed estate extends from the Arroyo del Padre Juan to San Carpojoro Creek, embracing eleven square leagues of excellent farming and dairy land. Steamers going to and from San Francisco land at this wharf every four days, touching at points on the coast as far south as San Pedro.

Mr. Forney gives some interesting statistics showing the large amount of imports and exports from San Simeon Bay during the fiscal year, and the thriving trade of which the town of Cambria is the center.

Other statements in his report with regard to the character of the coast, the effects of winds, etc., will be of value for the Pacific Coast Pilot.

Statistics of the work accomplished are as follows:

Number of miles of shore-line surveyed	13
Number of miles of roads surveyed	41
Number of miles of creeks surveyed	40
Number of miles of fences surveyed	115
Area of topography surveyed, in square miles	27

General charge of Pacific coast work.—Resurvey of Suisun Bay.—Coast Pilot work.—Hydrographic examinations.—The assignment of Assistant George Davidson to the general charge of the operations of the land parties of the Survey on the Pacific coast was continued during the year. He has submitted general plans for the prosecution of the land work in the different sections along the coast, made out detailed instructions for each chief of party, examined estimates and referred them to the Superintendent, and, whenever practicable, has conferred personally with the chiefs of parties. He has received and transmitted all official correspondence between the Office and the several Assistants and Subassistants.

In July, 1886, Mr. Davidson was occupied in making astronomical and magnetic observations at stations in Oregon, reference to which will be made under a heading in the next section.

On his way down from Oregon, in July, he made such notes and sketches for Coast Pilot purposes as the weather would permit. It was too thick to get views of headlands, etc., with the photographing apparatus.

Work was continued upon the fourth edition of the Coast Pilot for California, Oregon, and Washington Territory, and at the end of the fiscal year the manuscript had been finished to the head of Fuca Straits. Some nine hundred and thirty pages of the part from the southern boundary to and including the Gulf of the Farallones were sent to the Office for publication. Mr. Ferdinand Westdahl, draughtsman, was engaged in the fair copying during intervals in his regular duties, and finished the drawings of his views upon the coast. Mr. Davidson has about one hundred views of headlands, taken by himself upon his trips. Of Mr. Westdahl's views, thirty-four have been sent to the Office, and many more are in Mr. Davidson's possession.

In July and August the officers attached to Mr. Davidson's party, Assistant E. F. Dickins and Subassistant Fremont Morse, were occupied in office-work, tracing the topography of the proposed Los Angeles base-line, duplicating records, inking the astronomical and magnetic work of the Columbia River stations, and making preparations to take up the resurvey of the shore-line of Suisun Bay. In some of the work of duplicating, etc., Mr. P. A. Welker, Aid in Assistant Lawson's party, rendered assistance.

Topographical resurvey of Suisun Bay.—For the topographical resurvey of Suisun Bay, Mr. Davidson organized his party in September, 1886, placing Assistant Dickins in immediate charge, with Subassistant Morse to aid him. Work was begun from tertiary triangulation stations near Benicia. Most of the old stations had disappeared, and new ones had to be established and occupied. To mark the stations along the low marshy shores, sections of vitrified sewer-pipes were used, filled with sand, their tops level with the surface.

The work was continued during the winter, though impeded by the usual storms of the rainy season, and was carried along the south shores of Suisun Bay into the mouth of the San Joaquin River, and along the shores of the mouth of the Sacramento River, including the southern marsh islands. It was stopped April 19, when the allotment of funds was almost exhausted.

Assistant Dickins made the last tracings of his uninked topographical sheet for the party of Lieut. David Peacock, U. S. N., commanding the Coast Survey steamer *Hassler*. In his special report Mr. Dickins expresses his indebtedness to Lieutenant Peacock for many courtesies extended and facilities of transportation given in the course of his operations.

Soon after leaving the field Mr. Dickins was ordered to duty on the Oregon coast, mention of which will be made under a heading in the next section. Early in April, Subassistant Morse, after a short leave of absence, was assigned to duty in Section XI with Assistant Pratt.

Noonday Rock.—Special hydrographic duty.—Examination at Lompoc Landing.—In pursuance of instructions for a special investigation of Noonday Rock, Mr. Davidson directed an examination by Mr. Westdahl, and in December, 1886, forwarded to the Office a chart showing the results of the work, the principal ones of which were that the "Alaska" rock does not exist, and that the mammoth buoy should be placed, as was done later, near the Noonday danger.

In September Mr. Westdahl was instructed to examine the reported dangers near the end of the new wharf at Lompoc Landing. The Pacific Coast Steam ship Company had agreed to pay all of the expenses of this survey. The dangers were found and a chart of the whole work forwarded to the Office; also a chart of the survey on a large scale plotted and drawn by Mr. Westdahl.

In December Mr. Westdahl was authorized to assist the Light-house steamer in locating the new buoys in the Boneta Channel and on the Four-Fathom Bank.

The Lafayette Park Observatory was turned over to Assistant Edwin Smith in March, 1887, in accordance with instructions, for the use of the telegraphic longitude parties.

Duties of inspection, the charge of tidal stations, and other services performed by Mr. Davidson or carried on under his direction are referred to under subsequent headings in this section and the two following.

Continuation of the resurveys and examinations of the shore-line of San Francisco Bay for the determination of changes.—The resurveys and examinations in San Francisco Bay and approaches, which were referred to in the last annual report as having made progress until early in June, 1886, were resumed by Assistant A. F. Rodgers, under instructions dated April 15, 1887. Subassistant Isaac Winston, who had been temporarily detached, was re-assigned to Mr. Rodgers's party, and joined it April 28.

The necessity of determining a number of trigonometrical points was soon apparent; these being required to enable Mr. Rodgers's party to occupy in the shore-line survey positions sheltered from the violent northwest winds which sweep through the Golden Gate. By June 1 all of the points needed had been established in position and the shore-line survey begun, when instructions were received by Mr. Rodgers to take up a resurvey in San Diego Bay.

Reference to this duty has been made under a previous heading in this section.

For the San Francisco work the statistics reported are:

Number of stations occupied with theodolite	9
Number of directions observed	380
Number of geographical positions determined	27

One topographical sheet was partly completed.

Resurvey of San Pablo Bay, California.—The resurvey of San Pablo Bay, which was assigned to Assistant James S. Lawson under instructions dated August 4 and August 23, 1886, was especially directed to the examination of the immediate shore-line and the low-water marks, and to the delineation of such additions and changes in structures lying in from shore as would be available for aids to navigation.

Mr. Lawson received his instructions for this work while he was at Los Angeles, on his return from San Pedro and Anaheim. After his arrival at San Francisco his preparations were made as rapidily as possible, and on September 14, having organized his party, he proceeded to San Rafael, in which vicinity he proposed to begin field operations.

During the period (over thirty years) that had elapsed since the survey made by Assistant Rodgers, many of the old stations had been lost. On the south side of the bay only one old station was found, and on the north side, between Petaluma Creek and Mare Island, not one. Hence a new triangulation was needed to establish points as a basis for topographical work.

This triangulation was done as required for each successive topographical sheet. A number of the stations being on marshy ground, they could not be deemed permanent, and hence they were determined just in advance of the plane-table survey. For the preservation of the most important of the marsh stations for topographic and hydrographic uses, they were marked by sections of earthen drain pipes thirty inches long and five inches in diameter. These were set perpendicularly with their flanges downwards and with several inches of their length projecting above the surface.

Among the positions determined were the beacons marking the course of the channel in San Pablo Bay to Petaluma Creek, both the old and the new ones, the latter being made necessary by the movement of the channel towards the east, a movement which still continues. These beacons being well out in the bay furnish excellent signals for hydrographic work.

The topography was begun at Mare Island Straits, the town of Vallejo and the Mare Island navy-yard being included. It was evident that there had been no change in the contours since the former surveys, hence the time spent was devoted entirely to the delineation of the shore-line, wharves, jetties, landings, etc., with the buildings in the blocks in Vallejo immediately adjacent. On Mare Island all buildings, roads, and improvements existing at the time of the survey were shown.

Westward from Mare Island, towards Sonoma and Tolay Creeks, considerable change was found in the shore-line of the marsh from that shown in Assistant Rodgers's survey. During a very heavy southerly storm a few years ago the shore-line was washed away so that the sites of some of the old stations are now in the bay, one of them over one hundred meters.

From Sonoma Creek westward, including Tolay, Petaluma, and Novato Creeks, large quantities of the marsh have been reclaimed by dikes and ditches, and much of the land is now under cultivation. In the large creeks, as also in the small sloughs, marked changes have been made by the growth of the *Elymus maritima*, which has encroached greatly on the Bay of San Pablo.

At the mouth of Novato Creek and to the southward this growth has extended nearly a mile from the shore-line as represented in Mr. Rodgers's survey.

The work of the season was closed April 23, 1887, in order not to exceed the amount allotted for the expenditures of the party to the end of the fiscal year.

Following are the statistics reported:

Number of signals for triangulation erected	27
Number of stations occupied	17
Number of objects observed (primary)	133
Number of objects observed (secondary)	30
Length of shore-line surveyed in miles, including shore-line of bay, and of creeks, sloughs, and ditches	197
Length, in miles, of railroad and other roads surveyed	52
Length, in miles, of fences	35
Length, in miles, of dikes	37
Area surveyed, in square miles	24

In closing his report Mr. Lawson asks to have placed on record his sense of the ability and usefulness of Subassistant P. A. Welker, who was attached to his party during the entire field season.

Hydrographic resurveys in Suisun and San Pablo Bays, Karquines Straits, and vicinity.—The need of a revision of the hydrographic charts of San Francisco Harbor and the bays connecting with it has been perceived for some years past, causes having been actively at work to produce changes in the depths given by the old surveys. In September, 1886, the execution of this work was assigned to Lieut. David Peacock, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *Hassler*.

Lieutenant Peacock's surveys are shown upon six projections, three of them upon a scale of 1-10000, and one upon a scale of 1-20000 for Suisun Bay, Karquines Straits and vicinity, and one of 1-10000 and one of 1-20000 for San Pablo Bay. Hydrographic work was begun September 28, 1886, and closed April 10, 1887, all that was laid out upon the projections having been finished except a portion of San Pablo Bay, to complete which about a month's additional work will be required.

The following-named officers were attached to the party on board the *Hassler*: Ensigns J. H. Shipley, C. C. Marsh, D. P. Menefee, A. M. Beecher, N. S. Moseley, and J. D. McDonald, U. S. N.; Passed Assistant Surgeon D. O. Lewis, U. S. N., and Passed Assistant Engineer G. D. Strickland, U. S. N.

Lieutenant Peacock reports the following statistics for the work accomplished during the season:

Number of miles run of soundings	1,907
Number of angles measured	20,102
Number of soundings	123,529

Series of tidal observations with automatic tide-gauge continued at Saucelito, Bay of San Francisco, California.—The series of tidal observations with an automatic tide-gauge at Saucelito, near San Francisco Bay Entrance, was continued throughout the year by Mr. Emmet Gray under the supervision of Assistant George Davidson. The tabulations and the sheets of record, after examination by Mr. Davidson, were regularly transmitted to the Office. The usual meteorological record was also transmitted.

Observations for time and comparisons of the tidal chronometer, whenever it was brought over from Saucelito, were made by Mr. Charles B. Hill at the Lafayette Park station, San Francisco.

The tidal record was unbroken and of uniform excellence during the year. It will be very desirable to obtain a record for a complete lunar cycle at this important station.

Occupation of stations in San Francisco for longitude determinations.—Determination of longitude at Salt Lake City and at Portland, Oregon.—Magnetic observations at Portland.—In conformity with instructions, two parties for the determination of longitudes on the Pacific coast and in Utah Territory were organized in April, 1887, by Assistants Edwin Smith and C. H. Sinclair.

After arranging all details in regard to instruments, three sets of which had been stored at Salt Lake City and at Ogden, Utah, at the close of the preceding season, Assistant Smith arrived in San Francisco April 29, and Assistant Sinclair at Salt Lake City some days before.

At San Francisco, in conformity with instructions, Subassistant Welker reported to Mr. Smith for duty in the longitude party. The observatory and transit instrument at Lafayette Park station were placed at the disposal of the party by Assistant Davidson, and the longitude apparatus was at once put in position for the exchange of telegraphic signals.

On the nights of May 4, 7, 9, 10, and 12, time was determined and longitude signals exchanged between San Francisco and Salt Lake City; the observers then changed places, and similar exchanges were had on the nights of May 20, 25, 26, 27, and June 6.

Mr. Smith then proceeded to Portland, Oregon. During his stay at Salt Lake City, observations were begun to determine astronomically the difference of longitude between the Lafayette Park station in San Francisco and the old station in Washington Square, which had been occupied in the transcontinental longitude campaign of 1869, and which had been subsequently abandoned as an unfavorable locality. Permission having been obtained by Mr. Davidson from the city authorities for the re-occupation of the Washington Square station, Mr. Welker built a temporary observatory there, and on the nights of May 26 and 27, and June 3, 4, and 6, observed for time and exchanged longitude signals with Mr. Sinclair at Lafayette Park. The observers then changed places, and a second series of exchanges was obtained on the nights of June 7, 9, 10, 12, and 13.

Upon Mr. Smith's arrival at Portland he established a longitude station in the grounds of the custom-house. Time observations were made and longitude signals exchanged between San Francisco and Portland on the nights of June 20, 27, and 28, and continued after the close of the fiscal year. The foggy season began unusually early this year at San Francisco. Had the weather been favorable one-half of the longitude nights could have been had before July 1.

At Portland, during four days in June, Mr. Smith made observations for the determination of the magnetic declination, horizontal and total force, and dip.

He expresses cordial acknowledgments for ever-ready and liberal co-operation to the Western Union Telegraph Company in extending the use of their lines to the longitude parties.

Mr. Sinclair, in his report, refers to the diligence and intelligence shown by Mr. Welker in taking hold of the longitude work without previous experience in it.

Other service of a similar character, assigned to Messrs. Smith and Sinclair, is referred to under the heading of Section XVI.

SECTION XI.

OREGON AND WASHINGTON TERRITORY, INCLUDING COAST, INTERIOR BAYS AND SOUNDS, PORTS, AND RIVERS. (SKETCHES Nos. 2, 10, 11, 16, and 17.)

Hydrographic survey of the Umpquah River, Oregon, and its approaches completed.—Topographical survey of the coast of Oregon continued from Umpquah River southward.—In continuation of the hydrography of the Umpquah River, Oregon, already begun by Assistant L. A. Sengteller, that officer took the field in pursuance of instructions in August, 1886, landing with his party at Empire City, Koos County, Oregon, August 17.

From this point, through the kindness of Capt. Robert Simpson, owner of the steam-tugs at Koos Bay, he was enabled to obtain transportation to Gardiner, on the Umpquah River, just below which the work of the preceding season had been closed.

A temporary camp having been established near the mouth of the river, the work of recovering and re-erecting signals and establishing new stations for signals was at once begun, and a tide-gauge set up, at which observations were commenced August 20, and continued without interruption, so as to include all high and low waters between that date and September 2.

Soundings were begun below Gardiner August 23 and continued till September 7, when the work had reached to nearly the mouth of the river. There remained then only the bar and its dangerous approaches, both outside and inside, to complete the hydrographic survey.

Having transferred the party from its temporary camp to a location near the mouth of the river so that he would be enabled to take advantage of favorable opportunities for the survey of the bar and approaches, or for carrying forward the topography from the mouth southward, Mr. Sengteller advanced both surveys simultaneously from September 10 till the close of the season, November 6.

The survey of the bar proved to be a slow and hazardous work; it was only for an hour before and after low water that satisfactory results could be obtained, as at high water, owing to the rough sea and in a current of about five knots, the boat, which was short-handed, having but three men instead of six, her complement, could not be kept on her course. Mr. Sengteller succeeded, however, in enlisting the interest of the captain of one of the steam-tugs, the *Fearless*, in the survey, and through his courtesy a few hours' soundings were obtained during the prevalence of spring tides with high water occurring in the middle of the day. Between 9 a. m. and 5.30 p. m. of September 28, the bar was successfully examined and sounded before and after high water, thus completing all data required for the publication of a chart of Umpquah River from its entrance to Gardiner City, which is practically the head of ship navigation.

Mr. Sengteller observes that his examination of the bar developed a channel quite narrow and contracted, but for only a short distance, affording full twelve feet at the lowest of low waters, and that this entrance, as compared with many on the Pacific coast, possesses one great advantage to vessels entering or departing in that they either go with, or head, the seas and swells, and while the channel may shift daily, its general trend and depth have remained quite uniform during his four years' service in that section.

Sailing directions and descriptions of dangers to the navigation of the river are given in much detail in Mr. Sengteller's report. He renews his recommendation for the buoyage of the river.

In the development of the topography from the Umpquah River southward, the country passed over presented a formation of sand hills and hollows of the most irregular shapes, daily shifting in accordance with the prevalence of the winds. This drifting sand, during high winds, made plane-table work quite difficult, the instrument and sheet being covered with it. A belt of topography about five miles in length and having an average width of a mile and a half had been finished at the end of the season.

For the topography the statistics are:

Miles of ocean shore-line surveyed	5
Miles of shore-line of creeks surveyed	1
Miles of shore-line of lakes surveyed	5
Area surveyed, in square miles	8

Mr. Sengteller had the aid during the season of Mr. J. K. Moffitt, who served very acceptably as recorder in the party. Mr. Moffitt was relieved from duty upon returning from the field, and the reduction of the observations and preparation of the records devolved upon Mr. Sengteller, whose report shows a very large amount of office work accomplished and transmitted for registry in the archives.

Topographical reconnaissance of the coast of Oregon between the Umpquah and Yaquina Rivers.—As preliminary to a more detailed survey, a topographical reconnaissance of the coast of Oregon between the mouths of the Umpquah and Yaquina Rivers was assigned to Assistant E. F. Dickins on his detachment from the party of Assistant Davidson in April, 1887.

It was desired to obtain on a scale of 1–40000 the shore-line, some heights, landfalls, and sketches of bluffs. The positions of all dangers, rocks off shore—their heights and peculiarities of shape—were to be noted for immediate requirements. Provision was made for checking the direction of the work by observations of the sun for azimuth; observations were also to be made at suitable intervals for time and latitude, approximate determinations only being required.

Having made all needed preparations, Mr. Dickins organized his party May 17, and reached Gardiner, on the Umpquah River, May 25. Here some delay was encountered owing to the difficulty of obtaining pack animals. On June 4 work was begun at Five Mile Creek, and from that date the reconnaissance was pushed as rapidly as the weather would permit. High winds and dense fogs prevailed most of the time; the country was rough and unsettled and the trails poor, so that the outfit of the party had to be made as light as possible. By June 30 Heceta Head had been reached, nearly one-half of the reconnaissance done, and the first plane-table sheet completed.

To that date, closing the fiscal year, the statistics are:

Number of stations occupied for observations of time, latitude, and azimuth	2
Number of miles of shore-line surveyed	27
Number of miles of roads surveyed	1
Number of miles of creeks surveyed	10
Area surveyed (approximate), in square miles	27

Topographical reconnaissance of the coast of Oregon between Yaquina River and Tillamook Bay.—In April, 1887, Assistant Cleveland Rockwell was directed to execute a topographical reconnaissance on the coast of Oregon between Yaquina River and Tillamook Bay, intended to subserve the same purposes as the reconnaissance referred to under the preceding heading, which was assigned to Assistant Dickins.

Mr. Rockwell has submitted a very full report of this work, accompanied by a carefully prepared progress sketch on a scale of 1–100000, upon which are given the names of the capes, creeks, bays, and other topographical features delineated in his survey. A list of common names and of Indian names corresponding (Tillamook language) is appended.

An abstract only of this interesting report can be here given.

The party was established in temporary camp No. 1, north of Yaquina Point, May 18. Through the kindness of Mr. Wadsworth, agent for the Siletz Reservation, pack-horses were obtained from the Siletz Indians, and work was begun from the limits of the topography executed by Assistants Chase and Forney half a mile north of Cape Foulweather Light.

Observations for time and azimuth were made at a station eccentric to the Light. The latitude had been determined in 1883 by Mr. Fremont Morse. Mr. Rockwell observes that the Cape Foulweather Light-house is not on that cape, the middle and most prominent part of which is about eight and a half miles north of the Light.

The work made fair progress during the first month, the weather being moderately good, and a narrow strip of coast near the water, generally bare of trees and covered with grass and fern, extending for seven miles from Cape Foulweather, being favorable for using the plane table. Indentations in the coast-line, which might have taken days of hard labor to get around by the trails, were measured by a telemeter rod which Mr. Rockwell had made of extra length, capable of being read to five hundred and sixty meters.

On June 11 the work had been advanced to Siletz Bay, and observations for time and azimuth were again made. By the 27th of June the survey had been completed around Devil's Lake and Salmon River, and camp No. 8 had been pitched on top of Cascade Head, thirteen hundred feet above the sea-level. At this point the limit of the first topographical sheet (scale 1–40000) was reached.

Additional details of the work accomplished must be reserved for the next annual report. This survey was prosecuted by Mr. Rockwell to a successful conclusion despite many serious obstacles encountered during its progress. The following extracts from his report will indicate their character:

"The difficulties of the weather and of the work together seemed at times absolutely insurmountable. By reason of the contraction of the reservation limits, the trails had been long since abandoned by the Indians, and were overgrown with thick bushes and obstructed by large fallen dead trees on the steep sides of ravines. The brush had to be cut away and fallen trees bridged over with chunks of rotten logs so as to get the pack animals through. Other large trees, in many cases, had to be chopped away or the ground dug out from underneath to allow the packs to pass under. The trail would follow the steep ridges to their tops, eight hundred or a thousand feet high, and then descend into a gorge nearly at sea-level; then would ascend to the top of the next ridge.

* * * * * * *

"On some of the capes, which are not covered with timber, the points appear to be delightful grassy slopes when viewed from a distance. This appearance is, however, deceptive; the salmonberry and sallal bushes are a matted mass of stalks and verdure from eight to twelve feet high, out of which nothing but the sky is visible. A running vine, the old-man root, binds the whole mass together. At one station a bear, alarmed by the men a short distance off, ran around below the plane table not twenty feet away, but he could not have been seen ten feet away."

Service assigned to Mr. Rockwell earlier in the fiscal year is referred to under another heading in this section.

Hydrographic surveys in Tillamook Bay, off the coast of Oregon in that vicinity, and in Shoalwater Bay, Washington Territory.—Hydrographic surveys and examinations on the coast of Oregon and in Washington Territory were assigned in March, 1887, to the charge of Lieut. J. C. Burnett, U. S. N., Assistant Coast and Geodetic Survey, commanding the steamer *McArthur*.

The *McArthur*, having been fitted for work on that stormy coast, left San Francisco April 26 and arrived off Tillamook Bay May 1. The bar being too rough to be crossed, and there being every indication of bad weather, it was thought best to stand on to Astoria for shelter. From the 2d till the 11th of May strong gales, with heavy rain, prevailed, and detained the vessel in port; but on the afternoon of the 11th, the gales having abated, she arrived in Tillamook Bay, and next day the erection of signals was begun. All of the soundings needed for work inside the bay were obtained between the 14th and 18th. From the 18th to the 20th the bar was breaking heavily and the steamer could not get outside. On the 21st, the sea having moderated, the bar was crossed and the offshore work begun. This was practically finished on the 26th, and from that date till the 31st the *McArthur* was steaming on and off the entrance, waiting for the sea to moderate enough to permit the boats to run additional lines across the bar. No opportunity of doing this part of the work having offered by the 31st, and the supply of coal getting low, Lieutenant Burnett returned to Astoria. He observes that except under the most favorable conditions the bar at Tillamook is very dangerous, and that during the nineteen days' stay of the party the ship's boats were able to cross it but once. Enough work was done, however, to show what changes may have taken place since the former survey.

Nehalem River was the next locality proposed to be examined, but it was found impossible to get into it. On the calmest day the sea broke with great fury clear across the entrance. The boats were close in, and the depth on the bar was estimated to be not over four feet.

Having taken on board coal and water, the *McArthur* left Astoria for Shoalwater Bay on the morning of June 6, arriving at North Cove the same afternoon. Signals were at once put up, a tide-gauge established, and on the 9th soundings were begun. Strong tides prevailed in this bay, against which the boats could make but little headway. The survey had made sufficient progress, however, by the close of the fiscal year to assure its completion in less than two weeks from that time. Further notice of this work and of that off the coast between Shoalwater Bay and Gray's Harbor must be deferred till the next annual report.

The officers attached to the party were Ensigns W. P. White, J. A. Bell, and J. L. Purcell, U. S. N.; Assistant Surgeon E. W. Auzal, U. S. N., and Assistant Engineer R. I. Reid, U. S. N. Ensign N. S. Moseley, U. S. N., joined the party May 21.

Continuation of the survey of the Columbia River.—Astronomical and magnetic observations at stations on the left bank of the Columbia.—Hydrography of the river from Columbia City to the head of Bachelor's Island.—The occupation of station Balch, near Portland, Oregon, by Assistant George Davidson, for the determination of its latitude and for the azimuth of a connecting line of the triangulation, was referred to in the last annual report.

Assistant Cleveland Rockwell had been assigned to duty in Mr. Davidson's party. In July, 1886, Mr. Davidson occupied station Rainier, on the left bank of the Columbia River, opposite the mouth of the Cowlitz River, to check the latitude and azimuth of the Columbia River triangulation, and to serve as a basis for the triangulation already laid out between that river and Puget Sound. The secondary triangulation station, Rinearson, Oregon, was used as an azimuth mark.

During the regular astronomical work, advantage was taken of cloudy weather to occupy an eccentric magnetic station for observations of the magnetic declination and horizontal force.

Work at Rainier was finished about the 24th of July. Mr. Davidson reports the following statistics:

Number of nights of observations for time	20
Number of observations for time	173
Number of nights of observations for latitude	9
Number of pairs of stars observed	30
Number of nights of observations for azimuth	8
Number of observations on mark and star	173

Reference to other duties with which Mr. Davidson is charged is made under headings in Sections X and XII. In virtue of his assignment to the supervision of the operations of the land parties on the Pacific coast, he gave detailed instructions to Mr. Rockwell for the execution of general instructions received by that officer in September to resume the survey of the Columbia and Willamette Rivers. The portion of the work most needed was taken up by Mr. Rockwell, the hydrography of the Columbia from Columbia City to the head of Bachelor's Island. Having assumed charge of the party September 17, soundings were begun on the 25th, and continued assiduously till the completion of the hydrography on the 9th of November. The chief delays encountered were from the morning fogs, which did not generally disappear before half-past ten a. m., and sometimes lasted till noon.

The main portion of the Columbia River was surveyed by the usual system of rectangular lines or squares, about one hundred and twenty meters apart, divided in some places into half that space. A large part of the Willamette Slough, part of Lewis River and of Lake River and Bachelor's Island Slough, fell upon the same hydrographic sheet, and these streams were sounded by a system of zigzag lines which, in Mr. Rockwell's judgment, was a sufficient development. Tides for the reduction of the soundings were observed at Saint Helen.

The statistics are:

Miles of sounding lines run	175
Number of angles measured	2,078
Number of soundings	9,655
Area of hydrography, in square miles	7

Duty performed by Mr. Rockwell on the Oregon coast in 1887 is referred to under another heading in this section.

Determination of longitude and the magnetic elements at Portland, Oregon.—An account was given under a heading in Section X of the occupation of a station in Portland, Oregon, for the determination of its longitude by exchanges of telegraphic signals with the Lafayette Park station in San Francisco. The station at Portland was established by Assistant Edwin Smith, in charge of one of the longitude parties, and the exchanges of signals with Assistant C. H. Sinclair at San Francisco, which had been begun June 20, were still in progress at the close of the fiscal year.

The magnetic elements were determined by Mr. Smith at Portland during four days in June.

Other longitude operations, conducted by Messrs. Smith and Sinclair, are referred to under headings in Sections X and XVI.

Beach measurement and topographical survey between Shoalwater Bay and Gray's Harbor, coast of Washington Territory.—*Special triangulation and topography at Tacoma and Seattle, Puget Sound, Washington Territory.*—At the date of closing the last annual report, Assistant S. A. Gilbert had begun a beach measurement and plane-table survey on the coast of Washington Territory from Shoalwater Bay northward to and including the entrance to Gray's Harbor.

Preparation for this work was made by setting up stakes along the beach, beginning at the limit of triangulation completed in a former survey, about five miles north of Shoalwater Bay, and extending around into Gray's Harbor. The distances between these stakes were very carefully measured with a hundred-meter chain, which had been used on the Yolo Base and its length tested there. The positions of the stakes were determined by a plane-table triangulation, and the topography carried across Gray's Harbor entrance.

On July 10, 1886, the survey was finished, and by August 16, during intervals of other field duty, Mr. Gilbert had inked his topographical sheet of Gray's Harbor, made tracings of it, and forwarded one tracing, together with the original, to the Office.

Between the 15th and 29th of July, Mr. Gilbert was at Tacoma, Wash., whither he had proceeded under instructions to make a survey of the city water front. Upon completing this work he took up a similar survey for the city of Seattle, and finished it August 13.

The next duty assigned to him was the resumption of the triangulation and topography of Rosario Strait, and subsequently similar work in Bellingham Bay, both of these bodies of water forming parts of the approaches to or connections with Washington Sound. Mention of these surveys will be made under a later heading in this section.

For his work of 1886, up to the middle of August, Mr. Gilbert reports statistics as follows:

At Gray's Harbor:	
Miles of shore-line surveyed	29
Area surveyed, in square miles	10
At Tacoma:	
Number of signals erected	7
Number of stations occupied	5
Number of points determined	18
Miles of shore-line surveyed	5
Miles of roads and railroads	5
Area surveyed, in square miles	3
At Seattle:	
Number of signals erected	4
Number of stations occupied	4
Number of points determined	13
Number of miles of shore-line surveyed	4
Number of miles of roads and railroads	7
Area surveyed, in square miles	5

Reconnaissance of the coast of Washington Territory, from Gray's Harbor to Cape Flattery.—Instructions having been received towards the end of April, 1887, by Assistant J. F. Pratt, directing him to organize a party for a reconnaissance of the coast of Washington Territory between Gray's Harbor and Cape Flattery, preparations for the work were begun without delay. In these preparations Subassistant Fremont Morse, who had been assigned to duty in the party, rendered aid.

As the outside coast was not inhabited by white men, it was necessary to organize the party at some point where it would be convenient to disband it on completing the survey, and Olympia was selected as the most convenient in every respect.

By the 29th of April, transportation was obtained for the party to the coast, a team having been hired for the purpose, but the roads were in such poor condition that all hands were obliged to walk the greater part of the way. At Montezuno a small steamer was procured, which landed the party at Damon's Point, Gray's Harbor, May 1. The weather was very stormy, and so continued for ten successive days, with but short lulls. Attempts to begin work in the rain and sleet, which were almost continuous, resulted in one of the men becoming disabled by rheumatism, and the organization having been originally one man short, and it being impracticable to get more men, the work was carried all the way through short-handed. This imposed much additional labor upon Messrs. Pratt and Morse.

After the 11th of May, when active operations were resumed, the survey was pushed forward, with but two days' interruption from fog and rain, until Neah Bay was reached, on the night of June 13. On the 16th the party arrived at Olympia and was disbanded.

It was desired to obtain observations for latitude and azimuth at the outset of the work at Damon's Point, but this was found impracticable on account of clouds. Time and latitude were observed at Quinaielt, an Indian village about three miles north of Point Grenville, but observations for azimuth were prevented by clouds. At Quillihute, still further north, a similar attempt was made, but was frustrated by clouds.

From Damon's Point to Point Grenville the distance was measured with a one-hundred meter steel wire, and the terminals of these wire bases were occupied with a theodolite. Beyond Point Grenville the distances depend on telemeter measurements, the relation in distance of the ocular micrometer to the plane-table alidade having been carefully determined. Much of the topographical detail was sketched. At feasible points, angles were measured with the theodolite on conspicuous objects, stations being occupied as near to these objects as practicable.

Outfit and supplies for the party were moved as follows: From Damon's Point to the Quinaielt Indian Agency by wagon; thence to the mouth of the Queets River, a distance of about thirteen miles, on the backs of *klootchmen* (Indian squaws). From the Queets to the Hoh River by Indian ponies and *klootchmen;* from the Hoh to Toleak by canoes. From Toleak to Quillihute on the backs of Indians; thence to Wa-a-tch by canoe, and from Wa-a-tch to Neah Bay by ox-wagon.

The position of the work depends, at the north end, upon the latitude of Neah Bay and the longitude of Tatoosh Island; at the south end upon the position of station Lone Fir, as measured from a tracing of the topography of the entrance to Gray's Harbor by Assistant Gilbert in 1886.

Mr. Pratt expresses his obligations to Maj. J. C. Breckenridge, Surveyor-general of Washington Territory, for courtesies extended, including access to all information on file in his office respecting the outside coast-line.

The efficiency and thoroughness with which Subassistant Morse co-operated in the work elicits his warm commendation.

The statistics are as follows:

Number of stations occupied with the theodolite	52
Number of miles measured with wire	24
Number of miles of shore-line surveyed with the plane table	123
Number of miles of creeks surveyed	8
Number of outlying rocks and islets determined (approximate)	430

At the outset of the fiscal year Mr. Pratt was assigned to duty in Saratoga Passage, Port Susan, and vicinity, a report of which he has transmitted. An abstract is given under a subsequent heading in this section.

Hydrographic surveys in Admiralty Inlet, Port Townsend Bay, Possession Sound, and Port Susan.— At the opening of the season in 1886, Lieut. C. F. Forse, U. S. N., Assistant Coast Survey, having received the necessary instructions, made preparations for resuming the hydrography of Admiralty Inlet and the waters adjacent. After having had the steam-launch *Tarry-not* fitted for service, he organized his party on board the schooner *Earnest,* and proceeded with the two vessels to Port Ludlow, whence on April 24 he moved to an anchorage at the head of Oak Bay. Here a tide-staff was set up and observations begun. The weather was yet unfavorable for the work, blowing and raining frequently. For the survey of Admiralty Inlet and Port Townsend Bay, Lieutenant Forse was furnished with a projection, scale 1–20000. On May 28, the schooner was moved to an anchorage on the west side of Port Townsend Bay, and a tide gauge was set up there. In connection with this survey, the rock off Foulweather Bluff was re-located accurately, a number of radial lines being run out from it to deep water, and the vicinity thoroughly developed. The rock lies well in-shore, and is not apt to be a danger to navigation.

Lieutenant Forse observes that the tidal current in Admiralty Inlet is very strong, both during flood and ebb. Heavy tide-rips are met with from Admiralty Head to Marrowstone Point, and with a fresh breeze there is usually a heavy sea at this point. In Admiralty Bay, the current alongshore sets nearly always towards Admiralty Head. In this bay there is a shoal known to fishermen as the Halibut Bank, on which the shoalest water found was thirteen fathoms. Admiralty Inlet, from Foulweather Bluff to Admiralty Head, contains no good anchorage. Port Townsend Bay is entirely free from dangers and has good anchorage throughout its whole extent.

The survey in these localities having been completed June 23, Lieutenant Forse left Port Townsend on the 25th and proceeded to Possession Sound, having received a projection for the work there, scale 1–20000, from the suboffice in San Francisco. On June 30 he anchored at Tulalip and set up a tide-gauge. Sounding was begun on July 6. During July and August the work was greatly interfered with by smoke, which at times was so thick that the wharf at Tulalip, less than a quarter of a mile away, could not be seen from the schooner. During the prevalence of this smoke the signals in Port Susan were built. The hydrography of Possession Sound was finished September 1. This sound contains no important dangers except the extensive flats at the mouth of the Snohomish River and a sandy shoal extending out from the south end of Gedney Island. The shores are generally flat for a short distance and then drop suddenly into deep water.

Tulalip Bay is a safe anchorage for small craft, but it is said to be fast filling up. There is a rock in the entrance to this bay which Lieutenant Forse recommends should be marked by a buoy.

He marked it by a wooden buoy, anchored by a rope and a weight, but this, as he observes, can not be considered as at all permanent.

For the hydrography of Port Susan, which was begun August 23 and completed October 13, a projection, scale 1-20000, was furnished by Assistant Pratt, who had executed the triangulation and topography in that vicinity.

With regard to Port Susan, Lieutenant Forse remarks that the flats at its head are very extensive, and could be worked over only at or near high water. They constitute the only obstacle to navigation in Port Susan. The entrance to the Stillaguamish River is very shoal, and can be used only at high tide, even by the light-draught stern-wheel steamers. The soundings taken in the river were reduced to the low water of the day on which the work was done. The tide in this river was found to be quite different from that in Port Susan, but it was not deemed advisable to spend the time which would have been required to obtain for it a separate plane of reference.

On the receipt of instructions which left the time of closing work to Lieutenant Forse's discretion, he proceeded to Olympia October 27, and laid up the *Earnest* in winter quarters in Butler's Cove.

Lieut. H. T. Mayo, U. S. N., was attached to the party during the season.

The statistics are:

Miles run in sounding	828
Angles measured	4,830
Number of soundings	19,628

In June, 1887, Lieutenant Forse was instructed to resume his hydrographic surveys in Puget Sound at the beginning of the next fiscal year.

Triangulation and topography of Port Susan, Stillaguamish River, and Saratoga Passage, Washington Territory.—In accordance with telegraphic instructions dated June 29, 1886, Assistant J. F. Pratt began preparations for field duty in Port Susan, Saratoga Passage, and vicinity, Washington Territory.

The schooner *Yukon* having been overhauled and fitted for service, Mr. Pratt left without delay for the working ground, arriving at Port Susan, after some detention by calms and light winds, on the 16th of July.

Triangulation and topography were resumed in Port Susan from the limits of the survey of the preceding season. The triangulation was carried through to Skagit Bay, where, for the purpose of checking it, a connection can be made next season with the triangulation carried around on the west side of Camano Island by way of Saratoga Passage. The topography was carried over the same ground, and also up the Stillaguamish River to where Hat Slough branches off.

On October 8, Port Susan and its tributaries were completed, and the party was then transferred to Saratoga Passage, taking up the work from the limits of the season of 1885 and continuing it until the entrance to Holmes Harbor had been reached.

Early in November field operations were closed, and about the middle of the month the *Yukon* reached Budd's Inlet, where she was dismantled and laid up for the winter.

Mr. Pratt reports the following statistics:

For the triangulation:

Number of signals erected	41
Number of stations occupied	19
Number of geographical positions determined	40

For the topography:

Number of miles of shore-line surveyed	62
Number of miles of river shore-line	33
Number of miles of shore-line of creeks	8
Number of miles of shore-line of roads	8
Area surveyed (approximate), in square miles	39

Reconnaissance assigned to Mr. Pratt on the outer coast of Washington Territory in 1887 is referred to under a preceding heading in this section.

Triangulation and topography of Rosario Strait and vicinity.—Triangulation and topography begun in Samish and Bellingham Bays, Washington Territory.—Upon the completion of the special survey at Seattle, referred to under a previous heading in this section, Assistant J. J. Gilbert, acting under instructions already received, immediately prepared the steam-launch *Fuca* for service, and proceeded to Rosario Strait to resume the triangulation and topography of that strait and vicinity.

On August 25, 1886, he was ready for field-work. Beginning with the triangulation, he continued that till points enough had been obtained for one topographical sheet. On September 10, the topography was commenced, and thenceforward till the close of the season the work was arranged so that most of the triangulation was done on days that were too wet or stormy for using the plane table. Three topographical sheets were executed, each on a scale of 1-10000. Field operations were closed November 20.

For the Rosario Strait work the statistics are:

Number of signals erected	36
Number of stations occupied	28
Number of geographical positions determined	47
Number of miles of shore-line surveyed	109
Number of miles of roads surveyed	35
Area surveyed, in square miles	25

During the winter Mr. Gilbert was occupied in office work. On March 26, having received instructions to resume field-work, he made immediate preparations for proceeding in the steam-launch to Bellingham Bay. The repairs and refitting of the *Fuca*, including new smoke-stack and grate-bars, occupied the time till April 14. On the following evening Mr. Gilbert established his camp on Chuckanut Bay, on the eastern side of Bellingham Bay, and on the 21st began field-work.

During April, May, and much of June the weather was stormy and very strong gales were prevalent, compelling the removal of the camp to a more sheltered locality. The topography was taken up May 12, two sheets having been projected, each on a scale of 1-10000.

At the close of the fiscal year both triangulation and topography were in active progress. Further reference to Mr. Gilbert's work in this locality will be made in the next annual report.

SECTION XII.

ALASKA, INCLUDING THE COAST, AND THE ALEUTIAN ISLANDS. (SKETCH No. 12.)

Continuation of the survey of the coast, bays, straits, and harbors of southeastern Alaska.—At the beginning of the fiscal year the hydrographic parties under charge of Lieut. Commander A. S. Snow, U. S. N., Assistant Coast Survey, commanding the steamer *Patterson*, had been at work since early in May, 1886, in the vicinity of Fort Wrangell, Wrangell Island, and in Sumner Strait, southeastern Alaska. Lieutenant-Commander Snow had taken the immediate direction of the work at Fort Wrangell and in the vicinity, and had assigned the work in Sumner Strait to the charge of Lieut. James M. Helm, U. S. N., Assistant Coast Survey, commanding the steamer *McArthur*, Lieutenant Helm reporting progress to Lieutenant-Commander Snow every week or ten days. The steam-launch *Lively* was attached to Lieutenant Helm's command.

Until June 21 the *Patterson* remained at Fort Wrangell, where tides were observed day and night through one lunation. The work of triangulation and topography, sounding, etc., was carried to a distance of about twenty-five miles from this point. On June 21, Lieutenant-Commander Snow moved the *Patterson* to Steamer Bay, on the west side of Etolin Island, where a tide-gauge was established which was connected with that at Fort Wrangell by simultaneous observations, and the work was now carried on from this point until data had been obtained for completing a harbor chart of Steamer Bay. The *Patterson* was then moved to Dewey Anchorage, a few miles above Port Onslow, Etolin Island. Tidal observations were taken and a special chart of this anchorage was completed. This work was all that remained to finish the hydrographic sheet, scale 1-80000, of Clarence Strait and vicinity, which was accomplished August 14.

By this time the party on board the *McArthur* had completed the survey of Sumner Strait. This work was begun by the measurement of a base at Red Bay. From this base were carried the triangulation and topography of the harbors of Red Bay, Chican, Port McArthur, and Port Protection. Four astronomical stations were established—Red Bay, Inner and Outer Chican, and Port McArthur.

In the hydrographic work was included the survey of Sumner Strait and the adjacent bays and harbors from Level Island and Point Colpoys on the northward and eastward to Cape Decision and Cape Pole on the southward and westward. Tide-gauges were established at Red Bay and Chican. The hydrographic sheet, scale 1-80000, was completed by August 15, at which date Lieutenant Helm proceeded in the *McArthur* to Fort Wrangell, where he met the party on board the *Patterson*.

The combined parties, under the direction of Lieutenant-Commander Snow, then took up the survey of Wrangell Straits, which connect Sumner Strait with Frederick Sound. After the measurement of a base, the establishment of an astronomical station, and the location of a tide-gauge at a suitable locality, the *McArthur* was dispatched to the westward to obtain farther astronomical observations at Shakan (or Chican), and subsequently Lieutenant Helm was directed to proceed to Fort Wrangell, obtain final observations for chronometer rates, and while there to send Ensign Purcell in the *Lively* to get soundings in the Eastern Passage, Blake Channel, and Bradfield Canal. This accomplished, he was to proceed with the *McArthur* to Dewey Anchorage, obtain astronomical observations there, and thence go to Fort Simpson, British Columbia, for final observations at that station, and while waiting the arrival of the *Patterson*, to carry out, if possible, the instructions of the Hydrographic Inspector in relation to Cordova Bay, and to a reported rock at Fort Tongass. Bad weather made it impracticable to get the observations desired at Chican, or to do the work last referred to at Cordova Bay and Fort Tongass, but the other work was satisfactorily executed.

On September 12, having completed the survey of Wrangell Straits, Lieutenant-Commander Snow got under way and steamed to Fort Wrangell, where he made search, but without success, for Saranac Rock, which had been very indefinitely located by old charts off the north end of Woronoffski Island. Nothing could be learned regarding this rock from the natives or from the residents of Fort Wrangell.

On September 15, the *Patterson* having joined the *McArthur* at Fort Simpson, both vessels sailed for Port Townsend, and on the 22d for San Francisco, arriving September 28. Comparisons of chronometers were obtained the same day at the Mare Island Observatory.

The results of the season's work by the two parties under Lieutenant-Commander Snow's direction are shown upon the following-named hydrographic sheets, all of which have been received at the Office: Clarence Strait (1-80000) and adjoining channels from Point Lemesurier to the mouth of Stikine River; Sumner Strait (1-80000); Wrangell Strait, connecting Frederick Sound with Sumner Strait (1-30000); St. John's Harbor, Zarembo Island (1-20000); Dewey Anchorage, Clarence Strait (1-20000); Ratz Harbor, Prince of Wales Island (1-10000); Coffman's Cove, Prince of Wales Island (1-10000); Etolin Harbor, Wrangell Island (1-10000); Steamer Bay, Etolin Island (1-20000); Red Bay (1-10000); Shakan Straits (1-20000); Port Protection (1-10000); and Port McArthur (1-10000).

Tidal stations were established, as the work progressed, in localities most suitable for obtaining planes of reference for the soundings, the principal stations being at Fort Wrangell, St. John's Harbor, Steamer Bay, Dewey Anchorage, Red Bay, and Chican. Lieutenant-Commander Snow observes that the tides follow the general law of the Pacific coast, and the mean of the lower low waters was taken as a plane of reference. Observations for strength of current were made frequently during the season. Much space is devoted in his report to statements in detail of tidal action in the straits and harbors surveyed, these being prefaced by the remark that the flood tide, as a rule, makes in from the large bodies of water, Sumner and Clarence Straits, and sets into the smaller bays, inlets, and channels.

All of the operations incidental to a trigonometrical survey were executed by officers from the *Patterson* and *McArthur*, to whom special branches of the work had been assigned. Two base-lines were measured by means of sounding wire led over tripods, stretched taut with large reels, and leveled with theodolites. Eight stations were occupied during the season for the determination of time, latitude, and longitude. Every effort was made to keep the triangulation and topography in advance of the hydrography. Angles of elevation were taken to all prominent peaks. The shores in the vicinity of Fort Wrangell, Steamer Bay, Dewey Anchorage, St. John's Harbor, and all of Wrangell Straits were put in with the plane table; the remainder of the coast-line was run in by a modification of Fillmore's method (see pp. 133, 134, Coast and Geodetic Survey Report for 1884), the sheet being mounted on a plane table in the launch, and the patent log and sextants used.

The astronomical observations were made by Ensign C. C. Marsh, U. S. N., who took also a leading part in the measurement of the base-lines. In the party on board the *Patterson*, Ensign A. P. Niblack, U. S. N., was assigned to the charge of the triangulation. A large number of stations were rendered necessary in this work by the character of the country, the coasts being all thickly wooded to the water's edge and indented by numerous narrow channels. Ensign D. P. Menefee, U. S. N., had charge of the topographical work, assisted by Mr. John McHenry, one of the draughtsmen of the *Patterson;* Mr. J. C. Stone, draughtsman, also occupied with the plane table a sufficient number of stations to determine contours.

For the hydrographic work, Lieut. D. Coffman, U. S. N., and Ensign T. G. Dewey, U. S. N., were specially detailed, with the aid of such other members of the party as could from time to time be spared. With the exception of Clarence Straits and Stikine Straits (in part), sounded by the *Patterson*, all the hydrographic work was done in steam-launches, the boats being fitted with a small reel and register, so that wire could be used in sounding in deep water.

To Ensign S. Cook, U. S. N., was assigned the charge of all work done by the *McArthur;* Ensign J. H. Shipley, U. S. N., was detailed for the main triangulation; Ensign J. A. Bell, U. S. N., was given charge of the harbor work; Ensign J. L. Purcell, U. S. N., was ordered to command the steam-launch *Lively*, and did all the sounding not done by the ship for the hydrography of Sumner Strait. The triangulation and topographical work was divided between Ensigns Shipley, Bell, and Purcell. Soon after the *McArthur* joined the *Patterson* in Wrangell Straits, as already referred to, Ensigns Shipley and Bell were transferred from the *McArthur* to the *Patterson*, the former carrying on the triangulation of the straits, with Ensign Niblack and Ensign Bell putting in that portion of the shores above the mud flat, the southern half being put in by Mr. Stone.

To Lieutenant Helm, who was detached from the Survey soon after the close of the season, Lieutenant-Commander Snow expresses his indebtedness for most efficient co-operation, and for many valuable suggestions in connection with the work.

An interesting and valuable report on the characteristic fauna and flora of the region surveyed by the *Patterson* has been submitted to Lieutenant-Commander Snow by Passed Assistant Surgeon T. H. Streets, U. S. N., attached to that vessel.

Statistics of the work of the combined parties, as reported by Lieutenant-Commander Snow, and by Ensign Cook for Lieutenant Helm, are as follows:

Number of stars observed for longitude	595
Number of pairs of stars observed for latitude	165
Number of signals built	257
Number of measurements in triangulation	10,985
Number of miles of shore-line surveyed	964
Number of miles run in sounding	2,638
Number of angles measured	11,591
Number of soundings	16,282

The descriptions of ports and anchorages, with sailing directions, etc., which accompany the reports of the work, have been made available for the purposes of the Pacific Coast Pilot.

Lieutenant-Commander Snow, having been detached from the Survey April 30, 1887, was relieved in the command of the *Patterson* by Lieut. Commander Charles M. Thomas, U. S. N., Assistant Coast and Geodetic Survey.

Under the direction of this officer the *Patterson*, having been prepared for the season's work, left San Francisco May 3, and resumed hydrographic work in Frederick Sound, southeastern Alaska, May 21.

At the date at which this report closes the survey was in active progress in that sound and its vicinity, but further notice of the work of the party is necessarily deferred till the next annual report.

The officers attached to the party were: Lieut. De Witt Coffman, U. S. N.; Ensigns A. N. Wood, J. H. Shipley, C. C. Marsh, M. L. Read, A. P. Niblack, A. M. Beecher, and J. D. McDonald, U. S. N.; Surgeon T. H. Streets, U. S. N., and Passed Assistant Engineer H. N. Stevenson, U. S. N.

Ensign Shipley having had the misfortune to break his leg, was detached from the party June 18.

Continuation of the series of tidal records obtained from the automatic tide-gauge at Saint Paul, Kadiak Island, Alaska.—The series of tidal observations in the town of Saint Paul, Kadiak Island, Alaska, was continued by Fred. Sargent, observer, under the general supervision of Assistant Davidson. Mr. Sargent determines his own time.

During the winter a short break in the series occurred, owing to the necessity of removing the pier to a new and safer location. Unusually violent storms prevailed, in one of which the crib-work sustaining the gauge-house was wrecked and the clock injured. Assistant Davidson acknowledges valuable assistance rendered by the Alaska Commercial Company in the removal and re-establishment of the tidal pier and house. He expresses his obligations also to Mr. Ivan Petroff, Deputy Collector of customs at Saint Paul, for very acceptable aid rendered to the observer.

The usual meteorological record was forwarded by Mr. Sargent.

SECTION XIII.

KENTUCKY AND TENNESSEE. (SKETCHES NOS. 1, 5, 14, 16, and 17.)

Transcontinental triangulation near the thirty-ninth parallel, extended to the westward in Kentucky and Ohio.—For the continuation of the transcontinental triangulation near the thirty-ninth parallel in Kentucky and Ohio, Assistant A. T. Mosman took the field under instructions early in August, 1886.

The progress of this work in 1886 till the close of field operations November 21, and the advance made in it in 1887 from its resumption in May till the end of the fiscal year, are fully reported under the heading of Section XIV.

Reconnaissance for the extension westward of the transcontinental triangulation near the thirty-ninth parallel in Kentucky and Ohio, and for its connection with the triangulation advancing to the eastward in Indiana.—In 1881 a reconnaissance for the extension to the eastward of the transcontinental triangulation near the thirty-ninth parallel had been closed in the vicinity of Bloomington, Ind., by Assistant F. W. Perkins. The advance to the westward of the transcontinental triangulation in Kentucky and Ohio, and to the eastward of that in Indiana, made it desirable in 1886 to push a reconnaissance in the three States just named, and Assistant Perkins was detailed for this duty in August of that year.

A report of his operations will be found under the heading of Section XIV.

Geodetic operations.—Reconnaissance for the connection of the triangulation of the State of Tennessee with the primary triangulation of the Coast and Geodetic Survey in northern Georgia.—Instructions issued in May, 1886, to Prof. A. H. Buchanan, Acting Assistant, to resume geodetic operations in the State of Tennessee by beginning a reconnaissance for the extension of the triangulation westward from Nashville, were modified when additional funds became available for the work upon the passage of the Sundry Civil Expenses Act early in August, 1886. Upon the suggestion of Assistant C. O. Boutelle, to whom had been assigned the special charge of State surveys, Professor Buchanan was directed to transfer his party to the southeastern part of the State and take up a reconnaissance for obtaining a connection of his triangulation with the primary triangulation in Georgia which extends westward and northward from the Atlanta base-line.

Beginning his examinations in the mountain region of Tennessee from the base-lines Deadening–Roy and Deadening–Owen, about the middle of August, Professor Buchanan succeeded eventually in overcoming the many difficulties incident to reconnaissance where the observer has to depend upon temporary means of transportation over poor roads and in a sparsely settled country, and by October 23, when field operations closed, had submitted a scheme for the connection of the triangulation in Tennessee with that in northern Georgia upon the lines Grassy–John's Mount and John's Mount–Gulf of the primary triangulation in the latter State.

In May, 1887, he took the field under instructions to occupy stations selected during the season preceding. Commendable progress had been made at the close of the fiscal year, two stations, Deadening and Owen, having been occupied. With a continuation of favorable weather Professor Buchanan hopes to complete the desired connection during the present surveying season.

SECTION XIV.

OHIO, INDIANA, ILLINOIS, MICHIGAN, AND WISCONSIN. (SKETCHES Nos. 1, 14, 16, and 17.)

Transcontinental triangulation near the thirty-ninth parallel extended to the westward in Ohio and Kentucky.—Reconnaissance for site of a base-line in Ohio.—Instructions to take the field for the extension westward of the transcontinental triangulation near the thirty-ninth parallel in Ohio and Kentucky, were sent to Assistant A. T. Mosman immediately after the passage of the appropriation act in August, 1886.

Arriving at Cincinnati August 9, Mr. Mosman visited the Observatory to take a view of the country, and to get measurements on prominent points for use in making a connection between his triangulation and the Coast and Geodetic Survey longitude station in the Observatory grounds.

At the close of the previous season the reconnaissance had been extended to the line Ash Ridge–Minerva; the first-named point about nine miles northeast of Georgetown, Brown County, Ohio; the second about two miles in a southwesterly direction from Dover, Mason County, Ky. Proceeding from Cincinnati to Georgetown, and making on the way a general examination of the country along the Georgetown and Portsmouth Railroad, Mr. Mosman, on reaching Ash Ridge, reconnoitered the country from that station, and having directed his foreman in regard to the details of construction at Ash Ridge and Minerva of the signals required there, he went to Cave Hill to establish a station at that point, which is about five miles northwest of West Union, Adams County, and then proceeded to Portsmouth, Ohio, where he organized his party for the occupation of the first station, Twin Creek, about fifteen miles to the west of Portsmouth.

Lines having been opened and heliotropers posted, observations were begun at Twin Creek August 27 and finished September 1. The following-named stations were then occupied in succession: Peach Mount, two miles from Mineral Springs, Adams County, Ohio; Cave Hill (the locality of which has been stated), and Cherry Ridge, about two and a half miles from Concord, Lewis County, Ky.

Cherry Ridge is a sharp hill, over seven hundred feet above the Ohio River, and required for its occupation much difficult preliminary work, the observing tent, instruments, etc., having to be carried by hand from Concord. Observations at this station were completed October 20, the unusually short period of fifty-five days having sufficed for the occupation of four stations, owing to the generally favorable weather which prevailed during the season.

In pursuance of instructions dated October 9, directing a reconnaissance to be made near station Gould in the Scioto Valley for a site for a base-line, the party was transferred to Franklin Furnace, Scioto County, Ohio, towards the end of October, and Mr. Mosman took up an examination of the river-bottom land between Haverhill and Wheelersburgh in that county. Between these two places the Ohio River runs nearly north and is tolerably straight, the width of the bottom-land comprised between the foot-hills and the river bank varying from over a mile at Haverhill and Wheelersburgh to about one quarter of a mile at Franklin Furnace.

The conditions sought to be fulfilled by the site to be selected were, first, hard, firm ground, admitting of the placing of suitable monuments both under and above the surface, and a locality not liable to disturbance from ordinary causes; second, a sufficient elevation of the ends above the flood-line of the Ohio River; third, that the ends should be so located as to give the best possible connection with the triangulation; and fourth, that the length of the line should be about four miles.

These conditions were met as nearly as practicable by the selection of a site south of Chandler's Run, a creek which enters the river at the narrow part of the bottom-land. This line would have a length of five thousand nine hundred and twenty-three meters or three and sixty-seven one-hundredths miles; both ends occupy positions above the highest point ever reached by floods in the Ohio River and upon sites which can be secured from disturbance. The line was chained and stakes driven every twenty meters, and levels were taken on every stake, these levels being referred both to the level of the river at the time, and to its highest known level—the flood-line of 1884. Mr. Mosman has submitted with his report a sketch showing the location of this line, which he has named the Haverhill Base, and showing also its proposed connection with the triangulation, its topography and its profile. He gives also the location of an alternate line alongside the Scioto Valley Railroad north of Chandler's Run, and having a length of six thousand two hundred and eighty-one meters or three miles and nine-tenths, but less favorably located than the Haverhill Base to obtain a connection with the triangulation.

Field operations were closed and the party disbanded on the 21st of November. Mr. W. B. Fairfield, extra observer, served with great acceptance throughout the season. Mr. Mosman had as foreman in his party Mr. E. E. Torrey, who has acted for a number of years in that capacity. The observing tripods and signals built by him are models of strength, durability, and economical construction. Early in September Mr. Torrey was detailed as foreman in the party of Assistant G. A. Fairfield in Indiana.

The following statistics of the season's work are reported:

Number of stations occupied	4
Number of tripod and scaffold signals erected	2
Number of measurements of horizontal directions	1,635

During part of the winter, Mr. Mosman was engaged in completing for the Office the records and computations of his work, and in February, 1887, received instructions to make an examination of a portion of the triangulation in the vicinity of New York Harbor, with a view to its adjustment and rectification. Reference to this duty has been further made under the heading of Section II.

In May, 1887, having received instructions to resume field-work for the extension westward of the transcontinental triangulation in Ohio and Kentucky, he proceeded to Cincinnati, and having selected a site for a signal one hundred and twenty-nine feet in height at station Tate, and also a site for a signal ninety feet in height at station Flaugher, Ky., he made preparations for the occupation of station Ash Ridge, Ohio. Sites for signals were also selected at Dry Ridge, Ky. (ninety feet); one at Tanner, Ky. (one hundred and thirty-two feet), and one of fifty-two feet in height at station Stevens, Ky.

The building of these signals and posting the heliotropers at three stations occupied the time till June 21, at which date the party was ready to observe at Ash Ridge.

By the close of the fiscal year observations at this station had been nearly finished.

Reconnaissance near the thirty-ninth parallel for connecting the transcontinental triangulation in Ohio and Kentucky with that in Indiana.—Instructions having been issued to Assistant F. W. Perkins, towards the close of August, 1886, to resume the reconnaissance for the connection of the transcontinental triangulations near the thirty-ninth parallel, the one advancing westward from stations in Ohio and Kentucky, the other eastward from stations in Indiana, Mr. Perkins first determined a point in the vicinity of Bloomington, Ind., where he had closed his reconnaissance in 1881, and then took up work in Ohio and Kentucky.

Having conferred by letter with Assistants Fairfield and Mosman in regard to the requirements of the work in their respective sections, Mr. Perkins deemed it advisable to have a personal conference with Mr. Mosman before beginning the eastern portion of the work, which was entirely new to him, and for that purpose visited him at his station, Peach Mountain, near Mineral Springs, Ohio. Mr. Mosman's reconnaissance had been advanced to the line Ash Ridge–Minerva, two points about 17 miles apart, and lying from thirty to forty miles east of the city of Cincinnati, the first-named point in Ohio and the last in Kentucky.

Owing to unfavorable conditions of atmosphere in the vicinity of Cincinnati it was deemed advisable to carry the reconnaissance well to the southward of that city. On the Ohio side of the river there rise abrupt hills, back of which is an extensive slightly-rolling table land, about nine hundred feet above the sea-level, or about five hundred feet above the river. On the Kentucky side the same formation is diversified by deep creek valleys, which scar the surface in all directions, and which, when seen only in detail, give to the casual observer the impression of a hill country, but upon closer inspection the hills prove to be only partially-detached portions of a great level plain. The land is generally under a high state of cultivation, and the fertility of the soil is attested by the great height of many of the remaining forest trees, which not unfrequently measure from one hundred and twenty to one hundred and thirty feet.

Mr. Perkins strongly recommends the use of large revolving heliotropes in further reconnaissance in this or similar sections.

Points for two figures were selected, carrying the work to stations about thirteen miles west of Cincinnati, Tanner and Hogan, both in Kentucky, and favorably located for the western extension of the scheme. The astronomical station at Falmouth, Pendleton County, Ky., can be connected with the work by means of points determined from the line Hogan–Flaugher, and with a little cutting it is believed that the Cincinnati Observatory can be seen from station Alexandria, and the line Alexandria–Tanner gives a good base for the determination of any second point that may be selected for this connection, and for the determination of public buildings in the city.

Field-work was closed December 21, and a month later Mr. Perkins was instructed to organize a party for service on the Gulf coast. This work is referred to under the heading of Section VIII in this report.

Occupation of stations in Indiana for extending to the eastward the transcontinental triangulation near the thirty-ninth parallel.—In pursuance of instructions issued at an early date after funds for the work became available, Assistant George A. Fairfield was directed in August, 1886, to organize his party and proceed to the field in order to carry eastward in the State of Indiana the transcontinental triangulation near the thirty-ninth parallel from the limits of his work of the previous season.

Upon his arrival at Vincennes September 2, Mr. Fairfield made arrangements for the immediate occupation of station Wright, situated in the township of that name in Greene County, about half way between the towns of Sullivan and Worthington, and about twelve miles from each. Linton, a small town on the narrow-gauge railroad from Sullivan to Bedford, is about nine miles south of the station.

Night signal lights having been placed in position at the stations to be observed upon, observations were begun September 14 and finished on the 22d. Tents were then struck and camp moved, though not without delays from heavy rain-storms, to Calvary station, which is about twelve miles a little south of east of Worthington. Camp was pitched October 2. The signal at this station, ten feet and five tenths in height, had been struck by lightning during the preceding summer and one of the corner-posts of the scaffold considerably shattered. Necessary repairs having been made, signal-lights posted, and lines opened to stations Sisson and Osborn, observations were begun, and continued whenever the weather would permit until October 30. The first snow of the season occurred on the 26th.

By November 3 camp was moved to the last station occupied, Osborn, in McCameron township, in the northwestern part of Martin County, and about fourteen miles north of Loogootee, a small town on the Ohio and Mississippi Railroad. Snow fell on the night of November 5 to a depth of four inches, and from that date till the end of the season the ground was covered with snow varying in depth from one to fourteen inches.

All preparations for observing had been completed by the 8th instant, but owing to bad weather no observations could be made until the 14th. By the 24th all of the observations that it was practicable to make at the station had been completed except about three hours' work on one signal-light. It was not till the night of December 2 that this signal-light could be seen. The atmosphere had then become clear, with a temperature of four degrees above zero.

One direction at Osborn, that to Rariden station, near Mitchell, Lawrence County, was left to be determined the next season, it having been found that the two stations were not intervisible by reason of some obstruction, the nature of which would have involved too great a prolongation of the season to ascertain in the then condition of the weather and the roads.

A few miles east of Rariden station is the second principal meridian of the system of surveys of the General Land Office. This meridian, Mr. Fairfield observes, it is important to connect with the triangulation, as was done with the third principal meridian, which was connected with the work at Sturgess station, near Vandalia, Ill.

Subassistant F. H. Parsons was attached to the party during the season, and did his utmost to advance the work. He had special charge of placing in position the signal-lamps and of instructing the light-keepers. Mr. F. P. Bacon served as recorder. Mr. E. E. Torrey, foreman, reported for service from Assistant Mosman's party September 16, and began at once the erection of a tripod and scaffold signal seventy-five feet in height at Rariden station. This signal was finished on the 28th, and the next day Mr. Torrey went with his men to Beard station, near Springville, Lawrence County, where he put up a similar signal eighty-eight feet in height. With the erection of another signal seventy-five feet high at Leonard station, seven miles west of Bloomington, Monroe County, Mr. Torrey finished this class of work, discharged his hands, and joined Mr. Fairfield in camp at Calvary station. Mr. Torrey's experience and skill make his services as foreman exceedingly valuable.

The statistics of the season are as follows:

Number of tripod and scaffold signals erected (2 of 75 feet each, 1 of 88 feet)	3
Primary stations occupied	3
Number of observations	985
Number of micrometer readings	3,940

Assistant Fairfield reported in person at the Office in accordance with instructions December 11, and was engaged during the winter on office duty.

In April, 1887, having received instructions to take the field and resume work as early in May as he deemed practicable, Mr. Fairfield left Washington May 12 for Mitchell, Ind., accompanied by Mr. Parsons. Mr. W. B. Fairfield, extra observer, reported at Mitchell a few days later.

The first work to be done was to establish the direction of the line from Osborn to Rariden, to determine the nature and position of the obstructions on the line, and then to remove them. To do this properly it was necessary to measure a few angles with the small theodolite at Rariden, Beard, and Leonard stations. Owing to a dense smoky atmosphere, these measurements were not finished till the 28th, when the direction having been computed was laid off from Osborn to Rariden. The party was then moved to Osborn station, and Mr. W. B. Fairfield was directed to clear the line. The trees in the way, some twenty or thirty in number, were readily disposed of, but it was then found that a large barn forty by seventy feet right on the crest of a hill still obstructed the view.

After much negotiation with the owner, he agreed for a comparatively moderate sum to cut a gap in the roof wide and deep enough to allow the signal light at Rariden to be seen, and to keep it open till the observations at each end of the line were finished.

At Osborn station observations of horizontal directions, time, and azimuth were made, and were in progress, with but two nights' work needed to complete them, at the close of the fiscal year.

The observations for horizontal direction and for azimuth were made by Mr. Fairfield, Mr. Parsons reading one micrometer, and in the azimuth observations marking time, while the records were kept by Mr. F. P. Bacon. For time Mr. Parsons observed, Mr. Bacon recording.

On June 13 Mr. W. B. Fairfield was detached to extend the reconnaissance to the eastward, and was still engaged on that work at the close of the fiscal year.

The statistics of the season of 1887, to June 30, are:

Number of stations occupied for time, azimuth, and horizontal directions	1
Number of stations occupied in reconnaissance	3
Number of observations for time	214
Number of observations for azimuth	165
Number of observations for horizontal directions	789

Geodetic operations.—Extension of reconnaissance for additional stations of the triangulation of the State of Indiana.—The continuation of the reconnaissance for the extension of the triangulation of the State of Indiana having been authorized by instructions issued in May, 1886, to Prof. J. L. Campbell, Acting Assistant, he took up that work in the following month from the line O and M–Haystack.

While prosecuting the reconnaissance, he received on June 19 instructions to close operations and disband his party by the end of the fiscal year, owing to the refusal of the House of Representatives to insert any appropriation for State surveys in the Sundry Civil Expenses Bill. After this action had been reconsidered and a small appropriation made in August, Professor Campbell was directed to resume operations, but on account of the lateness of the season and the pressure of other duties he felt impelled to ask for the detail of an officer of the Survey who would relieve him of the charge of the party and continue the work. Assistant James B. Baylor was accordingly instructed towards the end of August to report to Professor Campbell for duty, and upon his leaving the field to prosecute the reconnaissance.

After visiting the several stations with Professor Campbell, Mr. Baylor was left in charge of the work early in September. It had reached that stage at which it was necessary to erect tripod and scaffold signals and open lines in order to carry the scheme forward. After suitable observing tripods had been put up at stations Haystack, Summit, and Bartle, and the pole replaced at O and M station, observations were begun by the occupation of Summit station in southern Indiana, near Henryville, Clark County. The quadrilateral figure, Haystack, Bartle, Summit, O and M was closed; the line Bartle–Finley was opened, and a reconnaissance was made for the location of a station Fairview, which, when definitely located, will give with Finley a base from which a connection can be had with the line Adams–Baughman of the transcontinental triangulation.

In January, 1887, Assistant Baylor was directed to take up a series of magnetic observations at southern stations. Reference to this duty has been made under the headings of Sections III, IV, V, VI, and VII.

Continuation of geodetic operations in the State of Wisconsin.—A small balance of allotment having been found available for work in Wisconsin during the month of June, 1886, Prof. J. E. Davies, Acting Assistant, was instructed early in that month to resume the triangulation in the State from the limits of his work of the previous season. He had barely had time to begin operations, however, when it became necessary to direct him to close all work by June 30, no appropriation having been recommended for State surveys in the bill as reported to Congress. Upon the final passage of the appropriation act, August 4, the action at first taken having been reconsidered, funds became available, but so late in the season that comparatively little progress could be made by Professor Davies in carrying out the instructions to arrange his work so as to provide a further connection with the triangulation of the Lake Survey at Minnesota Junction and to the north of it.

Having taken up a reconnaissance eastward from Cambria, Columbia County, in order to get stations which should be seen from Reeseville, he found a high prairie plateau, along which the selection of such stations did not seem difficult. Fixing upon a point near Randolph, Dodge County, he had about determined upon a scheme which could secure a connection with a station near Fox Lake and thence to Minnesota Junction, in one direction, and with the stations Arlington, Observatory Hill, and Fitzsimmons in the other. But just at the time this seemed feasible, instructions were received, as before stated, to close work, and upon its resumption in August, the atmosphere being then full of dense smoke from frequent forest fires, Professor Davies decided to occupy the high tripod built the preceding season at Lowell, near Reeseville, and make from there a reconnaissance which should give him the data for connecting in one figure Reeseville, Medina, Lebanon, and Delafield, these two last-named points being also stations of the Lake Survey. His examinations satisfied him ultimately that for this figure he would be obliged to substitute the quadrilateral Reeseville (or Lowell), Lebanon, Oakland, and Delafield, so as to complete that, continuing, therefore, the occupation of Lowell, and then occupying Lebanon.

At Reeseville a local triangulation was made to connect the triangulation point with the two church spires which had been observed upon in 1884 from Oakland and Delafield. This was rendered necessary by an obstruction preventing direct vision between Lowell and Delafield. Observations were kept up until September 8, though with great difficulty, owing to the faintness of the heliotropes as seen through the thick smoke. Night signal-lamps had been sent for, but arrived too late to be of service in contributing to the advance of the work.

Professor Davies hopes that in the immediate future the work begun at a favorable period of the year, and carried forward without interruption throughout an entire season, will be brought to a satisfactory close.

Under instructions received in May, 1887, he placed his party in the field on the 17th of that month, and was engaged in rebuilding signals and in the occupation of Reeseville up to the close of the fiscal year.

He will extend his observations northerly to a further connection with the Lake Survey, and also toward a connection with the new triangulation about to be begun in the adjoining State of Minnesota.

SECTION XV.

MISSOURI, KANSAS, IOWA, NEBRASKA, MINNESOTA, AND DAKOTA. (SKETCHES Nos. 1, 2, 14, 16, and 17.)

Reconnaissance for the extension to the westward of the primary triangulation near the thirty-ninth parallel in Kansas.—The occupation of the stations Bebé Mound in Johnson County, and Eckman in Leavenworth County, Kans., by Assistant F. D. Granger in 1885, had brought the triangulation up to the limits of the reconnaissance of 1881, and had furnished a base for the extension of the work to the westward.

In August, 1886, Mr. Granger was instructed to organize his party for carrying the reconnaissance westward from this base. Before the reconnaissance could be begun, it was found necessary to rebuild the fifty-feet observing tripod and scaffold at Bebé Mound, which had been destroyed by a storm.

The reconnaissance was then taken up, the outfit of the party consisting of a driver, one hand, and a covered wagon drawn by four horses. At the close of the field operations in December, the results obtained were very gratifying, nineteen new stations having been selected, and a practicable scheme of triangulation laid out, included in seven quadrilaterals, extending from stations near the ninety-fifth meridian to stations near the meridian of 97° 30′. The heights of signals required at the stations selected will range from fifteen to fifty feet.

During the winter Mr. Granger was employed on duty at the Office, and in April, 1887, he re-organized his party, and began the work of signal building April 22. By June 22 eight tripod and scaffold signals had been erected. Station Bebé Mound was then re-occupied for observations upon the new stations to the westward, and at the close of the fiscal year but a few days' observations were needed to complete the station.

Mr. Granger was ably assisted during the season beginning in April by Mr. A. P. Barnard, of New York.

For the fiscal year the statistics are:

Reconnaissance:	
Number of stations selected	19
Length of scheme, in miles, from its eastern to its western limits	140
Area, in square miles, covered by the scheme	2,215
Triangulation:	
Number of observing tripods and scaffolds erected	8
Number of observations for horizontal directions	317
Number of micrometer measures	214
Number of double-zenith distances	50

Magnetic observations at Saint Louis, Mo.—On returning to Washington in October, 1886, from duty in charge of a longitude party in Colorado and in Utah, Assistant C. H. Sinclair stopped at Saint Louis, Mo., and occupied a station near Shaw's Garden in that city for the determination of the magnetic declination, dip, and intensity.

This work was completed October 7.

Other duty assigned to Mr. Sinclair is referred to under the headings of Sections III, X, and XVI.

Geodetic operations preliminary to a triangulation of the State of Minnesota.—Under the general authority given in the Sundry Civil Expenses Act, and in response to requests received in the spring of 1887 from the Governor of Minnesota and from the State Geologist, asking that geographical positions might be determined trigonometrically in the State, Prof. W. R. Hoag, of the State University, on the nomination of the Governor, was appointed Acting Assistant, and early in June Assistant C. O. Boutelle, in general charge of all the State surveys, was assigned to the duty of beginning operations in Minnesota, Professor Hoag being associated with him.

These operations look first to a secondary triangulation of the Mississippi, at and near Saint Anthony's Falls, and also to the search for and selection of a site suitable for a base-line for the triangulation of the State. At the close of the fiscal year they were in active progress.

SECTION XVI.

NEVADA, UTAH, COLORADO, ARIZONA, AND NEW MEXICO. (SKETCHES Nos. 2, 14, 15, 16, and 17.)

Determination of the longitudes of stations in Colorado and Utah.—Observations for latitude and the magnetic elements.—The 1st of July, 1886, found the longitude parties in the field engaged in the determination of the difference of longitude between Colorado Springs and Gunnison, Colo., Assistant Edwin Smith being at Colorado Springs and Assistant C. H. Sinclair at Gunnison. Four nights' exchanges had been obtained in June; the observers had then changed places, and in their new positions an exchange of signals for longitude had been had June 30. Hence but three more nights were required to complete the work between these points. These were obtained on July 2, 3, and 8. Mr. Sinclair then moved from Gunnison to Grand Junction, Colo.

At Gunnison Mr. Smith determined the magnetic declination, dip, and horizontal and total intensity by observations on July 7, 8, and 9.

The station at Grand Junction was established by Mr. Sinclair in the public park. Observations for time were made and signals exchanged for longitude between Colorado Springs and Grand Junction on the nights of July 15, 24, 26, and 27, after which the observers changed places, and similar observations were made on the nights of July 30, 31, and August 4 and 5.

At Grand Junction the latitude of the station was determined by Mr. Sinclair and the magnetic elements by Mr. Smith, by observations made July 31, August 2 and 3.

Mr. Smith then moved to Salt Lake City, Utah, where he arrived August 7. The station established here in the Temple Block by Assistant Dean in 1869 was found to be in excellent condition, the observatory and piers still standing. Unfavorable weather prevented exchanges of signals between Salt Lake City and Colorado Springs for ten days after the parties were ready. Five nights were obtained between August 19 and 28, and after a change of stations by the observers, five more between September 2 and 6.

While at Salt Lake City Mr. Smith visited Ogden, Utah, and examined the observatory established there by the United States Engineers. It was in a fair state of preservation, but, in Mr. Smith's opinion, too inconveniently located to be used as a base station. Mr. Sinclair, who occupied the station later, expresses the opinion that as a central point for extending the longitude work in all directions Ogden has advantages over Salt Lake City, as it is the terminus of a telegraphic division, possessing batteries and extra wires, such as can not be had at the latter point.

On the completion of the work between Colorado Springs and Salt Lake City, all of the instruments and outfit were turned over to Mr. Sinclair, in conformity with instructions, and Mr. Smith was relieved by Subassistant R. A. Marr, who took charge of the station at Ogden. Longitude signals were exchanged between Ogden and Salt Lake City on five consecutive nights between September 12 and 16, and as soon as the observers changed stations five more consecutive nights were obtained between September 17 and 21. These exchanges finished the field-work of the longitude parties in 1886.

Duty in other localities assigned to Messrs. Smith, Sinclair, and Marr is referred to under headings in Sections III, X, XI, and XV.

Extension to the eastward of the transcontinental triangulation from stations in central Utah.—In continuation of the transcontinental triangulation in central Utah to the eastward, Assistant William Eimbeck took the field in May, 1887, under instructions issued during the month preceding.

On the 7th of May he visited Nephi and the base of Mount Nebo, two miles up Willow Creek Cañon, where, under the direction of his foreman, the first auxiliary camp was to be established. The plan for the work of the season contemplated the occupation of Mount Nebo as the first station. Mount Nebo has an altitude of twelve thousand feet, and as the equinoctial storms had been unusually violent, the snow in the higher mountains at this time was much deeper than usual; in fact, the slopes of the mountain were solidly snow-capped for about three thousand feet from its summit down. This circumstance, together with the high winds, frosty nights, and occasional storms, during which the snow was driving as in midwinter and the thermometer at several degrees below the freezing point, proved to be a source of much delay and embarrassment.

An obstacle yet more serious to the progress of the work, both at this time and later, resulted from the serious illness of the experienced aid, Mr. George F. Bird, contracted at Kansas City while on his way to report for duty. Mr. Bird had served most acceptably in the party during several seasons preceding, and the loss of his services was greatly felt. Under medical advice he withdrew from all field duty and subsequently resigned his position in the Survey. Mr. J. H. Turner, Aid, who was assigned in Mr. Bird's stead, reported in person at Nephi, June 6.

On the 8th of June Mr. Turner proceeded to Mount Nebo, taking charge of matters there, and supervising and directing the establishment of camp near its summit.

The difference of level between Willow Creek Camp, at the head of transportation by wagon, and the summit, was over five thousand feet, and the pack-trail, located and constructed by the party, was over five miles in length. Much heavy work had to be done by the party in repairing and rendering passable for wagons about a mile and a half of washed-out road, and in opening up the pack-trail, the upper two miles of which lead over naked rock, partly shattered and partly solid. Owing to the gradual thawing away of the snow, which in places was found to be fully fifteen feet deep, as, for example, at the very summit of the mountain, a thing never before experienced, the trail work never really ceased until late in June; hence the observations were delayed, it being the middle of June before they could be taken up. Yet, notwithstanding this, good progress had been made in the horizontal direction observations by the close of the fiscal year, very fine weather prevailing for a time after observing began. Besides the work at Mount Nebo, the field-work included also the extension and perfection of the reconnaissance for the connecting net of the Salt Lake Basin line, especially the examination of the lines which center at the stations Deseret and Onaqui.

Mr. Eimbeck devoted what time could be spared from the pressing demands of field-work to the preparation of a final report upon his Duplex Base Apparatus.

Field service performed by him in the early part of the fiscal year is referred to under a heading in Section II.

SPECIAL OPERATIONS.

Immediate supervision of the State surveys.—The immediate supervision of the State surveys, carried on under authority given in the Sundry Civil Expenses Act, having been placed in the hands of Assistant C. O. Boutelle in August, 1886, that officer immediately applied himself to discover the condition of each work, what had been proposed and what had been accomplished, with special reference to the question of direct connections with the work of the Coast and Geodetic Survey proper.

Finding that these connections had but seldom been kept in view as a definite object by the Acting Assistants, to whom had been entrusted the execution of the field-work, Mr. Boutelle made it his first endeavor to so direct the continuation of the surveys in each State as to bring them with as little delay as possible into connection with the coast or interior triangulation of the Survey. This accomplished, each one of the systems of triangulation in the several States would rest upon known and well-determined bases, and would form part of a general system, capable, even if temporarily suspended, of being taken up and carried forward in future years.

The special report which Mr. Boutelle has made upon this subject submits plans for the continuation of the work in each State, enumerating the difficulties to be encountered and stating the most effective methods of overcoming them.

Verification and adjustment at the United States Mint, Philadelphia, of certain weights intended for use as standards in the San Francisco Mint.—Recomparison of the Star Troy Pound of the Office of Construction of Standards of Weight and Measure with the Standard Troy Pound of the Philadelphia Mint.—A request having been made by the Director of the Mint for the services of the Office of Construction of Standards of Weight and Measure in the verification and adjustment at the United States Mint, Philadelphia, of certain weights intended for use as standards in the Mint at San Francisco, Assistant Andrew Braid was detailed by the Superintendent for this duty with the approval of the Secretary of the Treasury. On August 3 Mr. Braid proceeded to Philadelphia, accompanied by Dr. J. J. Clark, Adjuster of Weights and Measures. Dr. W. P. Lawver, Assayer of the Mint, was in attendance under the instructions of the Director, as the representative of the Mint, to witness the tests and verifications.

Mr. Braid's elaborate report shows that the closest attention was paid to every detail that would insure accuracy. Means were taken to remedy slight defects found to exist in the large Standard Balance of the Mint, and to obtain an additional balance of a greater degree of sensitiveness; the methods of weighing were so arranged as to eliminate any slight inequalities that might exist in the weights of the right and left parts of each balance; to eliminate also any inaccuracy of adjustment of the balances or any progressive change in the beams during weighings, due to expansion or contraction, and also any constant error due to unequal flexure of the two arms of the beam.

The weighings were made in the room known as the Cabinet, and the standard pound of the Mint and the weights to be tested were always left together in the balance case over night so as to insure equality of condition as to temperature, etc.

No comparisons were made between the new weights and the Mint Standards of like denomination, as no record could be found showing the precise value of these standards. The Kater Pound (the Standard Troy Pound of the Mint) was therefore made the sole basis of comparison for the determination of the values of the new weights and their subsequent adjustment and verification.

The weighings were made by Dr. J. J. Clark and the reductions and computations by Mr. Braid. From four to six repetitions of the weighings were made in each instance, and the value of one division of the balance scale was determined for each set.

Upon the completion of the weighings and the computation of their results, the adjustments were then made by Dr. Clark by taking off from the bottom of each weight the amount necessary to bring it within the allowable limit of error. Re-weighings were then made and the results placed on record.

Advantage was taken of the present opportunity to make a re-comparison of the Star Troy Pound of this Office with the Mint Standard, the last comparison having been made in 1876. The result of a large number of weighings of the Star Pound with the Mint Standard indicated a less discrepancy between the two weights than in 1876 by about 0.012 gr.

Determinations of latitude and gravity at stations on the Hawaiian Islands for the Hawaiian Government.—From the results of observations for latitude and gravity made in June, 1883, at Honolulu, Oahu, and at Lahaina, Maui (Freycinet's station of 1819), by Subassistant E. D. Preston, on his detachment from the Eclipse Expedition, and from a comparison of these results with those of Captain Tupman, of the English Transit of Venus party, who had determined latitude in 1874, it appeared very desirable, both from a scientific and practical point of view, to determine a number of astronomical latitudes at different points on these islands, where the great depth of the sea, the volcanic formation of the high mountains, and their distance from continental masses, furnished conditions presented by no other locality on earth for the study of the effects of gravity upon the direction of the vertical.

Subsequent correspondence on the subject between W. D. Alexander, esq., Superintendent of the Hawaiian Government Survey, and Mr. Preston, and a personal conference between Mr. Alexander and the Superintendent of the Survey in October, 1884, led ultimately to a request from the Hawaiian Government, received through its minister, Hon. H. A. P. Carter, to the Superintendent of the Survey, for the detail of Mr. Preston to make the observations for latitude and determinations of gravity required.

Mr. Preston's application for six months' leave of absence without pay having been approved by the Department, he left Washington in December, 1886, and arrived in Honolulu January 12, 1887, having with him the two-yard and meter Peirce pendulums Nos. 3 and 4. Pendulum No. 3 had been swung in 1883 at stations on the Caroline Islands, on the Hawaiian Islands, and at San Francisco, and final computations of results made by Mr. Preston. Before leaving Washington he had prepared and tested this pendulum so that it should be ready for immediate transportation. The plan of his work contemplated a thorough study of the plumb-line deflections in the Hawaiian Islands for the Hawaiian Government, and to this were added later, determinations of gravity at the base and summit of Haleakala, the largest extinct volcano in the world, and also at Honolulu, for the sake of a better determination of the correction for elevation above sea-level, and also to connect the gravity work of the United States Eclipse Expedition of 1883 with that of the present year. For the latitude determinations he had with him meridian telescope No. 1.

Between the 22d of January, when the work was begun, and the end of May, all of the stations occupied were for observations of latitude. The first was Ewa station; Puuloa, near the mouth of Pearl River. The second was at Kahuku, on the windward side of Oahu. Observations here were completed February 13. A preliminary reduction of results at this station showed a difference between the astronomical and geodetic latitudes of nearly a minute of arc, one of the most striking examples in the world of deflection of the plumb-line from mountain attraction.

The time from February 22 to April 2 was devoted to the island of Kauai, situated about eighty miles to the northwest of Oahu. On Kauai three latitude stations were occupied, two on the south and one on the north side. For the safe transportation of the instruments between the two southern stations, Waimea and Koloa, it was necessary to remove the eye-piece micrometer and latitude level from the telescope and carry them separately, the road being exceedingly rough and the cart of the most primitive kind.

Honolulu was occupied for latitude between April 3 and April 12. Three stations on the island of Hawaii occupied the party till May 29. Kohala consumed a week only. But here the wind was the whole time so violent that living in a tent was out of the question, and the party found lodging in an old sugar-shed. The station at Hilo, where the rain-fall is over sixteen feet a year, required nearly a month, and during that time only one good night for observations could be obtained. Observations were obtained on two other nights, partly clear, but it was not deemed advisable to wait for more favorable weather, as Mr. Preston was informed that the weather had been better than might be expected much of the time in Hilo.

At Ka Lae the weather was passably favorable. The difficulties of obtaining water for cooking and drinking were great. It had all to be carried on donkey back a distance of eight miles, part of the road being over the rough lava known as *aa*.

Gravity was determined at Honolulu between June 1 and June 14.

Owing to bad weather and inaccessibility of stations, it was found impossible to finish the work originally contemplated within the time at first assigned; hence an extension of furlough for three months was granted to Mr. Preston, in order that the entire programme might be completed. This extended his leave to September 15, 1887.

From June 14 to 22 Kailua, on Hawaii, was occupied for latitude, and from that date till June 30 the party was occupying station Haiku, on the island of Maui, for determinations of latitude and gravity.

Further account of the progress of this work will be given in the next annual report.

COAST AND GEODETIC SURVEY OFFICE.

The assignment of Assistant B. A. Colonna to duty in charge of the Office and Topography was continued throughout the year. Mr. Colonna's report of the Office operations, accompanied by the detailed reports of the chiefs of the several Office divisions, appears in Appendix No. 4 to this volume.

In his summary of progress made during the year Mr. Colonna refers to important information furnished in response to official requests from the National and State Governments; mentions improvements introduced in various branches of office and field-work; urges the great need of an increase of force in the Computing, Drawing, Engraving, and Tidal Divisions, and the necessity for the appointment of a Disbursing Officer for the Survey, and expresses his high appreciation of the earnest support afforded him by the Assistants and others in charge of divisions in the Office.

A table of statistics of the field and office work of the Survey during the fiscal year, with a summary of statistics to its close, appears in Appendix No. 2, and in Appendix No. 3 is given a tabular statement of information furnished in response to official requests, and to individuals upon application.

The Computing Division remained, as heretofore, under the charge of Assistant Charles A. Schott. Valuable reports submitted by Mr. Schott and published as appendices to this volume are referred to in Part I under the heading "Special Scientific Work." Among the requests referred to this division and promptly responded to was one from the Commissioners on the part of the States of Virginia and North Carolina for data needed in a resurvey of that part of the boundary line between those States which extends westward from the Atlantic coast to Nottaway River. Similar data of value were furnished to the Commissioners for the adjustment of boundary lines or parts of such lines between the States of Massachusetts and New Hampshire, Massachusetts and Rhode Island, and New York and New Jersey.

A special report was made by Mr. Schott on the construction of a new primary base apparatus.

The Drawing Division, under the charge of Assistant E. Hergesheimer, developed increased efficiency during the year. There was prepared in this division, at the request of the Attorney-General (for use in establishing the title of the United States to the Potomac Flats) and by direction of the Secretary of the Treasury, a *fac simile* of Major L'Enfant's original plan of the city of Washington in the condition in which it appeared on the 20th of May, 1887. From that *fac simile* and from all obtainable data, there was reproduced by photolithograph an accurate copy of the original map or plan, as drawn up in the name of Peter Charles L'Enfant, A. D. 1791. One of the copies of this valuable historic relic is now deposited in the archives of the Survey.

Information was supplied by this division in response to requests referred to it from the Engineer Department, U. S. Army; the U. S. Geological Survey; the U. S. Fish Commission, and from the Commissioners of Fish and Fisheries of the States of Connecticut, New York, and North Carolina.

Mr. Hergesheimer refers in his report to the loss sustained by the Survey, and specially by the Drawing Division, in the resignation of Mr. Charles Junken, a skilled topographer and draughtsman, whose thorough knowledge of his profession and long experience on the work had made his services of special value.

A table of charts completed or in progress during the year accompanies the report.

The Engraving Division remained under the direction of Assistant Herbert G. Ogden. He had also in charge the work of electrotyping, photographing, and printing.

Notwithstanding the great increase in the current work of this division due to the necessity of keeping up to date for the use of navigators all charts issued, a labor which grows every year as new charts are published, Mr. Ogden has allowed no work to fall behindhand, and has contributed greatly to the usefulness of the charts of the Survey by the publication of a series of index maps, showing the limits of the charts on various scales for the entire coast of the United States in a geographical order. These maps being for free distribution, it is hoped that by their means a knowledge of the charts will be widely disseminated among sea-faring men.

During the year the engraving of the important series of charts of the coast of Florida, from Cape Canaveral to Fowey Rocks, was completed.

Mr. D. C. Chapman, electrotypist and photographer, carried on most satisfactorily the operations under his immediate direction. He was specially successful in reducing original topographical sheets by photography, thus saving much time and labor of hand reduction by draughtsmen.

Mr. F. Moore remained in immediate charge of the plate-printing. An increase of upwards of two thousand five hundred copies in the number of charts supplied to the chart-room over the number for the preceding year is reported by Mr. Ogden. His annual report is accompanied by a tabular statement of engraved plates of charts begun, completed, or continued during the year.

He commends the very efficient services of Mr. J. H. Smoot, clerk to the Engraving Division.

Assistant Andrew Braid, in charge of the Instrument Division, presents in his annual report many interesting details of improvements introduced during the year in the workshops, including a new gas-engine to replace the Clerk gas-engine, which could never be depended upon for driving-power; new lathes, a new shaper, etc. The very satisfactory test of the graduating engine by a graduation to two minutes of the circle of a new twelve-inch theodolite is adverted to, a long series of observations for probable error of position giving a mean result of but one and four-tenths seconds for any one line. Attention is called to the introduction, at the instance of Assistant Fairfield, of an electric light, derived from a portable battery, to supersede the inconvenient and in many respects objectionable bull's-eye lantern, for axis illumination and for reading micrometers at night.

Assistant W. I. Vinal and Subassistant F. H. Parsons, temporarily attached to this division, rendered valuable assistance in the determination of the eccentricity and errors of graduation of theodolites.

Mr. R. C. Glascock attended to duties involving the care of the camp equipage and other property of the Survey and the correspondence relating thereto.

Mr. Braid has made a separate report upon the work executed in the Office of Construction of Standards of Weight and Measure, the immediate charge of which he had during the year. The work of re-determining and verifying values of standards was continued. Defects in the comparing apparatus brought out by this work were remedied, improvements were made in the Blair and Saxton comparators, the working balances were all carefully adjusted, and the reflecting principle of the Saxton pyrometer was applied to test the accuracy of standard balances. In the experiments for this purpose Subassistant Parsons rendered very acceptable aid.

Under special instructions, and by request of the Director of the Mint, Mr. Braid and Dr. J. J. Clark, adjuster and verifier, were associated with Dr. Lawver, of the Treasury Department, in August, 1886, as members of a Commission to test and adjust at the Philadelphia Mint a new set of Troy weights for the Mint at San Francisco. Advantage was taken of this opportunity to make a re-comparison of the standard Troy pound of this Office, known as the "Star pound," with the standard pound of the Mint. Mention more in detail of this service is made under the heading "Special operations."

Mr. A. S. Christie, in charge of the Tidal Division, has maintained and increased its efficiency during the year. Current work was kept up to date, and proof read for the tide-tables for the coasts of the United States for 1887. The tables for 1888, prepared at an early date, were published shortly after the close of the fiscal year. The two-year series of tides observed by the International Polar Expedition to Lady Franklin Bay in 1881–1883 were reduced and communicated for publication to Lieutenant Greely by direction of the Superintendent. This discussion involved great labor, an aggregate of seven hundred days of computing and clerical work being required to complete it.

Mr. L. P. Shidy, attached to the division for many years past, made the principal reductions of tides in the harmonic analysis. Predictions with the Ferrel tide-predicting machine were made by Mr. J. W. Whitaker.

The annual report of the Miscellaneous Division, submitted by its chief, Mr. M. W. Wines, General Office Assistant, indicates a range of various and responsible duty. It contains lists of the publications of the Survey sent to press, and of those received from the Public Printer during the year, and presents statements of the distribution of the annual reports and of the receipt and issue of charts, Coast Pilots, and tide-tables. The total issue of charts during the year exceeded that for the fiscal year preceding by thirty-three hundred copies, very nearly.

The Archives and Library remained in charge of Mr. Artemas Martin. His annual report is accompanied by tabular statements of the original and duplicate records, the computations, and the original topographic and hydrographic sheets received and registered in the Archives during the fiscal year. Also by a report of the number of books and pamphlets added to the Library.

By a re-arrangement of the original records of field-work, which was accomplished during the year with the aid of Mr. J. M. Duesberry, they were rendered much more easy of access. A card catalogue of the Library was begun.

The annual report of Mr. John W. Parsons, who, as the representative of Mr. George A. Bartlett, Disbursing Clerk of the Treasury Department, has been in charge of the Accounting Division of the Office since August 23, 1886, bears internal evidence of his entire devotion to the laborious and exacting duties devolving upon him. He emphasizes strongly the need of a Disbursing Officer of the Survey to avoid the almost inevitable delay in forwarding remittances after the receipt of vouchers for expenditures under the present arrangement, though recognizing at the same time that to facilitate the work of the division, the business of which is conducted in the name of Mr. Bartlett, everything within his power has been done by that officer.

Mr. Parsons acknowledges the faithful and conscientious service rendered in his division by Mr. Eugene B. Wills, accountant, Mrs. S. M. Taliaferro, book-keeper and entry clerk, and Miss Paula E. Smith, general clerk.

In the office of the Assistant in charge, Dr. W. B. French continued on duty as executive and accounting clerk, foregoing any extended leave of absence from laborious service at the request of his chief. Dr. French had the skillful assistance of Miss S. C. Ayres in office correspondence and the care of records. Miss F. Cadel (until transferred to the Tidal Division), Miss S. B. Harvie, and Miss Kate Lawn also rendered acceptable clerical service.

Mr. W. B. Chilton continued on duty as clerk in the office of the Superintendent.

SUB-OFFICES COAST AND GEODETIC SURVEY.

Sub-office at Philadelphia.—The charge of the sub-office at Philadelphia was continued during the fiscal year with Assistant S. C. McCorkle. All calls for information from citizens or from associations which did not involve a reference to Washington were promptly answered; other calls of more moment were duly referred without delay.

Charts were furnished to the Engineer Bureau, U. S. Army, and to the United States Light-House Inspector, Fourth District; to the Harbor Commission of Philadelphia, the Board of Trade, Board of Port Wardens, and Maritime Exchange; to the Pennsylvania Railroad Company; Engineers' Club; Appraiser of Customs for Japan, and to Messrs. Henry Winsor & Co., in return for valuable co-operation.

Information was given to the Engineer Corps and to the Signal Service, U. S. Army; to the Weather Bureau of the State of Pennsylvania; to the Chief of the Bureau of Surveys, Board of Public Works of the city of Philadelphia; to the Maritime Exchange, and to the Engineers' Club. Also in response to many unofficial requests from citizens.

Applicants for charts for private use were referred to the sale-agents.

Mr. McCorkle acknowledges favors received from many of the official bodies above named, and reports the continuance of cordial relations between them and the sub-office.

Facilities were extended during the year to the United States Advisory Board of the Harbor Commission, of which Assistants Henry Mitchell and H. L. Marindin are members. Also to Assistants R. M. and C. M. Bache, and to Assistant Marindin and aids.

Sub-office at San Francisco.—Assistant George Davidson continued in charge of the sub-office at San Francisco. Calls for information were answered with the aid of Mr. F. Westdahl, draughtsman, and Mr. Charles B. Hill, clerk. The general care of instruments and camp equipage at the sub-office remained with Vicente Denis, who served as heretofore as janitor, messenger, and porter.

But a slight idea of the amount of the work done at this office is conveyed by the space here devoted to it. Substantially all of the extensive geodetic and topographical operations of the Survey on the Pacific coast are under its immediate supervision, and a great deal of information of a technical character is supplied from it to civil, military, and naval officers of the General Government, to State officers, to municipalities and corporations, and to individuals.

CONCLUSION.

The preparation of this Report and the editing for publication of the Annual Reports and appendices thereto have been continued in charge of Assistant Edward Goodfellow.

First proofs of the Report for 1886, ordered printed March 3, 1887, were received at this Office early in May, and at the date at which this Report is transmitted to Congress all of the proof of the Report for 1886 has been for about two months in the hands of the Public Printer. But owing to delays in regard to the illustrations, over the reproduction of which this Office has no control, the publication of that Report may be retarded for some months to come.

In conclusion I may be allowed to express the hope that the development of this important national work may have a hearty support from the Executive, and may be sustained by a wise and liberal policy on the part of Congress.

Respectfully submitted.

F. M. THORN,
Superintendent.

Hon. C. S. FAIRCHILD,
Secretary of the Treasury.

PART III.

APPENDICES.

APPENDIX No. 1.—1887.

DISTRIBUTION OF THE 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, 1887.

Sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION I.				
Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island, including coast and seaports, bays and rivers.	No. 1	Triangulation and topography.	Charles H. Boyd, assistant	Topographical survey in the vicinity of Machias and triangulation of Cobscook Bay, Maine.
	2	Hydrography	Lieut. F. H. Crosby, U. S. N., assistant; Ensigns A. W. Dodd and N. J. L. T. Halpine, U. S. N.	Hydrographic survey of the Saint Croix River begun, and hydrographic examinations made in the Penobscot River, Maine. (See also Section II.)
	3	Topography	Eugene Ellicott, assistant	Topographical survey of the coast of Maine from Moose Cove to Quoddy Head, and of the western shore-line of Cobscook Bay and shore-line of Denbow's Neck.
	4	Topography	J. H. Gray, aid	Topographical survey of the south branch of Cobscook Bay, Maine.
	5	Hydrography	Lieut. J. M. Hawley, U. S. N., assistant; Ensigns Edward E. Wright, John E. Craven, Reuben O. Bitler, and Harry O. Field, U. S. N.	Hydrographic survey of the coast of Maine from Machias Bay Entrance to Quoddy Head, and hydrographic examinations on the coasts of Maine and Massachusetts.
	6	Tidal observations	J. G. Spaulding	Series of tidal observations with automatic tide-gauge continued at Pulpit Cove, North Haven Island, Penobscot Bay, Maine.
	7	Special triangulation.	Henry L. Whiting, assistant; Gershom Bradford, assistant; C. H. Van Orden, subassistant.	Co-operation with the Commission for the topographical survey of the State of Massachusetts.
	8	Special operations	Henry L. Whiting, assistant	Preliminary determination of the boundary-lines in tide-water of cities and towns in Massachusetts bordering on the sea.
	9	Triangulation	Gershom Bradford, assistant	Triangulation in aid of the topographical survey of the State of Massachusetts.
	10	Topography	John B. Weir, assistant; G. F. Bird, aid.	Resurvey of the shore-line of Cape Cod peninsula between Nausett and Monomoy. (See also Section VIII.)
	11	Physical hydrography.	Henry Mitchell, assistant	Physical hydrography, movements of the sands at the entrance to Vineyard Sound. (See also Section II.)
	12	Hydrography	Lieut. J. E. Pillsbury, U. S. N., assistant.	Special hydrography on the coast of Massachusetts from Powder Hole, Monomoy, to a point northward of Chatham River. (See also Sections II, IV, V, and VI.)
	13	Hydrographic examinations.	Ensign W. J. Maxwell, U. S. N., assistant.	Hydrographic examinations for the Coast Pilot on the coasts of Massachusetts, Rhode Island, and New York.

APPENDIX No. 1—Continued.

Sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION I—Continued.	No. 14	Topography	Henry L. Whiting, assistant	Completion of a topographical survey of a new opening in Cotamy Beach, forming an inlet into Edgartown Harbor, Martha's Vineyard.
	15	Hydrographic examinations.	Lieut. John M. Hawley, U. S. N., assistant; Ensigns E. E. Wright, John E. Craven, R. O. Bitler, and H. A. Field, U. S. N.	Hydrographic examinations in Edgartown Harbor and approaches.
	16	Topography	W. H. Dennis, assistant	Completion of the topographical resurvey of Block Island, Rhode Island. (See also Section II.)
SECTION II.				
Connecticut, New York, New Jersey, Pennsylvania, and Delaware, including coast, bays, and rivers.	No. 1	Triangulation	C. H. Van Orden, subassistant	Triangulation at the eastern end of Long Island Sound. (See also Section I.)
	2	Topography	W. C. Hodgkins, subassistant	Topographical resurvey of the north shore of Long Island Sound, between Stonington and Pequonnock, Conn. (See also Section VIII.)
	3	Hydrographic examinations.	Lieut. C. P. Perkins, U. S. N., assistant.	Hydrographic examinations and observations of currents in Long Island Sound.
	4	Hydrography	Lieut. F. H. Crosby, U. S. N., assistant; Ensigns A. W. Dodd, J. S. Watters, G. W. Street, C. E. Sweeting, C. M. Fahs, and N. J. L. T. Halpine, U. S. N.	Hydrographic resurvey of Long Island Sound from Faulkner's Island to Execution Rocks. (See also Section I.)
	5	Topography	W. H. Dennis, assistant	Topographical resurveys on or near the north shore of Long Island Sound, to complete resurveys previously made. (See also Section I.)
	6	Topography	W. I. Vinal, assistant	Detailed topographical resurvey of the north shore of Long Island Sound from East Bridgeport, Conn., to the eastward. (See also Section III.)
	7	Topography	E. L. Taney, aid	Topographical resurvey of the shore-line of New York Bay, Newark Bay, Kill van Kull, and Arthur Kill. Topographic resurvey from Woodmont to the eastward.
	8	Hydrographic examinations.	Lieut. G. H. Peters, U. S. N., assistant; Ensigns E. H. Tillman and W. J. Maxwell, U. S. N., and John Ross.	Hydrographic examinations for the Atlantic Coast Pilot in Long Island Sound and on the coast to the eastward.
	9	Topography	C. T. Iardella, assistant	Resurvey of the shore-lines of Hempstead Harbor, Long Island, and of the south shore of Long Island Sound from Setauket Harbor to Eaton's Neck.
	10	Topography	Charles Hosmer, assistant	Completion of the shore-line and interior topographical resurvey of the north coast of Long Island Sound from the Norwalk River to Rye Neck.
	11	Hydrography	Lieut. D. D. V. Stuart, U. S. N., assistant; Lieut. W. G. Hannum, U. S. N., Ensigns Marbury Johnston, W. O. Hulme, and H. E. Parmenter, U. S. N.	Resurvey of Long Island Sound. Continuation of inshore hydrography between Sheffield Island Light and Execution Rocks. Hydrographic survey of Hempstead Harbor. (See also Section VIII.)
	12	Hydrography	Lieut. F. S. Carter, U. S. N., assistant; Ensign W. J. Sears, U. S. N., assistant, and Ensigns A. W. Dodd and Roger Welles, U. S. N.	Resurvey of Long Island Sound. Inshore hydrographic surveys on the north coast of Long Island.
	13	Hydrography	Lieut. C. P. Perkins, U. S. N., assistant; Ensigns W. B. Fletcher and H. E. Parmenter, U. S. N.	Tidal examinations and comparisons in the Hudson, Harlem, and East Rivers, and in Flushing, Little Neck, and Newark Bays.
	14	Physical hydrography.	Henry Mitchell, assistant	Physical hydrography. The circulation of the sea through New York Harbor. Conclusions, recommendations, and suggestions, derived from studies of the resurvey of the harbor. (See also Section I.)

APPENDIX No. 1—Continued.

Sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION II—Continued.	No. 15	Physical hydrography.	Henry Mitchell, assistant; H. L. Marindin, assistant; Lieut. G. C. Hanus, U. S. N., assistant; Lieut. C. P. Perkins, U. S. N., assistant; J. E. McGrath, sub-assistant; Homer P. Ritter, E. E. Haskell.	Continuation of surveys for the development of the physical hydrography of New York Bay and Harbor. (See also Section I.)
	16	Physical hydrography.	Henry Mitchell, assistant; H. L. Marindin, assistant; J. B. Weir, assistant; J. E. McGrath, sub-assistant; W. B. Fairfield, extra observer; John Nelson, aid; Homer P. Ritter.	Physical hydrography of New York Bay and Harbor. Zeros of tide-gauges in the East River connected by geodesic leveling. (See also Section I.)
	17	Topography	D. B. Wainwright, assistant......	Topographical resurvey of shore-lines of New York Bay and Harbor and vicinity continued. (See also Section IV.)
	18	Triangulation	A. T. Mosman, assistant.........	Determination by triangulation of additional stations in Newark Bay and vicinity. (See also Sections XIII and XIV.)
	19	Topography	R. M. Bache, assistant	Continuation of the resurvey of New York Harbor and approaches by a shore-line survey of the south coast of Staten Island from New Creek to Tottenville, and of the New Jersey shore from Perth Amboy by way of South Amboy to Keyport.
	20	Hydrography.....	Lieut. G. C. Hanus, U. S. N., assistant; Ensigns C. S. Ripley, E. F. Leiper, G. R. French, and H. P. Jones, U. S. N.	Continuation of the hydrographic resurvey of New York Bay and Harbor.
	21	Hydrographic examination.	Lieut. F. H. Crosby, U. S. N., assistant; Ensigns A. W. Dodd and N. J. L. T. Halpine, U. S. N.	Hydrographic examination of the Swash Channel, New York Bay.
	22	Tidal observations	A. J. Brennan, tidal observer......	Series of tidal observations with automatic tide-gauge at Sandy Hook, New Jersey.
	23	Triangulation	Prof. Mansfield Merriman, acting assistant; William Eimbeck, assistant.	Extension of reconnaissance and triangulation in the State of Pennsylvania. (See also Section XVI.)
	24	Physical hydrography.	Henry Mitchell, assistant; H. L. Marindin, assistant.	Physical hydrography. Observations of currents in Delaware River and Bay. (See also Section I.)
	25	Physical hydrography.	S. C. McCorkle, assistant.........	Physical hydrography. Observations of the formation and movement of ice in the Delaware River and Bay.
	26	Geodetic operations.	E. A. Bowser, acting assistant....	Geodetic operations. Extension of the triangulation and reconnaissance in southern New Jersey towards Delaware River and Bay.
	27	Triangulation	Joseph Hergesheimer, assistant...	Connection of old with new triangulation in the vicinity of Absecon Light, coast of New Jersey. (See also Section VI.)
	28	Topography	C. M. Bache, assistant.............	Completion of the topographic resurvey of the coast of New Jersey.
	29	Hydrography.....	J. E. Pillsbury, U. S. N., assistant; Ensigns T. D. Griffin, J. H. Hetherington, R. M. Hughes, F. R. Brainard, and A. G. Rogers, U. S. N.	Deep-sea soundings to develop the 100-fathom curve between Cape Henlopen and Cape Henry and offshore hydrography, north of Cape May and south of Cape Henlopen. (See also Sections I, IV, V, and VI.)
SECTION III. Maryland, District of Columbia, Virginia, and West Virginia, including bays, sea-ports, and rivers.	No. 1	Special survey with base measure.	O. H. Tittmann, assistant; J. H. Turner, aid.	The Port-Warden Lines of the city of Baltimore traced out on the ground and connected with the triangulation of Baltimore Harbor. (See also Section VIII.)
	2	Topography and hydrography.	W. I. Vinal, assistant; E. L. Taney, aid.	Soundings in Baltimore Harbor, and measurements along the harbor front. (See also Section II.)

APPENDIX No. 1—Continued.

Sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION III—Continued.	No. 3	Magnetic observations.	C. A. Schott, assistant	Annual determination of the magnetic declination, dip, and intensity at the station on Capitol Hill, Washington. Necessity for the selection of a new station reported.
	4	Topography	J. W. Donn, assistant; J. A. Flemer, aid.	Continuation of the detailed topographical survey of the District of Columbia.
	5	Magnetic observations.	C. H. Sinclair, assistant	Magnetic observations: Establishment of a meridian line and marking of a station at Charlottesville, Va. (See also Sections IV, X, XI, XV, and XVI.)
	6	Magnetic observations.	J. B. Baylor, assistant	Magnetic observations at stations in Virginia. (See also Sections IV, V, VI, and VII.)
	7	Reconnaissance and triangulation.	R. A. Marr, subassistant	Reconnaissance and triangulation in the vicinity of Cape Charles, Virginia. (See also Sections X and XVI.)
	8	Boundary-line survey.	C. H. Sinclair, assistant; John Nelson, aid.	Re-establishment of that part of the boundary line between the States of Virginia and North Carolina extending from the Atlantic coast westward to the Nottoway River. (See also Sections IV, X, XI, and XVI.)
SECTION IV. North Carolina, including coasts, sounds, sea-ports, and rivers.	No. 1	Boundary-line survey.	C. H. Sinclair, assistant; John Nelson, aid.	Re-establishment of that part of the boundary line between the States of Virginia and North Carolina extending from the Atlantic coast westward to the Nottoway River. (See also Sections III, X, XI, and XVI.)
	2	Special hydrography.	Lieut. Francis Winslow, U. S. N., assistant; Lieut. B. T. Walling, U. S. N.; Ensigns J. C. Drake and C. M. Fahs., U. S. N.	Special hydrography for the State of North Carolina.
	3	Magnetic observations.	J. B. Baylor, assistant	Magnetic observations at stations in North Carolina. (See also Sections III, V, VI, and VII.)
	4	Triangulation and topography.	D. B. Wainwright, assistant	Connection of old with new triangulation near the mouth of Cape Fear River, North Carolina. Topographical resurvey of New Inlet and soundings in Masonboro Inlet, North Carolina. (See also Section II.)
	5	Hydrography	Lieut. J. E. Pillsbury, U. S. N., assistant; Lieut. T. D. Griffin, U. S. N.; Ensigns R. M. Hughes, A. G. Rogers, J. H. Hetherington, W. J. Sears, F. R. Brainard, Franklin Swift, and J. K. Seymour, U. S. N.	Observations of currents off Cape Hatteras. Hydrographic survey of New Inlet, North Carolina. (See also Sections I, II, V, and VI.)
SECTION V. South Carolina and Georgia, including coast, sea-water channels, sounds, harbors, and rivers.	No. 1	Special hydrographic examination.	C. O. Boutelle, assistant	Special hydrographic examination in Charleston Harbor. (See also Section XV.)
	2	Magnetic observations.	J. B. Baylor, assistant	Magnetic observations at stations in Georgia. (See also Sections III, IV, VI, and VII.)
	3	Hydrographic examinations.	Lieut. J. E. Pillsbury, U. S. N., assistant.	Hydrographic survey off the bar of Saint Simon's Sound, Georgia. (See also Sections I, II, IV, and VI.)
SECTION VI. Peninsula of Florida, from Saint Mary's River, on the east coast, to and including the Anclote Keys on the west coast, with the coast approaches, reefs, keys, sea-ports, and rivers.	No. 1	Magnetic observations.	J. B. Baylor, assistant	Magnetic observations at stations in Florida. (See also Sections III, IV, V, and VII.)
	2	Physical hydrography.	Lieut. J. E. Pillsbury, U. S. N., assistant; Ensigns R. M. Hughes, A. G. Rogers, W. J. Sears, F. Swift, and J. K. Seymour, U. S. N.; Passed Assistant Surgeon W. H. Rush, and Passed Assistant Engineer George W. Cowie, U. S. N.	Physical hydrography. Gulf Stream explorations. Observations of currents, 1887. (See also Sections I, II, IV, and V.)

APPENDIX No. 1—Continued.

Sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION VI—Continued.	No. 3	Triangulation.....	Joseph Hergesheimer, assistant; G. F. Bird and J. H. Gray, aids.	Completion of the triangulation on the west coast of Florida from Pavilion Key to Cape Sable. (See also Section II.)
	4	Hydrography.....	Lieut. J. F. Moser, U. S. N., assistant; Ensigns E. E. Wright, H. A. Field, W. O. Hulme, H. E. Parmenter, and H. P. Jones, U. S. N.; Passed Assistant Surgeon F. B. Stevenson, U. S. N., and Assistant Engineer S. H. Leonard, U. S. N.	Hydrographic survey on the west coast of Florida from Cape Romano to the southward. (See also Section VII.)
SECTION VII.				
Peninsula of Florida, west coast from Anclote Keys to Perdido Bay, including coast approaches, ports, and rivers.	No. 1	Magnetic observations.	J. B. Baylor, assistant............	Magnetic observations at stations in Florida. (See also Sections III, IV, V, and VI.)
	2	Hydrography.....	Lieut. J. F. Moser, U. S. N., assistant.	Inshore and offshore hydrography of the west coast of Florida from Cedar Keys to the Chassahowitzka River. (See also Section VI.)
SECTION VIII.				
Alabama, Mississippi, Louisiana, and Arkansas, including Gulf coasts, ports, and rivers.	No. 1	Reconnaissance and triangulation.	O. H. Tittmann, assistant; J. H. Turner, aid.	Occupation of stations of the triangulation in Alabama for extending the measurement of the oblique arc of the meridian from Atlanta towards Mobile. (See also Section III.)
	2	Geodesic leveling.	J. B. Weir, assistant; J. E. McGrath, subassistant; W. B. Fairfield, extra observer.	Lines of geodesic leveling carried from Citronelle, Ala., to Quitman, Miss. (See also Sections I and II.)
	3	Triangulation and topography.....	F. W. Perkins, assistant; C. T. Iardella, assistant; W. C. Hodgkins, subassistant.	Triangulation and topography upon the coast of Louisiana between Grande Isle and Raccoon Point. (See also Sections XIII and XIV.)
	4	Hydrography.....	Lieut. D. D. V. Stuart, U. S. N., assistant.	Hydrographic surveys on the coast of Louisiana. (See also Section II.)
SECTION X.				
California, including the coasts, bays, harbors, and rivers.	No. 1	Resurveys........	A. F. Rodgers, assistant; Isaac Winston, subassistant.	Triangulation begun for the examination of changes along the shore of San Diego Bay and vicinity.
	2	Triangulation and topography.	A. F. Rodgers, assistant; Isaac Winston, subassistant.	Continuation of the triangulation and topography of the south coast of California.
	3	Magnetic observations.	Carlisle Terry, jr., subassistant; R. E. Halter, assistant.	Series of magnetic observations with self-registering magnetic apparatus continued at Los Angeles, Cal.
	4	Topography	Stehman Forney, assistant........	Topographical surveys on the coast of California in the vicinity of San Simeon Bay.
	5	Topography and special hydrography.	Prof. George Davidson, assistant; E. F. Dickins, assistant; Fremont Morse, subassistant; F. Westdahl, draughtsman.	General charge of Pacific coast work. Resurvey of Suisun Bay. Coast Pilot work. Hydrographic examinations. (See also Section XI.)
	6	Resurveys........	A. F. Rodgers, assistant; Isaac Winston, subassistant.	Continuation of the resurveys and examinations of the shore-line of San Francisco Bay for the determination of changes.
	7	Resurveys.......	J. S. Lawson, assistant; P. A. Welker, subassistant.	Resurvey of San Pablo Bay, California.
	8	Hydrographic resurveys.	Lieut. David Peacock, U. S. N., assistant; Ensigns J. H. Shipley, C. C. Marsh, D. P. Menefee, A. M. Beecher, N. S. Moseley, and J. D. McDonald, U. S. N.; Passed Assistant Surgeon D. O. Lewis, U. S. N.; Passed Assistant Engineer G. D. Strickland, U. S. N.	Hydrographic resurveys in Suisun and San Pablo Bays, Karquines Straits, and vicinity.
	9	Tidal observations	Emmet Gray, observer	Series of tidal observations with automatic tide-gauge continued at Saucelito, Bay of San Francisco, California.

APPENDIX No. 1—Continued.

Sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION X—Continued.	No. 10	Telegraphic longitudes.	Edwin Smith, assistant; C. H. Sinclair, assistant.	Occupation of stations in San Francisco for longitude determinations. Determination of longitude at Salt Lake City and at Portland, Oregon. Magnetic observations at Portland. (See also Sections XI and XVI.)
SECTION XI.				
Oregon and Washington Territory, including coast, interior bays, ports, and rivers.	No. 1	Topography and hydrography.	L. A. Sengteller, assistant........	Hydrographic survey of the Umpquah River, Oregon, and its approaches completed. Topographical survey of the coast of Oregon continued from Umpquah River southward.
	2	Topographical reconnaissance.	E. F. Dickins, assistant..........	Topographical reconnaissance of the coast of Oregon between the Umpquah and Yaquina Rivers.
	3	Topographical reconnaissance.	Cleveland Rockwell, assistant....	Topographical reconnaissance of the coast of Oregon between Yaquina River and Tillamook Bay.
	4	Hydrography.....	Lieut. J. C. Burnett, U. S. N., assistant; Ensigns W. P. White, J. A. Bell, N. S. Moseley, and J. L. Purcell, U. S. N.; Assistant Surgeon E. W. Auzal, U. S. N.; Assistant Engineer R. I. Reid, U. S. N.	Hydrographic surveys in Tillamook Bay, off the coast of Oregon in that vicinity, and in Shoalwater Bay, Washington Territory.
	5	Astronomical and magnetic observations. Hydrography.	George Davidson, assistant; Cleveland Rockwell, assistant.	Continuation of the survey of the Columbia River. Astronomical and magnetic observations at stations on the left bank of the Columbia. Hydrography of the river from Columbia City to the head of Bachelor's Island.
	6	Telegraphic longitudes, and magnetic observations.	Edwin Smith, assistant; C. H. Sinclair, assistant.	Determination of longitude and the magnetic elements at Portland, Oregon. (See also Sections X and XVI.)
	7	Special surveys...	J. J. Gilbert, assistant............	Beach measurement and topographical survey between Shoalwater Bay and Gray's Harbor, coast of Washington Territory. Special triangulation and topography at Tacoma and Seattle, Puget Sound, Washington Territory.
	8	Reconnaissance...	J. F. Pratt, assistant; Fremont Morse, subassistant.	Reconnaissance of the coast of Washington Territory from Gray's Harbor to Cape Flattery.
	9	Hydrography	Lieut. C. T. Forse, U. S. N., assistant; Lieut. H. T. Mayo, U. S. N.	Hydrographic surveys in Admiralty Inlet, Port Townsend Bay, Possession Sound, and Port Susan.
	10	Triangulation and topography.	J. F. Pratt, assistant	Triangulation and topography of Port Susan, Stillaguamish River, and Saratoga Passage, Washington Territory.
	11	Triangulation and topography.	J. J. Gilbert, assistant.............	Triangulation and topography of Rosario Strait and vicinity. Triangulation and topography begun in Samish and Bellingham Bays, Washington Territory.
SECTION XII.				
Alaska, including the coast and the Aleutian Islands.	No. 1	Hydrography.....	Lieut. Commander A. S. Snow, U. S. N., assistant; Lieut. Commander C. M. Thomas, U. S. N., assistant; Lieut. J. M. Helm, U. S. N., assistant; Lieut. De Witt Coffman, U. S. N., Ensigns S. Cook, A. N. Wood, J. H. Shipley, C. C. Marsh, J. A. Bell, D. P. Menefee, J. L. Purcell, M. L. Read, A. P. Niblack, T. G. Dewey, A. M. Beecher, and J. D. McDonald, U. S. N.; Surgeon T. H. Streets, U. S. N.; Passed Assistant Engineer H. N. Stevenson, U. S. N.	Continuation of the survey of the coast, bays, straits, and harbors of southeastern Alaska.

APPENDIX No. 1—Continued.

Sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION XII—Continued.	No. 2	Tidal observations	Fred. Sargent, observer	Continuation of the series of tidal records obtained from the automatic tide-gauge at Saint Paul, Kadiak Island, Alaska.
SECTION XIII.				
Kentucky and Tennessee	No. 1	Triangulation	A. T. Mosman, assistant; W. B. Fairfield, extra observer.	Transcontinental triangulation near the thirty-ninth parallel extended to the westward in Kentucky and Ohio. (See also Section XIV.)
	2	Reconnaissance	F. W. Perkins, assistant	Reconnaissance near the thirty-ninth parallel for the extension westward of the transcontinental triangulation near that parallel in Kentucky and Ohio, and for its connection with the triangulation advancing to the eastward in Indiana. (See also Section XIV.)
	3	Geodetic operations.	Prof. A. H. Buchanan, acting assistant.	Geodetic operations. Reconnaissance for the connection of the triangulation of the State of Tennessee with the primary triangulation of the Coast and Geodetic Survey in Northern Georgia.
SECTION XIV.				
Ohio, Indiana, Illinois, Michigan, and Wisconsin.	No. 1	Triangulation and reconnaissance.	A. T. Mosman, assistant; W. B. Fairfield, extra observer.	Transcontinental triangulation near the thirty-ninth parallel extended to the westward in Ohio and Kentucky. Reconnaissance for site of a base-line in Ohio. (See also Section II.)
	2	Reconnaissance	F. W. Perkins, assistant	Reconnaissance near the thirty-ninth parallel for connecting the transcontinental triangulation in Ohio and Kentucky with that in Indiana. (See also Section VIII.)
	3	Triangulation	G. A. Fairfield, assistant; F. H. Parsons, subassistant; W. B. Fairfield, extra observer.	Occupation of stations in Indiana for extending to the eastward the transcontinental triangulation near the thirty-ninth parallel.
	4	Geodetic operations.	Prof. J. L. Campbell, acting assistant; J. B. Baylor, assistant.	Geodetic operations. Extension of reconnaissance for additional stations of the triangulation of the State of Indiana.
	5	Geodetic operations.	Prof. J. E. Davies, acting assistant.	Continuation of geodetic operations in the State of Wisconsin.
SECTION XV.				
Missouri, Kansas, Iowa, Nebraska, Minnesota, and Dakota.	No. 1	Triangulation	D. Granger, assistant; A. P. [illegible]nard, recorder.	Reconnaissance for the extension to the westward of the primary triangulation near the thirty-ninth parallel in Kansas.
	2	Magnetic observations.	C. H. Sinclair, assistant	Magnetic observations at Saint Louis, Mo.
	3	Geodetic operations.	C. O. Boutelle, assistant; Prof. W. R. Hoag, acting assistant.	Geodetic operations preliminary to a triangulation of the State of Minnesota. (See also Section V.)
SECTION XVI.				
Nevada, Utah, Colorado, Arizona, and New Mexico.	No. 1	Telegraphic longitudes.	Edwin Smith, assistant; C. H. Sinclair, assistant; R. A. Marr, subassistant.	Determination of the longitudes of stations in Colorado and Utah. Observations for latitude and the magnetic elements. (See also Sections X and XI.)
	2	Triangulation and reconnaissance.	William Eimbeck, assistant; G. F. Bird, aid; J. H. Turner, aid.	Extension to the eastward of the transcontinental triangulation from stations in central Utah. (See also Section II.)
SPECIAL OPERATIONS.			C. O. Boutelle, assistant	Immediate supervision of the State surveys.
			Andrew Braid, assistant; Dr. J. J. Clark.	Verification and adjustment at the United States Mint, Philadelphia, of certain weights intended for use at the San Francisco Mint. Recomparison of the Star Troy pound of the Office of Construction of Standards of Weight and Measure with the standard Troy pound of the Philadelphia Mint.
			E. D. Preston, subassistant	Determinations of latitude and gravity at stations on the Hawaiian Islands for the Hawaiian Government.

APPENDIX No. 2.—1887.

STATISTICS OF FIELD AND OFFICE WORK OF THE COAST AND GEODETIC SURVEY FOR THE YEAR ENDING JUNE 30, 1887.

	Total to June 30, 1886.	Total during fiscal year.	Total to June 30, 1887.
RECONNAISSANCE.			
Area, in square statute miles	378,860	4,400	383,260
Parties, number of		4	
BASE-LINES.			
Primary, number of	14	0	14
Primary, length of, in statute miles	90	0	90
Subordinate, number of	131	1	132
Subordinate and beach measures, length of	505	6	511
TRIANGULATION.			
Area in square statute miles	207,871	3,151	211,022
Stations occupied for horizontal measures, number of	11,328	517	11,845
Geographical positions determined, number of	21,679	1,069	22,748
Stations occupied for vertical measures, number of	792	13	805
Elevations determined trigonometrically, number of	1,997	35	2,032
Heights of permanent bench-marks by spirit-leveling, number of	*623	64	687
Lines of spirit-leveling, length of, in statute miles	3,496	137	3,633
Triangulation and leveling parties, number of		25	
ASTRONOMICAL WORK.			
Azimuth stations, number of	202	3	205
Latitude stations, number of	328	6	334
Longitude stations, telegraphic, number of	132	5	137
Longitude stations, chronometric or lunar, number of	110	0	110
Astronomical parties, number of		3	
MAGNETIC WORK.			
Stations occupied, number of	709	23	732
Permanent magnetic stations, number of		2	
Magnetic parties, number of		4	
GRAVITY MEASURES.			
Home stations occupied	19	0	19
Foreign stations occupied	12	2	14
Number of parties		1	
TOPOGRAPHY.			
Area surveyed, in square statute miles	30,547	706	31,253
Length of general coast, in statute miles	6,842	457	7,299
Length of shore-line, in statute miles, including rivers, creeks, and ponds	88,150	3,233	91,383
Length of roads, in statute miles	44,798	1,199	45,997
Topographical parties, number of		28	

* Only permanent bench-marks are now counted, hence the change of last year's numbers.

APPENDIX No. 2—Continued.

	Total to June 30, 1886.	Total during fiscal year.	Total to June 30, 1887.
HYDROGRAPHY.			
Parties, number of	----------	15	----------
Number of miles (geographical) run while sounding	393, 157	17, 557	410, 714
Area sounded, in square geographical miles	108, 281	11, 286	119, 567
Miles run, additional of outside or deep-sea soundings	75, 336	0	75, 336
Number of soundings	17, 575, 296	661, 682	18, 236, 978
Deep-sea soundings	13, 110	0	13, 110
Deep-sea temperature observations	12, 920	0	12, 920
Current stations, number of	----------	12	----------
Deep-sea current stations, number of	----------	37	----------
Deep-sea subcurrent observations, number of	----------	1, 336	----------
Deep-sea surface current observations, number of	----------	3, 694	----------
Specimens of bottom, number of	12, 844	171	13, 015
Automatic tide-gauges established	85	2	87
Automatic tide-gauges discontinued	82	0	82
Parties doing tidal work exclusively	----------	4	----------
Parties doing tidal in connection with hydrographic work	----------	27	----------
Staff and box gauges established	1, 711	155	1, 866
Staff and box gauges discontinued	1, 706	152	1, 858
RECORDS.			
Triangulation, originals, number of volumes	4, 847	178	5, 025
Astronomical observations, originals, number of volumes	1, 831	25	1, 856
Magnetic observations, originals, number of volumes	665	5	670
Duplicates of above, number of volumes	5, 211	220	5, 431
Computations, number of volumes	4, 165	16	4, 181
Hydrographic soundings and angles, originals, number of volumes	9, 786	555	10, 341
Hydrographic soundings and angles, duplicates, number of volumes	2, 475	303	2, 778
Tidal and current observations, originals, number of volumes	3, 855	224	4, 079
Tidal and current observations, duplicates, number of volumes	2, 492	144	2, 636
Aggregate years of record from automatic tide-gauges	254	4	258
Tidal stations for which reductions have been made	972	97	1, 069
Aggregate years of record reduced	211	11	222
MAPS AND CHARTS.			
Topographic maps, originals	1, 753	44	1, 797
Hydrographic charts, originals	1, 882	68	1, 950
ENGRAVING AND PRINTING.			
Finished charts published from engraved plates, total number of	425	10	435
Engraved charts withdrawn from circulation	141	4	145
Engraved plates of preliminary charts, sketches and diagrams for the Coast and Geodetic Survey reports, number of	654	13	667
Electrotype plates made	1, 866	91	1, 957
Charts published by photolithography	----------	15	----------
Charts published by photolithography, withdrawn from circulation	----------	4	----------
Engraved plates of Coast Pilot charts	80	0	80
Engraved plates of Coast Pilot views	89	2	91
Printed sheets of maps and charts distributed	594, 816	34, 016	628, 832
Printed sheets of maps and charts deposited with sale-agents	263, 439	21, 010	284, 449

APPENDIX No. 3.—1887.

INFORMATION FURNISHED TO DEPARTMENTS OF THE GOVERNMENT IN REPLY TO SPECIAL REQUESTS, AND TO INDIVIDUALS UPON APPLICATION,* DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

Date.		Name.	Data furnished.
1886.			
July	3	Tinsley, Mr. W. G., Columbus, Ohio	Substantial identity of Mr. Tinsley's theory of the tides with Newton's.
	10	Newcomb, Prof. S., U. S. N., Superintendent American Ephemeris and Nautical Almanac.	Seven separate Coast Survey Report Appendices on tidal matters.
	10	Wren & Cheney, Eureka, Nev	Latitude and longitude of several positions in the vicinity of the 117th meridian and the Central Pacific Railroad.
	10	Sweet, E., State Engineer and Surveyor, New York	Geographical positions and geodetic data of six primary stations located in New York, Vermont, New Hampshire, and Massachusetts.
	12	Queen, J. W. & Co., Philadelphia, Pa	Chart showing distribution of horizontal magnetic force in the United States.
	14	Kingsley, M., Assistant Engineer, U. S. A., Army Building, New York City.	Geographical position of the Centennial tower.
	14	Lorini, M., Department of Public Works, Yonkers, N. Y.	Geographical positions of stations in vicinity of boundary of New York and Connecticut.
	15	Chief Signal Officer, U. S. A	Chart of equal magnetic horizontal force for 1885.
	15	D. Eggert's Sons, No. 74 Wall street, New York City	Explanation of irregularities in the New London tide table for 1886, due to the declination of the moon.
	16	Light-House Board	Two tracings of Point Lobos, California.
	16	Sweet, E., State Engineer, Albany, N. Y	Copy of adjusted triangle sides of main triangulation between Monadnock and Helderberg.
	17	Lorini, M., Department of Public Works, Yonkers, N. Y.	Description of a number of trigonometrical stations in the vicinity of the boundary of New York and Connecticut.
	20	Hanly, W. W., Broadway, New York	Geographical position of Piney station, West Virginia, and azimuth and distances to surrounding objects; also, heights of stations visible from Piney.
	21	Sweet, E., State Engineer, Albany, N. Y	Descriptions of stations of the principal triangulation of New York State.
	21	Rainey, Dr. Thomas	Tracing of soundings in Blackwell's Island Channel.
	23	Harmer, A. C., House of Representatives	Tracings of topographical sheets, coast of New Jersey from Bennet Islands to Great Egg Harbor.
	24	Chief Signal Officer, U. S. A	Magnetic isogonic chart for 1885.
	26	Loomis, L. M	Heights of a number of trigonometrical stations, chiefly in South Carolina.
	28	Stratton, E. Platt	Tracing of hydrography of Blackwell's Island channels.
	29	Soulé, F., University of California, Berkeley, Cal	Geographical position of the new astronomical observatory at Berkeley.
Aug.	4	Dunn, W. H, Richmond, Va	Height of Clark Mountain, Virginia.
	5	Hatsch, W. F., Beaufort, N. C	Table of magnetic declinations at Beaufort, N. C., between 1730 and 1886.
	6	Bogart, J. P., Engineer Connecticut and Rhode Island Boundary Commission, New Haven, Conn.	Descriptions of stations in the vicinity of Stonington and up the boundary between Connecticut and Rhode Island; also, three triangulation sketches.

* Tracings from topographic or hydrographic sheets, transcripts from unpublished results of the work, and other data, when supplied for private use, are furnished upon payment of the cost of preparation in the Office.

APPENDIX No. 3—Continued.

Date.		Name.	Data furnished.
1886.			
Aug.	6	Bogart, J. P., Engineer Connecticut and Rhode Island Boundary Commission, New Haven, Conn.	Geographical positions (standard data of the Survey) vicinity of Stonington and up the boundary between Connecticut and Rhode Island.
	6	Blackford, E. G., New York Fish Commission	Projection west end of Raritan Bay, New Jersey.
	11	McCurdy, C. J. (request of Mr. Wait, House of Representatives).	Tracing of topography east side of mouth of Connecticut River.
	12	U. S. Geological Survey	Tracing of the shore soundings between New York and Cape Henry.
	43	King, J. I., Burgh Hill, Ohio	Dimensions of the earth's figure, with their logarithms.
	19	Chief of Engineers, U. S. A	Topography of Pacific coast (from original sheets) between Columbia River and Tillamook Head.
	19	Bulkley, H. D	Tracing of topography of part of Sandy Hook.
	20	Phillips, Prof. A. W., Yale College, New Haven, Conn	Relating to harmonic analysis of the tides at New London, Conn.
	20	Shedd, J. Herbert, Civil Engineer, Providence, R. I	Relating to low-water reading on rod at Derby, Conn.
	26	Gore, Prof. J. W., Chapel Hill, University of North Carolina.	Table of change in magnetic declination for every tenth year from 1750 to present time in North Carolina.
	28	King, J. I., Burgh Hill, Ohio	Length of the earth's equatorial diameter and polar axis.
	28	Waite, H. M., Nantucket, Mass	Geographical positions on the island of Nantucket.
	28	Gunter, W. F., Accomac Court-House, Va	Table of secular change of the magnetic declination in Accomac County between 1880 and 1890, and declinations observed in the county.
	28	Gillespie, G. L., Lieutenant-Colonel U. S. Engineers	Geographical positions of Boston State-House and Blind Asylum.
	30	Kœnig, J. B., Topographer Kentucky Geological Survey	Geographical positions of four astronomical stations in Kentucky and of one in Texas.
Sept.	1	Stevenson, C. L., American Society of Civil Engineers, New York.	Magnetic declination, vicinity of New York and Oyster Bay, Long Island.
	1	Lewis, General W. L., Goldsborough, N. C	Table of secular change of the magnetic declination in eastern North Carolina between 1750 and 1890.
	4	Stevenson, C. L., New York	Plan for tracing out ancient lines run by recorded compass courses.
	6	Nash, D. A., Secretary Board of Pilot Commissioners, New York.	Position of Scotland and Sandy Hook Light-vessels.
	9	Blackford, E. G., New York Fish Commission	Tracing of topographical sheet of Staten Island (1886 survey) from the Narrows to Great Kills.
	10	Harris, U. R., Lieutenant U. S. N., Mare Island Navy-Yard.	Star places for computation of latitude of Navy-Yard Observatory.
	11	Wheeler, George M., Captain of Engineers, U. S. A	Description of tidal bench-mark at Bar Harbor, Me.
	13	Quimby, E. T., Commissioner New Hampshire and Massachusetts State Boundary Survey.	Geodetic data for six stations to fix positions of southwest corner of State of New Hampshire.
	14	....do	Relative positions of station Powow by Borden and by the Coast and Geodetic Survey.
	16	Lorick, H. I., County Surveyor, New Berne, N. C	Present magnetic declination at New Berne and annual change.
	16	Hatch, L., Asheville, N. C	Relating to connection of earthquakes with magnetic disturbances.
	18	The Pennsylvania Railroad Company, W. W. Brown, Chief Engineer, Philadelphia.	Description of bench-marks and elevations from spirit-levels between Sandy Hook, New Jersey, and Washington, D. C.
	20	Wheeler, O. B., Assistant Engineer Missouri River Commission, Saint Louis.	Ratio of meter and foot used by the Coast and Geodetic Survey.
	21	Walker, Alexander, Civil Engineer, Williamstown, Mass	Magnetic declination Berkshire County, Mass.
	21	Hills, Mr. Frank T., Atlantic City, N. J	Half-monthly phase inequality at Atlantic City, N. J.
	25	Quimby, E. T	Position of Old Town station.
	25	Hurlbert, W. J., Civil Engineer and Surveyor, Lexington, Va.	Magnetic chart for 1885 and table of azimuth of Polaris when at elongation for various latitudes and years.
	27	Nimmo, W., jr	Information about the advantages of Gardiner's Bay as a harbor of refuge.
	29	Parsons, H. C., Office State Engineer and Surveyor, State of New York.	Information on the secular variation of the magnetic declination.
Oct.	1	Bogart, J	Clarke's data applied to two projections.
	1	Worthington, A. S., District Attorney, Washington	Information concerning the Kidwell meadows.
	1	Abert, S. T., United States Agent	Tracing of Patuxent River and Mattox Creek.
	4	Clark, J. M., New York	Length of seconds pendulum and acceleration of gravity.
	5	Ferris, J. Worcester, Otsego, N. Y	Appendix No. 13, Report for 1882, showing distribution of magnetic declination in the United States.
	5	United States Naval Observatory	Geographical positions at nine principal coast cities of the United States.
	5	Dyer, G. L., Lieutenant U. S. N	Latest data for west coast of Florida, Cape Romain to Tampa Bay.
	6	Wilson, O. S., New York State Survey, Albany	Three geographical positions and geodetic bearings of objects from Yellow Pine station.

APPENDIX No. 3—Continued.

Date.		Name.	Data furnished.
1886.			
Oct.	7	Robert, H. M., Colonel U. S. Engineers	Tracing of the topographical reduction of Coast Chart No. 24, north of Cape May.
	7	Phillips, A. W., Professor Yale College, New Haven, Conn.	Tabulation of high and low waters at Southwest Ledge Light, near New Haven, Conn., for August, 1885.
	12	Safford, T. W., Professor Williams College, Williamstown, Mass.	Geodetic positions and descriptions of stations of several primary and secondary trigonometrical points in the vicinity of Williamstown.
	14	Robert, H. M., Lieutenant-Colonel U. S. Engineers, Philadelphia.	Descriptions of stations and latitude and longitude of trigonometrical points near Trenton and Bordentown.
	15	Massachusetts Harbor and Land Commissioners	Two tracings of Monomoy Shoals accompanying report by Assistant Mitchell.
	16	Winslow, F., Lieutenant U. S. N., North Carolina Fishery Commission.	Geographical positions and descriptions of stations, Pamplico Sound.
	19	Webb, J. O., Oaks, Orange County, N. C	Table of change of magnetic declinations for every tenth year, between 1730 and 1890, applicable for central North Carolina.
	19	Jones, H. C., Surveyor, McArthur, Ohio	Table of secular change of the magnetic declination.
	19	Carter, O. M., Lieutenant U. S. Engineers	Sailing line of all surveys of Doboy Bar, on a proof of Doboy.
	20	Stanton, Maj. W. S., Engineer First and Second Light-House Districts.	Magnetic declination at ten stations, coast of Maine and Massachusetts, for the present time and for certain earlier epochs.
	20	Sinclair, C. H	Geographical position of Insane Asylum, Saint Louis, Mo.
	20	Larcombe, H., Beltsville, Md	Magnetic declination at Beltsville in 1764, 1796, and 1886.
	20	Cook, Prof. G. H., Director Geological Survey of New Jersey.	Geodetic data and descriptions of twenty-five trigonometrical stations.
	21	Houston, D. C., Lieutenant U. S. Engineers	Tracing of Long Beach and Orient Bays, east end of Long Island.
	22	Jones, E., Cold Spring Harbor, Suffolk County, N. Y	Method recommended for the application of Coast and Geodetic Survey results for secular variation to old surveys near Cold Spring Harbor.
	23	Carter, O. M., Lieutenant U. S. Engineers	Geographical positions and descriptions of stations, vicinity of Sapelo Light-house and Jekyl Creek, and on Savannah River.
	28	Cook, Prof. George H., State Geologist of New Jersey	Tracing of triangulation sketch of Kill van Kull and Arthur Kill and Newark Bay, by Assistant Halter, 1885.
Nov.	4	Jones, E., Cold Spring Harbor, New York	Two astronomical azimuths of triangulation lines at Cold Spring Harbor.
	4	Sears, Eben, Boston, Mass	Tracing of Cutler, Me. (topographical sheets numbered 1664 and 1665).
	5	Gillespie, George L., Lieutenant-Colonel Corps of Engineers.	Geographical positions and descriptions of four stations near Gloucester, Mass.
	5	Cook, Prof. George H., State Geologist, New Jersey	Geographical positions of stations on and near Staten Island, New York, and near Pierpont on the Hudson.
	9	Gillespie, G. L., Lieutenant-Colonel Corps of Engineers, Boston.	Geographical positions of eight stations in and about Plymouth, Mass.
	9	Sanford, Mr., General Superintendent Adams Express Company.	Height of Tashua station and geographical positions of three points in its vicinity.
	10	Goerke, E. W	Delineation of boundary line between Maryland and Virginia, on backed coast chart No. 33.
	12	Abert, S. T., U. S. Agent	Proof of Patuxent River, showing additional topography between Jones's Point and Nottingham.
	12	Black, W. M., Lieutenant Engineers, U. S. A	Descriptions of stations, base-line, triangle sides, and geodetic results of the survey of Key West and vicinity.
	12	Bradford, Mr. J. S., Brooks', D. C	The highest tide observed at New Castle, Del.
	13	Dupont, T. C., Superintendent Central Coal and Iron Company, Central City, Ky.	Magnetic declination at Central City, Ky., in 1798.
	13	Winslow, F., Lieutenant U. S. N	Description of twenty-one trigonometrical stations in Pamplico Sound.
	13	Light-House Board	Proof of coast chart No. 76, with curves of bottoms completed by hand.
	16	Winslow, F., Lieutenant U. S. N	Geographical positions, northern part of Pamplico Sound.
	19	Mendell, G. H., Colonel U. S. Engineers	Descriptions of stations and geographical positions of triangulation, vicinity of Newport Bay, California.
	20	Bogart, J. P., Engineer Commissioner Shellfishery Commission.	Twelve geographical positions on Connecticut and Rhode Island boundary.
	20	Shaler, Prof. N. S	Tracing of recent soundings off No Man's Land.
	24	Bogart, J. P., Engineer Connecticut Shellfishery Commission.	Tracing of Calumet Rocks, etc.
	24	Burchard, B. F., Chief Engineer and Superintendent Creosote Lumber and Construction Company, Wilmington, N. C.	Highest tides observed at Fernandina, Fla.

APPENDIX No. 3—Continued.

Date.		Name.	Data furnished.
1886.			
Nov.	24	Director U. S. Geological Survey	Geodetic data for seventeen trigonometrical points in Missouri.
	24	Pike, E. C., City Surveyor	Geographical positions and geodetic data of survey in the vicinity of Palatka, Fla.
	26	Director Geological Survey	Geographical position of station Cheehabaw, Alabama.
	29	Engineer to Boundary Commission Rhode Island and Connecticut.	Annual change of magnetic declination at the Boundary.
	30	U. S. Geological Survey	Geographical positions at Greenville, S. C., and secondary directions observed at stations Mauldin, Pinnacle, Paris, Wofford, S. C., and Benn and King, N. C.
Dec.	1	Field, J. W	Results of examination of Coast Survey records and Congressional Library, relative to chart of Assateague Island, 1687, or first publication subsequent.
	7	Elliot, George H., Lieutenant-Colonel U. S. Engineers	Tracing of plane-table and hydrographic sheets and triangulation points of Vineyard Haven.
	9	Bogart, J. P., Engineer to Boundary Survey Rhode Island and Connecticut.	Geographical position of Latimer's Reef Light.
	9	Chairman Rhode Island Boundary Commission	Geographical position of Latimer's Reef Light.
	11	Nimmo, J., Huntington, Long Island, N. Y	Heights of Harrow and West Hills stations.
	13	Wheeler, G. M., Captain of Engineers	Astronomical latitudes and longitudes, and heights of stations determined by Coast and Geodetic Survey west of Mississippi River.
	14	Mattock, J. A., County Surveyor, Silver Dale, N. C	Appendices on secular change and distribution of the magnetic declination.
	15	Director U. S. Geological Survey	Angle at Eckman, Kans., between Blue Mound and Lawrence University.
	16	Engineer to Boundary Survey Rhode Island and Connecticut.	Position of the Wicopesset spindles.
	16	Hardin, Thomas, Glenn's Valley, Ind	Position of Indianapolis, Ind., and position of astronomical station of 1882.
	16	Kimball, G., Newburgh, N. Y	Description of station Sheafe.
	18	French, T. M., Hickman, Ky	Magnetic declination at Hickman in 1881 and annual change.
	20	Pritchett, H. S., Director Washington University, Saint Louis.	Longitude of Meridian, Miss.
	20	U. S. Engineer Office, Savannah, Ga	Geographical positions and description of stations, entrance to Cumberland Sound.
	20	Chief Signal Officer, U. S. A., Washington, D. C	One hundred and seven pages, with six plates and illustrations, of the report upon the tidal observations made at Fort Conger, Grinnell Land, 1881-'83, by the expedition under command of Lieut. A. W. Greely, U. S. Army.
	22	Payson, A. H., Captain U. S. Engineers, Twelfth Light-House District, San Francisco.	Tracing of hydrographic sheet, Crescent City Harbor.
	23	Boller, F. J	Results of spirit leveling, vicinity of Staten Island, New York.
	27	Bingham, Lieut. T. A., Secretary Missouri River Commission, Saint Louis.	Geographical positions and description of stations, vicinity of Saint Louis.
	28	Pond, B. W., Examiner U. S. Patent Office	Elevations in Ohio, as given in Appendix 11, Report of 1882.
	28	Wilson, O. S., New York State Survey, Albany	Copy of a computation of the sides of a primary triangle.
	29	Koker, C. E., Merchants' Dispatch Company, Boston	Geographical positions in the United States determined by the Coast and Geodetic Survey, and references to other sources of information.
	29	Taylor, N. L., Assistant Engineer Pennsylvania Railroad Company.	Results of spirit levels, Sandy Hook to Saint Louis, and description of method used.
	29	Director U. S. Geological Survey	Geographical position of principal meridian, Missouri.
	29	Alley, W. S	Tracing of hydrography of Larchmont Harbor.
1887.			
Jan.	3	Reed, Mr. B. F. H., the Evening Standard, New Bedford, Mass.	The Table of Tidal Differences in the Tide Tables for 1887, and its defects.
	6	Bogart, J. P., New Haven, Conn	Tracing of Little Narragansett Bay, and neighboring waters, in map form, for publication.
	8	Director U. S. Geological Survey	Position and height of Fort Du Pont, D. C.
	12	Commissioner of General Land Office	Geographical position of Evanston, Wyo.
	12	Light-House Board	Tracing of recent survey of Housatonic River, Connecticut.
	13	Abert, S. T., U. S. Agent	Tracing between Benedict and Chesapeake Bay.
	13	Thompson, J. W., Surveyor, Vienna, Dorchester County, Md.	Information respecting secular change of the magnetic declination.
	14	Blackford, E. G., Commissioner Fisheries, New York State.	Tracing of topographical sheet of 1886, showing south side of Staten Island.

APPENDIX No. 3—Continued.

Date.		Name.	Data furnished.
1887.			
Jan.	17	Sanford, J. S., Lieutenant U. S. Engineers	Tracing of original of coast chart 20 of 1886, and Hempstead Harbor of 1859.
	18	Mahlo, Mr. Emil, Assistant Engineer, U. S. Engineer Office, Norfolk, Va.	Reference of mean low water to staff and bench-mark, Norfolk, Va.
	21	Harrison, Mr. E. W., Civil Engineer, Jersey City, N. J.	Mean low water on porcelain gauge, Governor's Island, New York.
	24	Taggart, Hugh T., United States Attorney, District of Columbia.	Memorandum of all charts and maps of the city of Washington, and Potomac River in vicinity, made by Coast Survey.
	25	Scofield & Starr	Tracing of topography, showing outlines of salt marsh and creeks between Bridgeport and Stratford, 1886.
	26	Chief Signal Officer, U. S. Army, Washington, D. C.	One hundred and seventy-two manuscript pages, reduction and discussion of the tidal observations made at Fort Conger, Grinnell Land, 1881-'83, by the United States Expedition to Lady Franklin Bay, Lieut. A. W. Greely, U. S. Army, commanding.
	26	Director U. S. Geological Survey	Position of station Long, Virginia.
	29	Wilson, George, Secretary Chamber of Commerce, New York.	Memorandum of the actual condition of the bars and entrances of Charleston and Galveston.
	31	Engineer Baltimore Harbor Board	Temporary use of topographical sheets 1441 *a* and *b*, 1442, and 1443 *a* and *b*.
Feb.	3	Director U. S. Geological Survey	Geographical position of Reform School and Agricultural College, near Washington.
	5	Robert, H. M., Colonel U. S. Engineers	Two tracings of part of Absecon Inlet, 1864 and 1874.
	7	Viele, Hon. E. L., House of Representatives	Tracing of topography from Sugar Loaf Hill to Constitution Island.
	8	Aukener, E., Engineer, New York	Geographical positions about Flushing Bay, Long Island.
	10	Senter, W., Portland, Me	Height of Mount Independence.
	10	Derby, George McC., Lieutenant U. S. Engineers	Triangulation results near the Raritan River up to New Brunswick; also description of stations.
	10	Haines, S. Henry	Tracings of original topographical sheets of Absecon Inlet, 1869-'70.
	10	Donham, Mr. G. M., Portland, Me	Copy of manuscript tide-tables for Boston and Portland for January, February, and March, 1887.
	11	Director U. S. Geological Survey	Position and description of astronomical station at Omaha, Nebr.
	16	Brown, Addison, United States District Judge, New York	Plotting of current results from Scotland Light-ship to Governor's Island.
	17	Brewer, Prof. W. H., Yale College, New Haven, Conn	Length of the nautical mile.
	18	Austin, W. W., Johnstown, Pa	Reference to the position of the island of Ferro.
	19	Finney, W. S., Secretary Jekyl Island Club, New York	Map of Jekyl Island, Turtle River, and Brunswick Harbor, and Big and Little Satella Rivers.
	21	Page, H. C., White Plains P. O., Md	Appendices Nos. 12 and 13, Report for 1882, on the magnetic declination, Atlantic coast, past and present.
	23	Suter, Lieut. Col. C. R., Missouri River Commission	Geodetic data of the triangulation, vicinity of Saint Louis, Mo.
	23	Bartlett, J. R., Commander U. S. N	Remarks on magnetic declination in Canada, on the geodetic spheroid used on the survey and arc measures.
	23	Dunn, Lanier, Washington, D. C	Geographical position of the Flag Rock, Virginia.
	25	Bogart, J. P., Boundary Commission, Rhode Island and Connecticut.	Position of old and new Light, Mystic, Conn.
	26	Harris, U. R., Lieutenant U. S. N	Star places for latitude of Mare Island Navy-Yard, Cal.
	28	Spofford, H. W., Washington, D. C	Copy of latest survey of Newtown Creek.
Mar.	1	Sears, Eben, Boston, Mass	Tracing of the survey of Cross Island, Maine.
	2	Crowell, Horace S., Boston, Mass	Blue-print of Great Island, Hyannis Harbor.
	2	U. S. Geological Survey	Height of Cowpen, or Cohutta, Ga.
	7	Chief of Engineers United States Army, Washington, D. C.	Description of Coast and Geodetic Survey permanent bench-mark at Gloucester, Mass.
	10	Director U. S. Geological Survey	Geographical positions defining the boundary lines of the District of Columbia.
	10	Olmstead, B. T. and G. S	Tracing of Easton's Point near the bathing beach at Newport, R. I.
	10	Goodyear and Kay	Information relating to changes in channel of Brunswick Harbor.
	10	Robert, Col. H. M., U. S. Engineers	Photograph of Assistant C. M. Bache's work, 1836, coast of New Jersey.
	14	Aukener, Ernst, Engineer, Bowery Bay Building and Improvement Company.	Tracing of Bowery Bay, from original hydrographic sheet.
	14	Gaddis, Col. O. O., Vice-President and General Manager Brunswick and Western Railroad.	Tracings of original plane-table and hydrographic sheets of Brunswick Harbor.
	17	McDonald, M. M., U. S. Fish Commission	Tracing of original hydrographic sheet of Hongres Creek, Northampton County, Va.
	18	Williams, F. R., Surveyor, Belair, Md	Present bearing of a magnetic line run near that place in 1683.
	19	French, Thomas M., Mayor, Hickman, Ky	Magnetic declination at Hickman, 1881 and 1887.

APPENDIX No. 3—Continued.

Date.		Name.	Data furnished.
1887.			
Mar.	21	Ernst, O. H., Major U. S. Engineers	Tracing of sketch of Aransas Pass, 1863.
	22	Russell, R. A., Cobton, N. C	Magnetic change of bearing between 1770 and 1886.
	24	Director U. S. Geological Survey	Description of astronomical station at Covington, Va.
	24	Rees, J. K., Professor of Geodesy, Columbia College, New York City.	Geographical positions in Massachusetts and adjacent States.
	26	Kimball, G., Newburgh, N. Y	Geodetic data for survey on the Hudson between Newburgh and West Point.
	29	Keith, George T	Tracing of topographical sheet between the mouth of the Crum and Ridley's Creeks, with soundings to center of channel.
	31	Porter, David, Admiral U. S. N	Maps of Fort Jackson and St. Philip, embracing two to three miles of shore-line on both sides of Mississippi above and below forts.
Apr.	2	Christie, P. H., Clove P. O., New York	Geographical positions, distances, azimuths, and heights of nine trigonometrical stations in eastern New York, and description of Clove station.
	2	Scripture, A. M., Surveyor, Clinton, N. Y	Advice as to value of his magnetic observations at the Clinton Observatory in 1885 and 1886.
	2	Williams, F. R., Surveyor, Belair, Harford County, Md	Present bearing of a line originally run in 1790 near Belair.
	2	Taylor, Henry, Secretary American Yacht Club, New York	Tracing of hydrographic survey of Milton Harbor, etc.
	2	Gillespie, George L., Lieutenant-Colonel U. S. Engineers	Tracing of original topographic sheet including Manchester Harbor, Massachusetts.
	4	Rees, J. K., Professor of Geodesy, Columbia College, New York.	Description of trigonometrical stations for the survey of Litchfield County, Conn.
	5	Cooley, Dr. James S., Glen Cove, N. Y	Geographical position of westernmost point of the territory of the United States.
	5	Director U. S. Geological Survey	Geographical positions of nine points in northern Alabama.
	6	Thornton, Prof. J. R., Hampden Sidney College, Prince Edward County, Va.	Change of magnetic declination since 1823 and present annual change.
	6	Director U. S. Geological Survey	Photograph of Byrd's 1886 Monomoy sheet.
	8	McAvoy, L. R., Lynn, Polk County, N. C	Heights and positions of trigonometrical points in or near that county.
	13	Chief of Engineers, U. S. Army, Washington, D. C	Descriptions of bench-marks in the vicinity of Saint Augustine, Fla.
	13	.....do	Descriptions of bench-marks in the vicinity of Punta Rasa, Fla.
	14	Black, W. M., Captain of Engineers, U. S. Army	Geodetic data of the triangulation in the vicinity of Saint Augustine, Fla., including description of station and sketches.
	19	Quimby, I. F., City Surveyor, Rochester, N. Y	Reference to geodetic results in the vicinity of Rochester.
	19	Bee, A. W	Drawing of Southeast Harbor, Mount Desert Island, embracing Echo Lake and Long Pond.
	22	Holmes, J. A., Acting State Geologist, North Carolina	List of geographical positions brought up to date.
	27	De Barril, Alex	Information relating to Drum Point, mouth of Patuxent River and Chesapeake Bay.
	27	Baldwin, James M	Comparative tracing of Atlantic Ocean coast-line.
	28	Schenck, M., Albany, N. Y	Description of bench-mark at Stuyvesant
	28	Mascart, J., Bureau Central Météorologique, Paris, France.	Copies of magnetic traces of variations of declinations and of horizontal and vertical force observed at Los Angeles, Cal., on December 25, 1884, and February 22, 1887.
	29	Black, Capt. W. M., U. S. Engineers, Jacksonville, Fla	Geodetic data and descriptions of stations of the triangulation about Punta Rasa and San Carlos Bay, Florida.
	29	Cowles, E. B. and C. P., New York City	Tracing of late survey of shores of Long Island Sound at Rye, Westchester County, N. Y.
	29	Bixby, William H., Captain U. S. Engineers	Tracings of original topographic and hydrographic sheets between Santee River and Bull's Bay, South Carolina.
	29	Steven, Simon	Tracing of South Brother, Flushing Bay, with six, nine, and twelve foot curves from original sheets.
	30	Director Geological Survey	Geographical positions and angles of certain principal triangulation stations in California.
May	4	Lewis, Charles H., Frenchman's Bay, Mount Desert Land and Water Company.	Two Coast-Survey maps, showing elevations of land on Waukeag Neck, Hancock County, Me.
	4	Hall, George W	Tracing of latest survey and soundings in vicinity of Wilson's Point, near South Norwalk.
	4	Wheeler, O. B., Assistant Engineer Missouri River Commission.	Log distance of five triangulation lines near Saint Louis, Mo.
	6	Morgan, Dr. E., Keyport, N. J	Geographical position of Keyport spire.
	12	Austin, W. W., Palmyra, N. J	Geographical position of Palmyra, N. J.
	14	Black, Capt. W. M., U. S. Engineers	Tracing of triangulation sheet as far south as the bar near buoy No. 6, San Carlos Bay.

APPENDIX No. 3—Continued.

Date.		Name.	Data furnished.
1887.			
May	16	Robinson, Thomas, Vienna, Va	Magnetic declination and change of declination, vicinity of Vienna.
	16	Redway, J. W., Geographer, publishing house of E. H. Butler & Co.	Distribution of rain-fall in the United States.
	19	Bogart, J. P., Engineer Commissioner Shellfishery Commission, New Haven, Conn.	A list of geographical positions and geodetic data of the principal points needed by the Shellfish Commission.
	23	Reed, Th. J., Napa, Cal	Geodetic data for stations Pah Rah and Carson Sink, Nevada.
	25	Sears, Eben, Boston, Mass	Tracing of soundings near Sprague's Neck, Machias Bay.
	25	Chief of Engineers, U. S. Army, Washington, D. C	Description of bench-mark, mouth of Pease Creek, head of Charlotte Harbor, Florida.
	26	Cochrane, W. B., Civil Engineer, Stamford, Conn	Magnetic declination at Stamford, and secular variation.
	26	Carter, Lieut. O. M., U. S. Engineers, Savannah, Ga	Geographical positions and distances, vicinity of Fort Jackson.
June	1	Sharpless, Isaac, Haverford College, Pa	Geodetic position of Station Yard, Pennsylvania.
	1	Garrison, J. R., Washington, D. C	Magnetic declination in 1822 and in 1887, in Stafford County, Va.
	4	Director U. S. Geological Survey	Geographical positions and descriptions of stations Fort Smith and Little Rock, Ark.
	8	Harkness, Prof. W., U. S. Naval Observatory	Geographical position of Yale College Observatory, and of the Lick Observatory, California.
	9	Director U. S. Geological Survey	Geodetic data of sixteen trigonometrical positions in Missouri.
	11	Robert, H. M., Lieutenant-Colonel U. S. Engineers, Philadelphia, Pa.	Description of tidal bench-mark, League Island Navy-Yard, Pennsylvania, 1878.
	14	McFarland, Walter, Lieutenant-Colonel U. S. Engineers	Tracing of channel leading from half mile outside (eastward and southward) Great Beds Light, in Raritan Bay, New Jersey, up to the docks at Perth Amboy and South Amboy.
	16	Young, Hon. Thomas	Tracing of topography of 1837 of west shore of Stony Brook Harbor.
	17	Van Duzee, H., Bayonne, N. J	Magnetic declination at side of Shorter's Island, Newark Bay, for 1887 and 1879.
	20	Director U. S. Geological Survey	Time of arrival of earth tremor at Los Angeles, Cal., May 3, 1887.
	20	Doyle, E. P., Secretary New York State Boundary Commission.	Projections giving shore-line of Raritan Bay. All light-houses and triangulation points and hydrographic signals determined by Lieut. G. C. Hanus, U. S. N., with two compasses on each projection showing variation of 1887.
	22	Shaffer, A. W., Raleigh, N. C	Magnetic declination observed at Raleigh in March, 1887.
	24	Harris, T. C., Raleigh, N. C	Magnetic declination at the observatory at Raleigh in March, 1887, and description of station.
	25	Director U. S. Geological Survey	Position and description of Sherrill's Mound, Iowa.
	27	Barnard, L. H., State College, Pa	Position and description of Maryland Heights and Sugar Loaf, Maryland.
	28	Van Duzee, H., Shooter's Island, New Jersey	Geographical position of three stations in Newark Bay.

APPENDIX NO. 4.—1887.

REPORT OF THE ASSISTANT IN CHARGE OF OFFICE AND TOPOGRAPHY FOR THE YEAR ENDING JUNE 30, 1887.

UNITED STATES COAST AND GEODETIC SURVEY OFFICE,
Washington, D. C., October 17, 1887.

SIR: I have the honor herewith to submit my annual report for the Office, with the reports from each division thereof.

The Computing Division has continued under the direction of Assistant Charles A. Schott, through whose able management it has met the usual calls made on it by the Survey, and been able to comply with the numerous requests from other departments and from individuals and corporations.

Geodetic and magnetic data and star places have been supplied to Maj. Conway R. Howard and Hon. W. D. Pruden, the Commissioners on the part of the States of Virginia and North Carolina, under whose direction a resurvey of the Interstate Boundary Line between these States extending from the Atlantic Ocean westward to the Nottaway River has been made. This line was originally surveyed by commissioners from England, and later by Colonel Byrd in 1728, and is one of the oldest of the surveys of Intercolonial Boundaries.

Important data of a similar nature have likewise been furnished to the Commissioners on the part of the States of Rhode Island and Massachusetts, for use in adjusting their Interstate Boundary, which has long been an unsettled matter. Like information has been supplied for the use of the honorable Commissioners of the Interstate Boundary Work between the States of New Hampshire and Massachusetts, and for the honorable Commissioners on the part of the States of New York and New Jersey, in the adjustment of their Interstate Boundaries in the vicinity of Hudson River and thence southward to Raritan Bay. Much information has also been furnished to the State of North Carolina, for use in the survey of the oyster beds along her shores, and to the States of New York and Connecticut similar information has continued to be supplied for use in the delineation of their oyster grounds.

The Drawing Division has remained under the charge of Assistant E. Hergesheimer, but for whose good management we should have had at times insufficient force to have kept up even the current work. The number of projections for original sheets called for by the field parties is a heavy strain upon the Office at times, and additional draughtsmen must be had for the proper execution of the work required of this Division. Our work should be published in due season, and this is impossible without an additional force of draughtsmen. At the request of the honorable Attorney-General, and by direction of the Secretary of the Treasury, there has been prepared in this Division under your supervision an exact copy of the Original Plan of the City of Washington, which was made by Peter Charles L'Enfant in 1790. This plan was so faded that very much of it was only deciphered after the most careful examination with reference to contemporary descriptions, and its reproduction at this time will preserve from entire loss a valuable historic paper. Important information has been furnished from this Division of the Office to the Interstate Boundary Commissions of New York and New Jersey; Massachusetts and Rhode Island; Massachusetts and

New Hampshire, and Virginia and North Carolina; and to the Commissioners of Fish and Fisheries of the States of Connecticut, New York, and North Carolina. United States District Judge Addison Wood, of New York, has been supplied with information concerning the tides and currents in New York Bay and Harbor for use in his court. The Baltimore Harbor Board, the U. S. Fish Commission, and the U. S. Geological Survey have each been furnished with various tracings or original sheets for photographing from time to time. We have supplied the usual amount of information for the Chief of Engineers and officers of his corps; and have received from them valuable information for our charts furnished us from their resurveys of the mouths and channels of rivers undergoing improvement.

I can only repeat here my recommendation of last year as to the necessity of additional draughtsmen. I also again call your attention to the fact that the Chief of this Division should receive at least three thousand dollars per annum.

The Engraving Division has continued under the charge of Assistant H. G. Ogden, to whose zeal and efficiency the Survey is indebted for our Index Maps, which have been completed during the year. These maps fill a long-felt want, and it is thought that their distribution will cause a much larger sale of our charts. Among the most important charts completed during the year are the 1–80000 series along the eastern coast of Florida, and on the coasts of Louisiana and Texas. I beg to call especial attention to that portion of the report of the Chief of the Engraving Division that treats of corrections to charts already published, as our resources at certain times are taxed to the utmost in correction of the copper-plates. As the coast becomes better lighted and buoyed, this work will increase, and I again mention the fact that additional help is required in this Division. We should have young men in training to help execute the new work now awaiting publication, and, in time, to take the place of those skilled engravers who are growing old in the service. Those who have been taken in to fill vacancies, so far as our itemized appropriations will admit, have given entire satisfaction. The success of Mr. D. C. Chapman as Electrotypist and Photographer has been marked, and his ingenuity has devised an apparatus by which photographs can be mounted exactly to scale. The services of the Chief of the Engraving Division are worth three thousand dollars per annum, and his efficient clerk, Mr. John H. Smoot, is earning better compensation than he receives.

The Instrument Division continues under the charge of Assistant Andrew Braid. New and improved tools have been introduced, and with them it is hoped we will be able not only to make all repairs necessary, but to turn out all of the new work of especial construction required by the Survey. Our graduating machine is now doing good work. Mr. Braid calls attention to many interesting matters in his annual report, among which the introduction of the electric light for use at night in our observatories is of especial interest to field officers. The Clerk gas-engine has been removed, and it is replaced by an Otto engine of ten horse-power, which is entirely satisfactory. Power from it has been supplied to the carpenter's shop, and as Wardwell's patent saw-bench and a superior wood-turner's lathe have been put in, these machines greatly facilitate the output of work. The Chief of this Division of the Office has been untiring in his efforts to promote its proficiency. The turning over to him of the General Property Account, which includes the inventories of field parties, has greatly increased his work, and to enable him to meet this Mr. R. C. Glascock, accountant, has been placed under his direction. I beg to renew my recommendation that Mr. Braid's pay be placed at three thousand dollars per annum. As Chief of this Division the responsibilities are great, and every party in the Survey on land or sea has to receive prompt attention from this Division of the Office to secure its success. His services will again be alluded to in the Report of the Bureau of Weights and Measures.

We seem to have secured the services of the right man as Chief Mechanician when we engaged Mr. Ernst G. Fischer in that capacity.

The Tidal Division has continued under the charge of Mr. A. S. Christie, who has accomplished a wonderful amount of work with most inadequate help. The dry rehearsal of work performed is not likely to interest the general reader, but to one accustomed to the steady application and constant strain required of the computer it tells of days and months of close application to duties requiring peculiar fitness. The reduction of the two-year series of tides at Fort Conger, in Grinnell Land, which was done for General A. W. Greely, was a laborious piece of work and reflects great credit upon Mr. Christie. The Tide Tables for the Atlantic and Pacific coasts for 1888 were printed somewhat in advance of previous years, and it is expected that, with no unlooked-for impediment, those for the year 1889 will be printed and ready for distribution early in April of 1888. Mr. Christie's remarks about the insufficient force at his command I know to be correct, and I earnestly recommend that in the estimates provision be made to remedy the defect. Besides the duties immediately under his charge in the Tidal Division, Mr. Christie has looked after the tidal stations at Pulpit Harbor, Maine, and Sandy Hook, New Jersey.

The Miscellaneous Division has continued under the charge of Mr. M. W. Wines, whose interesting report sets forth its work in a general way for the year. The various and responsible duties of the Chief of this Division have been performed by Mr. Wines in a most satisfactory manner. At his suggestion the charge of the general field property has been transferred to the Instrument Division, for convenience' sake. The correspondence with, and the forwarding of charts to the various agencies is growing in amount every year, and on the general introduction of our Index Maps and the Illustrated Chart Catalogues further increase is anticipated.

The Archives and Library have continued under the charge of Mr. Artemas Martin. Mr. J. M. Duesberry has performed the clerical duties of the Division in a most satisfactory manner and arranged the original records of Field Work so that they are much more accessible than formerly, although still arranged in the old order of sections. Whenever a man can be had in the place who is sufficiently familiar with the records of field-work, these records should be arranged by States and bound. The report of Mr. Martin mentions the classification of the books on the shelves, etc. A card catalogue is in course of construction under his direction, and it is hoped that it will be finished before June 30, 1888.

The Weights and Measures Bureau has continued under my charge, and I submit herewith the report of Mr. Andrew Braid, Assistant U. S. Coast and Geodetic Survey, on its operations. This Bureau will be placed in the hands of Assistant O. H. Tittmann, as we have verbally agreed, as soon as his duties in the field will admit of his devoting his entire time to it. Mr. Braid, having as much work in the Instrument Division as he can well attend to without the Weights and Measures, has earnestly recommended this.

The Accounting Division has been under Mr. George A. Bartlett, Disbursing Clerk of the Treasury Department, who has under his official bonds made all disbursements for the Survey. Advances of public funds are no longer made to officers of the Survey unless they are bonded or hold a commission in the military service. Mr. Bartlett has for two years past performed the thankless duty of disbursing the Coast and Geodetic Survey appropriations without any compensation for his services, and I most earnestly recommend that provision be made in the estimates for an allowance of not less than $500 per annum for this duty. Except for a period of two months beginning early in September, 1886, during which the experiment of auditing vouchers at the Disbursing Office of the Treasury was tried, all of the auditing of the vouchers and accounting for expenditures has been done since August 23, 1886, at the Coast and Geodetic Survey Office, under the direction of Mr. J. W. Parsons, whose report is herewith submitted. To his skill and untiring devotion to the service we are indebted for the splendid order in which the accounts now are. It is true that field officers have occasionally felt that their accounts were not passed as promptly as they wished; but it must be remembered that we have been harassed in many ways and have earnestly endeavored to send the accounts from this Office in such form that they might defy even captious criticism. We have at the same time had much extra work in the furnishing of explanations in the matter of the suspended vouchers in the unsettled accounts covering the last two years of the administration of Superintendent J. E. Hilgard. The amount of work growing out of these accounts can hardly be appreciated by any one not actually engaged upon it. The honorable First Comptroller has been very patient in considering them, even to the most minute details. The deeper matters have been inquired into, the more satisfactory the result has been for the Survey generally.

The report made by Mr. Parsons is worthy of careful consideration, and his views as to the advisability of our having a Disbursing Clerk coincide with my own.

Dr. W. B. French, assisted by Miss S. C. Ayres, has performed the laborious and exacting clerical duties of the immediate office of the Assistant in Charge. At my earnest request he has foregone any extended leave of absence and remained almost daily at his post. I wish especially to acknowledge the skillful assistance of Miss S. C. Ayres in Office correspondence and the care of the records of leave of absence. Mr. R. M. Harvey has attended to the filing of letters, registering mail, and receiving and forwarding express matter. Miss S. B. Harvie and Miss Kate Lawn have contributed much to facilitate the work of my part of the Office by promptly furnishing accurate copies, by hand and by type-writer, of material intrusted to them from all Divisions of the Office. On the 6th of January, 1887, the office of the Assistant in Charge lost the valued services of Miss F. Cadel by transfer to the Tidal Division. Up to that date she had given faithful attention to the preparation of descriptions and sketches of stations and to miscellaneous copying. The Survey lost the service of an accomplished clerk when Miss M. L. Oliver was promoted and transferred to the Treasury Department. It is hardly necessary that I should allude here to the valuable service rendered by your especial clerk, Mr. William B. Chilton, but it is proper that I should extend my thanks to him for his earnest efforts to facilitate the work of the Office generally.

Mr. Silas E. Parsons, a trustworthy and honest man, died suddenly October 11, 1886. Mr. William J. McMahon, who had served as plate-printer's helper in the Office but a short time, died January 23, 1887; and Mr. F. Courtenay, an accomplished engraver, died March 23, 1887.

I feel that after two years of service as Assistant in charge of the Office and Topography, I am beginning to understand its many complexities. I am also more than ever convinced that whoever manages such a work must rely for success mainly upon the earnest support of the Chiefs of Division and their skilled helpers. I have had this, and beg here to express to them my high appreciation of their untiring patience and industry.

In public as well as in private business a judicious division of labor is indispensable to the highest excellence in results. Such a division of labor is illustrated in the present distribution of their respective special duties between the Hydrographic Office of the Navy, the U. S. Geological Survey, and the U. S. Coast and Geodetic Survey, whose fields of operation are sufficiently distinct to prevent mutual encroachment, while their methods are in some particulars sufficiently similar to promote the earnest emulation which is a condition of the highest efficiency.

Believing that the U. S. Coast and Geodetic Survey has a future of great usefulness and promise before it, and looking with pride upon its previous performance, I shall not cease to devote my best efforts to its continued success and welfare.

Yours, respectfully,

B. A. COLONNA,
Assistant in charge of Office and Topography.

To Mr. FRANK M. THORN,
Superintendent U. S. Coast and Geodetic Survey.

REPORT OF THE COMPUTING DIVISION, COAST AND GEODETIC SURVEY OFFICE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

COMPUTING DIVISION, COAST AND GEODETIC SURVEY OFFICE,
June 30, 1887.

DEAR SIR: In conformity with regulations I have the honor to submit the usual report of work done by the several computers and others temporarily attached to this Division of the Office during the fiscal year ending June 30, 1887.

The charge of the Computing Division was continued with the undersigned, and no change occurred during the year in the personnel of the regular computing force, which remained the same as in the previous year, and thus demanded its utmost exertion in order to keep up the current work and make some impression on older work now capable of being placed on standard data. Mr. A. D. Risteen was transferred to the Computing Division October 1, 1886, taking a place which had become free by Mr. A. S. Christie's appointment to the Tidal Division. On October 26, 1886, Mr. M. Farquhar was temporarily transferred to the pendulum party under Assistant

C. S. Peirce; he reported for duty in the Computing Division February 1, 1887; between April 22 and May 11, he was again engaged on pendulum work; in consequence of these transfers the amount of astronomical work has suffered to some extent; besides the only telegraphic longitude work that could be attempted during the year had to be placed in the hands of Subassistant Preston, who was attached to the Division for less than two and one-half months. Mr. P. R. Stansbury, clerk to the Computing Division, resigned on account of ill health some time in August, 1886; his place has not been filled, but between August 20, 1886, and January 31, 1887, Miss P. E. Smith acted as writer, and in the same capacity Mr. W. C. Maupin was engaged between February 14, 1887, and the close of the fiscal year; technical and scientific papers are copied by one of the computers. Of temporary help the following computers were attached to this Division during the fiscal year: Subassistant F. H. Parsons from July 1, 1886, to August 20; Mr. W. B. Fairfield from July 1, 1886, to August 9; Subassistant J. E. McGrath from July 22 to 29, 1886; Subassistant E. D. Preston from September 18, 1886, to November 30; Assistant E. Smith from October 4, 1886, to March 22, 1887; Subassistant R. A. Marr from October 15, 1886, to April 7, 1887; Subassistant C. H. Van Orden from October 21, 1886, to March 31, 1887. Mr. J. M. Duesberry acted as writer between February 1 and 12 inclusive.

The increased general correspondence of the Office, relating to matter technical and scientific, makes occasionally heavy demands on the computing force, and is frequently a source of unavoidable interference with the regular computing work; the information called for is furnished as promptly as practicable. Besides directing, distributing, supervising, and reporting the work performed in this Division, special attention was given by me to the following discussions and reports: During July, August, September, October, and part of November, 1886, I gave all my spare time to the computations, the discussion, and the report for the press of the magnetic and corresponding astronomical work of the Fort Conger Polar Expedition under command of Lieut. A. W. Greely, U. S. A., 1881–'84; this work forms part of the International Polar Research, and will be published by the office of the United States Signal Corps. I have also brought out a new edition (the sixth) of the Discussion of the Secular Variation of the Magnetic Declination, which now comprises one thousand and seventy-one observations at ninety-four stations; this paper forms Appendix No. 12 in the Report for 1886. Considerable attention, also, was given to proof-reading of certain scientific appendices in the 1885 Report. Among a large number of reports made, one on the construction of a new primary-base apparatus and one on astronomical, geodetic, and magnetic field-work proposed for the next fiscal year may be specially mentioned. I also made the usual magnetic observations in this city at the close of the year.

The work performed by each computer during the year is herewith enumerated in detail.

Edward H. Courtenay was engaged in the least square adjustment of the old and new triangulations of Long Island Sound and adjacent coasts, bringing the results up to the standard astronomical and geodetic data of the Survey. He also chiefly supplied the required geodetic information for field and office parties; had full charge of the geodetic registers containing the geographical positions, and took care of the duplicate records deposited with the Computing Division. He also prepared manuscript computations for binding, making in all one hundred large volumes; assisted in getting up certain statistics bearing on the efficiency of the service for the years 1884–'85–'86–'87, and made satisfactory progress with the computation and adjustment of the triangulation about Baltimore, 1886.

Myrick H. Doolittle prepared final abtracts of horizontal directions at the eastern stations in Nevada, 1882–'83, and in western Utah, 1884–'85, and completed the computation of the primary and secondary triangulations; adjusted the primary triangulations, coast of California, south of Monterey Bay, 1884–'85–'86; computed the secondary and tertiary triangulations in the vicinity of San Simeon of 1871–'72–'73–'74 and of 1884–'85; solved a number of normal equations; computed the length of a set of four-meter base bars; adjusted the triangulation between Hereford Inlet and Absecon Light-house, New Jersey, 1881–'84–'86; computed the geodetic operations on the coast between Cape Fear River and the South Carolina boundary, 1886; computed the supplementary triangulation of Core Sound and of Beaufort Harbor, North Carolina, 1886; computed the heights of Mount Hamilton and surrounding stations, California, and prepared abstracts of vertical angles at all primary stations in Nevada and Utah.

Charles H. Kümmell was principally engaged on the solution of normal equations required in the adjustment of the old and new triangulations of Long Island Sound and shores of Connecticut and New York, and otherwise assisted Mr. Courtenay in the revision of angles of this work; computed some heights of stations in California; was engaged in preparing abstracts of angles of the new harbor survey of Baltimore, 1886; revised abstracts of vertical angles of primary stations in Nevada and Utah; computed a number of geographical positions in the Gulf of Georgia, Washington Territory, and attended to miscellaneous revisions of information prepared for field parties.

Henry Farquhar attended to the preparation of lists of star places required for field parties or office use; reduced the transit observations at Fort Conger, 1881–'84, in connection with moon culminations and gravity observations; computed the astronomical latitude of stations Adobe, Colo., 1881, Vincennes, Ind., 1881, Cape Sable, Florida, 1886, Madison, Wis., 1885, two stations, and nearly completed the computation for latitude of five boundary stations between Virginia and North Carolina, 1886–'87.

Alexander Ziwet converted the hourly differential readings of the magnetic declination made at Fort Conger, 1882–'83, into absolute measure; prepared six large diagrams of the term-day observations taken at that station, and verified certain astronomical computations connected with this work; computed the azimuths at the following stations: West Base, Louisiana, 1883, Blue Buck Ridge, Louisiana, 1883, Gratiot Grove, Wisconsin, 1880, Sherrill's Mound, Iowa, 1880, Mount Callahan, Nevada, 1881, South Caswell, N. C., 1885, Toiyabe Dome, Nevada, 1880, New Macon, N. C., 1886, Cape Romano, Florida, 1886, Cape Sable, Florida, 1886, and made progress with the azimuth computation station Tassel, N. Y., 1880; assisted in solving normal equations in connection with magnetic discussions; reduced the magnetic observations made at five stations in Missouri and Colorado, 1886, and at five stations on the North Carolina and Virginia boundary, 1886–'87, also at Charlottesville, Va., 1887, and at Washington, 1887, and introduced the correction for change of temperature in the spirit-level results between Mobile and New Orleans.

John B. Boutelle was chiefly engaged in revisions of abstracts of angles and in computation of geographical positions in Connecticut, New York, and Washington Territory; attended to the geographical registers, to miscellaneous revisions, and to copying professional papers and reports.

Allan D. Risteen attended to revising abstracts, revisions of geodetic computations, proof-reading, copying, solving normal equations in connection with geodetic work; he assisted in Mr. Courtenay's work, and in computations of geographical positions, vicinity of Baltimore, 1842–'86.

William C. Maupin attended to plain copying, insertion of positions in the registers, and making copies of descriptions of stations, and of other information for field parties.

The work performed by temporary assistance was as follows:

Subassistant F. H. Parsons was engaged on miscellaneous geodetic work and revisions of magnetic computations.

W. B. Fairfield revised abstracts of angles, stations in the western part of Long Island Sound and about New York.

Subassistant J. E. McGrath made some revisions of magnetic computations.

P. R. Stansbury attended to clerical work.

P. E. Smith was engaged in plain copying.

Subassistant E. D. Preston computed the telegraphic difference of longitude between Kansas City, Mo., and Ellsworth, Kans., 1885, and between Saint Augustine, Fla., and Savannah, Ga., 1882, and made good progress with the longitude computation, Kansas City to Colorado Springs, Colo., 1885. He was also engaged on matter relating to pendulum work.

Assistant E. Smith revised abstracts of horizontal directions at primary stations in California and Nevada; computed some geographical positions; computed the magnetic observations made by Subassistant Baylor between July and October, 1885, and at various stations in 1884–'85–'86; was engaged in reading chronograph sheets in connection with pendulum work; revised the azimuth computations at Eureka, Nev., 1881, and at Pioche, Nev., 1883, and computed the spirit levels between Mobile, Ala., and New Orleans, La., 1886.

Subassistant R. A. Marr was engaged on geodetic computations connected with the resurvey of the Connecticut and Rhode Island boundary; in miscellaneous geodetic revisions, and in computing geographical positions on standard data, Gulf of Georgia. He also computed the triangulation of Rosario Strait, 1885.

Subassistant C. H. Van Orden attended to some revision and duplication of geodetic records, and made good progress with the computation of the spirit levels between Mobile, Ala., and Citronelle, Ala., 1884.

J. M. Duesberry was engaged in copying descriptions of stations for field parties.

Yours, respectfully,

CHAS. A. SCHOTT,
Assistant in charge Computing Division.

Mr. B. A. COLONNA,
Assistant in charge Office and Topography.

REPORT OF THE DRAWING DIVISION, COAST AND GEODETIC SURVEY OFFICE, FOR THE YEAR ENDING JUNE 30, 1887.

U. S. COAST AND GEODETIC SURVEY OFFICE, DRAWING DIVISION,
Washington, July 28, 1887.

SIR: During the year ending June 30, 1887, the force of draughtsmen has been subject to change only by the loss of Mr. C. Junken, by resignation, and the employment at intervals on extra-labor account of Mr. H. J. Schneider.

Mr. Junken's long service and varied experience in the field and office fitted him for duties of a character that can be discharged only through careful training and familiarity with the science and methods of our work, so that adding his loss to an already small force, for most of the year we have been fighting accumulating work with insufficient strength to handle it with vigor and system.

Still the year has not been without valuable results.

Messrs. A. Lindenkohl, H. Lindenkohl, C. Junken, E. H. Fowler, E. J. Sommer, and C. Mahon have been employed upon topographical and hydrographic reductions, compilations, and projections for field and office work.

Messrs. P. Erichsen, E. Molkow, and C. Mahon have been for the greater part of the year, and E. A. Trescot occasionally, employed inking plane-table sheets.

Mr. A. Lindenkohl has, in addition to his regular chart work, kept up the progress sketches for the annual report.

Messrs. H. Lindenkohl, E. H. Fowler, E. J. Sommer, and E. A. Trescot have made finished drawings for photolithographing.

Mr. E. H. Wyvill has been employed most of the year on projections for field-work.

Messrs. E. A. Trescot, J. Olberg, and W. H. Benton have made tracings of topographical and hydrographic maps and sketches, and the miscellaneous drawings that have been required.

Messrs. E. Willenbucher, W. C. Willenbucher, and F. C. Donn have been on duty during the year with the Hydrographic Inspector.

During the year work has been done upon the following charts and maps: On seventeen general charts from 1-1200000 to 1-200000 scales; on twenty-eight coast charts 1-80000 scale; on twenty-three harbor charts of various scales; on eleven charts of various scales, finished drawing has been done for photolithography, of which five have been published during the year; sixty-nine plane-table sheets have been inked wholly or in part; one hundred and eleven projections were made for field-work; eighty-four tracings of original surveys, topographical and hydrographic sheets, have been furnished during the year at the request of private parties.

The usual amount of verifications and measurement of area of engraved work has been done, and the average amount of studies for new charts made.

The clerical duties of the Division have been satisfactorily performed since February 19, 1887, by Mr. J. H. Roeth.

The statistical details for the year are hereto appended.

Respectfully, yours,

E. HERGESHEIMER,
Assistant Coast and Geodetic Survey,
In charge Drawing Division.

Mr. B. A. COLONNA,
Assistant in charge of Office Coast and Geodetic Survey.

DRAWING DIVISION.

Charts completed or in progress during the year ending June 30, 1887.

1. Topography. 2. Hydrography.

Numbers of charts. Series.	Numbers of charts. Catalogue.	Titles of charts.	Scale.	Draughtsman.	Remarks.
		SAILING CHARTS.			
	A	Cape Sable to Cape Hatteras	1-1200000	2. A. Lindenkohl	Additions.
	B	Cape Hatteras to Key West	1-1200000	1. A. Lindenkohl	Do.
	600[1]	San Diego to Point Arena	1-1200000	H. Lindenkohl, lettering	In progress.
	600[2]	San Francisco Bay to Strait of Juan de Fuca	1-1200000	H. Lindenkohl, lettering	Do.
	601	San Diego to San Francisco	1-1200000	2. A. Lindenkohl	Additions.
		GENERAL COAST CHARTS.			
	6	Quoddy Head to Cape Cod	1-400000	1. H. Lindenkohl	Additions.
	9	Cape May to Cape Henry	1-400000	2. A. Lindenkohl and C. Mahon	Do.
	11	Cape Hatteras to Cape Romain	1-400000	1. H. Lindenkohl	Do.
	12	Cape Romain to St. Mary's Entrance	1-400000	1, 2. H. Lindenkohl and C. Mahon	Do.
	14	Cape Canaveral to Fowey Rocks	1-400000	2. A. Lindenkohl	Do.
	21	Galveston to the Rio Grande	1-400000	2. A. Lindenkohl	Do.
	673	Santa Rosa Island to Point Buchon	1-200000	1. H. Lindenkohl	In progress.
	677	Point Arena to Cape Mendocino	1-200000	2. C. Mahon	Do.
	681a	Approaches to Columbia River	1-200000	2. A. Lindenkohl	Additions.
	706	Sumner Strait and north part of Clarence Strait	1-200000	1, 2. H. Lindenkohl	In progress for photo-lithographing.
	(*)	Nantucket to Block Island	1-200000	1, 2. A. Lindenkohl	In progress.
	(*)	Block Island to New York	1-200000	1, 2. A. Lindenkohl	Do.
		COAST CHARTS.			
1	101	Eastern boundary to Seal Island	1-80000	1, 2. A. and H. Linkenkohl, C. Junken, and E. H. Fowler.	In progress.
2	102	Head Harbor to Petit Manan	1-80000	2. A. and H. Lindenkohl	Do.
5	105	Penobscot Bay to Kennebec Entrance	1-80000	2. A. Lindenkohl	Additions.
6	106	Kennebec Entrance to Saco River	1-80000	2. A. Lindenkohl	Do.
7	107	Seguin Island to Kennebunkport	1-80000	2. A. Lindenkohl	Do.
9	109	Boston Bay and Approaches	1-80000	1, 2. E. H. Fowler and E. J. Sommer	Do.
13	113	Cuttyhunk to Block Island, with Narragansett Bay	1-80000	2. C. Junken	Do.
14	114	Long Island Sound, eastern sheet	1-80000	1. E. H. Fowler	In progress for photo-lithographing.
15	115	Long Island Sound, middle sheet	1-80000	1, 2. A. Lindenkohl	Additions.
19	119	Southern coast of Long Island, western sheet	1-80000	2. A. Lindenkohl	Do.
20	120	New York Bay and Harbor	1-80000	2. A. and H. Lindenkohl	New edition.
22	122	Barnegat Inlet to Absecon Inlet	1-80000	1. A. Lindenkohl	Additions.
24	124	Delaware Entrance	1-80000	1, 2. A. Lindenkohl and C. Junken	In progress.
31	131	Entrance to Chesapeake Bay, Hampton Roads, etc.	1-80000	1. A. Lindenkohl	Additions.

* Mercator chart.

DRAWING DIVISION—Continued.

Number of charts. Series.	Catalogue.	Titles of charts.	Scale.	Draughtsman.	Remarks.
		COAST CHARTS—continued.			
39	139	Oregon Inlet to Cape Hatteras	1-80000	1. E. H. Fowler.	Additions.
52	152	Merrill's Inlet to Cape Romain, including Winyah Bay.	1-80000	2. E. J. Sommer	In progress.
53	153	Winyah Bay to Long Island	1-80000	2. A. Lindenkohl	Do.
54	154	Long Island to Hunting Island	1-80000	2. H. Lindenkohl	Additions.
63	163	Latitude 27° 40′ north to Jupiter Inlet	1-80000	2. A. Lindenkohl	Do.
65	165	Hillsboro' Inlet to Fowey Rocks	1-80000	2. A. Lindenkohl	Do.
66	166	Key Biscayne to Carysfort Reef	1-80000	2. A. Lindenkohl	Do.
76	176	Lemon Bay to Tampa Bay	1-80000	1, 2. H. Lindenkohl	In progress.
78	178	Tampa Bay to Bayport	1-80000	2. C. Mahon	Do.
80	180	Cedar Key to Deadman's Bay	1-80000	1. A. Lindenkohl	Do.
81	181	Apalachee Bay	1-80000	1. A. Lindenkohl	Additions.
87	187	Pensacola Entrance to Mobile Bay	1-80000	2. A. Lindenkohl	Do.
88	188	Mobile Bay	1-80000	2. A. Lindenkohl	Do.
89	189	Bon Secours Bay to Round Island	1-80000	2. A. Lindenkohl and C. Junken	Do.
		HARBOR CHARTS.			
	305	Pleasant Bay to Prospect Harbor	1-40000	1. E. H. Fowler	In progress.
	308	Approaches to Blue Hill Bay and Eggemoggin Reach.	1-40000	2. A. Lindenkohl	Additions.
	311a	Fox Island Thoroughfare	1-20000	2. E. H. Fowler	Do.
	337	Boston Harbor	1-40000	1, 2. H. Lindenkohl and E. J. Sommer	Do.
	369	New York Bay and Harbor	1-40000	1, 2. A. and H. Lindenkohl and E. H. Fowler.	Do.
	369[4]	Hudson and East Rivers from West Sixty-seventh Street to Blackwell's Island.	1-10000	1, 2. A. and H. Lindenkohl	Completed; photolithograph.
	370	Hudson River No. 1	1-60000	1, 2. A. Lindenkohl	Additions.
	384	Patapsco River and Baltimore Harbor	1-60000	2. A. Lindenkohl	Do.
	385	Annapolis Harbor	1-60000	2. A. Lindenkohl	Do.
	455a	St. John's River, Jacksonville, to Lake Monroe	1-80000	2. H. Lindenkohl	Completed; new edition photolithograph.
	469	Key West Harbor	1-50000	2. A. Lindenkohl	Additions.
	610	San Pedro and Wilmington Harbors	1-25000	1, 2. E. J. Sommer	Do.
	611	Santa Barbara Harbor	1-20000	1, 2. E. J. Sommer	In progress for photolithographing.
	640	Columbia River Entrance	1-40000	2. A. Lindenkohl	Do.
	641a	Columbia River No. 6, Willow Bay to Portland	1-40000	2. A. Lindenkohl	In progress.
	659	Tillamook Bay	1-20000	2. C. Mahon	Additions.
	708	Harbors in Clarence Strait	1-40000	1, 2. H. Lindenkohl	Completed; photolithograph.
	424, 425	Cape Fear River	1-40000	1, 2. A. and H. Lindenkohl	In progress.
	369[5]	Hell Gate and parts of East and Harlem Rivers	1-5000	1, 2. H. Lindenkohl	Completed; photolithograph.
	638	Umpquah River	1-20000	1, 2. W. H. Benton	In progress for photolithographing.
	356	Block Island	1-10000	1, 2. E. H. Fowler	Completed; photolithograph.
	639	Siuslaw River	1-10000	1, 2. H. Lindenkohl	Do.

REPORT OF THE ENGRAVING DIVISION, COAST AND GEODETIC SURVEY OFFICE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

COAST AND GEODETIC SURVEY OFFICE,
Washington, August 4, 1887.

SIR: I respectfully submit the following report on the operations of the Engraving Division during the fiscal year ending with June 30, 1887.

The statistics are as follows:

ENGRAVING.

Number of new charts published from engravings, printed from copper	10
Number of new editions of charts	4
Number of new sketches and illustrations	15
Number of new charts commenced	8
Number of new editions of charts commenced	8
Number of new sketches and illustrations commenced	10
Number of copper plates corrected for printing:	
Charts	465
Sketches and illustrations	10
Number of unfinished plates on hand:	
Charts	41
New editions	7
Sketches and illustrations	15

ELECTROTYPING.

Number of pounds of copper deposited	2,479
Number of square inches on which deposit was made	97,410
Number of copper plates made:	
Basso	45
Alto	51

Of this number, two basso and one alto were for the Hydrographic Office, Navy Department, and one basso and one alto for the Engineer Corps, U. S. Army (Lake Survey plates).

PHOTOGRAPHING.

Number of negatives made	160
Number of prints made	359

PRINTING.

Number of impressions for Chart-room	31,007
Number of impressions for Assistant in Charge	1,203
Number of impressions for Engraving Division	2,360
Number of impressions for Hydrographic Inspector	1,122
Number of impressions for lithographers (transfer proofs)	73
Number of impressions for Atlantic Coast Pilot	1,106

I am pleased to report that the young men who have been added to the force of engravers have rendered most satisfactory service, and promise in due time to make up the losses sustained during the preceding year.

The engravers were employed during the year principally as follows: H. M. Knight, A. Petersen, J. G. Thompson, and A. C. Ruebsam on lettering; W. A. Thompson on topography and sand; J. Enthoffer and R. F. Bartle on topography; H. C. Evans and E. J. Enthoffer on sand; E. H. Sipe and W. A. Davis on outlines, lettering, and miscellaneous corrections and additions; T. Wasserbach on sand and miscellaneous corrections and additions; H. T. Knight and H. L. Thompson on outlines and lettering; and F. Courtenay, R. F. Bartle, jr., and J. P. Cox a portion of the year on lettering, under the appropriation for extra engraving.

In addition to their general occupation, all the engravers were employed at different times on the miscellaneous corrections and additions to the plates, to prepare them for printing, in cleaning electrotypes, and other incidental work.

The most important engravings completed during the year include the coast charts on 1–80000 scale of the east coast of Florida from Cape Canaveral to Fowey Rocks, and a series of "Index Maps" to the charts published by the Survey, for all the coasts of the United States. The Index Maps are for free distribution, and it is hoped that their instrumentality will place our charts before a larger number of sea-faring people interested in securing reliable chart publications than any advertisement that has heretofore been attempted.

The correction of the "Aids to Navigation" on the printing plates continues to occupy a large portion of the time in miscellaneous engraving, and as they are necessary changes for the benefit of the mariner, must be provided for in all estimates for future work. Every new chart published adds to the labor, and taken in connection with engraving arising from resurveys and the extension of old surveys to the limits required by law, it is probable that on the completion of all the charts contemplated by the approved scheme a larger force of expert engravers will be required to maintain the charts in condition for issue than we now employ for all purposes. If the rate of increase in this class of work experienced during the past year is maintained for a few years longer, and no substantial increase is made in the force of engravers, it will practically suspend the publication of new charts, with the result of locking up in the archives a mass of original surveys that are urgently required for the benefit of national maritime interests. I feel that I can not, therefore, present too strongly to your consideration the necessity of an immediate increase in the number of draughtsmen and engravers employed in the Office, if we would prevent such a state of affairs.

The electrotyping has continued most satisfactorily under the immediate direction of Mr. D. C. Chapman, assisted during the first part of the year by Mr. C. N. Darnall, and during the last six months by Mr. L. P. Keyser. Mr. Chapman has also been most successful in reducing original topographical sheets by photography. Thirty-eight original sheets were thus reduced during the year and mounted to scale; over one hundred negatives were required in the process, and the net result is represented by the outlines and topography on eight copper plates. The direct reduction of original sheets by photography, however, is of limited application. As a rule, a clearly inked sheet can be reduced four times and furnish a clear copy of the whole of it, and eight times if only the principal outlines are required; but in the latter case the services of a draughtsman may be necessary in some cases to bring the work out fully. Engraved charts on scale of 1–80000 have also been reduced to 1–400000, the outlines inked and generalized by a draughtsman, and the detail to be omitted washed out before mounting the print. In all cases of reduction, the limit permissible is largely defined by the generalization required on the reduced scale, and generally a reduction of more than four times necessitates the employment of a draughtsman to perfect the prints. Further experiments with processes of reduction were in contemplation, but the overburdened condition of the Drawing Division has necessitated their postponement to a more convenient season.

The Printing Office has continued under the management of Mr. F. Moore, with Messrs. D. N. Hoover and J. Beck in charge of the thirty-eight and thirty-six inch presses, as heretofore. The aggregate of prints pulled is not so large as in former years, as only one thousand one hundred and six copies were furnished the Coast Pilot Division against seven thousand four hundred and eighty-two the preceding year. Thirty-one thousand and seven copies were pulled for the chart-room, an increase of two thousand five hundred and eleven over the preceding year. This is the largest number ever furnished the chart-room in one year.

Many changes have taken place during the year in the force employed in the Division. Mr. F. Courtenay, an expert letter engraver engaged on contract work, died March 25, 1887, after a service of about twenty years. In the estimation of his associates, Mr. Courtenay's earlier engravings were unexcelled in clearness and beauty of form, and serve to-day as a standard for the most expert. William J. McMahon, a "printer's helper," died January 15, 1887, after a brief term of service. Mr. McMahon, although suffering from an incurable malady, stood manfully to his work, only relinquishing his labor when there was no longer physical strength to maintain it.

Mr. A. C. Ruebsam, engraver, resigned August 9, 1887, after a service of ten years. Mr. Ruebsam had learned his art in the employ of the Survey, under the immediate direction of his uncle, Mr. E. A. Maedel, and showed much of the family talent in the execution of his work. Mr. T. Sullivan, printer's helper, resigned April 22, 1887, after a service of more than four years. Mr. Sullivan was industrious and efficient in the performance of his duties through the whole period of his service.

Mr. Lynn Troutman, first employed as an extra hand in the electrotype rooms October 19, 1886, was transferred to the Printing Office January 11, 1887, where he has since rendered satisfactory service as printer's helper. Mr. S. B. Shelton, appointed a printer's helper April 23, 1887, has also rendered satisfactory service during the brief term of his employment. Mr. Louis P. Keyser was appointed assistant to the electrotyper and photographer February 11, 1887, and has thus far shown an aptitude for the delicate and responsible work required of him that is exceedingly gratifying. The appointment of Messrs. H. T. Knight and H. L. Thompson to the regular force of engravers on September 1, 1886, has thus far proved most satisfactory, and promises to perpetuate in the Survey the talent of their predecessors.

It also gives me pleasure to report a continuance of most satisfactory and efficient services by Mr. John H. Smoot, the clerk of the Division. His duties are detailed and laborious, and he attends to them with a promptness and zeal well worthy of emulation.

I transmit herewith the usual list of plates completed, continued, and commenced during the year, and I have the honor to remain,

Yours, very respectfully,

HERBERT G. OGDEN,
Assistant U. S. Coast and Geodetic Survey,
In charge of Engraving Division.

B. A. COLONNA, Esq.,
Assistant in charge of Office, etc.

Engraved plates of maps and charts completed, commenced, and continued during the fiscal year ending June 30, 1887.

1. Outlines. 2. Topography. 3. Sanding. 4. General lettering.

Catalogue No.	Plate No.	Title.	Scale.	Engravers and work.
		CHARTS COMPLETED.		
153	1503	North Island to Long Island, including Cape Romain	1-80000	1, 2. W. A. Thompson. 3. H. M. Knight. 4. J. G. Thompson.
162	1924	From Cape Canaveral southward to latitude 27° 41′	1-80000	2, 3. W. A. Thompson. 4. J. G. Thompson and H. L. Thompson.
163	1872	From latitude 27° 41′ to Jupiter Inlet	1-80000	1, 2. W. A. Thompson. 3. H. C. Evans. 4. H. M. Knight, A. Petersen, F. Courtenay, and H. L. Thompson.
164	1875	Jupiter Inlet to Hillsboro Inlet	1-80000	3. H. C. Evans. 4. H. M. Knight and A. Petersen.
165	1876	Hillsboro Inlet to Fowey Rocks	1-80000	1, 2. W. A. Thompson. 3. H. C. Evans. 4. H. M. Knight, A. Petersen, and F. Courtenay.
180	1746	Cedar Keys to Deadman's Bay	1-80000	1, 2. W. A. Thompson. 3. T. Wasserbach. 4. A. Petersen and T. Wasserbach.
184	1917	Saint Joseph's and Saint Andrew's Bays	1-80000	2. W. A. Thompson. 4. J. G. Thompson and W. H. Davis.
192	1537	Chandeleur and Breton Island Sounds	1-80000	2, 3. W. A. Thompson. 4. H. M. Knight.
210	1779	Aransas Pass and Corpus Christi Bay, with the coast to latitude 27° 12′.	1-80000	3. W. A. Thompson and T. Wasserbach. 4. H. M. Knight, J. G. Thompson, and T. Wasserbach.
379	1847	Cape Henlopen and the Delaware Breakwater	1-20000	2. W. A. Thompson. 4. J. G. Thompson.
124	1899	Delaware Entrance; new edition, 1886	1-80000	3. W. A. Thompson. 4. J. G. Thompson.
311a	1128	Fox Islands Thoroughfare; new edition, 1886	1-20000	2. E. J. Enthoffer. 4. W. H. Davis.
440	1831	Tybee Roads and Savannah River; new edition, 1886	1-40000	4. H. M. Knight and J. G. Thompson.

Engraved plates of maps and charts completed, commenced, and continued, etc.—Continued.

Catalogue No.	Plate No.	Title.	Scale.	Engravers and work.
		CHARTS COMPLETED—continued.		
154	1910	Long Island to Hunting Island; new edition, 1887	1-80000	1, 2. H. C. Evans. 3. W. A. Thompson. 4. J. G. Thompson.
	1893	Index Map No. 1, Cape Sable to Barnegat		4. H. T. Knight.
	1894	Index Map No. 2, Gay Head to Cape Lookout		4. H. T. Knight.
	1895	Index Map No. 3, Cape Hatteras to Fernandina		4. H. T. Knight.
	1896	Index Map No. 4, Fernandina to Key West		4. H. T. Knight.
	1911	Index Map No. 5, Key West to Cape San Blas		4. James P. Cox and H. L. Thompson.
	1912	Index Map No. 6, Cape San Blas to Ship Shoal		4. James P. Cox and H. L. Thompson.
	1913	Index Map No. 7, Ship Shoal to the Rio Grande		1. H. L. Thompson. 4. James P. Cox and H. L. Thompson.
	1921	Index Map No. 8, San Diego to San Francisco		1. H. L. Thompson. 4. James P. Cox and H. L. Thompson.
	1922	Index Map No. 9, San Francisco to Koos Bay		1, 4. James P. Cox and H. L. Thompson
	1923	Index Map No. 10, Koos Bay to the Boundary		1, 4. James P. Cox and H. L. Thompson.
	1918	Index Map No. 11, sailing and general coast charts, Atlantic and Gulf.		1, 4. H. T. Knight and H. L. Thompson.
	1919	Index Map No. 12, sailing charts, Pacific coast		1, 4. H. T. Knight and H. L. Thompson.
	1950	Index Map No. 13, harbor charts, Alaska coast		1, 4. H. T. Knight.
	1694	Atlantic Coast Pilot, view entrance to Salem Harbor		4. W. H. Davis.
	1952	View of western approaches to Santa Barbara Channel		
		ENGRAVED PLATES OF MAPS AND CHARTS COMMENCED.		
8	1926	Approaches to New York	1-400000	4. E. H. Sipe.
31	1942	Nantucket Shoals to New York; western sheet	1-200000	1. W. H. Davis.
101	1937	Eastport to Little River, Maine	1-80000	1, 2. Joseph Enthoffer. 4. J. G. Thompson and T. Wasserbach.
101	1955	Eastport to Little River, Maine, offshore	1-80000	4. T. Wasserbach.
119	1927	Great South Bay, Fire Island; new edition	1-80000	1. W. A. Thompson. 4. E. H. Sipe.
126	1935	Delaware Bay and River; new edition	1-80000	1. W. A. Thompson.
178	1931	Hog Island to Wall's Creek	1-80000	1, 2. R. F. Bartle. 4. J. G. Thompson.
179	1932	Wall's Creek to Cedar Keys	1-80000	1, 2. R. F. Bartle. 4. J. G. Thompson.
304	1938	Cross Island to Nash Island	1-40000	1, 2. Joseph Enthoffer. 4. J. G. Thompson.
	1911	Index Map No. 5, Key West to Cape San Blas		4. James P. Cox and H. L. Thompson.
	1912	Index Map No. 6, Cape San Blas to Ship Shoal		4. James P. Cox and H. L. Thompson.
	1913	Index Map No. 7, Ship Shoal to the Rio Grande		1. H. L. Thompson. 4. James P. Cox and H. L. Thompson.
	1921	Index Map No. 8, San Diego to San Francisco		1. H. L. Thompson. 4. James P. Cox and H. L. Thompson
	1922	Index Map No. 9, San Francisco to Koos Bay		1, 4. James P. Cox and H. L. Thompson.
	1923	Index Map No. 10, Koos Bay to the Boundary		1, 4. James P. Cox and H. L. Thompson.
	1918	Index Map No. 11, sailing and general coast charts Atlantic and Gulf.		1. H. L. Thompson. 4. H. T. Knight.
	1919	Index Map No. 12, sailing charts, Pacific coast		1. H. L. Thompson. 4. H. T. Knight.
	1950	Index Map No. 13, harbor charts, Alaska coast		1, 4. H. T. Knight.
	1952	View of western approaches to Santa Barbara Channel.		
124	1899	Delaware Entrance; edition of 1886	1-80000	3. W. A. Thompson. 4. J. G. Thompson.
5	1887	Key West to the Rio Grande, eastern sheet; edition of 1887.	1-1200000	1, 4. E. H. Sipe.
9	1945	Cape May to Cape Henry; edition of 1887	1-400000	4. A. Petersen.
106	1925	Kennebec Entrance to Saco River; edition of 1887	1-80000	3. W. A. Thompson. 4. J. G. Thompson and T. Wasserbach.
127	1200	Cape May to Isle of Wight; edition of 1887	1-80000	4. E. H. Sipe.
154	1910	Long Island to Hunting Island; edition of 1887	1-80000	1, 2. H. C. Evans. 3. W. A. Thompson. 4. J. G. Thompson.
190	1943	Round Island to Grand Island; edition of 1887	1-80000	3, 4. T. Wasserbach.
659	1948	Tillamook Bay; edition of 1887	1-20000	1, 4. H. T. Knight.

Engraved plates of maps and charts completed, commenced, and continued, etc.—Continued.

Catalogue No.	Plate No.	Title.	Scale.	Engravers and work.
		ENGRAVED PLATES OF MAPS AND CHARTS CONTINUED.		
6a	1362	Quoddy Head to Isle au Haut	1-400000	1, 2. Joseph Enthoffer.
16	1855	Key West to Tampa Bay	1-400000	4. J. G. Thompson.
102	1742	Seal Island to Petit Manan	1-80000	1, 2. Joseph Enthoffer. 4. J. G. Thompson.
102	1860	Seal Island to Petit Manan, offshore	1-80000	4. J. G. Thompson and T. Wasserbach
124	1884	Delaware Entrance; new edition	1-80000	1, 2. Joseph Enthoffer. 3. W. A. Thompson. 4. J. G. Thompson and A. Petersen.
147	1861	Cape Lookout to Bogue Inlet	1-80000	3. H. M. Knight.
150	1841	Masonboro Inlet to Shailotte Inlet	1-80000	1, 2. W. A. Thompson. 3. H. C. Evans. 4. H. M. Knight and A. Petersen.
176	1848	Lemon Bay to Tampa Bay	1-80000	3. H. C. Evans. 4. A. Petersen.
187	1284	Pensacola Entrance to Mobile Bay	1-80000	4. R. F. Bartle, jr.
305	1821	Pleasant Bay to Prospect Harbor	1-40000	3. H. C. Evans. 4. A. Petersen and E. H. Sipe.
424	1892	Cape Fear River, No. 1, entrance to Reeves Point; new edition.	1-40000	1, 2. R. F. Bartle. 4. A. Petersen and R. F. Bartle, jr.
425	1890	Cape Fear River, No. 2, Reeves Point to Wilmington; new edition.	1-40000	2. R. F. Bartle. 4. A. Petersen and R. F. Bartle, jr.
455 D	1888	Saint John's River, Tocoi to San Mateo	1-40000	2. W. A. Thompson. 4. A. Petersen.
600[1]	1755	San Diego to Point Arena	1-1200000	1. H. M. Knight.
600[2]	1908	San Francisco to the Straits of Juan de Fuca	1-1200000	1, 4. H. M. Knight.
641c	1867	Columbia River, No. 5, Kalama to Willow Bar	1-40000	4. A. Petersen and F. Courtenay.
641 D	1868	Columbia River, No. 6, Willow Bar to Portland	1-40000	4. F. Courtenay.
677	1818	Point Arena to Cape Mendocino	1-200000	4. J. G. Thompson and E. H. Sipe,
480	1889	Cedar Keys; new edition	1-50000	3. E. J. Enthoffer.

REPORT OF THE INSTRUMENT DIVISION, COAST AND GEODETIC SURVEY OFFICE, FOR THE YEAR ENDING JUNE 30, 1887.

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, September 7, 1887.

DEAR SIR: I have the honor to submit the following report of the Instrument Division for the fiscal year ending June 30, 1887.

The duties of this Division include the care of the instruments, camp equipage, and miscellaneous property of the Survey, and the receipts and shipments of the same; the repairs and alterations of instruments, and the making and purchase of new ones; the preparation of instruments for the field, including their critical examination and adjustment, and the determination of constants, such as level values, micrometer values, inequality of pivots, etc.; the official correspondence relating thereto, and the keeping of the records and inventories.

As heretofore, the main work of the mechanicians has consisted of repairs and alterations of instruments, but some new work, mainly protractors, sectors, declinators, etc., has also been accomplished, and several old instruments that had become unserviceable have been reconstructed or converted into other forms. The large amount of repairing needed for the various classes of instruments used in the extensive and varied operations of the Survey precludes the possibility, with our limited force, of manufacturing on a large scale, but it is hoped that with our now improved facilities a better showing in this respect will be made in the future.

During the year four new lathes, a new shaper, and sundry minor tools were added to the shop equipment to replace worn-out or antiquated implements, and the result has been a marked improvement both as to quality and quantity of work turned out. The gas-engine heretofore in use had never worked satisfactorily, and finally gave out altogether. Its irregular and spasmodic working, or more frequently its failure to work at all, caused great annoyance and vexatious delays, and it has now been superseded by one of better construction and greater power. The new engine, so far, has given entire satisfaction, and we have been able since its introduction to extend the shafting, not only to all the machinery of the instrument shop, but also to the carpenter shop, where new machinery has also been added.

The level-grinder commenced during the previous fiscal year has been completed, but the results so far obtained have not been satisfactory, and some modifications of the original design have been found necessary. The fault is not in the principle of the machine, but in the mechanical execution, there being too much flexure in some of its parts and too much play in some of the points.

In my last report I mentioned the experimental two-minute graduation of a fourteen-inch circle, which had not at the date of the report been tested. A similar graduation has been put upon the circle of a new twelve inch theodolite and carefully tested through a long series of observations by Messrs. F. H. Parsons and W. I. Vinal, whose mean results show a probable error of only one and four-tenths of a second for the position of any one line. The maximum combined error of graduation and uncertainty of observation in any set of the series is six and a half seconds. This result is very satisfactory.

The instrument is now in use in the field by Assistant G. A. Fairfield, who will make a report upon it at the close of the season.

I would here call attention to the introduction, at the instance of Assistant Fairfield, of the electric light to supersede the inconvenient and objectionable bull's-eye lanterns for axis illumination and for reading micrometers during night observations. The battery used is very portable, being contained in a box ten by four and three-quarter inches, and will run a three-candle power incandescent lamp about three hours. By having several of these batteries, continuous observations can be made throughout the night when necessary. A strip of sheet rubber surrounding the base of the theodolite carries the two copper wires connected with the battery and insulates them from each other. The observer has the lamp attached to the button-hole of his coat by means of a telephone cord, to which is attached a spring clip, by means of which he can in any position bring his lamp into the circuit. Another similar lamp, suitably mounted, furnishes the axis illumination, and can at will be thrown out of the circuit. It is believed that the use of these lights will add to the accuracy of night observations by largely reducing the heating effect upon the instrument, and will moreover save the observer the inconvenience and discomfort of handling hot lamps and inhaling the offensive products of combustion.

The following statement shows in detail the force employed in this Division during the year, and indicates the character of the work performed by each:

Mr. R. E. Schubert served as foreman of the shop from October 4, 1886, to May 14, 1887, when he resigned and was succeeded by Mr. E. G. Fischer, who entered upon his duties June 1, 1887.

Mr. E. Eshleman served during the entire year. He was employed upon the examination and adjustment of instruments; the repairs of theodolites, reconnoitering telescopes, meridian transits, heliotropes, levels, barometers, vertical circles, zenith telescopes, sectors, etc.; in testing levels; silvering sextant and heliotrope mirrors; ruling of diaphragms, etc.; and in graduating theodolite circles, protractors, sextants, station transits, etc.

Mr. L. A. Fischer served during the entire year. He has made new protractors, position indicators, letter-gauges for the Engraving Division, glass scales and adapters, tools for the shop and dividing engine, and has worked upon the repairs of theodolites, dip circles, magnetometers, vertical circles, alidades, levels, sextants, etc., and attended to the office clocks.

Mr. S. A. Kearney likewise served during the entire year, and has made new station transits, screw stocks, tripod heads, clamps, hub and dies, microscope brackets, straight-edges, tools, and tracing apparatus; repaired pantograph, steel tapes, alidades and plane tables; attended to the running of the gas-engine and assisted in the erection of the new shafting.

Mr. P. Vierbuchen served during the entire year, and has been engaged upon the repairs of plane tables, plane-table compasses, alidades, protractors, tide-gauges, levels, sectors, ships' compasses, signal lamps, and zenith telescopes. He has also made twelve new plane-table compasses, two one-hundred feet base wires, and sundry tools, and reconstructed two self-registering tide-gauges.

Mr. W. Suess served during the entire year. He has completed the new level-grinder; made and graduated metric scales; attended to the office bells and batteries; and repaired magnetometers, pantographs, compasses, clocks, heliotropes, sextants, and dip circles.

Mr. Theodore Gerhard was employed from the beginning of the fiscal year to August 6 and again from October 15 to the close of the year. He has made new micrometers, beam compasses, and patterns, and has repaired theodolites, sextants, heliotropes, levels, engineers' transits, planimeters, compasses, gradienters, and binoculars. He has also mounted lenses and micrometers, and made three new triangles for the Los Angeles Magnetic Observatory.

Mr. M. Lauxman served during the whole year, and was employed upon miscellaneous work, such as making bolts, taps, and dies, shoes for instrument stands and telemeters; clamps, screws, hooks, plummets, and capstan bars; in cleaning and polishing drawing instruments and metal work; in marking instrument boxes, etc. He also assisted Mr. Kearney in the work upon the gas-engine.

In the carpenter shop, the usual work, consisting of the making of telemeters, instrument stands and cases, plane-table and drawing boards, and patterns; the packing of instruments, etc., for transportation; the erection of shelving; the making of book, record, and chart cases for the various Divisions, and for the Archives and Library; the miscellaneous repairs of the building and its furniture, etc., has been attended to.

Mr. H. O. French has had immediate charge of this work, and was assisted during the whole year by Mr. G. W. Clarvoe; from the beginning of the year to October 11 by Mr. S. E. Parsons, and from March 1, 1887, by Mr. C. M. Darnelle.

Mr. R. C. Glascock has attended to the books and records relating to the camp equipage and other miscellaneous property of the Survey and the official correspondence relating thereto.

During the interval between field seasons, Assistant W. I. Vinal and Subassistant F. H. Parsons were temporarily attached to the Instrument Division and rendered valuable assistance in the determination of eccentricity and errors of graduation of theodolites, and in miscellaneous observations and computations.

Mr. Parsons's services will be further mentioned in the annual report of the Weights and Measures Division, which has also remained under my charge.

Yours, respectfully,

ANDREW BRAID,
Assistant Coast and Geodetic Survey.

Mr. B. A. COLONNA,
Assistant in charge of Office, Washington, D. C.

REPORT OF THE TIDAL DIVISION, COAST AND GEODETIC SURVEY OFFICE, FOR THE YEAR ENDING JUNE 30, 1887.

TIDAL DIVISION, U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, D. C., June 30, 1887.

SIR: I have the honor to submit herewith the report of this Division for the fiscal year ending June 30, 1887.

The work done during the year was as follows:

1. An aggregate of three years one month of tide-rolls, four years one month of tabulated high and low waters, three years one month of tabulated half-hourly ordinates, two years eleven months of meteorological abstracts, two months of temperatures and densities of the sea, one hundred and sixty-two original volumes of staff readings, and one hundred and thirty-eight duplicate volumes of staff readings was received, examined, and registered; and seventy letters were prepared relating thereto.

2. The major part of the proofs were read for the Tide Tables for the Atlantic and Pacific coasts for the year 1887, two volumes octavo; like tables for the year 1888 were prepared, and the proofs read for the Atlantic coast.

3. Tidal data and information were prepared and furnished in response to nineteen calls from persons not connected with the Survey. This includes the report furnished to the Chief Signal Officer, U. S. Army, upon the two years of tidal observations made at Fort Conger, Grinnell Land,

by Lieutenant Greely's command in 1881-'83. This report consisted of one hundred and seventy-two pages of text in manuscript, with six plates and illustrations, and represents an aggregate of seven hundred days of computing and clerical work.

4. Tide notes for twenty-two stations were prepared for publication on the charts of the Survey, and a considerable number of like notes (no record was kept until recently) were prepared for the Coast Pilot Division.

5. The mean sea-level at Biloxi, Miss., was computed by lunations from September 7, 1881, to December 24, 1882, and furnished for the use of the Computing Division.

6. Tidal data have been prepared for the use of field parties as required. A record beginning April 15, 1887, shows that from that date to June 30, such data were prepared and furnished for eighty-seven stations in response to eighteen requisitions.

7. An aggregate of two years of observations was discussed by the harmonic analysis for purposes of prediction at New London, Washington, and Key West.

8. The reduction and co-ordination of all available tidal data in the vicinity of New York City was begun by the reduction of some forty short series, and a like work was initiated for Delaware Bay and River.

9. Stencil addition forms were prepared for harmonic component v.

The following is a statement of the total force of computers and clerks, including the chief, attached to the Tidal Division during the fiscal year:

Name.	Attached to Tidal Division.	
	From—	To—
Mr. Alex. S. Christie	July 1, 1886	June 30, 1887
Mr. L. P. Shidy	July 1, 1886	June 30, 1887
Miss C. B. Turnbull	July 1, 1886	June 30, 1887
Mrs. M. E. Nesbitt	July 1, 1886	June 30, 1887
Mr. J. W. Whitaker	July 1, 1886	June 30, 1887
Mrs. S. M. Taliaferro	July 1, 1886	Nov. 15, 1886
Mr. C. D. Gedney	July 22, 1886	Oct. 22, 1886
Mrs. A. G. Reville	Nov. 8, 1886	June 30, 1887
Miss F. Cadel	Jan. 6, 1887	Jan. 13, 1887
	Jan. 19, 1887	Jan. 21, 1887
	Feb. 3, 1887	June 30, 1887

Mr. Alex. S. Christie remained in charge throughout the year.

It was found practically convenient, if not absolutely essential to the prompt production of results called for, to employ each member of the force more or less upon almost every description of the work. As exceptions to this rule the examination and registration of records received, the preparation of correspondence, and the writing of reports, were attended to invariably by the Chief of Division, the principal reductions in the harmonic analysis were made by Mr. L. P. Shidy, and the predictions with the machine by Mr. J. W. Whitaker. The whole force was kept constantly employed, and with one exception (brought to your attention by my letter of October 6, 1886) the several computers and clerks evinced a very satisfactory disposition to do their duty.

The Division is, however, lamentably deficient in computing power and should be re-enforced by two computers of standard ability, preferably by young men of sixteen to twenty years. This would insure the putting of the tidal work on its feet.

Yours, very respectfully,

ALEX. S. CHRISTIE,
Chief of Tidal Division.

Mr. B. A. COLONNA,
Assistant U. S. Coast and Geodetic Survey,
In charge of Office and Topography.

REPORT OF THE MISCELLANEOUS DIVISION, COAST AND GEODETIC SURVEY OFFICE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

DEAR SIR: I have the honor to submit herewith the usual report of this Division for the fiscal year ending June 30, 1887.

The work of the Division included, as in former years, the printing and issue of the Annual Reports and other publications of the Survey, and of all record books, blank forms, etc., used in the field-work and in the business of the Office; the correspondence with sale agents relating to the supply and sale of charts, Coast Pilots, and Tide Tables, and keeping the accounts connected therewith; the purchase, custody, and issue of stationery; the supervision of the Office buildings, and such other special duties as were assigned from time to time. Experience having shown that it would facilitate business to place the general field property, including camp equipage, in charge of the Instrument Division, an order to that effect was issued on my suggestion, and the transfer was made on April 21, 1887. From that date the Instrument Division has had charge of the issue of such property, together with all the books and papers relating to the same.

The Report of the Superintendent for the year ending June 30, 1885, and the Tide Tables for the year 1887, for both the Atlantic and Pacific coasts of the United States, which had been sent to press in the preceding fiscal year, were published. A third edition of the Atlantic Local Coast Pilot, Subdivision 13, "South Coast of Long Island, New York Bay, and Hudson River," was also published.

The following publications were sent to press during the year:

Tide Tables for the Atlantic coast for 1888; Tide Tables for the Pacific coast for 1888; Atlantic Local Coast Pilot, Subdivision 6–7, "Cape Ann to Monomoy;" Atlantic Local Coast Pilot, Subdivision 9, "Buzzard and Narragansett Bays;" Atlantic Local Coast Pilot, Subdivision 21, "Tybee Roads to Jupiter Inlet;" and a new edition of the "Catalogue of Charts."

The usual distribution of the Report for 1885 and of the other publications of the Survey, to the Departments of Government, to institutions, and individuals was made. The Appendices to the Annual Reports, published in pamphlet form, were, upon application, distributed gratuitously as heretofore. Twelve Notices to Mariners, a list of which is embodied in this report, were issued during the year.

The following is a summary of the work done in the Division during the year:

Letters written	1,811
Orders for purchases issued	283
Requisitions made for printing and binding	120
Requisitions for stationery, etc., filled	415
Annual Reports distributed	2,801
Tide Tables issued	2,915
Atlantic Coast Pilots issued	49
Subdivisions, Atlantic Local Coast Pilot	537
Pacific Coast Pilot; Alaska, Part 1	57
Hand corrections on 19,973 printed charts	149,340
Buoys and lights colored on 22,435 printed charts	673,188

The total receipts from all sources on account of sales of publications for the fiscal year ending June 30, 1887, were $5,115.96.

The distribution of Annual Reports was as follows:

Date of Report.	Domestic distribution.		Foreign distribution.		Total.
	To institutions.	To individuals.	To institutions.	To individuals.	
1851	1	1	1		3
1852	1		1		2
1853	3		1		4
1854	1		1		2
1855	1		1		2
1856	1		1		2
1857	1		1		2
1858	1		1		2
1859	1	2	1		4
1860	2	3	1		6
1861	2	2	1		5
1862	3		1		4
1863	2	1	1		4
1864	2		1		3
1865	5	1	3		9
1866	5		3		8
1867	5	2	3		10
1868	5	3	3		11
1869	6	1	4		11
1870	12	2	4		18
1871	14	5	5		24
1872	14	5	7		26
1873	18	6	7	1	32
1874	18	11	7	1	37
1875	20	12	8	1	41
1876	22	12	7	1	42
1877	23	12	7	1	43
1878	28	20	8	2	58
1879	27	141	7	2	177
1880	36	88	8	3	135
1881	36	78	9	3	126
1882	71	143	10	4	228
1883	58	145	11	5	219
1884	43	209	9	6	267
1885	546	477	191	20	1,234
	1,034	1,382	335	50	2,801

The following is a list of the publications of the Survey, with the number of copies of each, received from the Public Printer during the year:

Name of publication.	No. of copies.	Name of publication.	No. of copies.
Annual Report, 1885	2,991	No. 8.—Geographical positions in the States of Massachusetts and Rhode Island	983
Atlantic Local Coast Pilot, Subdivision 13, south coast of Long Island, New York Bay, and Hudson River	480	No. 9.—Connection of the Yolo Base with the Primary Triangulation of California, including a reduction and adjustment of the Davidson Quadrilaterals	500
Tide Tables for the Pacific coast of the United States for the year 1887	1,530	No. 10.—On Geodetic Reconnaissance	20
Tide Tables for the Atlantic coast of the United States for the year 1887	2,025	No. 11.—A Plea for a Light on St. George's Bank	300
Instructions and Memoranda for Descriptive Reports to accompany original sheets	500	No. 12.—Comparison of Transverse Sections in the Delaware River from the surveys of 1819, 1843, and 1878	100
Superintendent's Circular No. 2, 1886, "Commutation of Subsistence"	1,000	No. 13.—Tides at Governor's Island	500
APPENDICES TO THE REPORT FOR 1885.		No. 14.—Gulf Stream Explorations. Observations of Currents.	50
No. 6.—Magnetic Dip and Intensity, with their Secular Variation and Geographical Distribution in the United States	1,000	No. 15.—On a Device for Abbreviating Time Reductions	500
No. 7.—Magnetic Variations off the coasts of California and Mexico, 1774 to 1790	300	Nos. 16 and 17.—Gravity Research. Effects of a Noddy and of Unequal Temperature upon the Periods of a Pendulum	300
		No. 18.—Tribute to the Memory of Henry W. Blair, Assistant	100

Name of publication.	No. of copies.	Name of publication.	No. of copies.
NOTICES TO MARINERS.		No. 81.—Correction of an Error in Notice to Mariners No. 77.	1,000
		No. 82.—Ledge developed in East River, New York	1,000
No. 76.—Chart Corrections during the Quarter ending June 30, 1886	1,000	No. 83.—Chart Corrections during the Quarter ending December 31, 1886	1,000
No. 77.—Chart Corrections during the Quarter ending September 30, 1886	1,000	No. 84.—Obstruction to Navigation in the Gulf Stream	1,000
No. 78.—Velocity and Direction of the Gulf Stream between Fowey Rocks, Florida, and Gun Cay, Bahamas	1,000	No. 85.—Chart Corrections during the Quarter ending March 30, 1887	1,000
No. 79.—Development of Shoals off False Cape, Virginia	1,000	No. 86.—Dangerous Sunken Wreck in Long Island Sound	1,000
No. 80.—Ledges developed in the Resurvey of Long Island Sound	1,000	No. 87.—Shoal Spot on Rocky Ledge off Eaton's Point, Long Island Sound, N. Y	1,000

List of persons who furnished valuable information to the Survey, and to whom charts were issued free of charge, pursuant to authority granted in the letter of the Secretary of the Treasury dated October 28, 1885.

Date.	Name.	Address.	Number of copies.
1886.			
Feb. 24	John Grant	Mobile, Ala	2
Mar. 4	New York, Philadelphia and Norfolk Railroad	Cape Charles City, Va	4
July 26	D. W. Fox	Hallet's Point, N. Y	1
Oct. 16	Simpson & Brother	San Francisco, Cal	4
Nov. 23	W. I. Hough	Martinez, Cal	1
1887.			
Feb. 3	J. W. Keen	Sitka, Alaska	12
Mar. 11	W. B. Bell	Fernandina, Fla	1
Mar. 13	J. C. Breckenridge	Olympia, Wash	1
May 14	Captain Avelarius	New York, N. Y	2
May 17	M. Kahn	College Point, N. Y	2

The following table shows the total number of charts received in the Chart Room, the number issued, and the number condemned during the year, and the number remaining on hand June 30, 1887:

On hand and received.	Number of copies.	To whom issued.	Number of copies.
On hand July 1, 1886	36,810	Executive Departments	8,824
Received during the year:		Senators and Representatives	2,515
Printed from copper plates	29,852	Sale agents	21,010
Printed from stone	5,278	Institutions	451
Returned by sale agents	485	Foreign Governments	587
		Miscellaneous	629
		Total number issued	34,016
		Number condemned	1,868
Total	72,425	Total	35,884

Total on hand and received		72,425
Total number issued	34,016	
Total number condemned	1,868	
		35,884
On hand June 30, 1887		36,541

The total issue of charts during the year was thirty-four thousand and sixteen copies; of these, 21,010 copies were deposited with sale agents, being 1,086 more copies than were issued to agents in the preceding fiscal year. The total issue exceeded the number issued during the year 1885-'86 by 3,495 copies.

Mr. Hugo G. Eichholtz has continued in charge of the Chart Room, and the correction and issue of charts have been made under his immediate supervision.

Mr. Freeman R. Green has kept the accounts of the sale agents and performed clerical duties.

Mr. J. H. Barker has been employed in plotting corrections on standards, examining proofs for the Engraving Division, and in making corrections and additions on printed charts. During the year he examined and corrected 10,056 charts, making 71,509 corrections.

Mr. James L. Smith has been engaged in clerical work in the Chart Room.

Mr. A. Upperman continued making chart corrections, and has greatly improved in neatness and accuracy. He made during the year 74,124 corrections on 9,155 charts.

Miss Mary Thomas colored 370,508 buoys and lights on 10,633 charts.

Miss Lily A. Mapes was engaged in coloring and correcting charts. She made 3,707 corrections on 762 charts, and colored 302,680 buoys and lights on 11,802 printed charts.

Miss May Thomas was assigned to this Division April 1, 1887, and has been engaged in correcting catalogues.

Mr. R. T. Bassett has continued in charge of the Map-mounting Room. He was employed in mounting antiquarian drawing paper on muslin for original topographical and hydrographic sheets; joining charts for Chart Room; binding quarterly proofs for the use of the Superintendent and Engraving Division; mounting charts on muslin for Office use and other purposes; varnishing tracing paper for Drawing Division; mounting and repairing original sheets and charts for the use of the Office, and other miscellaneous work for the Office.

Mr. William M. Long performed the duties of janitor, and Messrs. David Parker and C. O. Rockwell and John G. Culverwell those of watchmen, throughout the whole year. Mr. C. O. Rockwell was dismissed June 30, 1887.

The messengers, under the immediate supervision of William H. Butler, Chief Messenger, and the laborers employed in the Office have faithfully performed their duties.

Yours, respectfully,

M. W. WINES,
General Office Assistant.

B. A. COLONNA, Esq.,
Assistant in charge of Office and Topography,
U. S. Coast and Geodetic Survey.

ARCHIVES AND LIBRARY, UNITED STATES COAST AND GEODETIC SURVEY OFFICE. REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, D. C., August 23, 1887.

DEAR SIR: I have the honor of submitting herewith the report of the receipt and registry in the Archives of original and duplicate records, computations, original topographic and hydrographic sheets, and specimens of sea bottom, turned into the Office during the fiscal year ending June 30, 1887; and also a report of the number of books and pamphlets received in the Library during the same time.

I.—*Records and Computations.*

GEODETIC WORK.

	Number of volumes.		Number of cahiers.	Total.
	Original.	Duplicate.	Original.	
Observations of horizontal measures	75	84	....	159
Observations of vertical measures	1	6	....	7
Descriptions of stations	22	16	....	38
Base measurement	5	4	....	9
Spirit-leveling observations	69	59	....	128
Geodetic miscellany	6	2	....	8
Computations	10	....	115	125
Total	188	171	115	474

I.—*Records and Computations*—Continued.

ASTRONOMICAL WORK.

	Number of volumes.		Number of cahiers.	Number of sheets.	Total.
	Original.	Duplicate.	Original.	Original.	
Observations for latitude	7	11			18
Observations for longitude	2	10			12
Chronograph sheets				128	128
Observations for time	6	9			15
Observations for azimuth	6	9			15
Micrometer measures	2	2			4
Astronomical miscellany	2	2	2		6
Computations	6		67		73
Total	31	43	69	128	271

MAGNETIC WORK.

	Number of volumes.		Number of cahiers.		Number of sheets.		Total.
	Original.	Duplicate.	Original.	Duplicate.	Original.	Duplicate.	
Observations for terrestrial magnetism	5	6	51	51		1	114
Magnetic traces					501	504	1,005
Computations			4		141		145
Total	5	6	55	51	642	505	1,264

PENDULUM WORK.

	Number of volumes.		Number of cahiers.		Total.
	Original.	Duplicate.	Original.	Duplicate.	
Pendulum observations		1			1
Sheet readings of pendulum transit		2			2
Computations			4		4
Report on computations			1		1
Total		3	5		8

METEOROLOGICAL WORK.

Meteorological observations	2				2
Meteorological report			1		1
Total	2		1		3

HYDROGRAPHIC WORK.

	Number of volumes.		Number of cahiers.		Number of bottles.	Number of rolls.	Total.
	Original.	Duplicate.	Original.	Duplicate.			
Observations for soundings	495	270					765
Observations for angles	47	32					79
Descriptions of hydrographic signals	8	1					9
Specimens of sea-bottom					181		181
Specimen books	4						4
Tidal observations	220	142					362
Tide curves						11	11
Descriptions of tide-gauges and bench-marks			2				2
Current observations and data	4	2	6				12
Miscellaneous	1		14				15
Total	779	447	22		181	11	1,440

II.—*Topographic and Hydrographic Surveys.*

TOPOGRAPHIC WORK.

Titles of topographic sheets.	No. of sheets.
Indian River from the Narrows to the Inlet, Fla	1
From head of East Bay (Galveston Harbor) to Sabine Pass, Tex	2
Vicinity of Bolivar Point to Rollover Station, coast of Texas	1
East of Sabine Pass, coast of Louisiana, from longitude 93° 31′ to Calcasieu Pass, La	1
Coast in vicinity of San Juan Capistrano, Cal	1
East coast of Florida:	
Between Hillsboro and New River Inlets, Fla	1
South End of Lake Worth and Hillsboro Inlet	1
Lynn Haven Bay, Va	1
Faulkner's and Goose Island, Long Island Sound, Conn	1
Toro Point to Villa Creek, Cal	1
Puget Sound from Point Defiance to Ketron Island, Wash. Ter	1
Carr's Inlet, Wash. Ter	1
Shore-line of Marsh Island, La	1
Snohomish River to Snohomish City, Wash. Ter	1
Possession Sound, Wash. Ter	1
Resurvey of the Point of Monomoy, Mass	1
Chenier le Tigre and vicinity	1
Coast of Louisiana from Freshwater Bayou to Big Constance and Pecan Island	1
Coast of Louisiana:	
From Big Constance Bayou to the westward	1
From Point au Fer to near Oyster Bayou	1
Shore-line of Caillou Bay	1
Shore-line from Oyster Bayou to Caillou Bayou	1
Northwest shore of Vermilion Bay, Petite Anse Bayou and Canal	1
Part of Cape Lookout, N. C	1
Revisory survey of shores of Straits of Karquines, Cal	1
Shores of San Pablo Bay, Cal	1
West coast of Florida:	
From Clear Water Harbor to Anclote Keys	1
From Trouble Creek to Cedar Point	1
From Cedar Point to Wall Creek	1
Coast of Washington Territory, Gray's Harbor Entrance southward to Shoalwater Bay	1
South opening into Edgartown Harbor and Cotamy Bay, Mass	1
Shore-line in vicinity of Chatham, Mass	1
Greenwich Cove and Stamford Harbor, Conn	1
Coscob Harbor to Rye Neck, Conn. and N. Y	1
Shore-line from Stony Brook to Northport Beach, L. I	1
North shore of Long Island from Port Jefferson to Stony Brook	1
East River from Lawrence's Point to Throg's Neck and Flushing Bay	1
Rosario Strait:	
Ship Harbor and Padilla Bay, Wash. Ter	1
Fidalgo and Padilla Bays, Wash. Ter	1
Cypress, Guemes, and Sinclair Islands, Wash. Ter	1
City and water front of Tacoma, Wash. Ter	1
City and water front of Seattle, Wash. Ter	1
Coast of North Carolina from Smith's Island to Federal Point, N. C	1
Total	44

HYDROGRAPHIC WORK.

Titles of hydrographic sheets.	
Channel of East River on either side of Blackwell's Island, N. Y	1
East River, from Suspension Bridge to Blackwell's Island, N. Y	1
Part of upper New York and East River to Suspension Bridge, N. Y	1
New York Lower Bay, N. Y	2
New York Bar and Entrance, N. Y	1
Gravesend Bay and Narrows, N. Y	1
Straits of Florida, deep sea-soundings, Fla	1
Horn Island Pass, Miss	1
New York Upper Bay, including Kill van Kull, N. Y	1
Hudson River:	
From Battery to Fourteenth street, New York	1
Fourteenth street to Eighty-eighth street, New York	1
Eighty-eighth street to One hundred and forty-first street, New York	1
Columbia River, Oregon	1
Willamette River, Oregon	1
Willamette and Columbia Rivers, Oregon	1
Bull's Bay, S. C	1
Entrance to Santee River, S. C	1
Maurice River, N. J	1
Maurice River Cove, N. J	2
Dewees', Capers', and Price's Inlets, S. C	1
North shore of Long Island Sound, David's Island to Rye Neck, N. Y	1
Englishman's Bay, west, Me	1
Englishman's Bay, east, Me	1
Little Kennebec River, Me	1
Machias River and upper part of Machias Bay, Me	1
Machias Bay, Me	1
Machias Bay and Cross Island Narrows, Me	1
Little Machias Bay and to the eastward, Me	1
Coast of Maine:	
From Ravine △ to James Head, Me	1
James Head to Quoddy Head, Me	1
Quoddy Head to Libby Island, Me	1
Puget Sound:	
Port Orchard, Dye's Inlet, and Dogfish Bay, Wash	1
Southern part of Hood's Canal, Wash. Ter	1
Coast of New Jersey from Hereford Inlet to latitude 39° 14′, N. J	1
Offshore soundings, coast of Delaware	1
Along north shore Long Island Sound:	
From Sheffield Island to Stamford Light, Conn	1
From Stamford Light to Manursing Island, Conn	1
Hempstead Harbor and approaches, Long Island, N. Y	1
Hudson River, from One hundred and forty-first street to Tubby Hook, N. Y	1
Harlem River:	
From Randall's Island to High Bridge, N. Y	1
From High Bridge to King's Bridge, Spuyten Duyvil Creek, and Hudson River, from Tubby Hook to Spuyten Duyvil, N. Y	1
Passaic and Hackensack Rivers, N. J	1
East River, New York, from Lawrence's Point to College Point, including Flushing Bay, N. Y	1

II.—*Topographic and Hydrographic Surveys*—Continued.

HYDROGRAPHIC WORK—Continued.

Titles of hydrographic sheets.	No of sheets.
Huntington Bay, Long Island, N. Y	1
Approaches to Huntington Bay, Long Island, N. Y	1
Smithtown Bay, Long Island, N. Y	1
Oyster Bay, Long Island, N. Y	1
Offshore soundings:	
Cape Henlopen to Cape Charles, Del., Md., and Va	1
Cape Charles to Cape Hatteras	1
Pacific coast, vicinity of Tillamook Bay, Oregon	1
Tillamook Bay and approaches, Oregon	1
Columbia River:	
Vicinity of Walker's Island	1
Vicinity of Tongue Point	1
Off Nauset Beach, Mass	1
East side of Monomoy Island, from the Point to latitude 41° 37′, Mass	1
Long Island Sound:	
From Stratford Shoal to Eaton's Neck	1
From Eaton's Neck to Execution Rocks	1
From Faulkner's Island to Stratford Shoal	1
Port Jefferson Harbor and vicinity, L. I	1
Along north shore of Long Island Sound:	
From Welch's Point to Stratford Point	1
From Stratford Point to Bridgeport	1
From Fairfield Bar to Cockenoes Island, Conn	1
From Cockenoes Island to Sheffield Island, Conn	1
Soundings in search of reported shoal, Port Harford, Cal	1
West Coast of Florida:	
North of Anclote Keys to Rainbow Point, Fla	1
Rainbow Point to Chassahowitzka Bay, Fla	1
Total	68

From the preceding statement, it will be seen that there were registered in the Archives during the fiscal year ending June 30, 1887, 349 volumes of geodetic observations, and 10 volumes and 115 cahiers of computations; 68 volumes and 2 cahiers of astronomical observations, 128 chronograph sheets, and 6 volumes and 67 cahiers of computations; 11 volumes, 102 cahiers, and 1 sheet of magnetic observations, 1,005 sheets of magnetic traces, and 4 cahiers and 141 sheets of computations; 3 volumes and 1 cahier of pendulum observations, and 4 cahiers of computations; 2 volumes and 1 cahier of meteorological observations; 1,226 volumes and 22 cahiers of hydrographic observations, 11 rolls of tide curves, and 181 bottles of specimens of sea-bottom; 44 completed original topographic sheets, and 68 completed original hydrographic sheets.

During the past fiscal year the records in the Archives have been re-arranged and labeled, so that they are now in much better condition and easier of access than heretofore; and 117 volumes of computations have been bound in a substantial manner, but there still remains a large mass of observations and computations that ought to be bound.

During the fiscal year ending June 30, 1887, there were received and registered in the Library 470 volumes, bound and unbound, besides periodicals and scientific publications.

Although 130 volumes were bound in a substantial manner during the past fiscal year, there are still quite a number of volumes that need rebinding, and also a large number of unbound works and periodicals that ought to be bound.

The books in the Library have been mostly re-arranged and classified, and the shelves numbered, and a card catalogue begun.

I was sick from July 1, 1886, till some time in September, and was not able to be at the Office but a few days during that time. Mr. J. M. Duesberry was in charge of the Archives and Library during my absence.

On November 10, 1886, Mr. Duesberry was temporarily assigned to the Accounting Division, and did not return to the Archives till February 14, 1887.

Mr. A. D. Simms was employed in the Library from February 14, 1887, till May 6, 1887, except while sick.

Yours, respectfully,

ARTEMAS MARTIN,
Librarian and Custodian of Archives.

Mr. B. A. COLONNA,
Assistant in charge of Office.

ANNUAL REPORT OF THE OFFICE OF CONSTRUCTION OF STANDARD WEIGHTS AND MEASURES.

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, September 27, 1887.

DEAR SIR: I have the honor to submit herewith the report of the Weights and Measures Division for the fiscal year ending June 30, 1887.

During the year the redetermination and verification of values of standards has been continued, and this work has led to the discovery of defects in the comparing apparatus, which have as far as possible been remedied. The Blair comparator has been overhauled and appliances added for securing the verticality and parallelism of the two microscopes. The values of the micrometer screws of this instrument have also been redetermined, and observations are now in progress to determine the effect of temperature upon these values.

The Saxton comparator has also been thoroughly repaired and put in good working order, and an additional eye-piece of higher magnifying power has been added to its microscope.

The comparing apparatus for four and five meter bars has been tested and found unsatisfactory, owing to the instability of the piers on which the comparators are mounted. These piers are tall and slender, and the slight lateral pressure incident to making contacts during observations produces a perceptible motion, equal to at least ten divisions of the comparator level.

If the present comparing room is still to be used, these piers must be rebuilt, but as before reported, this room is very unsuitable for the purpose and another should be provided without delay. This is especially important in view of the proposed construction of a new primary base-apparatus.

The working balances have all been carefully adjusted, and their planes and knife-edges examined.

In determining values of weights it has been found impracticable at present to arrive at greater accuracy than the thousandth of a grain, as repeated observations, made with the greatest care and under the same conditions, always show variations in the fourth decimal place. To overcome this difficulty, which was supposed to be due to uncertainty in estimating tenths of scale divisions, the reflecting principle of the Saxton pyrometer was applied to one of the medium-sized Becker balances. A small mirror was attached to the upper part of the pointer, its center in line with the central knife-edge. A piece of parallel plate-glass was inserted in the side of the balance case, and a telescope with a vertical scale attached was mounted at a distance of twenty feet. The oscillations of the beam were noted by observing readings of the reflected scale.

The hundredths of scale divisions were now read with greater certainty than the tenths by the usual method; but the results obtained, while more accordant and satisfactory than before, were still uncertain in the fourth decimal place, as minute defects found to exist in the knife-edges neutralized to a great extent the advantage of increased reading power. These knife-edges were made with great care and by one of the best makers, and when examined with a microscope seem to be nearly perfect, yet their defects become apparent when tested in this way.

A Philadelphia manufacturer now makes a balance which, it is claimed, is superior to any heretofore in the market, and I would recommend that one be procured for trial, and purchase if found satisfactory. The weighing and comparing apparatus of the Bureau of Standard Weights and Measures should, of course, be the best obtainable.

In August, 1886, in accordance with instructions from the Superintendent and by request of the Director of the Mint, a visit to the Philadelphia Mint was made by Dr. J. J. Clark and myself for the purpose of testing and adjusting a new set of Troy weights for the San Francisco Mint, and advantage was taken of the opportunity to make a recomparison of the standard Troy pound of this Office, known as the "Star pound," with the standard pound of the Mint.

The results have already been fully stated in my report of September 4, 1886.*

The calls upon this Office by other Departments of the Government and by private parties for the testing and adjustment of weights, standards of length and capacity, thermometers, hydrometers, etc., and for information on subjects related to weights and measures, have, as heretofore, received prompt attention.

* An abstract of this work is given more in detail under the heading "Special Operations," at the close of Part II of this volume.

For work done for private parties a charge is made sufficient to cover the actual expense involved. The receipts from this source during the year have, however, been small, amounting to only twenty-three dollars.

For work done for Departments of the Government, no charge is made.

The employés of the Division are two in number, viz, Dr. J. J. Clark, adjuster and verifier, and T. Gerhard, mechanician. The latter, during the greater part of the year, was detailed for duty in the Instrument Division.

Subassistant F. H. Parsons, of the Coast and Geodetic Survey, while temporarily assigned to duty in the Division, rendered valuable assistance in the experiments with the reflecting balance.

Yours, respectfully,

ANDREW BRAID,
Assistant Coast and Geodetic Survey.

Mr. B. A. Colonna,
Assistant in charge of Office, Washington, D. C.

ANNUAL REPORT OF THE ACCOUNTING DIVISION COAST AND GEODETIC SURVEY OFFICE.

Accounting Division, U. S. Coast and Geodetic Survey Office,
Washington, D. C., October 11, 1887.

Sir: I have the honor to submit herewith a brief résumé of the operations of the Accounting Division for the fiscal year ending June 30, 1887.

On August 23, 1886, in obedience to your verbal instructions, subsequently confirmed by the Superintendent in his letter of August 28, 1886, I assumed charge, as the representative of the Disbursing Clerk of the Treasury Department, of this Division, with Mr. James C. Edwards, Accountant, as principal assistant. I had previously acted in an advisory capacity to the Disbursing Clerk in the preparation and rendition of his accounts to the First Auditor, and when assigned to the charge of the Accounting Division, was on duty in his office at the Treasury Department.

The appointment of Mr. Edwards as Accountant became effective from August 24, 1886, the services of his predecessor having ceased upon the preceding day. I found, upon taking charge of the Division, that the daily current work had been fairly well brought up to date, and but few accounts remained unadjusted. I subsequently, however, had much trouble in securing a balance, as transactions involving many thousands of dollars had been entirely overlooked by the person formerly in charge of the Division, and no record whatever of their entry or payment could be found upon any of the books. After much labor and research, in which I had the valuable assistance and experience of the Disbursing Clerk, the accounts were finally brought into thorough balance, in which condition they have since remained.

In the early part of September, 1886, the Division, with all its appurtenances, excepting the duplicate files, was transferred to the Treasury Department, and placed under the immediate supervision of Mr. George A. Bartlett, Disbursing Clerk. In making this removal it was assumed that a more rapid adjustment of the accounts could be effected by being in close proximity to the accounting officers, whose decisions as to disputed points in the accounts could be more readily obtained and hence acted upon with greater promptitude. This arrangement was continued until November 6, 1886, when the delay necessarily incident to a response to referred communications from the Office became so embarrassing, owing to the distance apart of the two offices, as to compel its abandonment, and the Division was returned to its old quarters in the main building of the Survey. The necessity for an almost continual reference to the records of the Division was an element which also contributed largely towards bringing about its return to the Office.

Owing to an unfortunate illness Mr. Edwards was compelled to return home on August 25, 1886, and did not again report for duty until October 4, 1886. On the day following he resigned from the Service. During his absence the entire work of the Division was necessarily performed by myself alone, and owing to the unusually large number of parties in the field at this time, the labors of the office were exceedingly onerous and exacting, and the adjustment and settlement of the accounts progressed but slowly, naturally causing much complaint. During a large portion of this period, aside from personal affliction by death in my family, I was much embarrassed and hampered, and the work of the Division delayed to an almost immeasurable and unreasonable extent, by the necessity which arose for the response on my part to maliciously false and vindictive charges filed against me at the Department by parties whose futile attempts to use me as a means of gratifying their personal prejudices and spite against leading officers of the Survey resulted in their own complete discomfiture.

Upon the return of the Division to this Office, Mr. J. M. Duesberry, on November 10, 1886, and Mrs. S. M. Taliaferro, on November 16, 1886, were assigned to duty therein, the former as General Clerk, and the latter as Entry Clerk and Book-keeper. Mr. Duesberry rendered faithful service until February 1, 1887, when he was transferred to the Computing Division.

A change being deemed advisable in the method of keeping the property records of the Survey, Mr. R. C. Glascock, Accountant, acting as Property Clerk, was assigned to duty in the Division on November 29, 1886. It was soon found, however, that the attention necessary to the formulation and keeping of the property records, and the supervision of the general property on storage in the Office, could not be successfully prosecuted by this Division, as at present organized, owing to its inadequate force; and, as the Instrument Division was keeping a record of its own special class of property, to avoid duplication and to centralize as nearly as possible in one office the records of property, Mr. Glascock was, on April 11, 1887, transferred to the Instrument Division, together with the general property records.

On December 11, 1886, Mr. Eugene B. Wills was appointed Accountant and assigned to duty in the Division; and on February 1, 1887, Miss Paula E. Smith reported for duty as General Clerk in place of Mr. Duesberry, transferred.

It is almost impossible to furnish intelligible statistics of such work as that accomplished in this Division. The following, however, is submitted as showing to some extent the volume of work which required attention during the last fiscal year:

Vouchers received and audited	16,742
Approved estimates received and filed	420
Checks drawn and issued	3,568
Letters received, acted on, and filed	3,343
Letters written	3,257
Appropriation and allotment accounts	444

In addition to the foregoing, there are a large number of books of entry, records, etc., which have to be maintained, besides the preparation of the annual statements for Congress and the numerous responses to calls for information.

During the month of January, 1887, new forms of vouchers for the use of the Survey, both in the field and in the Office, were prepared, and issued shortly thereafter. Each voucher carries with it, in the form of printed directions, nearly all essential instructions for its preparation and rendition, under the rulings and decisions now enforced by the accounting officers.

In view of the technical character of the work required from the employés of this Division, and, the necessity for a comparative isolation from interruption, I would respectfully recommend the erection of a counter or similar barrier, surmounted by the usual screen work, in the rooms of the Accounting Division at as early a date as may be practicable. The expense involved would be small compared to the advantages which would accrue in a more rapid accomplishment of the work. This feature of freedom from interruption for accounting clerks is fully recognized at the Treasury Department, where the most stringent regulations are in force as to admission to the rooms, and in many cases permission must first be obtained from the chief clerk or other officer in charge of the office. The conditions are somewhat different here, as the necessities of the service require frequent conferences with the Accounting Division on the part of officers and others as to the condition of available balances on appropriations, allotments, etc.; but apart from these, good business principles would seem to demand a certain degree of privacy and quietude for persons engaged in the laborious, exacting, and absorbing duties of auditing, adjusting, and settling accounts, involving an almost continual series of perplexing questions, rulings, and decisions, and an interminable reference to laws and regulations bearing thereon. Even in the most ordinary line of commercial pursuits, the merchant, realizing the necessity for the essential features of accuracy, rapidity, and neatness in the keeping of his records and the management of his accounts, allots a separate apartment or office to his accounting clerk or book-keeper, isolated from the interruptions and confusion incident to his general business transactions.

I trust it may not be considered out of place for me to express my belief that the prompt, and, I may say, better accomplishment of the work of the Accounting Division almost imperatively requires the appointment of a Disbursing Officer. A more complete organization of the Division is required. In my opinion, the record of receipts and disbursements of public money, no matter from what source, and the proper and systematic keeping of the accounts of public property on hand and purchased (the vouchers for which pass through the Division), relating to the Coast and Geodetic Survey, should be a part of the work of the Accounting Division. To do this properly some responsible bonded officer should be in charge with an adequate force to assist him. No doubt such an arrangement would be more expensive than the present one, but in the end the results would show the wisdom of such action. The present system, moreover, is productive of much delay in the prompt settlement of accounts, and has resulted more than once in great embarrassment to officers of the field service, and thereby to some extent in crippling and retarding the progress of the field work. With a disbursing officer, remittances could be made frequently on the same day that the accounts or vouchers are received. As it is now, however, a delay of three or more days is almost inevitable in each case, and even this minimum is obtained only by extra exertion and almost constant labor long after office hours. Much more could be said upon this subject in support of the necessity which exists for a Disbursing Officer for the Survey, and at some future time I hope to make a separate report more clearly defining the difficulties under which we now labor without one.

Mr. Eugene B. Wills, Accountant, Mrs. S. M. Taliaferro, Book-keeper and Entry Clerk, and Miss Paula E. Smith, General Clerk, have all rendered conscientious and faithful service, and it gives me great pleasure to so record it. Mr. Wills has been most untiring in his efforts to assist in the adjustment of accounts, and has, of his own volition and from a sincere interest in his work, given much extra time beyond office hours in seconding my efforts to secure a prompt transaction of the business of the Division. Much of his time, moreover, is necessarily passed at the Department in drawing checks, etc., and during these intervals his work in the Division naturally falls behind, and his usefulness as an accounting clerk is constantly impaired by the frequent interruptions occasioned by his enforced absence. It is impossible for any person to thoroughly analyze and adjust intricate accounts under such circumstances with any degree of satisfaction. Mrs. Taliaferro and Miss Smith have accomplished an amount of work in their respective positions which is worthy of all praise, and it would seem only just that some provision should be made by which an increased emolument could be given them as a recognition of the services they have rendered.

Mr. George A. Bartlett, Disbursing Clerk of the Treasury Department, has ever done everything within his power to facilitate the work of this Division, the business of which is all conducted in his name, and for which he is mainly responsible. His uniform courtesy in all matters of business pertaining to the Coast Survey coming within his province has made the burdens of the work of the Division appear much easier. It is not saying too much when I express the opinion that the disbursements made by Mr. Bartlett for this service, small in amount as they are compared with his disbursements for the Department, which aggregate millions of dollars per annum, occasion him more annoyance and embarrassment, and are a greater source of anxiety and trouble to him than all his other disbursements combined. It would seem, in justice to Mr. Bartlett, and in view of the fact that the Coast Survey has no Disbursing Officer of its own, that some compensation should be made to him for the onerous responsibility thrust upon him, in addition to his own legitimate duties, of making disbursements for the Coast and Geodetic Survey.

In conclusion, I would respectfully recommend that some action be taken to secure for the Division the services of some person who could act, when necessary, as a stenographer. Such service would not probably be required as a permanent feature in the organization of the Division, as a few hours daily would, no doubt, suffice; but, unquestionably, some relief should be afforded in the preparation of the correspondence of this Division, which, while it is of a technical character, is also greater than that of any other office in the building. With the assistance of a stenographer much of the time now given to the rough drafting of letters in settlement of accounts could be utilized in other ways much more to the advantage of the service, and would relieve the Division of much of the extra labor out of office hours which is now imposed upon it, and, I think, unjustly so.

Yours, respectfully,

JOHN W. PARSONS,
Computer U. S. Coast and Geodetic Survey,
In charge of Accounting Division.

B. A. COLONNA, Esq.,
Assistant U. S. Coast and Geodetic Survey,
In charge of Office and Topography.

APPENDIX No. 5.—1887.

REPORT OF THE HYDROGRAPHIC INSPECTOR FOR THE YEAR ENDING JUNE 30, 1887.

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, October 8, 1887.

SIR: I have the honor to submit the following report of hydrographic work and care of vessels of the Survey, with which I am charged, for the fiscal year ending June 30, 1887.

HYDROGRAPHY—ATLANTIC COAST.

When the appropriations would admit of it, the hydrographic parties were already in the field at the beginning of the fiscal year.

The Long Island Sound parties, for instance, began work in May and June, supported by money that had been saved from the preceding summer's work, thus giving them a long season, the results of which are much more gratifying than if the work had had to be delayed until July 1.

The hydrography on the coast of Maine was carried on by a party in the *Bache* under charge of Lieut. J. M. Hawley, U. S. N. As the outside work from Libby Island to Quoddy Head had never been surveyed, it was deemed important that it should be pushed as rapidly as possible, and completed before the end of the season. This was accomplished, and the chart indicating this work is about ready for issue.

In May, 1887, Lieut. F. H. Crosby, U. S. N., in the *Gedney*, was ordered to proceed to the coast of Maine and take up some hydrographic examinations required in the Penobscot River, and upon the completion of these, to begin a hydrographic survey of the St. Croix River from Eastport northward. His party reached Eastport and began this survey at the end of the fiscal year.

Lieut. J. E. Pillsbury, U. S. N., in the *Blake*, made a physical survey of the coast of Massachusetts near Chatham, with a view of ascertaining the changes that were made in the coast-line by littoral currents, this information being needed by Prof. Henry Mitchell, Assistant Coast and Geodetic Survey, in carrying on his investigations.

The work in Long Island Sound was carried on by the *Gedney*, Lieut. F. H. Crosby, U. S. N.; the *Palinurus*, Lieut. D. D. V. Stuart, U. S. N.; and the *Arago*, Lieut. F. S. Carter, U. S. N., and Ensign W. J. Sears, U. S. N. These parties were well provided with skilled officers and experienced men, well fitted with steam-launches and boats, and the results of the season's work were all that could be expected, the resurvey of this important water thoroughfare being completed in such a manner as to render another survey unnecessary, with the exception, possibly, of entrances to rivers and special developments that may be required for engineering purposes, for a hundred years at least.

The survey of the harbor of New York was carried on to completion, during the summer season of 1886, by parties under command of Lieut. C. P. Perkins, U. S. N., in the *Eagre*, and Lieut. G. C. Hanus, U. S. N., in the *Endeavor* and *Daisy*.

As it was deemed advisable to make the survey of this, the most important harbor in the United States, as perfect as possible, a degree of refinement was used not called for in most hydrographic work.

As an indication of the extent and closeness of this work I find that over two thousand one hundred miles of sounding lines were run, with over 143,200 casts of the lead—all of this in one season.

The tidal stations occupied in the Lower Bay and North and East Rivers were numerous.

With a view of determining if any changes occurred on or near Sandy Hook bar, due to tidal currents at different phases of the moon, or to gales of wind, a small area was selected in the East Channel and a survey was made at intervals of about seven days. These latter data have not yet been put in the hands of the draughtsmen, owing to press of other work. When an opportunity occurs, however, the results obtained will be put in such shape as to make them available for study.

In August, 1886, Lieut. J. E. Pillsbury, U. S. N., in the *Blake*, was engaged in developing the one-hundred fathom curve off the coast of Delaware, Maryland, and Virginia—a much-needed addition to our coasting charts of this locality. The same party also made an examination of St. Simon's Bar and a survey of a section of the coast off New Inlet, North Carolina, during the year.

The schooner *Scoresby*, Lieut. Francis Winslow, U. S. N., commanding, was engaged during the whole year in making an examination of the oyster-beds of the sounds of North Carolina.

The steamer *Bache*, under command of Lieut. J. F. Moser, U. S. N., who was detached from duty in this Office and assigned by you as the relief of Lieutenant Hawley in November, 1886, was unusually successful in her work in the vicinity of Cedar Keys and Cape Romano, working under many difficulties.

The work on the coast of Louisiana was carried on in the *Endeavor*, under command of Lieut. D. D. V. Stuart, U. S. N. The work included the survey of the dredged channel in Atchafalaya Bay, a survey in Vermillion Bay, and outside work.

GULF STREAM.

The investigation of the Gulf Stream was continued by Lieut. J. E. Pillsbury, U. S. N., in command of the *Blake*. Three sections were occupied during the season—one from west end of Cuba to Yucatan, one from Rebecca Shoal (Florida Keys) to Cuba, and one extending to southward and eastward from Cape Hatteras Shoal. The greatest depth in which an anchorage was made was in the latter section—in one thousand eight hundred and fifty-two fathoms of water, with over four knots surface current. This is in itself an indication of the perfection to which Lieutenant Pillsbury has brought the ground-tackle of the *Blake* for anchorage in great depths.

The results obtained in the cross-sections in and near Florida Straits tend to confirm the theories deduced during the seasons of 1885-'86 in relation to the daily and monthly variation of the Gulf Stream, due to the advent of the tidal wave on this coast.

Lieutenant Pillsbury's detailed and comprehensive report of the last season's work is now in your possession.

HYDROGRAPHY—PACIFIC COAST.

Lieut. C. F. Forse, U. S. N., with a party in the *Earnest*, was engaged in work in Admiralty Inlet, Port Townsend Harbor, Possession Sound, and Port Susan, all in the waters of Washington Territory.

The *McArthur*, Lieut. J. C. Burnett, U. S. N., commanding, in May and June, 1887, was engaged in hydrographic work off the coasts of Oregon and Washington Territory.

In October, 1886, Mr. C. Rockwell, Assistant Coast and Geodetic Survey, made a survey of a portion of Columbia River from Columbia City to Bachelor Island, Washington Territory, and in the same month Mr. L. A. Sengteller, Assistant Coast and Geodetic Survey, was engaged in hydrographic work in Umpquah River, Oregon.

An appropriation having been made for the re-survey of San Francisco Bay and its tributaries, Lieut. David Peacock, U. S. N., then in command of the *Hassler*, was assigned to the work, which was carried on from September, 1886, to the 21st of March, 1887.

On the return of the Alaska parties the services of the officers, crews, and boats were utilized in this work, and Lieutenant-Commander Snow was given general charge of it.

The work, so far as completed, including Suisun and San Pablo Bays, was very close, it being desirable to ascertain the extent of the filling of these basins due to hydraulic mining near the shores of the rivers leading into them.

On the detachment of Lieutenant-Commander Snow, Lieutenant-Commander Thomas was given charge of the work, and later it was assigned to Lieut. David Peacock, who continued it to the close of the season.

In August, 1886, Prof. George Davidson, Assistant Coast and Geodetic Survey, made a hydrographic survey of Lompoc Landing, Santa Barbara County, Cal.

SURVEY OF ALASKA.

The result of the season's work of 1886 in Alaska was especially gratifying. The work was carried on by the *Patterson*, Lieut. Commander A. S. Snow, U. S. N., commanding, and the *McArthur*, Lieut. J. M. Helm, U. S. N., commanding. An area of sixteen hundred miles was covered, and over seventeen thousand five hundred miles of soundings run by the combined parties. The work completed during the season included Clarence and Sumner and Wrangell Straits.

Lieut. Commander Charles M. Thomas, U. S. N., having relieved Lieutenant-Commander Snow in command of the *Patterson*, started for the working-ground to the northward of Wrangell Straits in May, 1887. While his report of this season's work is not yet in, his letters indicate unusually bad weather in Alaska, and much of the work has been carried on in the rain, the instruments, when necessary, having been set up under awnings.

COAST PILOT DIVISION.

The work in the Coast Pilot Division, in charge of Lieut. G. H. Peters, U. S. N., assisted by Ensigns E. H. Tillman and W. J. Maxwell, U. S. N., and Mr. John Ross, has been pushed as rapidly as possible.

It being desirable to have a condensed Coast Pilot to meet the needs of the mariner, sample pages of a scheme prepared by Lieutenant Peters, to illustrate the method of treatment suggested by him to cover in one volume the whole Atlantic coast, were submitted to a number of experts for suggestions and criticism. The result being satisfactory, the scheme received your approval, and is now being followed in the work in the course of preparation.

The field-work, or collection and verification of data, has received the attention necessary. Lieutenant Peters and members of his party were engaged in such work in Long Island Sound and on the eastern coast from April to June, the steamer *Daisy* being used for the purpose.

The necessity of a new Pacific Coast Pilot has been apparent for some years. The manuscript of Prof. George Davidson, Assistant Coast and Geodetic Survey, is now nearly all in, and it is hoped that this important work may be in shape to place before the public before many months.

There are many new data affecting the comparatively unknown coast of Alaska now in the Office, and I intend at an early day to submit you a scheme for the new Coast Pilot for these waters.

The report of Lieutenant Peters is forwarded herewith.

HYDROGRAPHIC DIVISION.

The Hydrographic Division of the Hydrographic Inspector's Office was in charge of Lieut. J. F. Moser, U. S. N., from the beginning of the fiscal year to November 10, 1886, when he was detached and ordered to command the *Bache*, thus retaining in another field of the Survey his valuable services.

Lieut. J. M. Hawley, U. S. N., then took charge of this Division, and he in turn was relieved on April 27, 1887, by Lieut. M. L. Wood, U. S. N.

The duties of this Division are numerous and exacting, consisting of laying out hydrographic work, examining and verifying the sheets as they come in from the field, and seeing that proper notification of all changes in aids to navigation and all hydrographic information that may be of interest to the navigator are given promptly.

While the Hydrographic Inspector is charged with the immediate supervision of the *preparation* of such corrections and the giving of notification that they exist, the duty of *making the cor-*

rections, in order that the charts issued from the Office may show such changes, is assigned to others. It is a question whether this divided responsibility is productive of the best results.

The report of Lieut M. L. Wood, in charge of the Division, is forwarded herewith.

REPAIRS AND MAINTENANCE OF COMPLEMENT OF VESSELS.

In October, 1886, a report was submitted by Lieut. Commander A. S. Snow, U. S. N., commanding the steamer *Patterson,* showing that the small steamer *Lively* that had been used for some years in the survey of Alaska, was in a condition that did not warrant her being repaired. She was an old vessel when her employment on this work began. With your approval, arrangements were entered into with the Bureaus of Construction and Engineering, Navy Department, for the building at Mare Island of a steamer fifty-five feet in length, with accommodation for three officers and a crew of five men. This steamer was completed in May and has been in every way satisfactory. On the passage up the coast she encountered a very heavy gale of wind, and separated from her convoy, but proved herself a most excellent sea-boat. The commanding officer of the *Patterson* reports that she is of great service to his party, adding materially to the amount of work done.

The old *Lively* being of no further use to the Survey, I had the honor to recommend that she be sold, and bids were accordingly advertised for.

During the year three steam-launches have been completed for the Survey at different navy-yards, one of them having been commenced in the fiscal year ending June 30, 1887. These launches are large, with fair speed, excellent sea-boats, and are in every way well adapted to hydrographic work.

During the fall and winter the *Gedney* was thoroughly overhauled at Baltimore, Md., a new boiler was put in, nearly all the fastenings below the water-line replaced, they having been seriously injured by galvanic action, and a number of the frame and floor timbers renewed. She is now in condition for any work that may be assigned her.

Owing to the large amounts expended for the repairs of the *Gedney* and for the new steamer for the Alaska survey, great economy was necessary in keeping the other vessels of the fleet in good running condition without exceeding the appropriation; that this was done without serious inconvenience to the Survey was due principally to the fact that the reduced crews of the vessels laid up in New York were kept busy during the winter in making repairs to hulls, spars, sails, etc., rendering it necessary to expend money for material only.

While possibly outside of the province of this report, still my interest in the Survey and my knowledge of the necessity of bringing out at the earliest possible moment the results of the field-work induce me to urge that an appropriation be asked for to increase the number of draughtsmen and engravers at present employed by the Office. An inspection of the list of hydrographic sheets now on hand, the results of which have not yet been properly indicated on the coast and general coast charts, will at once show how necessary it is that the increase should be made.

The duties of clerk to Hydrographic Inspector were performed in a satisfactory manner by Mr. George J. Vestner.

As forming part of this report, I append at its close tabulated statements giving the names of naval officers attached to the Survey during the fiscal year and on June 30, 1887; the number of officers serving on board Coast and Geodetic Survey vessels at two periods of the year; the number of men on those vessels, and the names of vessels belonging to the Service, their tonnage, etc. Also a table showing the localities in which hydrographic work was done during the year, with the names of officers in charge of the parties, and details relating to their work.

Very respectfully,

W. H. BROWNSON,
Lieutenant-Commander U. S. Navy,
Hydrographic Inspector, Coast and Geodetic Survey.

Mr. F. M. THORN,
Superintendent Coast and Geodetic Survey.

REPORT OF THE COAST PILOT DIVISION FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, October 21, 1887.

SIR: I have the honor to submit the following report, covering the work of the Coast Pilot Division during the fiscal year ending June 30, 1887. Under the general direction of the Hydrographic Inspector, the duties of this Division involve the execution of work both at the Office and in the field.

A new (third) edition of the Atlantic Local Coast Pilot, Subdivision 13, has been put through the press and published. New editions of Subdivisions 6, 7, and 9 and the first edition of Subdivision 21 have been prepared and sent to the printer. Much other work has been done in connection with other volumes to be issued hereafter. The great care and accuracy necessary in this class of work render it laborious and exacting in its requirements.

Sample Coast Pilot pages having been prepared by me in illustration of the method of treatment which I had proposed for such work, these pages were printed. For the purpose of eliciting expressions of opinion and suggestions, a number of the printed copies were distributed among experts, whose careful attention and criticism were invited, with a view to the improvement of the plan and the excision of unnecessary matter. Much interest was taken in the subject, as shown by the responses received. While the suggestions made exhibit the variety of opinion which was to have been expected on minor points, the result, as regards the general features of the plan suggested, is gratifying. The method has received the Superintendent's approval for adoption in a volume to cover the Atlantic coast.

Most excellent results have followed the use of the general form of interrogatories devised with a view to obtaining directly from the best local sources special information concerning our ports and harbors. Many matters of practical interest to mariners are covered by these questions; much of the information thus made available is not ordinarily accessible. The interrogatories, as prepared in the Coast Pilot Division, have been submitted by the Superintendent to responsible local authorities of a great number of places on the Atlantic coast, from Maine to Florida, with the request that the questions be referred to the persons best qualified to give the information desired. It has been a matter of surprise to find how large a proportion of the papers thus sent out have called forth careful replies, frequently developing matters of special interest which might perhaps have been otherwise overlooked. Verification in the field shows the general reliability of the information thus received, which is then incorporated in new editions and in new works. Putting the matter in shape for publication of course involves careful scrutiny and much labor.

The field-work of collection, revision, and verification of data has been carried on from time to time, as necessary, under special instructions, and reports covering such work have already been made. Ensign Maxwell was engaged in work of this nature on portions of the New England coast in December, 1886. In April, 1887, the steamer *Daisy*, being temporarily available, was assigned to the Coast Pilot party, and under my command was employed in the Coast Pilot work until June 28, 1887, in Long Island Sound and on the Eastern coast. A special report of this work has been submitted. The *Daisy* being required for other work, and the *Endeavor* having returned from Southern waters and being available, the Coast Pilot party was transferred to her, and at the end of the fiscal year she was being refitted at New York to continue the work on the Eastern coast.

Mr. John B. Goode, jr., did clerical work in the Coast Pilot Division until he resigned in August, 1886. His duties were performed in a most commendable way. Ensign W. J. Maxwell, U. S. N., assigned to duty in this Division in September, 1886, and Ensign E. H. Tillman, U. S. N., assigned in December, 1886, were still engaged on this duty at the end of the fiscal year. Mr. Tillman was on board the *Daisy* with me from April 19, 1887, until relieved in June by Mr. Maxwell, who was transferred to the *Endeavor* later in the month.

Mr. John Ross, who had already rendered valuable service in hydrographic parties of the Survey, was employed as a compiler in the Coast Pilot Division in September, 1886, and was transferred to the *Daisy* as Recorder, in April, 1887, and from that vessel to the *Endeavor* on June 28.

Very respectfully,

GEORGE H. PETERS,
Lieutenant U. S. N., Assistant Coast and Geodetic Survey,
Chief of Coast Pilot Division.

Lieut. Commander W. H. BROWNSON, U. S. N.,
Hydrographic Inspector, Coast and Geodetic Survey.

REPORT OF THE HYDROGRAPHIC DIVISION FOR THE YEAR ENDING JUNE 30, 1887.

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, October 5, 1887.

SIR: I have the honor to submit the following report of the work performed by the Hydrographic Division during the year ending June 30, 1887.

Lieut. J. F. Moser, U. S. N., was in charge of this Division from July 1, 1886, until November, 1886, when he was relieved by Lieut. J. M. Hawley, U. S. N., who remained until April 27, 1887, when he was relieved by myself.

The draughtsmen assigned to this Division performing regular office work during the year are Eugene Willenbucher, W. C. Willenbucher, and F. C. Donn.

Owing to the different classes of work, a comprehensive statement giving credit to each individual for all the work performed by him is almost impossible.

Much of the most severe labor, such as correcting proofs of plates for engraved charts, and drawings for lithographed charts, verifying reductions for charts, comparing charts of the same locality, preparing data for correcting charts already published, and making tracings and projections for examinations of reported dangers, can not be shown in such a manner as to give a proper idea of the amount of labor and research involved.

Statistics show that the amount of data passing through this Division is steadily increasing.

Hydrographic statistics for the fiscal years 1883–1887, *inclusive.*

Fiscal year ending June 30—	Number of—					
	Sheets.	Vols.	Angles.	Soundings.	Miles.	Sq. miles.
1883	56	248	73,081	390,735	10,806	3,314
1884	66	297	95,990	481,068	12,846	4,631
1885	29	208	60,340	318,870	8,732	4,240
1886	63	377	117,588	567,968	14,932	8,701
1887	74	470	134,301	661,682	17,557	11,285

This season's work will be received at the Office before the data from last year have been put in a shape for reference.

In view of the schemes laid out for the coming season, I respectfully suggest the assignment of another draughtsman to this Division, so that the publication of charts will not run the risk of an additional delay by the inability of the hydrographic draughtsmen to keep the plotting and verification of the original hydrographic records ahead of the demand for the new data.

Since it can not be decided exactly what data will be needed, or their value for correcting charts determined, until the results are in a shape for comparison, it is necessary, for economy in laying out work, that the results of hydrographic surveys be plotted and inked as soon as possible after their receipt from the field parties.

To show the extent and variety of work required from this Division and give an idea of the labor involved, the following is given as a partial list:

To check all schemes for projected charts and project the plans for new charts in such a manner as will best assist mariners; to revise the hydrography of the reduced drawings for all charts, and verify by comparison with the original hydrographic sheets and other data; to see that all hydrographic features on the drawings are derived from proper authority, and that all points necessary to mariners are shown in such a manner as to be used without danger of misconstruction; to verify the proofs of all charts, and indicate important corrections received since the verification of the drawing; to obtain the correct position of buoys from the Light-House Board, and indicate changes in aids to navigation for which there has been proper authority received; to compare the charts covering any locality and see that they agree so far as scale and construction will allow; to keep copies of charts of localities where changes are liable to occur, in the hands of persons able to determine alterations in physical features; to select the hydrographic corrections of importance, and determine what investigation is necessary to secure proper data for intelligent action, and notify Chart Room of the correction to be applied; to find out the localities needing surveys, resurveys, or examinations, and furnish the Hydrographic Inspector with a list on which to base estimates for appropriations for the next fiscal year; to hunt up and obtain data from other sources outside the Survey, so as to embody the most recent and trustworthy information on the charts when published; to correspond with any person able to give authoritative hydrographic information, and use all knowledge to the best advantage, either for correcting charts or for indicating the need for future investigation; to make projections, tracings, or working sheets for examinations sufficient to allow a survey to be made with the minuteness required for the individual case; to select the data from the archives of the Office, for each party to complete its work, lay out the schemes for projections, and keep the chiefs of parties in the field supplied with necessary data received from any source; to compare the original sheets sent in by chiefs of hydrographic parties with their records, and with the instructions under which the work was performed, and see that all points laid out have been attended to and notes made for future reference and required examinations; to see that the sounding lines are so indicated and that the soundings are spaced in such a manner that no doubtful intervals exist, and that the hydrography agrees in its details, and joins properly to connecting completed work; to keep the file of standard charts up to date, and thus to have a copy of the last print of each chart corrected to date for all information that has been received at this Office; to keep a record of corrections applied to each chart in such a manner that the authority for any change can be found on file, and to supply the data for informing users of charts of important changes in a Notice to Mariners, issued the last day of each month, giving the corrections that have been put on the charts since the last monthly notice.

The following is a tabular statement of the work performed by the draughtsmen:

HYDROGRAPHIC DIVISION.

Original hydrographic sheets plotted, verified, and inked during the fiscal year ending June 30, 1887.

Title of sheet.	Scale.	Draughtsman.	Remarks.
ATLANTIC COAST.			
Coast of Maine:			
Quoddy Head to Libby Island	1-40000	Eugene Willenbucher	Plotted and drawn.
Quoddy Head to James Head	1-10000	do	Do.
James Head to Racine △	1-10000	do	Do.
Little Machias Bay and to the eastward	1-10000	do	Do.
Machias Bay Entrance and Cross Island Narrows, Maine	1-10000	do	Do.
Machias Bay, Maine	1-10000	do	Do.
Machias Bay, upper part, and Machias River, Maine	1-10000	do	Do.
Little Kennebec River, Maine	1-10000	do	Do.
Englishman's Bay, east, Maine	1-10000	do	Do.
Englishman's Bay, west, Maine	1-10000	do	Do.
Off Chatham, Mass	1-10000	do	Do.
Off Monomoy Point, Massachusetts	1-10000	do	Do.
Smithtown Bay, Long Island Sound	1-10000	do	Do.
Approaches to Huntington Bay, Long Island Sound	1-10000	do	Do.
Huntington Bay, Long Island Sound	1-10000	do	Do.
Oyster Bay and approaches, Long Island Sound	1-10000	do	Do.

HYDROGRAPHIC DIVISION.

Original hydrographic sheets plotted, verified, and inked, etc.—Continued.

Title of sheet.	Scale.	Draughtsman.	Remarks.
ATLANTIC COAST—continued.			
Long Island Sound:			
Rye Neck to David's Island	1-10000	E. and W. C. Willenbucher	Plotted and drawn.
Hempstead Harbor	1-10000	......do	Do.
Cockenoes Sound to Sheffield Island	1-10000	F. C. Donn	Do.
Cockenoes Sound to Penfield Reef	1-10000	......do	Do.
Sheffield Island to Stamford Light-house	1-10000	......do	Do.
Stamford Light-house to Rye Neck	1-10000	......do	Do.
Port Jefferson and vicinity	1-10000	......do	Do.
Faulkner's Island to Stratford Shoal	1-40000	W. C. Willenbucher	Do.
Stratford Shoal to Eaton's Neck	1-40000	......do	Do.
Eaton's Neck to Execution Rocks	1-20000	......do	Do.
Welch's Point to Stratford Point	1-10000	......do	Do.
Stratford Point to Bridgeport	1-10000	......do	Do.
East River:			
From College Point to Lawrence Point	1-5000	......do	Do.
From Lawrence Point to Astoria	1-2500	......do	Do.
Harlem River:			
From Ward's Island to High Bridge	1-5000	......do	Do.
From High Bridge, Spuyten Duyvil Creek, and part of Hudson River.	1-5000	......do	Do.
Hudson River, from One hundred and forty-first street to Tubby Hook.	1-5000	......do	Do.
Passaic and Hackensack Rivers, New Jersey	1-10000	......do	Do.
Arthur Kill, Ward's Point, to Woodbridge Creek	1-5000	Eugene Willenbucher	Do.
Off coast of New Jersey, Hereford Inlet (northward)	1-40000	......do	Do.
Off coast of Delaware, south of Henlopen	1-40000	......do	Do.
Delaware Bay, Maurice River Cove	1-10000	F. C. Donn	Do.
Offshore soundings:			
Cape Henlopen to Cape Henry	1-200000	Eugene Willenbucher	Verified and finished.
Cape Henry to Cape Hatteras	1-200000	......do	Do.
Shoal off False Cape, Virginia	1-80000	......do	Plotted and drawn.
New Inlet, North Carolina	1-10000	W. C. Willenbucher	Do.
Off mouth of North and South Santee Rivers	1-10000	......do	Do.
Bull's Bay, South Carolina	1-20000	Eugene Willenbucher	Do.
Dewees's, Caper's, and Price's Inlets, South Corolina	1-10000	......do	Do.
West coast of Florida:			
Anclote River to Rainbow Point	1-40000	......do	Do.
Rainbow Point to Chassahowitzka Bay	1-40000	......do	Do.
Horn Island Pass, Mississippi	1-20000	W. C. Willenbucher	Protracted, plotted, and drawn.
PACIFIC COAST.			
Offshore soundings, vicinity of Tillamook Bay	1-40000	F. C. Donn	Verified, inked, and finished.
Tillamook Bay Entrance, Oregon	1-10000	......do	Do.
Columbia River:			
Vicinity of Tongue Point	1-10000	......do	Do.
Walker Island Bar	1-10000	......do	Protracted, plotted, and drawn.
Columbia City to Bachelor's Island	1-10000	......do	Plotted and drawn.
Bachelor's Island to Hewlett's Point	1-10000	......do	Do.
Columbia River and Willamette River	1-10000	......do	Do.
Willamette River to Portland, Oregon	1-10000	......do	Do.
Hood's Canal, upper part, Puget Sound	1-20000	......do	Verified, inked, and finished.
Port Orchard, Puget Sound, Washington Territory	1-20000	......do	Do.
Clarence Strait, Southeastern Alaska	1-80000	Eugene Willenbucher	Verification.
Sumner Strait, Southeastern Alaska	1-80000	......do	Do.
Additional hydrography for twenty-three sheets	Various	W. C. Willenbucher	Protracted, plotted, and drawn.
Additional hydrography for eight sheets	..do	F. C. Donn	Do.

Synopsis from the records of the hydrographic sheets plotted, etc., during the fiscal year ending June 30, 1887.

Name of draughtsman.	Number of—					
	Sheets.	Volumes.	Angles.	Soundings.	Miles.	Deep-sea soundings.
Eugene Willenbucher	30	166	63, 002	235, 201	9, 935½	42
W. C. Willenbucher	19	116	31, 305	143, 497	2, 513¼	....
F. C. Donn	17	98	33, 703	141, 285	2, 692¼	....
Total	66	380	128, 010	519, 983	15, 141	42

Examinations and additional work.

Locality	Surveyed by—	Plotted by—	On sheet number—
Pleasant River, Maine	J. M. Hawley, U. S. N.	F. C. Donn	1644
Moos-a-bec Reach	do	W. C. Willenbucher	1059
Tibbett's Rock and Jackson Ledge	do	do	1398
West Entrance, Southwest Harbor, Mount Desert	do	do	1121
Casco Passage and York Narrows	do	do	1366
Off Wood Island, Maine	do	do	699
Off Boon Island, Maine	do	do	667
Monomoy Passage, Massachusetts	J. E. Pillsbury, U. S. N.	do	1573
Near Bishop and Clerks Light-house	do	do	1243
Squash Meadows, Vineyard Sound	do	do	527
Edgartown Harbor, Massachusetts	J. M. Hawley, U. S. N.	do	1126
Around No Man's Land, Massachusetts	J. E. Pillsbury, U. S. N.	do	596
Off Watch Hill Point, Rhode Island	do	do	1577*a*
Long Island Sound, north of Faulkner's Island	F. H. Crosby, U. S. N.	do	1637*a*
Long Island Sound, Sachem Head to Negro Head	do	do	1637*b*
Long Island Sound, Negro Head to Southwest Ledge Light-house	do	do	1638*a*
Off Stratford Point, Long Island Sound	do	do	1736
Five-Mile River, Long Island Sound	do	F. C. Donn	1698
Guilford Harbor, Long Island Sound	do	do	1637*a*
Off Stratford Light, Long Island Sound	do	do	1699
Off Rye Neck and Delancey Cove	C. P. Perkins, U. S. N.	do	1683
Off Eaton's Neck, Long Island Sound	do	do	1708
Oyster Bay, Long Island Sound	do	do	1710
Off City Island, New York	G. H. Peters, U. S. N.	W. C. Willenbucher	1560
Little Neck Bay and East River, New York	C. P. Perkins, U. S. N.	do	1569
East River, off Lawrence Point	do	do	1703
Swash Channel, New York Lower Bay	F. H. Crosby, U. S. N.	do	1662
New York Lower Bay	G. C. Hanus, U. S. N.	do	1664
New York Upper Bay	do	do	1667
Hudson River, Communipaw	do	do	1668
St. Simon's Bar, Florida	J. E. Pillsbury, U. S. N.	F. C. Donn	1675

Verification, revision, and correction of reduced drawings of hydrography for the fiscal year ending June 30, 1887.

Catalogue number of chart.	Title of chart.	Scale.	Draughtsman.
D	Gulf of Mexico, additional hydrography	1-2100000	Eugene Willenbucher.
9	Cape May to Cape Henry, new work	1-400000	Do.
101	Coast Chart No. 101	1-80000	Do.
102	Coast Chart No. 102	1-80000	Do.
106	Kennebec Entrance to Saco River, new work	1-80000	Do.
119	Coast Chart No. 19, new drawing	1-80000	Do.
111	Monomoy to Nantucket Shoals, additions	1-80000	Do.
115	Mercator chart of Long Island Sound, etc	1-80000	Do.
115	Long Island Sound, middle sheet	1-80000	Do.

Verification, revision, and correction of reduced drawings of hydrography, etc.—Continued.

Catalogue number of chart.	Title of chart.	Scale.	Draughtsman.
109	Boston Bay and approaches, additions	1-80000	Do.
120	New York Bay and Harbor, new drawing	1-80000	Do.
124	Delaware Bay Entrance, new drawing	1-80000	Do.
152	Murrill's Inlet to Cape Romain, South Carolina	1-80000	Do.
153	Winyah Bay to Long Island, South Carolina	1-80000	Do.
178	Coast Chart No. 178	1-80000	Do.
187	Pensacola Entrance to Mobile Bay	1-80000	Do.
210	Aransas Pass to latitude 27° 12′, additions	1-80000	Do.
212	Latitude 26° 33′ to Rio Grande, additions	1-80000	Do.
337	Boston Bay, additions	1-40000	Do.
369	New York Bay, upper part, new drawing	1-40000	Do.
369[4]	Hudson and East Rivers	1-10000	W. C. Willenbucher.
369[5]	Hell Gate and approaches	1-5000	Eugene Willenbucher.
424	Cape Fear River Entrance	1-40000	Do.
425	Cape Fear River, Federal Point to Wilmington	1-40000	Do.
601	San Diego to San Francisco, additions	1-200000	Do.
602	San Francisco to Umpquah River, additions	1-200000	Do.
610	San Pedro and Wilmington Harbors	1-40000	Do.
641c	Columbia River, Sheet No. 5	1-40000	Do.
641d	Columbia River, Sheet No. 6	1-40000	Do.
659	Tillamook Bay (changed)	1-40000	Do.
677	Point Arena to Cape Mendocino	1-200000	Do.
706	Sumner Strait and Clarence Strait	1-200000	Do.
707	Tongass Narrows	1-30000	Do.
708	Harbors in Clarence Strait	Various	Do.

Miscellaneous draughting done during fiscal year ending June 30, 1887.

Description.	Draughtsman.
Reducing engineer's survey of Providence River for charts 352, 353, and 113	W. C. Willenbucher.
Reducing shoal off False Cape for chart 137a	Eugene Willenbucher.
Reducing western passage of Southwest Harbor, Maine, for charts 103-408	W. C. Willenbucher.
Reducing offshore work, from Cape Henlopen to Hatteras, for file copy of A	Eugene Willenbucher.
Reducing engineer's survey of Columbia River Entrance for chart 641a	W. C. Willenbucher.
Plotting, by longitude and latitude, forty-two deep-sea soundings	Eugene Willenbucher
Project for chart 706, Sumner Strait, etc	Do.
Triplicating Long Island Sound scheme of projections for 1886	W. C. Willenbucher.
Duplicating scheme of projections of 1887 for steamer *Bache* and schooner *Eagre*	Do.
Plotting current stations on chart 116	Do.
Gulf-Stream curves, making copies of curves, etc	F. C. Donn.
Gulf-Stream curves, additional signs	Do.
Correction of numerous charts for files, Engraving Division and Chart Room	W. C. Willenbucher.
Sixteen tracings for special examination by hydrographic parties	Do.
One tracing for special examination by hydrographic party	F. C. Donn.
Five tracings for special examination by hydrographic parties	Eugene Willenbucher.
Three tracings for Light-House Board	W. C. Willenbucher.
Bringing up progress sketches, finishing reports, statistics, etc	Do.

Very respectfully,

M. L. WOOD,
Lieutenant U. S. N., Chief of Hydrographic Division.

Lieut. Commander W. H. BROWNSON, U. S. N.,
Hydrographic Inspector Coast and Geodetic Survey.

List of Naval Officers attached to the Coast and Geodetic Survey during the fiscal year ending June 30, 1887.

Name.	Date attached.	Date detached.	Remarks.
LIEUTENANT-COMMANDERS.			
C. M. Thomas	Jan. 20, 1887	....	Still in service.
A. S. Snow	Aug. 1, 1883	Apr. 30, 1887	
W. H. Brownson	*Aug. 11, 1881	....	Do.
LIEUTENANTS.			
E. D. Taussig	Apr. 30, 1883	Aug. 10, 1886	
J. E. Pillsbury	July 13, 1882		Still in service.
J. F. Moser	Jan. 29, 1884	....	Do.
Charles T. Forse	July 7, 1884	....	Do.
John M. Hawley	Mar. 21, 1885	Apr. 27, 1887	
Charles P. Perkins	Apr. 27, 1886	....	Do.
D. D. V. Stuart	July 10, 1885	....	Do.
Francis Winslow	Mar. 12, 1886	....	Do.
F. H. Crosby	Oct. 6, 1884	....	Do.
G. C. Hanus	Mar. 20, 1883	Feb. 3, 1887	
J. C. Burnett	Mar. 23, 1886	....	Do.
George H. Peters	June 30, 1885	....	Do.
LIEUTENANTS, JUNIOR GRADE.			
David Peacock	Mar. 29, 1886	....	Still in service.
J. M. Helm	Feb. 13, 1885	Nov. 5, 1886	
F. S. Carter	Apr. 23, 1885	Oct. 19, 1886	
M. L. Wood	Apr. 21, 1887	....	Do.
B. F. Walling	Mar. 31, 1886	July 31, 1887	
H. T. Mayo	May 7, 1886	....	Do.
Charles F. Pond	Apr. 8, 1886	Aug. 7, 1886	
De Witt Coffman	Apr. 12, 1886	....	Do.
W. G. Hannum	Apr. 27, 1886	Sept. 8, 1886	
ENSIGNS.			
T. D. Griffin	May 2, 1883	July 10, 1886	
E. E. Wright	Apr. 7, 1885	....	Still in service.
H. W. Harrison	May 2, 1887	....	Do.
N. J. L. T. Halpine	May 2, 1887	....	Do.
A. W. Dodd	Apr. 9, 1885	....	Do.
Simon Cook	Sept. 22, 1885	Mar. 10, 1887	
A. N. Wood	Mar. 17, 1887	....	Do.
R. M. Hughes	Jan. 13, 1886	....	Do.
A. G. Rogers	Apr. 29, 1885	....	Do.
W. P. White	Feb. 10, 1883	....	Do.
J. H. Shipley	Apr. 7, 1885	....	Do.
J. E. Craven	Nov. 28, 1883	Dec. 18, 1886	
J. H. Hetherington	June 19, 1883	Nov. 20, 1886	
B. C. Dent	Mar. 17, 1887	....	Do.
C. C. Marsh	May 3, 1884	....	Do.
C. W. Jungen	Aug. 25, 1883	Aug. 31, 1886	
C. S. Ripley	May 4, 1883	Dec. 16, 1886	
W. J. Sears	Apr. 28, 1885	May 18, 1887	
J. A. Bell	Feb. 22, 1885	....	Do.
D. P. Menefee	July 28, 1883	Jan. 4, 1887	
E. H. Tillman	Dec. 28, 1886	....	Do.
ENSIGNS—continued.			
J. L. Purcell	Mar. 26, 1886	....	Still in service.
M. L. Read	Apr. 27, 1887	....	Do.
R. O. Bitler	Apr. 29, 1885	....	Do.
A. P. Niblack	July 2, 1884	....	Do.
J. S. Watters†	July 7, 1883	Oct. 12, 1886	
E. F. Leiper	Apr. 26, 1883	Dec. 10, 1886	
J. C. Drake	Apr. 16, 1886	....	Do.
F. R. Brainard	July 20, 1883	Oct. 10, 1886	
W. J. Maxwell	Sept. 1, 1886	....	Do.
Franklin Swift	Oct. 30, 1886	....	Do.
Theodore G. Dewey	June 18, 1883	Nov. 5, 1886	
G. R. French	May 4, 1883	Feb. 4, 1887	
W. B. Fletcher	May 17, 1886	....	Do.
Marbury Johnston	May 19, 1886	....	Do.
George W. Street	Aug. 31, 1885	Dec. 29, 1886	
C. E. Sweeting	Aug. 4, 1885	Jan. 15, 1887	
Harry A. Field	Aug. 1, 1885	....	Do.
C. S. Williams	July 12, 1886	Oct. 27, 1886	
A. M. Beecher	Aug. 16, 1886	....	Do.
Roger Welles, jr	July 12, 1886	Jan. —, 1887	
N. S. Moseley	Aug. 23, 1886	....	Do.
Walter O. Hulme	July 12, 1886	....	Do.
J. D. McDonald	Aug. 10, 1886	....	Do.
H. E. Parmenter	July 14, 1886	....	Do.
H. P. Jones	July 16, 1886	....	Do.
I. K. Seymour	July 22, 1886	....	Do.
C. M. Fahs	July 17, 1886	May —, 1887	
PASSED ASSISTANT SURGEONS.			
T. H. Streets	Mar. 19, 1884	....	Still in service.
F. B. Stephenson	Sept. 1, 1884	....	Do.
D. O. Lewis	Nov. 28, 1885	....	Do.
A. A. Austin	Sept. 22, 1885	....	Do.
William H. Rush	June 3, 1884	....	Do.
Ernest W. Auzal	....	....	Do.
PASSED ASSISTANT PAYMASTERS.			
J. R. Stanton	Nov. 1, 1883	Dec. 31, 1886	
J. N. Speel	Dec. 20, 1886	....	Still in service.
PASSED ASSISTANT ENGINEERS.			
H. Main	May 29, 1883	Sept. 15, 1886	
H. N. Stevenson	Mar. 10, 1883	....	Still in service.
George Cowie, jr	Jan. 1, 1885	....	Do.
George D. Strickland	Sept. 17, 1886	....	Do.
ASSISTANT ENGINEERS.			
E. T. Warburton	Feb. 21, 1883	Sept. 17, 1886	
Robert I. Reid	June 9, 1882	....	Still in service.
Samuel H. Leonard, jr	Dec. 21, 1886	....	Do.

* Re-attached January 29, 1885. † Resigned

RECAPITULATION.

Lieutenant-commanders	3
Lieutenants	12
Lieutenants (junior grade)	9
Ensigns	48
Passed Assistant Surgeons	6
Passed Assistant Paymasters	2
Passed Assistant Engineers	4
Assistant Engineers	3
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NOTE.—From the statement immediately following it appears that of the eighty-seven officers above named, fifty-eight were on duty in the Survey at the close of the fiscal year.

List of Naval Officers attached to the Coast and Geodetic Survey June 30, 1887.

COAST AND GEODETIC SURVEY OFFICE.

Lieut.-Commander W. H. Brownson, U. S. N., Hydrographic Inspector.
Lieut. (Junior Grade) M. L. Wood, U. S. N., Hydrographic Division.
Ensign E. H. Tillman, U. S. N., Coast Pilot Division.
Passed Assistant Paymaster J. N. Speel, U. S. N., in charge naval pay accounts.

ATLANTIC AND GULF COASTS.

Steamer Blake (Atlantic Coast).—Lieut. J. E. Pillsbury, U. S. N., Commanding; Ensigns R. M. Hughes, A. G. Rogers, Franklin Swift, Roger Welles, and I. K. Seymour; Passed Assistant Surgeon W. H. Rush; Passed Assistant Engineer George Cowie.

Steamer A. D. Bache (Atlantic Coast).—Lieut. J. F. Moser, U. S. N., Commanding; Ensigns E. E. Wright, H. A. Field, W. O. Hulme, H. E. Parmenter, and H. P. Jones; Passed Assistant Surgeon F. B. Stephenson; Assistant Engineer S. H. Leonard, jr.

Schooner Eagre (Atlantic Coast).—Lieut. Charles P. Perkins, U. S. N., Commanding; Ensigns H. W. Harrison, N. J. L. T. Halpine, Baine C. Dent, and Franklin Swift.

Steamer Daisy (Atlantic Coast).—Lieut. George H. Peters, U. S. N., Commanding; Ensign W. J. Maxwell.

Steamer Endeavor (Atlantic Coast).—Lieut. D. D. V. Stuart, U. S. N., Commanding; Ensign R. O. Bitler.

Steamer Gedney (Atlantic Coast).—Lieut. F. H. Crosby, U. S. N., Commanding; Ensigns A. W. Dodd, W. B. Fletcher, and Marbury Johnston; Passed Assistant Surgeon A. A. Austin.

Schooner Scoresby (Atlantic Coast).—Lieut. Francis Winslow, U. S. N., Commanding; Ensign J. C. Drake.

PACIFIC COAST.

Steamer Patterson (Coast of Alaska).—Lieut. Commander C. M. Thomas, U. S. N., Commanding; Lieut. De Witt Coffman; Ensigns A. N. Wood, J. H. Shipley, C. C. Marsh, M. L. Read, A. P. Niblack, A. M. Beecher, J. D. McDonald; Passed Assistant Surgeon T. H. Streets; Passed Assistant Engineer H. N. Stevenson

Steamer McArthur (Coast of Oregon and Washington Territory).—Lieut. J. C. Burnett, U. S. N., Commanding; Ensigns W. P. White, J. A. Bell, J. L. Purcell, N. S. Moseley; Assistant Surgeon Ernest W. Auzal; Assistant Engineer R. I. Reid.

Steamer Hassler (Coast of California).—Lieut. David Peacock, U. S. N., Commanding; Passed Assistant Surgeon D. O. Lewis; Passed Assistant Engineer G. D. Strickland.

Schooner Earnest (Coast of Washington Territory).—Lieutenant Charles T. Forse, U. S. N., Commanding; Lieut. Henry T. Mayo.

Number of Naval Officers attached to the Coast and Geodetic Survey vessels during the fiscal year ending June 30, 1887.

Name of vessel.	September 30, 1886.	March 31, 1887.	Name of vessel.	September 30, 1886.	March 31, 1887.
Steamer Arago	3		Steamer Hassler	8	6
Steamer Bache	6	7	Steamer McArthur	6	5
Steamer Blake	7	7	Steamer Patterson	9	9
Steamer Daisy			Schooner Palinurus	4	
Schooner Eagre	4	1	Schooner Scoresby	2	3
Schooner Earnest	2	2	Coast Survey Office	4	5
Steamer Endeavor	5	4	Total	65	52
Steamer Gedney	5	3			

Average number, 58.

Number of men attached to the Coast and Geodetic Survey vessels during the fiscal year ending June 30, 1887.

Name of vessel.	September 30, 1886.	December 31, 1886.	March 31, 1887.	June 30, 1887.
Steamer Arago	17	8	4	2
Steamer Bache	33	32	32	32
Steamer Blake	38	39	38	37
Steamer Barataria	1	1	1	1
Barge Beauty	....	1	1	1
Steamer Daisy	9	7	3	11
Schooner Drift	2	2	2	....
Schooner Eagre	19	17	13	19
Schooner Earnest	15	7	6	15
Steamer Endeavor	21	19	21	19
Steamer Gedney	26	25	26	25
Steamer Hassler	33	30	16	15
Steamer Hitchcock	1	2	....	2
Schooner Matchless	....	....	1	3
Steamer McArthur	29	25	24	29
Steamer Patterson	38	36	23	44
Schooner Palinurus	16	12	6	....
Schooner Quick	1	....	....	1
Schooner Ready	....	2	3	....
Schooner Scoresby	13	16	13	16
Schooner Silliman	....	....	2	1
Schooner Yukon	....	1	1	1
Steam-launch Number Three	1	1	1	....
Total	312	283	237	274

Average number of men 276.

Names of vessels, their tonnage, etc., in the service of the Coast and Geodetic Survey during the fiscal year ending June 30, 1887.

No.	Name of vessel.	Tonnage.	Complement of—	
			Officers.	Men.
1	Steamer Patterson	453	12	44
2	Steamer Hassler	243	10	34
3	Steamer Blake	218	10	37
4	Steamer Bache	186	10	37
5	Steamer Gedney	133	8	26
6	Steamer McArthur	112	7	29
7	Steamer Endeavor	105	7	19
8	Steamer Hitchcock	83	5	2
9	Steamer Barataria	50	....	1
10	Steamer Arago	38	5	2
11	Steamer Daisy	44	3	11
1	Schooner Eagre	202	6	22
2	Schooner Drift	87	5	....
3	Schooner Earnest	80	5	14
4	Schooner Ready	80	5	0
5	Schooner Yukon	78	6	....
6	Schooner Palinurus	76	5	....
7	Schooner Silliman	72	5	....
8	Schooner Scoresby	72	5	14
9	Schooner Matchless	....	....	1
10	Schooner Quick	38	4	1
1	Barge Beauty	28	....	1

RECAPITULATION.

Whole number of vessels:	
Steamers	11
Schooners	10
Barges	1
Total	22
Number of vessels in active service	18
Average number of naval officers for the year	58
Average number of men for the year	276

The complements given on the preceding page do not represent the actual number of officers or men in the Survey during the year, owing to the fact that some vessels were employed only a part of the time.

Statement of hydrographic surveys executed during the fiscal year ending June 30, 1887.

Parties.	Locality.	Surveyed by—	Sheets.	Scale.	Volumes.	Angles.	Soundings.	Miles.	Area in geographical square miles.
1	Coast of Maine, *offshore* from West Quoddy Head to Libby Island	John M. Hawley, U. S. N.	5	4 on 10,000; 1 on 40,000	25	10,424	21,638	939	170
1	Examinations along the coasts of Maine, New Hampshire, and Massachusetts.	......do	(*)	Various.	9	1,363	6,407	75	3
2	Off Monomoy Point and Chatham Harbor, Massachusetts.	J. E. Pillsbury, U. S. N.	2	10,000	13	6,734	20,820	258	9
2	Examinations along the coasts of Massachusetts and Rhode Island.	......do	(†)	Various.	2	438	3,405	36	1
	Long Island Sound:								
3	Faulkner's Island to Execution Rocks	F. H. Crosby, U. S. N.	4	2 on 40,000; 1 on 10,000	49	10,322	48,679	1,530	484
4	Northern shore from Norwalk Island to David's Island	D. D. V. Stuart, U. S. N.	3	10,000	24	7,198	32,305	633	48
4	Hempstead Harbor	......do	1						
5	Southern shore from Smithtown Bay to Huntington Bay	W. J. Sears, U. S. N.	3	10,000	15	6,323	22,318	498	45
5	Oyster Bay and approaches	F. S. Carter, U. S. N.	1						
	Examination and additional work in	C. P. Perkins, F. H. Crosby, and G. H. Peters, U. S. N.	(‡)	10,000	28	5,338	26,085	314	10
6	East River, New York, College Point to Astoria	C. P. Perkins, U. S. N.	2	1 on 5,000; 1 on 2,500	13	4,330	19,907	200	5
6	Hudson River, Spuyten Duyvil Creek, and Harlem River.	......do	3	5,000	15	3,179	15,411	112	6
6	Passaic River and Hackensack River, New Jersey.	......do	1	10,000	4	721	5,481	50	2
6	Additional work, East River, College Point to Throg's Neck.	......do	(§)	10,000	1	204	969	10	1
7	New York Entrance (off Sandy Hook)	G. C. Hanus, U. S. N.	1	20,000	9	2,158	13,467	293	9
7	Raritan Bay and Sandy Hook Bay	......do	1	20,000	20	5,122	40,346	696	46
7	The Narrows, New York Harbor	......do	1	5,000	3	722	2,655	44	1
7	Arthur Kill and Staten Island Sound, New York Harbor.	......do	4	5,000	19	5,518	31,307	266	9
7	Newark Bay, New Jersey	......do	1	10,000	6	1,344	11,633	109	8
7	New York Upper Bay, additional work	......do	(‖)	10,000	2	580	2,364	37	1
2	Off coast of New Jersey	J. E. Pillsbury, U. S. N.	1	40,000	6	2,138	9,342	521	525
2	Off coast of Delaware	......do	1	40,000	2	420	1,333	204	
2	Off coast of Maryland and Virginia	......do	1	300,000	1	63*	526	1,019	5,200
2	New Inlet, North Carolina	......do	1	10,000	4	1,400	5,447	68	3
2	Saint Simon's Entrance, Georgia, examination of bar.	......do	1	10,000	1	367	2,255	31	2
8	Cape Romano and to the Sound, Florida	J. F. Moser, U. S. N.	2	40,000	19	4,007	36,860	1,258	733
8	Cedar Keys and to the Sound, Florida	......do	2	40,000	25	4,625	51,018	1,666	1,068
8	Examination of Sea Horse Key Bar, Cedar Keys.	......do	1	10,000	1	169	871	17	....
8	Examination of Harbor Cut, Cedar Keys	......do	1	10,000	1	86	506	4	....
9	Atchafalaya dredged channel	D. D. V. Stuart, U. S. N.	2	10,000	3	532	4,907	63	2
9	Vermillion Bay, Louisiana	......do	1	20,000	6	1,257	10,245	147	26
9	Off coast of Louisiana	......do	1	80,000	9	494	14,121	716	946
	Lompoc Landing, California	George Davidson	1	10,000	1	493	2,502	29	1
10	San Francisco Bay and tributaries, resurvey.	D. Peacock, U. S. N.	6	20,000	72	20,216	123,891	1,904	185
11	Umpquah River, Oregon	L. A. Sengteller	2	10,000	12	2,881	27,207	248	9
12	Columbia River, Oregon	C. Rockwell	1	10,000	4	2,886	9,656	175	5
13	Admiralty Inlet and Port Townsend Harbor, Washington.	C. T. Forse, U. S. N.	1	20,000	9	3,110	6,814	294	57
13	Possession Sound, Washington	......do	1	20,000	9	3,038	7,538	245	37
13	Port Susan, Washington	......do	1	20,000	8	2,512	5,176	190	30

* Astronomical positions.

Statement of hydrographic surveys executed during the fiscal year ending June 30, 1887—Continued.

Parties.	Locality.	Surveyed by—	Sheets.	Scale.	Volumes.	Angles.	Soundings.	Miles.	Area in geographical square miles.
14	Clarence Strait, northern part, and adjacent waters, Southeastern Alaska.	A. S. Snow, U. S. N	1	80,000					
14	Wrangell Strait, Southeastern Alaska	do	1	30,000					
14	Ratz Harbor, Southeastern Alaska	do	1	10,000					
14	Saint John Harbor, Southeastern Alaska	do	1	20,000	13	5,844	8,449	1,353	1,600
14	Etolin Harbor, Southeastern Alaska	do	1	10,000					
14	Steamer Bay, Southeastern Alaska	do	1	20,000					
14	Dewey Anchorage, Southeastern Alaska	do	1	20,000					
14	Coffman's Cove, Southeastern Alaska	do	1	10,000					
15	Sumner Strait and adjacent waters, Southeastern Alaska.	J. M. Helm, U. S. N	1	80,000					
15	Red Bay, Southeastern Alaska	do	1	10,000	7	5,747	7,833	1,285	....
15	Shakan Strait, Southeastern Alaska	do	1	20,000					
15	Port Protection, Southeastern Alaska	do	1	10,000					
15	Port McArthur, Southeastern Alaska	do	1	10,000					
	Grand total		74	Various.	470	134,301	661,602	17,537	11,287

* Plotted on 8 sheets. † Plotted on 5 sheets. ‡ Plotted on 14 sheets.
§ Plotted on 1 sheet. ‖ Plotted on 2 sheets.

DEEP-SEA WORK, 1886-'87.

Number of current stations	37
Number of subsurface current observations	1,336
Number of surface current observations*	3,694
Number of specimens of bottom	171
Current stations occupied by hydrographic parties	12

* 1,173 observed with current meter; 2,521 observed with current pole.

APPENDIX No. 6.—1887.

ON THE MOVEMENTS OF THE SANDS AT THE EASTERN ENTRANCE TO VINEYARD SOUND.

By HENRY MITCHELL, Assistant.

WASHINGTON, D. C., *May* 7, 1887.

SIR: I submit below a continuation of my discussion of the changes among the Monomoy Shoals and a table of results.

Very respectfully, yours,

HENRY MITCHELL,
Coast and Geodetic Survey.

Mr. F. M. THORN,
Superintendent Coast and Geodetic Survey.

MOVEMENTS OF THE SANDS AT THE EASTERN ENTRANCE TO VINEYARD SOUND.

In my report on "Monomoy and its Shoals," presented last year,* I did not attempt anything more than a historical sketch of the increase and advance of those obstructions, because the causes of change that we observed did not seem adequate to the effects that comparative surveys revealed. But our physical studies in New York Harbor during the past year have discovered to us a relationship of *tidal stage* to the resultant effect of tidal currents that throws new light upon old themes.†

The report and its illustrations of last year showed that sands from the outside coast were tending towards the entrance to the Sound from both directions; but, that while the sands from the north were pressed into this entrance, those from the south were turned off on presenting themselves. One may recognize in this disposition of things a slow rotary motion or circular development. Moreover, we have seen that while some of the shoals move on like *dunes* by the running over of sands from rear to front, others grow or extend, as if they were simply dumping-grounds; the Handkerchief on one side and the Point Rip on the other side of the entrance are instances of dumping-grounds, as opposed to the Pollock Rips and the Stone Horse, which are progressive.

The question of practical interest is, do these movements and re-inforcements threaten to close the thoroughfare to commerce? We do not expect to answer this question now, but we propose to exhibit the evidence as we gather and digest it.

The sands from the north press in, at the entrance, not simply because it offers a dead angle or pocket, but also because there is a *draught* through to the southwestward. Our first step in this

* Appendix No. 8, 1886.

† Appendix No. 13, 1886.

paper is to show this—which we regard as a primary point. To this end we offer a sketch (Illustration No. 31), a table of observations, and a diagram illustrating the table.

Tides and currents at the entrance of Vineyard Sound.

[Current station, Butler's Hole, is $1\frac{1}{4}$ nautical miles south, 2° west of Monomoy Light, in $17\frac{1}{4}$ fathoms of water.]

Date.	Civil time.	Tide of No Man's Land.	Tide of Powder Hole.	Current Butler's Hole.	Date.	Civil time.	Tide of No Man's Land.	Tide of Powder Hole.	Current Butler's Hole.
1857.	*h. m.*	*Feet.*	*Feet.*	*Feet per sec.*	1857.	*h. m.*	*Feet.*	*Feet.*	*Feet per sec.*
Aug. 9	6 00	4.75	5.60	....	Aug. 9	21 30	....	3.60	+2.90
	30	....	4.91	....		22 00	7.40	3.81	2.60
	7 00	5.80	4.40	....		30	7.47	4.12	2.45
	30	....	3.90	....		23 00	7.45	4.52	1.60
	8 00	6.46	3.55	....		30	7.43	5.10	1.25
	30	....	3.39	....	10	0 00	6.94	5.60	+0.10
	9 00	7.32	3.40	....		30	....	6.10	-0.10
	30	....	3.66	....		1 00	5.90	6.63	-0.30
	10 00	7.62	4.05	....		30	....	7.12	-1.75
	30	7.60	4.60	....		2 00	4.95	7.45	-2.70
	11 00	7.37	5.13	....		30	....	7.67	-2.75
	30	....	5.57	....		3 00	4.33	7.73	-3.55
	12 00	6.60	5.76	+0.10		30	....	7.75	-3.55
	30	....	6.36	-0.75		4 00	4.06	7.69	-3.90
	13 00	5.70	6.75	-2.10		30	3.93	7.51	-3.00
	30	....	7.20	-2.50		5 00	3.95	7.20	-1.95
	14 00	4.75	7.50	-3.30		30	4.10	6.79	-1.40
	30	....	7.63	-3.30		6 00	4.29	6.31	-0.80
	15 00	4.25	7.66	-3.90		30	....	5.76	-0.20
	30	4.14	7.60	-3.90		7 00	4.97	5.10	+0.35
	16 00	4.03	7.40	-2.60		30	....	4.45	2.00
	30	4.00	7.21	-2.60		8 00	5.80	4.00	2.15
	17 00	4.11	6.70	-2.25		30	....	3.67	2.20
	30	....	6.34	-1.10		9 00	6.90	3.58	3.05
	18 00	4.60	5.78	-0.10		30	....	3.64	3.00
	30	....	5.20	+0.10		10 00	7.59	3.84	3.05
	19 00	5.25	4.60	1.00		30	7.84	4.10	2.75
	30	....	4.10	2.10		11 00	7.85	4.44	2.40
	20 00	6.05	3.65	2.10		30	7.84	4.89	1.90
	30	....	3.45	2.25		12 00	7.61	5.33	0.90
	21 00	6.88	3.45	2.85		30	....	5.87	+0.10

NOTE.—The plus (+) sign indicates flood or easterly current, and the minus (—) ebb or westerly current.

It may seem at first glance upon our map (Diagram No. 1), that we have at the entrance to the Vineyard Sound, at least in embryo, the outside and inside bars of an "*inlet*" (as an opening through the *sandy cordon* of our southern coast is called), but, as we shall see, the conditions at this opening are peculiar. At the "*inlet*" the outer bar represents what is gone from the *sandy cordon* at the opening, while the inside bar, sometimes called the "*swash*," is the ground-up sand delivered by the breakers to the flood current and dumped at the point where the flood current loses its power in the lagoon. The circus of shoals outside of the Monomoy Entrance is an encroachment from an independent source, as the comparative maps show.

The least section is found on a curve extending from Monomoy Point, convex to the ocean, passing over Shovelful, Stone Horse, and Point Rip to Great Point. On this *sill* the average depth (20 feet) is less than 50 and the area of section less than 60, per cent. of what is found at the narrow pass from land to land. The inside shoals belong to the same foreign force, but represent the portion that has dashed across the battle-ground in the narrow pass where the currents were too strong to permit a lodgment. Both of these *sills* are *interrupted*, or, perhaps, *incomplete*, but the inside *sill* (represented mostly by the Handkerchief) is more so than the outer one.

There is no difficulty in tracing upon Commander Brownson's hydrographical sheet of 1883 a connecting ridge between Great Point, Nantucket, and Great Round Shoal, through which, at a distance of $5\frac{1}{4}$ nautical miles N. 70° E (true) from Great Point Light, one finds the deepest channel

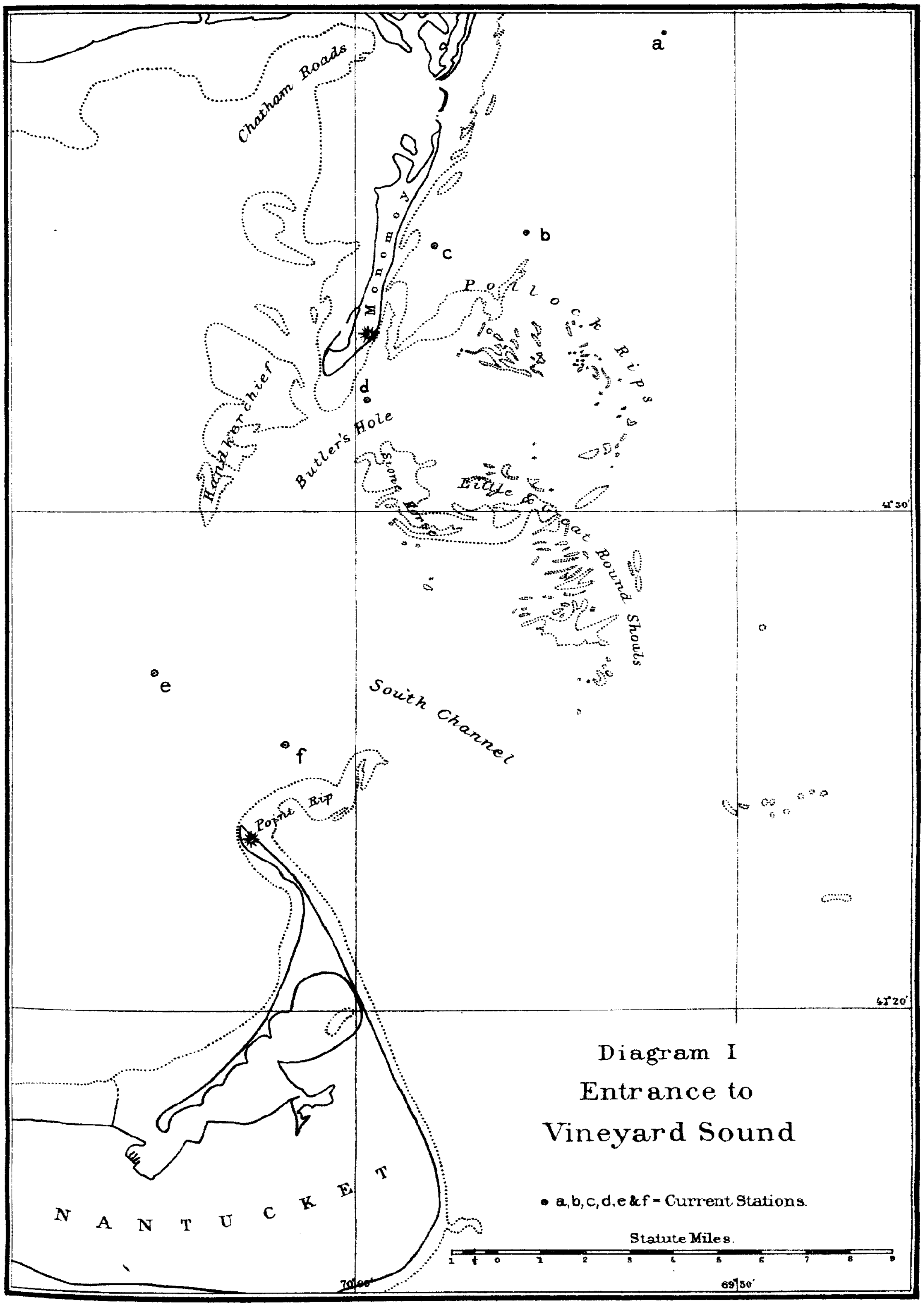


Diagram I
Entrance to
Vineyard Sound

to be 6¼ fathoms at low water. This ample depth, under very close marking, might be found by the navigator, but the course has so many changes that, practically, the South Channel is good only for 4 fathoms with 2½ feet additional for rise of tide. This ridge ought to be closely watched. In our report of last year we inclined to the belief that the Great Round Shoal stood firm; this, as the abutment of the ridge, should be tested by re-survey. Its breaking up would be, no doubt, an injury to the channel.

The other exit from the Sound is by way of channels through and past the Pollock Rips. These channels are well marked, but the greatest low-water depth is but 20 feet, with 4 feet or less of tide additional.

It is entirely possible that in a very great southeasterly gale the breaker may be continuous, or overlapping, from Monomoy around through the Pollock Rips, the Twelve Feet Shoal, the Broken Rip, the Great Round Shoal, and along the "*ridge*" to Point Rip and Great Point. This outer *sill* of the entrance is about 18 miles long, of which only 3 miles may be crossed by heavy vessels in smooth weather.

Before losing sight of our map (I) we must explain that we call it the "Entrance to Vineyard Sound," because the title "Nantucket Sound" (first given, I think, by Lieut. Charles Henry Davis), has never been adopted by the commercial world, and because our theme involves the entire water space sheltered by the islands of Nantucket and Martha's Vineyard, and we must choose here the most comprehensive name in use.

The table we have given is from actual observations never before published, and the second diagram (Sketch No. 32) illustrates these observations in its second figure.

The first figure of this diagram furnishes types of the tidal profiles for the two entrances of the Vineyard Sound from a combination of the observations at Powder Hole (Monomoy) and Great Point (Nantucket) to represent the eastern entrance, and from observations at Menemsha Bight (under lee of Gay Head, Martha's Vineyard) to represent the western entrance. From this figure, one sees at a glance that the *slopes* (alternately eastward and westward) must be equal, for these are but serpentine curves with a common axis which is assumed to be *mean sea-level.* But it is also evident that the two *slopes* occur at different *stages:* The slope westward (IX½ to III½) is in greater depth of water than the reverse slope (III½ to IX½). The equal *slopes* are 3.54 feet each; the unequal *stages* differ 1.20 feet.

My object, as will presently appear more distinctly, in presenting this general case, based on a long series, is to establish the fact that whatever may be the local contrasts from side to side at the eastern entrance, the *net effect is a westwardly movement,* because, notwithstanding that the slopes are equal in the two alternate directions, differences of *velocity* and *discharge* must result from the differences of *sectional area* and *perimeter.* "*Scour*" is *work* done by water flowing over sands; it is therefore in proportion to the square of the velocity, and varies with *section* directly, and *perimeter* inversely, when other things are equal.

In the second figure we have given actual observations only, and precisely as recorded, except that we have plotted the tidal profiles for ordinates measured from the *mean level of the sea* as well as we could determine it. In taking the tide of No Man's Land as representing the western entrance to the Vineyard Sound we are doing no violence to our case, because in a comparison at other dates when we happened to have simultaneous observations at No Man's Land and at Gay Head (Menemsha Bight) it was found that the former station had the same time of tide as the latter and a little greater range. In this second figure of our diagram, the *slopes* are of course equal, east and west, being 2.37 feet in the average, but the western *slope* is, at an average *stage,* 0.27 foot above the eastern *slope.*

The difference of depth over the *sill* of the entrance which this higher *stage* represents seems insignificant—insufficient to account for the predominance of westwardly flow that the synchronous observations in Butler's Hole reveal. But this is not the whole story; we have a much stronger case than our *convenient* data support. As we have already said, the tides at the western entrance are really of less range than the sample from No Man's Land that we have given, and if our observations had been made at Monomoy Point instead of the Powder Hole we should have found a range there nearly 25 per cent. greater. In short, if our stations had been located with special reference to our problem, we should have found the *stage* of the *western slope* more than 1.20 feet above its alternative. And, furthermore, as our diagram shows distinctly, the maximum westerly current occurs at local high water when the depth over the *sill* is nearly 4 feet greater than at maximum easterly current about six hours later.

Perhaps this is a proper place to explain that in popular usage the term "*flood*" is applied to the easterly current because "*it makes high water*" in the Sound.

It is convenient to remember the phenomena coincident with the transit or "*southing*" of the moon as a key to the apparently occult tidal system of this neighborhood. *At the southing of the moon* (nearly) *it is high water on both sides of Cape Cod* and in that portion of the Sound lying east of Vineyard Haven; *it is slack water* (turning from easterly to westerly flow) in the main channel from Gay Head to the Handkerchief Shoal nearly; *but down along the outer coast of Cape Cod and into the Sound through Butler's Hole the ebb current* (southerly and westerly) *is already at its strength.*

Thus we see at the *southing* of the moon, when the tide is full, the sweepings from the outside of Cape Cod are being dumped into the still waters of the Sound.

The observations plotted in our Diagram II were made by my party thirty years ago, and the current observations of Butler's Hole, that so happily fit our present argument, bear the signature of William H. Gardner, now a well-known surgeon of the U. S. Army, and always reliable. He was the actual observer at most of the important stations around Monomoy Shoals in 1857.

The South Channel stations "e" and "f" give resultants tending seaward and with a different local slope, for we approach the node as we go southward. The shift from the Bay of Fundy system to the regular Atlantic tide occurs on an arc from the southeastern angle of Nantucket Island to Cape Sable, Nova Scotia. (See Appendix 10, Annual Report Coast and Geodetic Survey for 1879.)

The movements of the sand swept by tidal currents are often conspicuous, so that the casual observer may notice that the bottom is "*alive;*" but the motion is usually much less rapid than that of the stream, so that the effect of one flood or ebb is not sufficient to carry it far from its original position, and the adverse stream may take it back. The ebb and flood currents are, however, rarely equal and opposite, so that the particles of sand, by long zigzags, make a gain one way. Our method is to observe the velocities and directions of the currents every half hour for a full tidal day (24½ hours), and then make a composition of them as if they were synchronous forces. The following table gives our results, which are consistent with the historical data furnished last year, although no corrections for *range* and *stage* have been introduced.

Composition of tidal forces.

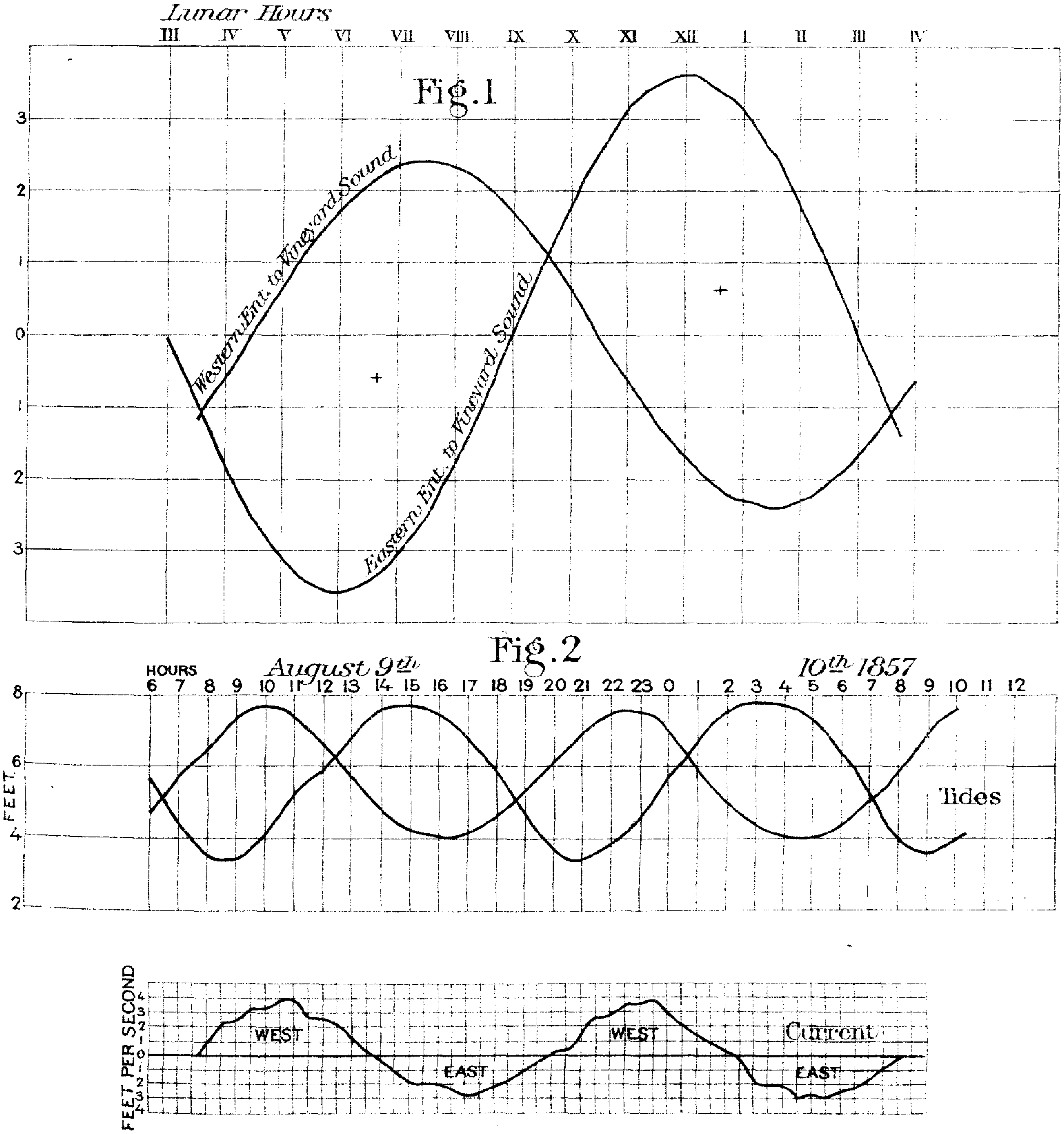
Station.	Location.	No. of tidal hours occupied.	Resultant.		Chiefs of observation parties.
			Value 24 hours.	Direction.	
a	7 nautical miles N. 55° E. (true) from Monomoy Light.	12	2.5	S. 6° W.	H. Mitchell and William H. Gardner, 1857.
b	3½ miles N. 53° E. from Monomoy Light	12	18.0	S. 55° W.	Same, 1857.
c	2¼ miles N. 35° E. from Monomoy Light	24	7.0	S. 56° W.	Commander J. E. Pillsbury, U. S. N., 1885.
d	1¼ miles S. 1° W. from Monomoy Light	24	6.0	N. 71° W.	H. Mitchell and William H. Gardner, 1857.
e	4½ miles N. 30° W. from Great Point Light	48	3.4	S. 50° E.	Same, 1857.
f	2 miles N. 14° E. from Great Point Light	24	8.8	N. 28° E.	Same, 1857.

The discrepancy between the values of "b" and "c" is due mostly to *diurnal inequality*, cancelled in the latter case.

As we have not yet determined the coefficient which should reduce velocities of current to movements of sand induced by such currents, we can not assign real values to our *resultants.* We can only say that stations "a," "b," and "c" concur in showing that the sand which augments Monomoy and the Handkerchief comes from the north, while "d," "e," and "f" indicate that this

Diag. 11

TIDES AT ENTRANCES OF VINEYARD SOUND



Butler's Hole

movement is part of a convolution confined somewhat to the neighborhood of this entrance to the Vineyard Sound, which forms a sort of pocket. There is no whirl, except in *ultimate resultant effect.* We have been tempted to trace upon our map the locus of this movement, but hardly dare do so yet.

The most unexpected result of this new computation is, that what appeared inconsistent in the movement of Little Round Shoal as breaking the general order of march in our historical sketch of last year, now seems quite probable under our dynamic scheme.

The Handkerchief looks, upon the chart, as if it might be a broken part of Monomoy, but it never joined on, that we can learn. The slough channel that separates them did so from the beginning. The shoal building has not been here a growing and traveling *dune,* but here has been the dumping-ground for Butler's Hole in its vain endeavor to keep itself free. It will be remembered that we showed last year that this channel had lost half its width by encroachment from the north; but had made up for it in some part by excavating its bed.

Among tidal currents where ebb and flood repeat and reverse each other's velocities and directions very nearly, we should expect to find channels and shoal-ridges lying somewhat transversely to the general course of the two streams, because the *resultant* is the diagonal of a very obtuse angle. The shoals are prone to lie in windrows. As we have seen, the variation of depth, or change of "*stage,*" is a potent cause of inequality of ebb and flood velocities in confined channels, it is therefore productive of *resultants.* To offer a very patent instance: we find on the outside of Monomoy and Chatham that the southerly (ebb) current reaches its maximum at high water, so that it alone sweeps the upper part of the strand and probably runs faster than its alternative all along the *breaker belt.*

Now the *breaker belt, i. e.,* the strand uncovered by the falling tide and the shallow aproning adjacent, is the proximate source of supply of the shoal-building and beach-building materials.

It is here that the earth torn from the cliff is ground up and assorted. The fine grade is taken off by the current in suspension to build flats and salt marshes in tranquil and sheltered places, but the next coarser grade is rolled or swept along slowly. The shingle alone resists the current and awaits the storm seas. Where the waves habitually drive on diagonally they themselves urge forward masses of sand and are often more potent than the tidal currents, so that beaches are extended where no tidal currents sweep the strand.

Comparative hydrography, it would seem, should begin with the survey of the *cliff, strand,* and aproning. It is not the ambitious way, but it is the slow and sure one.

I am indebted to Assistant George A. Fairfield and especially to Messrs. E. E. Haskell and Homer P. Ritter for computations and drawings to a far greater extent than this report may indicate; because although we have rejected no data that we had bearing upon the points here discussed, we have tried many other themes where our data promised more than they fulfilled.

HENRY MITCHELL,
Coast and Geodetic Survey.

APPENDIX No. 7.—1887.

FLUCTUATIONS IN THE LEVEL OF LAKE CHAMPLAIN AND AVERAGE HEIGHT OF ITS SURFACE ABOVE THE SEA.

A Preliminary Report by CHARLES A. SCHOTT, Assistant.

COMPUTING DIVISION, COAST AND GEODETIC SURVEY OFFICE,
October 10, 1887.

The subject of the fluctuations, annual and secular, as well as temporary, of Lake Champlain, demanded the attention of the Coast and Geodetic Survey when it became necessary to decide upon some determinate level to which the soundings of the lake, taken in different months and years, should be reduced as standard level. Closely connected with this inquiry was the question of the average elevation of the lake above the half-tide or mean level of the ocean.

Up to the present time the average elevation of the lake above the ocean, as given by various authorities, was generally confined within the limits of 90 and 100 feet; thus we find in H. Gannett's Dictionary of Altitudes (Washington, 1884), elevation of Lake Champlain, 91 feet (authority, Adirondack Survey), and 101 feet (authority, railroad reports). In Lippincott's Gazetteer (Philadelphia, 1882), we find the statement "the surface is 93 feet higher than the level of the sea." In the seventh annual report of the Adirondack Survey, for 1879, the superintendent of that survey gives 99.31 feet, but in a letter to this Office dated June 26, 1887, he says "the mean height of Lake Champlain, by my measurements is 96.56 above mean tide level at Governor's Island, New York Harbor." This last statement is not far from the truth, and we are promised shortly by Mr. V. Colvin, Superintendent Adirondack Survey, a publication of his researches.*

Much more vague have been the statements as to the greatest depth of the lake. While the new American Cyclopædia (New York, 1859), gives the greatest depth 282 feet, a value which is reproduced in Johnson's New Universal Cyclopædia (New York, 1875), the Lippincott Gazetteer (Philadelphia, 1882) states that the greatest depth ascertained is 600 feet.

In the years 1870–'74 the Coast Survey sounded out the lake and published its survey in four sheets in 1879 and 1880; here we find the deepest sounding indicated, viz, 399 feet off Wing's Point in about latitude 44° 18′, longitude 73° 19′. The adopted plane of reference on these charts is half a foot above an extreme low water (observed between 1870–'74),† and this level of reference I now find to be about two feet and a half below the average level of the lake as observed during

*Letter of July 25, 1887, addressed to this Office.

†The word "ever" occurring in the notes explanatory of the level of reduction should be struck out as too general.

the period 1871 to 1882, hence the greatest depth may be said to be 402 feet, and consequently parts of the bottom of this lake basin descend more than 300 feet below the level of the Atlantic Ocean.

The irregular, periodic, and secular variations in the lake level as observed during twelve years indicate a *total* range of 8 feet at the northern outlet of the lake, and no doubt this range is greatly exceeded at points near its opposite extremity, since strong and continuous northerly winds would drive the water into the narrower, southern parts of the lake, heaping it up there, while southerly winds could not do this in the wider, northern part of the lake where it is free to discharge its surplus waters through the Sorel or Richelieu River. This outlet is quite shallow; the maximum depth at low stage of the river and where it is crossed by the Canadian boundary line is but 18½ feet and its width is three-quarters of a statute mile.

As early as 1857 the Coast Survey undertook to carry a line of spirit levels from New York to Albany for the purpose of studying the influence of the slope of the Hudson River and of its variations in profile, on the time of propagation of the tide up the river and upon the shape of the tidal wave during its progress. The results of these levels were afterwards utilized by the U. S. Lake Survey as a step in the operations which determined the heights of the Great Lakes and extended their influence even as far as Saint Louis, Mo., where a satisfactory rough first check was had by comparison with the lines of spirit levels carried by the Coast and Geodetic Survey from Sandy Hook, New Jersey, through Pennsylvania, Maryland, West Virginia, etc., to the Mississippi River. The Adirondack State Survey also availed itself of these levels. In 1876 and 1877 the spirit levels were extended to meet the requirement of supplying check data for the determination of heights for the triangulations in New York, Massachusetts, Vermont, and New Hampshire. These operations were in charge of Assistants R. D. Cutts and O. H. Tittmann. In 1882 the latter observer carried the line of spirit levels northward along the Champlain Canal as far as Putnam Station, N. Y., where he extended his work by means of water levels, covering the whole length of the lake, and thus gave the first means of determining the absolute height of the lake and consequently also that of the plane of reference used in the hydrographic surveys of 1870–'74.

In connection with this work it was a fortunate circumstance that the Survey could avail itself of a series of daily observations of the water level made at Fort Montgomery, near Rouse's Point, at the northern extremity of the lake. This series was made under the direction of the U. S. Engineers, and the Survey is indebted to the Chief of Engineers, U. S. A., and to Maj. M. B. Adams of the Engineer Corps for transmitting a certified copy of the record, which extends over nearly eleven years, commencing with March, 1871, and ending with September, 1882. It does not appear that the series has been discussed before. The preface to the record book reads as follows: "The following record shows the water level of Lake Champlain for the date indicated. The figures in the last column show height of water surface in feet and decimals above zero at Fort Montgomery, which zero is 1.5 below top of base course of scarp wall, at the left re-entrant angle of Bastion B, at the outer end of lake postern. When water surface is below zero the fact is noted. The above note was added to this book at Fort Montgomery on August 9, 1882, and was read to William McComb, the fort keeper, by whom the observations were made, and was approved by him as correct; signed, William P. Judson, Assistant Engineer (and dated) U. S. Engineer Office, Fort Montgomery, August 9, 1882."

From this record monthly means were formed and tabulated as below.

Fluctuations of the level of Lake Champlain, as shown by monthly means from daily observations made by the U. S. Engineers at Fort Montgomery, N. Y., between the years 1871 *and* 1882.—The values are expressed in feet and give the mean of the readings of the water level on a fixed staff graduated from zero upwards; interpolated values are inclosed in parentheses.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1871	(2.58)	(2.58)	3.95	4.45	4.28	2.66	1.80	1.57	1.94	1.45	1.50	(2.32)	(2.59)
1872	(2.09)	(1.43)	(2.22)	4.03	4.32	3.94	3.00	3.63	4.59	3.80	3.97	3.46	(3.37)
1873	(3.23)	(1.97)	2.76	5.99	6.49	4.15	2.50	1.81	1.02	1.37	2.17	2.92	(3.03)
1874	4.15	(3.42)	(3.94)	(5.31)	5.13	5.06	3.88	3.47	2.16	1.64	1.06	0.89	(3.34)
1875	0.72	0.74	1.59	4.38	4.91	3.57	2.44	1.80	1.42	1.77	2.59	2.31	2.35
1876	3.18	3.06	3.71	5.22	6.61	4.74	3.07	1.39	0.97	0.77	0.67	0.48	2.82
1877	0.46	0.55	1.47	4.36	3.89	2.36	2.21	2.00	1.56	1.39	2.22	2.60	2.09
1878	2.06	1.56	2.28	4.42	4.85	2.94	1.98	2.80	2.71	1.53	1.76	4.05	2.74
1879	3.31	2.70	2.95	4.44	6.00	3.73	2.50	1.64	1.06	0.66	0.80	2.24	2.67
1880	2.34	3.06	3.56	3.92	3.53	2.33	1.51	0.86	0.31	0.14	1.70	1.47	2.06
1881	1.04	1.43	3.06	3.46	4.63	3.22	1.99	1.38	0.95	0.62	1.06	1.53	2.03
1882	2.55	2.37	3.79	3.50	3.26	3.88	3.01	1.86	1.42	(1.13)	(1.69)	(2.25)	(2.56)
Mean of 7 years, 1875-'81	1.87	1.87	2.66	4.31	4.92	3.27	2.24	1.70	1.28	0.98	1.54	2.10	2.40
Mean of 12 years	2.31	2.07	2.94	4.46	4.82	3.55	2.49	2.02	1.68	1.36	1.77	2.21	2.64

The few interruptions in the monthly means of the earlier years are due to obstructions by ice. The means for seven complete years are introduced for the purpose of interpolation, viz: For January and February, 1871, we note that the observed values for March and April, 1871, are on the average 0.71 foot in excess of the corresponding values in the seven-year series, 0.71 was therefore added to the January and February values of the latter series and the respective results inserted for 1871. Similarly for December, 1871, and January, 1872, the October and November values for 1871 were on the average 0.22 foot above the corresponding seven-year means, and that amount was added to the December and January means of that series to obtain the interpolated tabular values; in like manner the April and May values were employed to give the interpolations for February and March. The remaining interpolations were made on the same principle. The monthly means for the period of twelve years were then inserted in the last line, which shows:

The annual variation in the level of Lake Champlain, 1871 to 1882.

By subtracting the general mean reading 2.64 from each of the monthly means we obtain the mean annual variation in the surface of the lake. A plus sign signifies elevation, a minus sign depression in the surface as compared with the average state during the twelve years.

Month.	Feet.	Month.	Feet.
January	−0.33	July	−0.15
February	−0.57	August	−0.62
March	+0.30	September	−0.96
April	+1.82	October	−1.28
May	+2.18	November	−0.87
June	+0.91	December	−0.43

Hence during March, April, May, and June the lake is higher than its average stage and in the remaining months lower. It must, however, be remembered that our series is short and that this conclusion needs qualification. The maximum elevation in May finds its obvious interpretation as the effect of the melting of snow and ice accumulated within the drainage area of the lake during the preceding winter, and the minimum in February is due to the freezing up of water-courses which otherwise would feed the lake, but the apparent principal minimum in the month of October could not be so readily explained, and its cause is rather obscure. It then appeared to me desirable to compare the state of Lake Ontario with that of Lake Champlain. For this purpose the monthly means of the gauges of that lake were extracted from the annual reports of the U. S. Lake Survey (from Reports of Chief of Engineers from 1876 to 1881), and tabulated as follows:

Fluctuations in the level of Lake Ontario, shown by monthly means from observations at Charlotte Harbor, as a representative station, between the years 1859 *and* 1881.—The tabular figures give the *depression* of the surface *below* a fixed plane of reference, *i. e.*, a supposed high stage of 1838, and are expressed in feet and decimals. The series is made complete by interpolated values for certain months in the first and in the last year of observation. These values are indicated by parentheses. Thus the seven observed values for 1859 are, on the average, 0.91 foot below their corresponding monthly means in the twenty-one-year series; hence the interpolated values for the first five months of 1859 are the respective values in the twenty-one-year series diminished by 0.91 foot. The last year of the series was made complete in a similar way.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1859	(2.12)	(2.16)	(1.94)	(1.34)	(0.87)	0.15	0.46	0.96	1.66	2.13	2.62	2.29	(1.56)
1860	2.40	2.57	2.46	2.44	2.20	2.01	1.89	1.90	2.31	2.57	2.49	2.48	2.31
1861	2.70	2.69	2.25	1.71	0.94	0.70	0.69	0.98	1.44	1.29	1.38	1.58	1.53
1862	1.94	2.20	2.09	1.23	0.40	0.55	0.66	0.99	1.52	2.02	2.39	2.53	1.54
1863	2.46	2.27	2.10	1.51	1.01	1.01	1.25	1.56	2.11	2.54	2.73	2.72	1.94
1864	2.88	2.90	2.83	2.29	1.24	0.91	1.31	1.69	2.22	2.51	2.42	2.20	2.12
1865	2.47	2.81	2.40	1.77	1.51	1.54	1.74	2.23	2.59	2.94	3.26	3.34	2.38
1866	3.53	3.76	3.45	3.10	2.64	1.90	2.13	2.35	2.49	2.61	2.59	2.13	2.72
1867	2.19	2.21	2.08	1.67	0.88	0.58	0.90	0.89	1.09	1.63	3.42	3.64	1.77
1868	3.82	4.18	3.82	3.16	2.63	2.28	2.41	2.62	2.85	3.55	3.44	3.46	3.19
1869	3.60	3.47	3.28	2.54	1.95	1.78	1.51	1.56	1.71	2.01	2.42	2.27	2.34
1870	1.74	1.59	1.66	0.63	—0.05	0.17	0.44	0.89	1.49	1.84	2.26	2.46	1.26
1871	2.68	2.90	2.61	1.95	1.66	1.73	1.90	2.34	2.68	3.25	3.63	4.20	2.63
1872	4.35	4.55	4.68	4.26	4.02	3.70	3.64	3.79	4.04	4.14	4.25	4.44	4.16
1873	4.51	4.60	4.43	2.75	2.07	2.02	2.08	2.32	2.76	3.12	3.28	3.15	3.09
1874	2.68	2.34	1.90	1.79	1.66	1.70	1.59	1.84	2.34	2.95	3.48	3.78	2.34
1875	4.13	4.46	4.30	3.52	3.17	3.12	2.97	3.15	3.38	3.63	3.81	3.91	3.63
1876	3.50	2.87	2.28	1.36	0.68	0.56	0.54	0.96	1.62	1.96	2.30	2.56	1.77
1877	2.96	3.19	3.07	2.46	2.31	2.49	2.46	2.72	3.13	3.52	3.66	3.51	2.96
1878	3.37	3.13	2.61	2.21	1.88	1.88	1.92	2.02	2.17	2.60	2.63	1.95	2.36
1879	2.18	2.52	2.50	2.24	2.08	2.05	2.24	2.61	3.01	3.45	3.84	3.82	2.71
1880	3.60	3.30	2.98	2.75	2.54	2.40	2.47	2.84	3.15	3.63	3.73	3.93	3.11
1881	4.23	4.14	3.57	3.20	2.90	(2.68)	(2.76)	(3.02)	(3.40)	(3.77)	(4.03)	(4.06)	(3.48)
Mean of 21 complete years	3.03	3.07	2.85	2.25	1.78	1.67	1.75	2.01	2.39	2.76	3.02	3.05	2.47
Mean of 23 years	3.04	3.08	2.84	2.26	1.79	1.65	1.74	2.01	2.40	2.77	3.05	3.06	2.47

The annual variation in the height of Lake Ontario is here brought out with much greater regularity and distinctness, as might be expected from the longer series, as compared with that of Lake Champlain. The minimum occurs in February and thus supports the surmise that the same is the case for Lake Champlain and that the October low water of the latter lake is accidental and would disappear in a longer series of observations.

The waters of Lake Ontario rise steadily from February to June, when the highest stage of the year is reached. The total or mean range is 1.43 feet, whereas Lake Champlain fluctuates 2.75 feet between February and May, as might be expected from the narrowness of the lake. It can be shown that the annual variation of Lake Ontario follows quite closely the variation in the rain-fall, excepting that the small October rise in the amount of precipitation is not reflected in the variation of the lake. The following figures of ratios of the monthly mean rain-fall are taken from my discussion of the aqueous precipitation in the United States published by the Smithsonian Institution, second edition, Washington, 1881, pages 198, 199, type II. for twenty-seven stations in western New York: *

Month.	Feet.	Month.	Feet.	Remarks.
January.	0.78	July.	1.28	Least monthly precipitation in rain and melted snow in February; greatest precipitation in June.
February.	0.69	August.	1.09	
March.	0.79	September.	1.07	
April.	0.86	October.	1.17	
May.	1.14	November.	0.97	
June.	1.29	December.	0.87	

A comparison of the state of Lake Champlain with the amount of rain (and melted snow) at Burlington, Vt., during the years 1871–1882 is not so conclusive, the rain-fall at any one station being too local a phenomenon to be a reliable index for adjacent localities. I have extracted and tabulated the following figures from the annual reports of the Chief Signal Officer; they give the observed precipitation in inches for the Burlington station established in May, 1871. The observations cover the same period during which the height of the lake was gauged.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total for year.
1871	----	----	----	----	----	----	----	----	----	2.75	0.73	0.78	-----
1872	0.42	0.13	0.13	0.73	3.59	3.66	7.27	9.70	3.38	3.05	2.75	1.35	36.16
1873	2.18	0.36	1.54	1.43	1.46	1.35	4.83	2.21	2.09	5.87	1.59	1.01	25.92
1874	3.44	0.82	1.34	3.19	4.21	3.85	7.15	1.07	4.21	1.09	0.82	0.75	31.94
1875	1.26	0.86	1.12	1.38	3.56	3.00	2.73	2.84	4.56	3.54	1.34	0.75	26.94
1876	1.60	1.31	3.11	2.38	2.30	2.91	2.49	2.66	4.82	0.92	1.51	1.52	27.53
1877	1.43	0.32	2.52	2.53	0.95	3.11	4.06	4.74	3.45	6.39	2.21	1.46	33.17
1878	7.52	0.79	1.65	3.06	3.05	2.49	5.18	5.18	1.13	4.78	3.38	3.24	41.45
1879	0.78	1.11	1.45	0.97	0.38	4.52	2.71	2.39	2.82	1.36	3.56	2.22	24.27
1880	1.87	0.62	0.97	1.73	1.46	1.33	2.30	2.26	3.26	6.22	2.57	0.62	25.21
1881	0.88	1.79	1.56	0.62	2.27	1.89	2.22	2.69	2.34	1.54	1.30	1.89	20.99
1882	0.44	1.10	2.34	1.23	2.00	3.17	2.37	3.49	5.22	1.21	1.47	1.60	25.64
Mean of 12 years.	1.98	0.84	1.61	1.75	2.29	2.84	3.94	3.57	3.39	3.23 3.27	1.94 2.05	1.43 1.49	28.81 29.02

Accordingly on the average of twelve years the precipitation at Burlington shows a minimum in February and a maximum in July.

Reverting to the anomaly of a low state of the lake in about the month of October, that peculiarity is most pronounced in the year 1880. During the first half of that year the lake was above the average height nearly half a foot; in July it lowered and stood for the second half of the year one foot and two-thirds below that level. This extraordinary depression was supposed to be due to the effect of winds, but these would only partially and indistinctly respond, as may be seen from the following set of figures, showing the relative frequency of observed northerly (NE.,

* These ratios sum up to twelve for the total of the year; to convert them into absolute measure or inches multiply by three, very nearly.

N., and NW.,) and southerly (SE., S., and SW.) winds, taken from the annual reports of the Signal Corps for the station Burlington:

1880.	Northerly winds.	Southerly winds.	Difference N.-S.	1880.*	Northerly winds.	Southerly winds.	Difference N.-S.
January.	29	58	—29	July.	26	51	—25
February.	30	49	—19	August.	40	44	— 4
March.	53	30	+23	September.	31	51	—20
April.	33	43	—10	October.	23	62	—39
May.	28	59	—31	November.	24	52	—28
June.	32	45	—13	December.	42	37	+ 5

Thus in October, 1880, the southerly winds blew with greatest frequency as compared with northerly winds, and corresponding thereto we find the greatest depression of the lake level.

The extreme fluctuation of the level of Lake Champlain as observed between March, 1871, and September, 1882, is noted as follows:

Highest stage, May 18, 1876, reading of staff 7.85, equal to 5.21 feet above average level.

Lowest stage, October 12, 1880, reading of staff —0.14 equal to 2.78 feet below average level.

Hence total range observed at Fort Montgomery 7.99, or about 8 feet, and it will be shown that in an extreme case the soundings on the chart published by this Office may have to be increased by this amount.

Secular variation in the level of Lake Champlain.

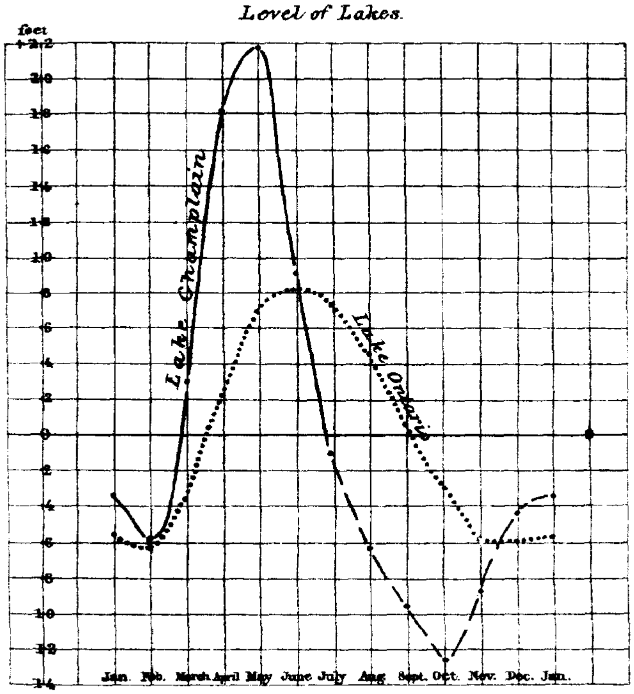
Any inquiry into the non-periodic fluctuations in the annual mean levels for a series of years may, at this time, appear premature, yet we shall present what information we have and supplement the same by a similar inquiry respecting the changes noted from year to year in Lake Ontario, as this may possibly help to extend the scanty material for Lake Champlain at present available.

The annual means for the heights of both lakes are already given in the last column of our tables, and when plotted* indicate a certain correspondence in the secular variation, commencing with the year 1873. This would bring the lakes under similar climatic conditions, and would permit the inference that, as in Lake Ontario, since the earliest records in 1859, a gradual subsidence in the level has taken place, the total secular lowering being somewhat less than 1 foot. This fluctuation is given by the following numbers, found by subtracting 2.64 from the individual annual means in the case of Lake Champlain, and by subtracting the individual annual means from 2.47 in the case of Lake Ontario. A plus sign will then indicate for either case a higher stage, a minus sign a lower stage than the average.

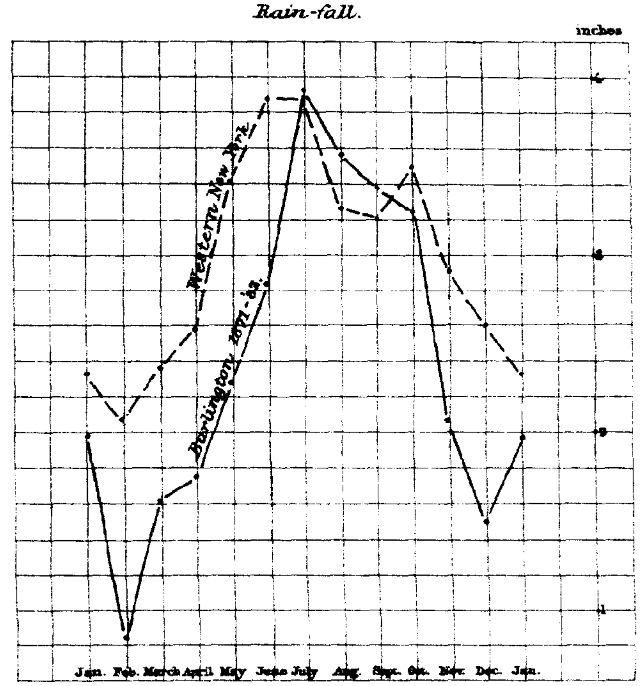
Year.	Lake Ontario.	Year.	Lake Ontario.	Lake Champlain.
	Feet.		*Feet.*	*Feet.*
1859	+0.91	1871	—0.16	—0.05
1860	+0.16	1872	—1.69	+0.73
1861	+0.94	1873	—0.62	+0.39
1862	+0.93	1874	+0.13	+0.70
1863	+0.53	1875	—1.16	—0.29
1864	+0.35	1876	+0.70	+0.18
1865	+0.09	1877	—0.49	—0.55
1866	—0.25	1878	+0.11	+0.10
1867	+0.70	1879	—0.24	+0.03
1868	—0.72	1880	—0.64	—0.58
1869	+0.13	1881	—1.01	—0.61
1870	+1.21	1882	----------	—0.08

* See illustration No. 33.

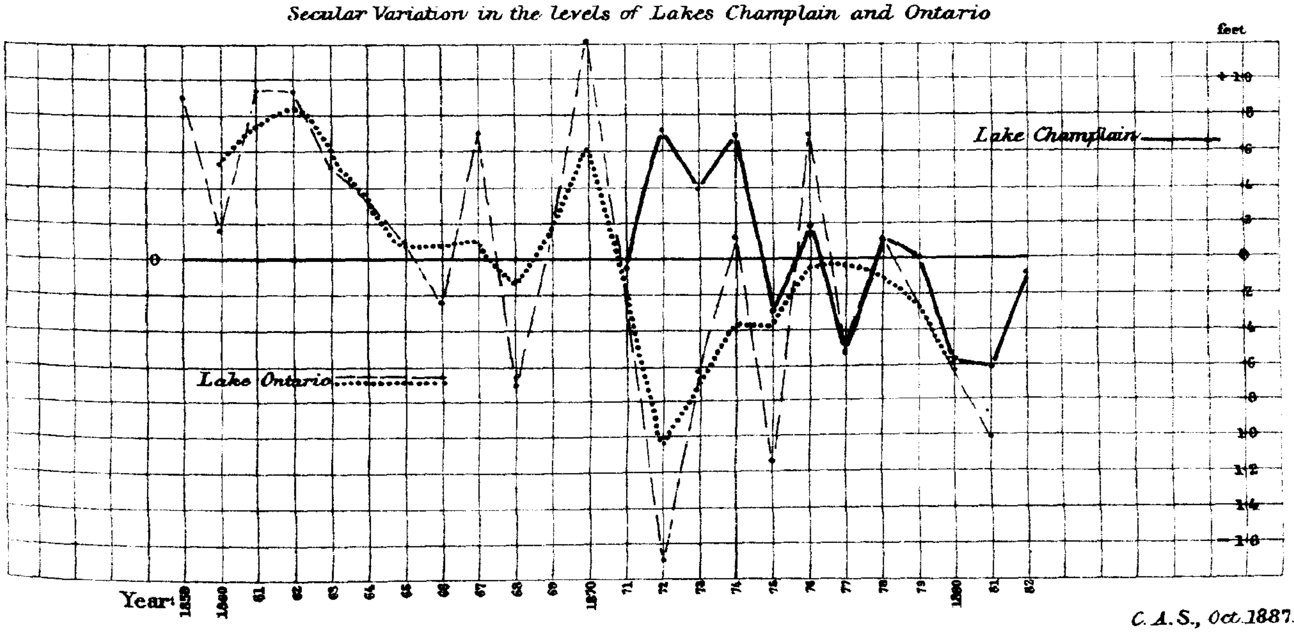
Annual Variation in Level of Lakes.



Annual Variation in Rain-fall.



Secular Variation in the levels of Lakes Champlain and Ontario



C. A. S., Oct. 1887.

To lessen the influence of accidental circumstances on the main effect of the secular variation these numbers may be smoothed out, when their bearing can be more readily understood, and when treated graphically will assume a more characteristic form. The following simple treatment will answer in the present case. Suppose a, b, c be any three consecutive values of a function for equi-distant arguments, then the smoothed-out value for b will equal $\frac{1}{4}(a + 2b + c)$; this is equivalent to forming two sets or columns of figures of means of two. We then have for secular fluctuation the values:

Year.	Lake Ontario.	Year.	Lake Ontario.	Lake Champlain.
	Feet.		*Feet.*	*Feet.*
1860	+0.54	1871	−0.20	------
1861	+ .74	1872	−1.04	+0.45
1862	+ .84	1873	− .70	+ .55
1863	+ .58	1874	− .38	+ .37
1864	+ .33	1875	− .38	+ .08
1865	+ .07	1876	− .06	− .11
1866	+ .07	1877	− .04	− .20
1867	+ .10	1878	− .12	− .08
1868	− .16	1879	− .25	− .11
1869	+ .18	1880	− .63	− .44
1870	+ .60	1881	------	− .47

The gradual change from the positive to the negative figures in each series is significant of the character of the secular change. It is, however, only by continued observations that further advances can be made in this inquiry, which itself is linked together and interlaced with the subject of secular changes in the rain-fall and of the climate in general.

The accompanying illustrations of some of the principal results require no further remarks.

The absolute height of the lake above the ocean.

The absolute height of Lake Champlain when in an average state, as measured by the water-gauge at Fort Montgomery between 1871 and 1882, may now be closely approximated. The following data are available for this purpose: Bench-mark on grist-mill at Greenbush, opposite Albany, N. Y., above the half-tide or average level of the ocean, $4^{m}.489$ or 14.73 feet. This result depends on tidal observations in New York Harbor, by the Coast Survey, at Governor's Island, between 1852 and 1879, inclusive (comprising, therefore, one and a half revolutions of the moon's nodes), and on spirit-leveling along the eastern side of the Hudson River, by J. B. Vose, in 1857–'58,* and resumed by O. H. Tittmann in 1877. This same bench-mark was the starting point (level) for the determination of the heights of the Great Lakes (Professional Papers, Corps of Engineers, No. 24, p. 608). In 1882 Assistant Tittmann resumed the leveling operations for the connection of Albany with the lake. The line started from Albany, at Lock No. 1 of the Erie Canal, the height of which he had determined in 1877, viz: Miter-sill at southeast gate of lock, above mean sea level, $-1^{m}.873$ or −6.145 feet. He then followed the tow-path of the Champlain Canal to White Hall, N. Y., and thence carried the line along the track of the Delaware and Hudson Canal Company's Railroad as far as Putnam station. There a water-gauge and mark was established and connected with others placed at Port Henry, Plattsburgh, Burlington, and Rouse's Point. He makes B. M. No. 40, cut in the railroad culvert at Putnam, to be $32^{m}.536$ above B. M. at Lock 1; the absolute height of No. 40 is therefore $30^{m}.663$ and the zero of his water-gauge $30^{m}.048$, the latter being $0^{m}.615$ below this mark. Simultaneous observations were made by means of these gauges of the stage of the

* The zero of gauge at Governor's Island was transferred to mark on Hudson River, foot of Eighteenth street, New York, by water level.

lake surface for fifteen consecutive days, November 4 to 19, at the hours 8 a. m., noon, and 5 p. m. The zero of each gauge was referred to a permanent bench-mark established near it. These gauges were each 4 feet long and graduated from top downward.

We have: Mean water-level, November 4–18, 1882, corresponds to reading 0.995 on the Putnam gauge; this mean level, therefore, is $29^{m}.053$ above the ocean, and corresponds to the reading $0^{m}.843$ of the Rouse's Point gauge. This places the zero of the Rouse's Point gauge $29^{m}.896$ above the ocean, and since the Rouse's Point bench-mark on Chapman's Block, north side, is $3^{m}.649$ above it, the latter is $33^{m}.545$, or 110.06 feet above the mean sea-level. This mark has been proposed for an international bench-mark for the connection of the American and Canadian spirit levels in this region.

According to Assistant Tittmann the Chapman Block bench-mark is $1^{m}.350$ above the level of heel of loop-hole of Bastion A, Fort Montgomery, which is also known as the hydrographic bench-mark of the fort, and this hydrographic mark is $2^{m}.925$ above the U. S. Engineers' bench-mark, which is the level of base course of scarp wall of Bastion B;* the latter is therefore $29^{m}.270$ above the mean sea-level. The zero of the Engineers' water-gauge being one and a half feet below this mark, and the average readings of the water-level between 1871 and 1882 (*vide* preceding table) being 2.64 feet, we have finally the height of the average lake level above the mean sea-level $29^{m}.618$, or 97.17 feet. Pending spirit-leveling between the Putnam and the Rouse's Point marks and further observations of the lake level for a series of years, this result may be accepted as a close approximation to the true value.

I estimate its probable error or uncertainty at about ± 0.3 foot (exclusive of uncertainty due to secular change).

We can now also determine the height above the ocean (mean tide) of the level of reference adopted on the Coast Survey charts of the lake; this level has reference to a gauge and mark at Plattsburgh, and computation shows that the chart-plane very nearly corresponded to the zero of the Engineers' gauge at Fort Montgomery (was about $0^{m}.02$ above it); this plane of reference consequently is very nearly $28^{m}.83$, or 94.6 feet above the mean level of the Atlantic, and is also $0^{m}.78$, or 2.56 feet below the average level of the lake, period 1871–1882. No investigations bearing on the distribution of temperature of the waters of the lake have been made, as far as known. The relation of temperature to depth down to 400 feet, and the depth to which the diurnal and the annual fluctuations of the temperature of the superincumbent air are propagated, could not but prove interesting and valuable as physical facts.

Respecting tides it is hardly necessary to remark that no measurable amount† can exist in this lake in consequence of its small size and inconsiderable mean depth and width.

The present preliminary investigation of the height of the bench-mark at Rouse's Point was undertaken at the instance of the Department of Public Works, Ottawa, the secretary of that department being anxious to connect his levelings with one of our marks of precise levels.

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* This same level is designated by Assistant Tittmann "water-sill level at the fort."

† The subject of tides in large lakes and of some kindred phenomena of oscillations has received the attention of the U. S. Lake Survey, and reference to it may be found in some of the annual reports; *e. g.*, that of 1872 contains a very valuable discussion on the tides observed at Milwaukee, Wis., by General C. B. Comstock. Both the solar and lunar components of the tides are sensible in Lake Superior and in Lake Michigan; in the latter case the ranges are 0.05 foot, or $1^{cm}.5$, and 0.08 foot, or $2^{cm}.4$, respectively, for the two luminaries. Spring and neap tides and other tidal features are plainly brought out.

APPENDIX No. 8.—1887.

GULF STREAM EXPLORATIONS—OBSERVATIONS OF CURRENTS—1887.

A Report by Lieut. J. E. PILLSBURY, U. S. N., Assistant.

U. S. COAST AND GEODETIC SURVEY STEAMER BLAKE,
September 19, 1887.

SIR: I have to make the following report of the season's work of the hydrographic party under my command, in continuing the investigation of the Gulf Stream currents.

The *Blake* left New York on January 11, and, after a stormy passage, reached Key West, and commenced the observations. The only alteration in the anchoring gear from that in use last year, has been to place the reel carrying the anchoring wire rope below decks. A room was bulkheaded off from the forward coal-bunker, and the reel securely fastened in this room to beds placed on the sister keelsons. The brake governing the reel in paying out the rope was held down by weights on the end of the lever, and by a line leading from the lever to the upper deck, the friction was controlled from the latter point. This was adopted in order to avoid confusion or mistakes, which, by the use of signals to the men stationed at the reel, would probably occur. The throttle of the engines reeling up the wire rope on its reel was also governed on the upper deck, so that one man could attend to the whole operation of paying out or heaving in and reeling up the wire, and he was on the upper deck where he could be under the immediate direction of the commanding officer. Two men were stationed in the reel-room, whose duty it was to keep the machinery oiled and to guide the rope smoothly on the reel as it revolved.

The diameter of the rope was less this year than before, one-half inch (in diameter) being the one used. This size presents about one-fifth less surface and this difference is very marked in the strain caused by the skin friction. Only once did it carry away during the season. The anchor became caught on the bottom, probably in a coral rock, and it was with the greatest difficulty that it could be broken.

The current meters were the same as were used last year, except that the registers of the velocity were renewed, and the new ones were so graduated that the readings could be made more easily and with less chance of error.

In order to distinguish the cross-sections south of the initial one (cross-section A at Fowey Rocks) from those to the northward, I have given them double letters. Illustration No. 34 shows all the cross-sections in the project for the development of the Gulf Stream. This has already been submitted to you, except a line marked EE, and the lines drawn between the islands of the Caribbean Sea. These additions to the scheme I believe to be necessary for the full development of the Gulf Stream, and will explain my reasons for this conclusion later in the report.

In presenting the most noticeable features of this year's observations, I shall venture to draw your attention also to the connection between this year's work and that of the previous years.

While a report is supposed to be confined only to operations completed since the last report was made, yet a better understanding will be gained by comparing all the observations.

The first two years were devoted to investigating the currents of section A, the narrowest part of the Stream, with the object in view of ascertaining the laws governing the flow. This year's investigations have been made at three sections, and I think that, viewing the latter with the light of the former, an interpretation of the record can be made with considerable certainty, in spite of the fact that the observations on the sections this year are not so numerous.

The sections occupied this season were CC, between Rebecca Shoal and Cuba; DD, between Cape San Antonio, Cuba, and Yucatan, and section F, from Cape Hatteras Shoal in a direction about southeast.

All of these sections are of much greater depth than ever before attempted, and not the least gratifying feature of the season's work was our ability to anchor expeditiously and safely in these depths. The greatest was off Cape Hatteras in 1,852 fathoms, and that, too, with a surface current of over four knots.

I shall take up the different subjects in this report in the following order:

1. General characteristics and limit of the Stream at each cross-section.
2. Daily variation.
3. Axis of the stream.
4. Depth of the stream and velocity at different depths.
5. Comparison of results obtained at various sections.

I.—CROSS-SECTION CC.

1. *General characteristics and limit of the Stream.*

The currents at this entrance to the Straits of Florida have been long known to mariners to be extremely erratic. Vessels sometimes have an easterly current along the Florida Banks, and sometimes a westerly current. Sometimes they are set toward the bank, and again toward the middle of the Stream. These variable currents are to be expected west of "the Elbow," but the width of the variable zone is much wider west of American Shoal than it is east of that point. Vessels in passing across the channel between Rebecca Shoal and Tortugas experience, generally, a northerly or southerly set. Many think that a large portion of the Gulf Stream water enters the strait through this passage; and many more are of the opinion that the predominating current is northerly, and give this as a reason why so many vessels are wrecked on Southwest Reef at Loggerhead Key. To settle these questions, therefore, I established three stations in the vicinity, and placed a reference tide-gauge at Rebecca Shoal light-house. One station, "a," was near Rebecca Shoal; station "b" was near the western side of the passage, and station "c" was on the bank, situated about 5 miles west of Loggerhead Key. Stations "a" and "b" were occupied twice each. I found the current setting practically north with the flood tide and south with the ebb, in the passage between Rebecca Shoal and Tortugas.

The currents are shown by curves and the directions by arrows on Illustrations Nos. 35, 36, and 37. All northerly currents are plotted above the zero of velocity, and southerly currents below the same zero. At station "c" the observations show that there was a southerly set which overcame the lesser flood tide, so that for eighteen hours it was running south.

The flood tide, however, was indicated during this time by a decrease in the velocity of the southerly set.

Station No. 1 of the cross-section was situated 18 miles distant and nearly south of Rebecca Shoal, and was about 3 miles outside the 100-fathom curve in a depth of about 240 fathoms, (Illustration No. 42). Here, also, the tidal action was noticed, causing a very irregular current. Only once during the three times we anchored at this locality did the current set with regularity to the eastward, and then only in the upper strata.

It is probable that this station is at least 10 miles from the usual northern limit of the Stream, and, although there may be a slight eastern tendency to the flow, it is so slight and variable that the interference of the tides and winds easily overcomes it. There are indications in the record that, with the flood tide, the easterly set predominates. On anchorage 1 and 1ᵃ (Illustration No.

35) there seems to be a somewhat regular change following the tides. Separating the curves into their component parts toward the cardinal points of the compass, the curves of the east and west components at No. 1 show decided fluctuations at flood and ebb.

No. 1ª happened to be at a time when the tide-gauge at Rebecca showed a very irregular tide, and the curve shows a like irregularity.

At No. 1ᵇ (Illustration No. 36) the directions at the surface, at 15 fathoms, at 30 fathoms, and at 65 fathoms, with one exception, are all to the eastward. At 130 fathoms the flow was found to be southerly and northerly, the change in direction coming two or three hours after high and low water. The tide-gauge at Rebecca was, unfortunately, down at this time, but for the times of the high and low waters the prediction tables are probably sufficiently close for our needs.

Station No. 2, which is about 16 miles south of No. 1 and 34 miles from Rebecca Shoal, has also very irregular currents. At the first anchorage the surface direction was easterly; at 15 fathoms and 30 fathoms very irregular; and at 65 and 130 fathoms depth all were southerly, with but one exception at each depth. At No. 2ª (Illustration No. 37) the surface was irregular, but the southerly flow predominated. At the other depths the southerly flow was always found, with the exception of two observations, one at 15 fathoms when the current was ENE., and one at 30 fathoms when it was E. by N. These anchorages (Nos. 2 and 2ª) were at about the time of zero declination of the moon, and there is a marked similarity in the observations. The next time the station (No. 2ᵇ) was occupied, the surface, 15 fathoms, and 30 fathoms flow was steadily to the southward and eastward, while at the lower depths it was irregular in direction, but the southerly predominated. Comparing the three sets of observations according to strength of currents, it is seen that the stronger the current the more constant the direction. No. 2ᵇ had the greatest velocity, and the upper stratum flows regularly, while the lower and weaker currents are irregular. No. 2 is the next in order of strength, and we see that its surface is fairly regular in direction, the intermediate strata irregular, and the lower strata setting south. No. 2ª is the weakest of all. Its surface is irregular in direction, while all the water below flows southerly.

Stations.	2ᵇ.	2.	2ª.
Strength of surface current	1.76	0.86	0.38
Depth of strata having easterly set	3½, 15, 30	3½	
Depth of strata having irregular current	65-130	15-30	3½
Depth of strata having southerly set		65-130	15, 30, 65, 130

From this table it is seen that the stronger the current the deeper is the stratum flowing to the eastward, and the lower down we have to go to find the southerly set, or the irregular flow which is between them. The Stream in its daily and monthly variation carries a varying quantity of water, and consequently either its limits or its velocity must change. The latter we know is the fact; but from the observations at this station we see that the limit changes also, and probably at all parts of the Stream where there is room for an expansion it takes place, spreading out on the surface to a greater width as well as increasing in velocity. The Stream at this section does not touch the banks or the bottom, except, possibly, on the Cuban side, and that but rarely, and the surface limit is therefore continually changing its position.

This station is very near the average edge of the Stream. Sometimes tidal action extends to and beyond it toward the middle of the Straits, and sometimes it is to the northward of it. Ordinarily, on the surface, an easterly or southerly set may be expected. The first time the station was occupied, which was at about zero declination of the moon, probably the edge was nearer the anchorage than at the other times. The surface flow only, was easterly, but it was constant. At times the velocity would increase a knot or more in ten or fifteen minutes, and return again to its original speed. The wind was from the eastward, and the vessel was generally lying broadside-to. She would suddenly tail to the current, and the pole would show the increased speed, but in a very short time the vessel would swing back again to her original position, and the current would lose its speed as suddenly as it had gained it. It seemed as if the edge of the stronger current was snake-like, and sometimes the convex part would reach our position, causing a momentary increase.

The same effect would have been caused by the anchor dragging steadily over the bottom, and then suddenly nip, but I am positive the anchor did not drag, for whenever such was the case, the accumulator rubbers, being released from their pressure, would cause the anchoring boom to jump in such an unmistakable manner that there was never a doubt on the question.

Anchorage No. 2[a] was outside the limit, or rather the limit of the Stream was to the southward of the anchorage, and at No. 2[b] it was to the northward.

Stations Nos. 3, 3½, 4, 4½, and 5 need no special mention under this head, but attention will be drawn to them under the head of axis of the Stream, and also under monthly variations.

2. *Daily variation.*

The daily variation at Section CC is as marked as at Section A, and with no greater irregularities in point of time than are found in the tides in most harbors. There were eight maximum velocities, arriving at a mean time of 9^h 18^m before the upper transit of the moon, and three arriving at a mean time of 3^h 25^m after the transit. These times are from the mean curves, which are constructed the same as last year, by taking one-fifth the sum of the readings of each current curve for each hour. The surface current may have been abnormal at a given time, therefore the mean of all the different strata, it is thought, will show more nearly the time of the normal variation. The regular variations at this section are not as excessive as at the other sections, but this is to be expected, as will be seen later in the report in the comparisons of the different curves. The time of the "establishment" at this section coincides very closely with that found at Section A, the latter being 9^h 09^m before and 3^h 37^m after the transit. It is probable that there is actually a slight difference in the times of the establishment at the two points, but to determine it with exactness would require many more observations than it is possible to obtain without a great expenditure both of time and of money. I think, however, for the practical purposes of navigation, we may place the "establishment" at Section CC at 9^h 20^m before and 3^h 10^m after the transit.

3. *Axis of the Stream.*

The axis of the Stream at this cross-section, or the point at which the surface velocity is the strongest, is best shown by the horizontal curves, Illustration No. 38, Fig. 1. It will be noted that the lower part of the curve at station 1 represents a minus current. This station being outside the limit of the true Stream, the velocities were separated into their components, toward the four cardinal points of the compass, and the east and west components were used in the curves.

The observations show a stronger current at station 4 than at any other point, but they were taken at a higher declination of the moon than any of the others. Fig. 2, on the same plate, shows a mean curve of all the observations taken at each station, in a broken black line and an imaginary curve in a thin black line, in the construction of which an allowance has been made at various stations for an increase in velocity according to the declination of the moon. This places the axis between stations 3 and 4.

The direction of the flow of the water on the surface, at this section, was entirely different from the other sections thus far examined; on all the northern stations the average direction was to the southward of east, and on the southern stations it was to the northward of east. The following table gives the average surface direction for each of the stations except No. 1, which is outside the Stream.

Station	2.	3.	3½.	4.	4½.	5.
Direction	SE. by E. ½ E.	E. ¼ S.	E. ¾ S.	E. by N.	NE. by E. ½ E.	NE. ½ N.

It will be noticed that beween stations 3½ and 4 the current changes its direction toward the east, and on both sides of this neutral line, the current draws toward it.

On the other sections, the surface always maintains about the same direction in all parts of the Stream. It would seem that this inward tendency also indicated the position of the axis. One of the most interesting features of the position of the axis of this section is the fact that it is situated near mid-stream instead of on one side. Your attention will be called to this point later in the report.

4. *Depth of the Stream and the velocity at different depths.*

Illustration No. 39 shows the profile of the Florida Straits at this section and the vertical curves at their stations, but revolved 90° from the true direction of the flow, so that they can be compared. The curves are constructed by plotting, at the proper depth, the average velocity as given by the observations at that depth. The zero of each curve is the position of the station on the line. The observations were taken only to 130 fathoms, and below that depth to zero the line is prolonged in the same direction. This continued line is drawn straight, but probably it should be a curve gradually approaching the vertical as the velocity approaches zero.

No. 1 station is undoubtedly outside the limit of the Stream, but for the time of the observations a slight easterly flow is indicated above 60 fathoms, and to the westward below that depth to about 150 fathoms. No. 2 station is near the edge of the Stream, but the interference of the tides makes the vertical curve, as shown, slightly in error, and probably the average depth of the true current is not much if any below 100 fathoms. All the other stations are within the limits of the Stream, and No. 4, which is next to the southward of the axis, extends to the greatest depth. The observations at this station were taken at the highest declination, and it is probable, therefore, that the average zero current will be found at a less depth than shown. The dotted line joining the zero points of the vertical curves on Illustration No. 39 shows the form of the current prism as observed, and it will be at once remarked that there is a certain symmetry in the two halves of the curve. A similar line drawn through the zeros of the vertical curves of section DD passes through nearly a constant depth (about 300 fathoms) which is very much less than the greatest depth at section CC. It is a remarkable coincidence, however, that the areas inclosed in the two dotted lines are almost exactly the same, the proportion being 100 to 103. In both sections the channel is more than sufficient to carry the water. At CC the bottom or sides do not interfere with the Stream.

At DD the bottom does interfere slightly on the Yucatan side of the channel.

Section CC has the larger area of prism of the two.

II.—Cross-Section DD.

1. *General characteristics and limit of the Stream.*

The profile of the bottom at this section is quite unlike that of section CC, but resembles section A, with the exception of its depth.

To the eastward, the island of Cuba rises precipitously from considerable depth. The western side is bordered by the Yucatan Bank, which has a depth of 100 fathoms 20 miles from the shore. From this point the slope is gradual at first, but the inclination increases rapidly between 500 and 1,000 fathoms. Station No. 1 (see Illustration No. 40) was on the Yucatan Bank in 23 fathoms of water, 15 miles from Contoy Island and about 5 miles from the 100-fathom curve. The current here was partly tidal and partly Gulf Stream, the flood tide combining with the Gulf Stream current, causing the former to run eighteen hours. The direction of the ebb was about east, and at the turn, the direction changed to northwest by the way of north. The current at 15 fathoms was quite irregular, as if affected by the bottom causing it to eddy and swirl.

That this was the case was, on one occasion, shown conclusively. At 7.49 a. m., March 25, the direction of the current at 15 fathoms was SW. Observations were taken for direction in quick succession with the following result:

Time.	Depth.	Direction.
h. m.	*Fathoms.*	
8 11	3½	NW.
8 15	8	N.
8 17	8	N.
8 19	15	SE.
8 21	15	SSE.
8 23	12	NNE.
8 25	12	NE.
8 57	15	SE.

At the distance of this station inside the 100-fathom curve (5 miles), probably at the time of greatest declination of the moon, the Stream current entirely overcomes the tidal current, but as the water becomes shoaler and more removed from the Stream, the tides predominate. The true limit of the Stream is probably near the 100-fathom curve, and this limit does not vary to any great amount. The other stations do not need particular mention until we reach Station No. 6, the easternmost of the section. The first anchorage at the station was at a low declination of the moon, and the surface current set northeasterly most of the time. The next anchorage at the station (No. 6[a]) was at high southern declination, and a southeasterly current was found on the surface, and an east or southeast below. The normal flow below the surface was in each case from the Gulf of Mexico into the Caribbean, and the fact that this eddy extended to the surface with high declination leads to the belief that this station is situated outside the average limit of the Stream, that the stronger the Stream itself the more the volume of the eddy, and that with a weak Stream the less marked is the eddy. At this time the Stream is spread out to the eastward and flows northeasterly into the Straits of Florida. Anchored on the bank off Cape San Antonio (which is very narrow), the current was found to follow the tides, the flood setting to the northward and the ebb to the southward; so that between the eastern limit of the Stream and Cuba we have the eddy or southeast current and the ebb and flood currents mutually interfering with each other and with the Stream. The eastern limit of the Stream is to be placed at an average of about 20 miles west of Cape San Antonio, with a probable zone of variable flow for some distance on either side of this.

2. *Daily variation.*

The time of the daily variation is as marked at this section as elsewhere, but the variation in velocity is more excessive than before experienced. At one time it increased in five hours nearly 3 knots, and in the next nine hours decreased again; at another time in three hours it increased 3¼ knots. The average of all the maximum velocities gives, as the "establishment" of the Stream at this section, 10^h before and 2^h 20^m after the moon's transit. In these results, the number of the maxima from which the averages were obtained were equal, but on the other sections the number of the maximum velocities arriving before the transit far exceeded those arriving after it.

The lunar and solar attractions (to which causes the daily variations are probably for the most part due) are of unequal periods. The tides are at some places regular in height and in times, and at others irregular.

It is possible that in the same way the daily variations may be modified in character, from local or other causes, so that the time of the arrival of the maximum may be always before the upper transit at some places, as at Section A, and at others, as at Section DD, the maximum for half the lunar month will arrive before the upper transit, and the other half before the lower transit.

The excessive variations were, like those at Section A, on the west side of the Stream. They were accompanied by tide rips and were in shoal water, also points of resemblance. These questions will be touched upon later in this report.

3. *The axis of the Stream.*

The curves showing the horizontal flow of the different strata will be found on Illustration 38, Fig. 3. These curves are from the actual means at the different stations, except at Stations No. 1 and No. 6, where the north and south components only were used and the algebraic differences plotted. The axis of volume is west of the middle of the Stream, and the axis of surface velocity still farther to the westward. Stations 2, 2¼, and 2½ were successively occupied at near the time of the greatest declination of the moon, in order to determine the exact point of the axis, and the curves show the effect of the increased volume by a remarkable increase in velocity, amounting in one instance to over 3 knots per hour. This increase was accompanied by decided tide rips, as if caused by the interference of the bottom as the current spread out. The maximum velocity is to be placed at about 5 miles distant from the 100-fathom curve of Yucatan Bank.

4. *The depth of the Stream and the velocity at different depths.*

Illustration No. 39 shows the profile of the Stream at this section, and the vertical curves placed at their proper positions, but revolved 90 degrees from the direction of the flow, the same as those of section CC. No. 1 station is situated on the Yucatan Bank. The algebraic sum of the north and south components is plotted and the line is prolonged to zero velocity from the lowest point observed (15 fathoms), and it reaches this zero at or near the bottom.

The other curves, continued to zero, reach it at approximately the same depth, 300 fathoms, except at No. 6 station, which is outside the limit of the Stream, and is a combination of Gulf Stream, eddy, and tides. It is noticeable that the depth to which the eddy extends is the same at this station as at station 1, section CC, but it is more decided in its character.

The approximate volume of waterflowing through the three sections as observed, is, section A, 95 billion tons per hour; section CC, 103 billion tons, and section DD, 110 billion tons. The evaporation from the Gulf of Mexico and the eddy current would account for the excess at section DD. At section CC, in the calculation, the directions have been taken as flowing east, and this, of course, gives too great an amount. The excess would probably be accounted for by this difference and the eddy, and the volume actually flowing east be equal to that found at section A.

THE MONTHLY VARIATION.

The observations at section A in 1885 and 1886 indicated that there was a monthly variation in the velocity of the Stream, the maximum being shortly after the greatest declination of the moon. The observations which by their continuity could be used in drawing a conclusion on this point were mostly taken at southern declination.

In 1885 only a few hours' observations were made with the moon north of the equator, but these indicated a maximum following the same law as when it was south. In 1886 all the observations obtained with a northern moon gave a *similar* curve, but with much lower velocity, from which I stated in my report that it was possible that the lower velocities, with northern declination, might be normal, but the observations were not sufficiently numerous to determine the fact. I regret that I am obliged to state that I can not definitely conclude as to the *exact* law, even now, after another year's observations.

At section CC, on April 28, with the moon just reaching its greatest northern declination, I found at station 3 a surface current of less than 1 knot per hour, where I had found, with a declination of 7° south, over 3 knots. This seemed to indicate that the velocity following the north declination was less than with the moon south, or else that other factors entered the problem, causing an irregularity. I had found, at section A, the previous year, the same irregularity (low velocity with the moon north); but I attributed it to abnormal influences, barometer, and wind. When, on this year, I found the irregularity, I determined at once to go to section A and observe its currents. I was, unfortunately, able to remain at the anchorage but twelve hours, on account of bad weather; but I found an average surface current, during that time, of 3.7 knots, and that, too, at the time of the lesser daily maximum. This average is over 1 knot greater than I found in 1886, with the same declination, and not more than one-fourth of a knot less than that found with corresponding south declination. At section DD a maximum of 6.2 knots was found after south declination, and about 3.5 knots at the same station with 9° of northern declination. Off Cape Hatteras, at station 3, the velocity reached 4.36 knots two days after the greatest northern declination of the moon. It is probable that the regular variations change somewhat in time and velocity with the changes in the relative positions of the sun, moon, and earth, with the barometer, thermometer, rain, or wind, or, in other words, by anything which will affect the volume of the Stream. The conclusions of last year regarding this variation seemed to be confirmed, except in the observations described at section CC. This section is at the gateway to the Straits of Florida, and is probably liable to more anomalies than at stations where the Stream is more defined. The actual increase in volume due to the monthly variation is probably small; but it is intensified in velocity by local causes (shoal water, etc.). At section CC the local causes do not appear to exist, and the monthly variation is not prominent. There is a possibility, too, that the direction of the flow of the Stream, with reference to the position of the sun and moon, may have some effect on the volume or velocity, and the Stream at this section, flowing east, may be accelerated at different parts by differing conditions. We can only say, at this time, that there is a monthly variation, and that apparently the time of the maximum flow is shortly after the moon's highest declination.

A comparison of the vertical and other curves of the sections A, CC, and DD will be of interest. It will be noticed that at section A, where the currents are uninfluenced by the bottom, the zero points of the vertical curves are at 300 to 350 fathoms depth. This is the case at stations 2, 3, and 4. At stations No. 1 and 1½ the current reaches the bottom at the moon's highest declination, and at station 5 it probably does the same at all times, by direct impingement from the inertia of the mass of water in going around the curve of the Straits of Florida. At section DD the zero points of the curves are at about the same depth (300 fathoms). The current at station No. 1 probably touches the bottom at the time of the maximum flow; but the average depth of the zero is the same as at the deeper stations. The bottom shoals gradually at the western anchorages at both sections, from considerable depths, and when the current interferes with the bottom, an exaggerated surface flow is found.

Section CC, on the other hand, is entirely unlike either of the others in these respects. It flows over no shoal, and consequently the normal daily or monthly increase in volume has nothing to interfere with its spreading to the northward but its own water walls, and to the southward, the interference of the coast of Cuba is probably but little; the increase in velocity is therefore comparatively small. The vertical curves, it will be seen, are wholly different from the other stations, the zero line changing its depth continually, and the deepest current and the maximum surface velocity are coincident.

On Illustration No. 38, Fig. 2, I have drawn the curves of mean horizontal flow, by taking the means at each station of the average currents at each depth observed. In order to compare them with each other, I increased the length of the line representing the width of the Stream at sections A and CC so as to correspond to the width at DD, and reduced the velocities (the abscissæ) by a like amount. It will be seen that, throwing out the portion of the curve of section DD, the excessive velocity of which is due to the shoal water of Yucatan Bank, the curve of section A is almost identical with it, the velocities, as well as the position of the axis of volume, coinciding most remarkably. Section A has also an increase of surface velocity exactly similar to that of section DD, as will be seen by referring to last year's report. The increase, however, was small in comparison with the latter section, and as it was only on the surface, it does not show in the mean.

The mean curve of section CC is entirely different, the maximum being situated near the center of the current prism.

To recapitulate the points of similarity and dissimilarity in the three sections:

Sections A and DD are alike in the following:

I. The depth at which the current reaches a zero velocity, where it is not influenced by shoals.

II. General contour of bottom, steep-to on eastern side and shoal on western.

III. Greatest mean velocity of the flow of the strata above 130 fathoms situated at the same relative distance west of the middle of the Stream.

IV. Axis of velocity situated on the slope of the Bank on western side of the Stream.

V. Greatly increased velocity at the axis following the highest southern declination of the moon.

VI. Direction of the flow always about north.

Section A is not like DD in the following:

I. The current touches the Bank to the eastward.

II. Under the supposition that the Gulf Stream flows, as a stream of greater or less magnitude, through the Caribbean Sea in a westerly direction, and changes its course to the northward somewhere not far south of section DD, looking in the direction of the flow, the axis of volume, and also the axis of surface velocity, are on the convex side of the curve, while at section A they are on the concave side.

Section CC is similar to both the other sections only in the contour of the bottom—that is, the slope is gradual on the left of the Stream, looking in the direction of its flow, but the Stream does not reach this slope.

Section CC is like section DD in the area of the current prism. It is unlike the other sections in the following:

I. The depth at which the current reaches zero velocity is not the same at any station.

II. The axis of volume coincides very closely with the axis of velocity, and both are at or near the middle of the current prism.

III. No large increase in velocity depending upon the declination of the moon.

IV. General direction of the flow east, but variable in direction, at different parts of the section, the general movement being inclined toward the axis.

Without a doubt the whole Stream in all its variations obeys as fixed and regular laws as those which govern any other natural phenomenon. In an investigation of this kind, where so many factors enter to cause anomalies, without simultaneous observations at different places, not only of the results as shown in the water of the Gulf Stream, but of the causes which go to form the resultant, it is very difficult to reconcile everything and ascribe a cause for a certain result. We recognize the fact of the existence of the Stream; we surmise that certain things cause the flow; we see that it has regular variations obeying some law of nature, but there are exceptions to the law, and to discover the cause of the exceptions and so establish definitely the law, is made very difficult without a complete study of all the data available.

The current at section A impinges on the Eastern Bank at all times, but its velocity is not excessive, and the increase at high declination is only about one-half knot.

The question which naturally arises is, if the current in touching the shoal to the westward increases its velocity, why does not the same occur on the Bahama side of the channel? This is on the convex side of the circle and at or near the end of the curve of the Straits of Florida. The Stream has been flowing east and has just turned to the north before reaching the section, and by the inertia impinges on the East Bank.

This side is comparatively steep-to; but throwing out any influence other than that which causes the water to flow, it should increase its velocity where it shoals its depth.

In actual fact the velocity here is less than at other parts of the Stream, but the current is deeper.

At section DD the water, by its inertia, presses against the Yucatan Bank, and an increased current is caused, which is abnormally increased at the time of the monthly maximum.

At section A the maximum was 5 25 knots per hour, and at section DD 6.25 knots. The first was the monthly maximum, without the effect of inertia, and the last the monthly maximum combined with the inertia of the Stream.

On a straight stream of water, with equally smooth inclosing banks and uninfluenced by outside forces other than those causing the flow, the axis of velocity and volume should be in the middle of the Stream.

At section CC the current prism is south of the middle of the straits and the axis is near the center of the current prism. At the axis the current extends deeper than anywhere else, and while the flow is east it inclines toward the axis on either side.

At the other sections the flow is, approximately, north at all parts; the axis is west of the center of the Stream and of the straits, and at the same time on opposite sides of the Stream with reference to the inertia of the incoming water.

All these phenomona, I can but conclude, are chiefly due to the rotative action of the earth.

The direction of the flow at section CC is east, and the rotative action retards the velocity but deepens the current, and the inertia carries this deep current to the Bahama side of the Stream in rounding the bend, but the rotative action throws the axis west of the middle. In the Caribbean Sea the rotation is contrary to the motion of the Stream.

The inertia and rotation combine to cause the maximum velocity of the current at section DD to be on the west side of the Stream and to be greater than at section A, or, in other words, at the latter, the velocity of the axis is effected by the rotation minus the inertia and at the former by rotation plus inertia.

The course traveled by the current-bottles set afloat in the Stream when we were at anchor may have some bearing on the subject. Of the bottles thrown overboard *west* of the axis at section A, 50 per cent. have been found on the coast of Florida within 150 miles of the point of starting, and not a single bottle set afloat in the Stream east of the axis has been heard from. It would appear as if some force other than wind and current was at work. Lieutenant Maury's idea of the elevation of the middle of the Stream I think receives support from the bottles, if we substitute *axis* for *middle*. If the theory is true, everything floating in the current would gradually approach the edges of the Stream. Those west of the axis could hardly escape our shores, but those east of the axis would go into the broad Atlantic and probably would never be heard from.

If the Stream is elevated at the axis, as seems probable, the rotative effect would be greater on this axis than on the less elevated portions, and would move it west of the center. The temperature observations obtained when at anchor show that the warmest water is at or near the axis of the Stream, as placed by the current observations. The average temperatures at section A are as follows:

Stations.	1.	1½.	2.	3.	4.	5.
Section A........	° 80.2	° 82.0	° 80.5	° 80.5	° 79.6	° 79

This would point to a greater elevation, and although it is slight in amount, it probably has its effect on the position of the maximum flow.

SECTION F.

Two anchorages were made at this section (southeast from Cape Hatteras) and the results are particularly interesting. The first anchorage was in a depth of 1,852 fathoms, with a surface current varying between 3.16 knots and 4.36 knots. The rubber springs in the accumulator, some of which were three seasons old, commenced to split by the great strain upon them, and I was obliged to get under way for threatening weather, after but eight hours' observations. At the second anchorage, in about 300 fathoms, I remained fifty-eight hours and carried the observations for a part of the time down to a depth of 200 fathoms.

Illustration No. 41 shows the curves of both anchorages. The data are not sufficient to enable us to determine the establishment of the Stream at this point, but the curves indicate the same kind of fluctuations as at the other sections. The existence, too, of over a 4 knot current on the second day after the highest declination of the moon confirms the opinion that the monthly variation does not cease in the Gulf Stream with its departure from the Straits of Florida.

The most interesting feature in the observations off Hatteras is the discovery by direct evidence of the existence of tidal action and the polar counter-current underneath the Gulf-Stream water. Referring to the arrows representing the directions of the currents, it will be seen that at station No. 1, at 200 fathoms depth, the current alternates its direction with regularity. Dividing up the hours of observation into periods according to the direction of the flow north and south, we have the following average directions and intervals.

Northerly—(N. by W.) at commencement of observations.
Southerly—(S. ½ E.) ....from 7^h 30^m a. m. until 2^h 30^m p. m. = 7 hours.
Northerly—(N. by W. ¾ W.) ....from 2^h 30^m p. m. until 8^h 00^m p. m. = 5½ hours.
Southerly—(SE. ½ E.)...............................from 8^h 00^m p. m. until 2^h 00^m a. m. = 6 hours.
Northerly—(NW. ½ N.)...............................from 2^h 00^m a. m. until 7^h 15^m a. m. = 5¼ hours.
Southerly—(S. ½ E.) ....from 7^h 15^m a. m. until 2^h 45^m p. m. = 7½ hours.

This gives an average current flowing about SSE. ½ E. nearly seven hours, and NNW. ½ W. a little more than five hours.

Carrying the same proportion back to the time of the observations taken at station 3, to discover if the tidal action influenced the direction at 130 fathoms, we find that, for over five hours, during which observations were taken at that depth, the mean direction should be northerly. It was, in fact, N. ¾ E., showing that probably if observations had been taken 50 fathoms deeper, the same tidal action would have been found. One hundred and thirty fathoms was so near the dividing line between the Gulf-Stream current and the tidal current that they mutually interfered with each other, resulting in a direction between the two.

The unequal duration of the ebb and flood shows the probable existence of a subcurrent coming from the Arctic. This current, lengthening or shortening the two tides less than an hour, seems but a slight current, but if the whole mass of water is affected below the depth at which it is observed, it amounts, in the aggregate, to an immense volume flowing to the southward. It is probable, too, that at this depth the influence of the Stream is felt at times, and the average directions (NNW. ½ W. and SSE. ½ E.) are not the same as would be found at a lower depth.

The following is a summary of the conclusions arrived at from a hurried study of the salient points of the observations:

The Gulf Stream is found flowing about north into the Gulf of Mexico through the western part of the Straits of Yucatan; is found again flowing east in the southern part of the Straits of

Florida, south of Rebecca Shoal, and north again through the narrowest part of the Straits of Florida, east of Fowey Rocks, but now occupying the whole of the passage.

The axis of volume of the Stream, in its northerly courses, is west of the middle of the current prism, and the axis of surface velocity is still farther west. When it flows east, the axes of volume and of surface velocity coincide very nearly with the middle of the Stream. The depth to which the current flows is about 300 fathoms in the northerly courses, when not affected by the depth of water or outside influences. When it flows east it extends to a much greater depth (at the axis off Rebecca Shoal to 600 or 700 fathoms). The deep current, at the axis of volume and velocity, in the Stream, when flowing east, appears afterwards at section A as a deep current of less velocity flowing north, but it is on the extreme eastern side of the Stream. The high surface velocity does not accompany it, but is found farther west. The position of the axis of volume of the Stream, at the sections where it is flowing north, is found at relatively the same distance west of the middle. The maximum temperature follows very closely the maximum velocity, whether flowing east or north.

A daily variation exists in all parts of the Stream. At Fowey Rocks the maximum flow is $9^h\ 09^m$ before the transit of the moon, at Rebecca Shoal $9^h\ 20^m$, and at the Straits of Yucatan $10^h\ 00^m$ before the transit. This variation is most excessive where the Stream flows with a northerly course over, or extends to, shoal water (from 100 to 300 fathoms).

A monthly variation exists, the maximum arriving two or three days after the moon's greatest declination, and is more excessive when the Stream flows over shoal water. Between Rebecca Shoal and Tortugas the current is tidal, flowing about north with the flood and south with the ebb. Five miles west of Loggerhead Key, Tortugas, tidal action was found, but the southerly (the ebb) set predominated.

South of Rebecca Shoal Light-house, the average edge of the Stream is about 30 miles distant. Between this limit and the Light-house the direction of the current varies, the tidal action being felt near the latter and the easterly current toward the former.

In the Stream, south of Rebecca Shoal, the set of the current is inclined toward the axis; the nearer the edges the more the divergence from east.

Between Cuba and Yucatan, the eastern limit of the Stream is about 20 miles distant from Cape San Antonio. In the western part of this space of 20 miles an eddy current exists, probably flowing about SE. at high declination of the moon and NE. at low declination. In the eastern part, near the cape, the current is tidal, flowing north with the flood and south with the ebb.

On the Yucatan Bank at this section the current is tidal, but the nearer the edge of the Bank the more the tidal action is overcome by the overflow from the Gulf Stream.

The greatest velocity of the Stream is found on the edge of the Bank in from 200 to 300 fathoms depth

Off Cape Hatteras, tidal action is found at 200 fathoms depth underneath the Gulf Stream, the set being to the northward and westward five hours, and to the southward and eastward seven hours. The difference in time is probably accounted for by a polar subcurrent partly overcoming the tidal wave.

The deep current at the axis where the Stream flows east; the position of the axis at relatively the same distance *west* of the middle of the Stream at both sections, where it is flowing north, although with opposite conditions as regards the inertia of the incoming water; the direction of the current at all parts of the Stream, about parallel with the flow at the axis, when north, and inclined toward the axis when east; and last, the highest temperature accompanying the highest velocity, all point to the influence of the rotation of the earth on this vast body of moving water.

The sketch (Illustration No. 34) showing the project of the lines for the development of the Gulf-Stream current in the accompanying report is slightly different from that which I originally submitted. The line marked EE has been inserted for this reason: The currents at section DD flow north, except at station 6, where at times during the month they have been found setting SE. and NE., with a subcurrent setting SE. at all times. At section CC, north of the axis, the set is SE., and south of the axis NE. The route by which the water travels from the first section to the last mentioned is in doubt, and I think the section EE will solve the question.

The sections drawn between the islands of the West Indies are for the purpose of ascertaining the relation between the times and velocities of the current entering the Caribbean and passing into the Gulf of Mexico. Reasoning upon temperatures and depths found in these passages and in the Gulf of Mexico, it has been stated that the water entering the latter comes through the Windward and Mona Island Passages. Many of the principal islands are separated by depths through which most of the water flowing out of the Straits of Florida could pass. We have investigated currents flowing north at two sections and one flowing east. The only place where opposite conditions can be found (and within the province of the Coast Survey to investigate), that is, where the Stream is flowing west, or *contrary* to the direction of the earth's rotation, is in the passages between the Windward Islands.

On the observations now completed, the conclusion would be arrived at that in all ocean currents flowing north the axis is west of the middle and the current extends to about a constant depth.

When flowing east the axis coincides with the middle of the current, and the flow is deepest at that point. To ascertain the characteristics of the current flowing west will be of the greatest importance to science as well as commerce, and will enable us to define the fixed laws governing the currents of the world with a degree of certainty which, without these data, would be very incomplete.

I beg to call your attention to the record as attesting to the faithful labors of the officers and crew belonging to the party.

The following is the list of officers:

Ensign R. M. Hughes, executive officer and navigator; Ensigns A. G. Rogers, W. J. Sears, F. Swift, and I. K. Seymour, observers; Passed Assistant Engineer George W. Cowie, jr.; Passed Assistant Surgeon W. H. Rush, Pay Yeoman N. G. Henry, and Ship's Writer W. W. Appelget, recorders.

Respectfully,

J. E. PILLSBURY,
Lieutenant U. S. Navy,
Assistant Coast and Geodetic Survey.

Mr. F. M. THORN,
Superintendent Coast and Geodetic Survey.

APPENDIX No. 9.—1887.

HEIGHTS FROM SPIRIT-LEVELINGS OF PRECISION BETWEEN MOBILE, ALA., AND CARROLLTON (NEW ORLEANS), LA., BY J. B. WEIR, ASSISTANT, IN 1885-'86.

Report by CHARLES A. SCHOTT, Assistant.

COMPUTING DIVISION, COAST AND GEODETIC SURVEY OFFICE,
August 4, 1887.

DEAR SIR: The following report on the results of spirit-levels of precision between Mobile, Ala., and Carrollton (New Orleans), La., in 1885-'86 is hereby respectfully submitted.

Route-line of levels.—Mobile, Ala., to New Orleans, La., via East Pascagoula, Biloxi, Bay St. Louis, and Fort Macomb, to Carrollton, a suburb of New Orleans. The line follows the railroad and crosses several bays. Much of the leveling had to be done over trestle-work and bridges. Length of line Mobile, Ala., to Biloxi, Miss., 94.3 kilometers (58.6 statute miles), and Biloxi, Miss., to Carrollton (New Orleans), La., 138.8 kilometers (86.3 statute miles).

Date of leveling.—December 4, 1885, to April 12, 1886.

Observer.—John B. Weir, Assistant Coast and Geodetic Survey.

Instruments.—The geodetic micrometer levels No. 1 and No. 3. The first instrument was used on the line Mobile to Bay St. Louis, the second between Bay St. Louis and New Orleans; both instruments were used in crossing the bays of Biloxi and St. Louis and the Rigolets. The metric rods E and F were used and rods A_1 and B only exceptionally (when crossing the Bay of St. Louis).

The instrumental constants are as follows:

Geodetic micrometer level No. 1.		Geodetic micrometer level No. 3.	
Aperture of telescope	3.5cm		4.3cm
Focal length of telescope	40.7cm		41.0cm
Magnifying power of telescope	26		37
One division of striding level, determined November 21, 1885, by J. B. Weir	5''.79	February 21, 1886	4''.43
One division of *new* striding level, determined July 7, 1886, by J. B. Weir	5''.62	May 24, 1886	3.89
Collar-inequality, object-end smaller, determined November 21, 1885, by J. B. Weir	1''.58	February 11, 1886 / February 21, 1886 } Object-end larger	1''.30
Collar-inequality, object-end smaller, determined July 7 and 9, 1886, by J. B. Weir	0''.54	May 24, 1886, object-end larger	0''.78
Mean	1''.06	Mean	1''.04

Angular value of telemeter-lines or threads:			
Before March 8, 1886	33′ 51″.8	Before February 18, 1886	33′ 08″.0
After March 8, 1886	33′ 22″.9	After February 18, 1886	18′ 40″,6
Increasing turns and divisions of micrometer correspond to *depressing* object-end of telescope.		} The same holds for levels Nos. 1, 2, and 3.	
Value of 1 turn = 100 divisions of micrometer:			
O. H. Tittmann, August 10, 1877	443″.5	O. H. Tittmann, March 6, 1879	255″.6
O. H. Tittmann, September 15, 1877	442″.8	J. B. Weir, June 16 and 17, 1880	257″.6
Mean	443″.1	Mean	256″.6
Instrument illustrated in Coast and Geodetic Survey Report for 1880, plates Nos. 46, 47.		Coast and Geodetic Survey Report for 1879, plate No. 52.	
Weight of instrument and stand, 23 pounds or 10.4 kilograms.		Weight of instrument and stand, 45 pounds or 20.4 kilograms.	

The rods are figured in Coast and Geodetic Survey Report for 1879, plate No. 53. A_1,* B, C, D, E, and F are all of the same construction.

These rods are divided from bottom up and are above 3 meters in length. The brass scale is fastened in the *middle* and is read to millimeters and by estimation to tenths of millimeters. Coefficient of expansion of brass=.000010 for Fahrenheit scale, or .000019 for centigrade scale. Distance from lower or abutting surface of brass knob to the zero of graduation, or the so-called "index correction," is as follows:

	mm.	
1 rod A_1,	78.2,	determined August 26, 1886, at Washington, D. C.
B,	78.1,	determined August 26, 1886, at Washington, D. C.
E,	63.1,	determined February 3, 1886, at Biloxi, Miss.
F,	60.4,	determined February 3, 1886, at Biloxi, Miss.

Comparison of length and divisions of rods with standard on Saxton's dividing and comparing machine.

Observer, E. B. Lefavour:
- September 21–25, 1882; Temperature at 68°.4 Fahrenheit:
  - 1st staff meter of A_1 = 1m.000244
  - 2d staff-meter of A_1 = 0m.999931, double weight
  - 3d staff-meter of A_1 = 0m.999949
- September 26, 27, 1882; Temperature at 68°.4 Fahrenheit:
  - 1st staff-meter of B = 1m.000141
  - 2d staff-meter of B = 0m.999876, double weight
  - 3d staff-meter of B = 0m.999974

hence, average length of a staff-meter on A_1 at 68°.4 Fahrenheit, 1m.000014

hence, average length of a staff-meter on B at 68°.4 Fahrenheit, 0m.999967

or, A_1 is of standard length at a temperature of 67°.0 Fahrenheit and B at 71°.7 Fahrenheit (average for A_1 and B, 69°.3 Fahr.).

Observer, E. B. Lefavour:
- December 19–21, 1882; Temperature at 68°.4 Fahrenheit:
  - 1st staff-meter of E = 1m.000052, of F = 1m.000052
  - 2d staff-meter of E = 1m.000039, of F = 0m.999959
  - 3d staff-meter of E = 1m.000121, of F = 1m.000120

	E	F
or, first staff meter of standard length at	63°.1 Fahrenheit for E and	63°.2 Fahrenheit for F
first and second meters	63°.8 Fahrenheit for E and	67°.8 Fahrenheit for F
all three meters	61°.3 Fahrenheit for E and	64°.0 Fahrenheit for F
Average, double weight to middle meter	62°.1	66°.1

* Rod A was accidentally broken in August, 1881.

Method of observing.—It was the same as that used heretofore and described in Coast and Geodetic Survey Report for 1880, Appendix No. 11, pp. 137, 138, with this important exception, however, that the *simultaneous double* line with reversal of direction for *alternate* sections was given up for the method of securing *two independent* measures by running a single line (say) forward, followed by a single line running backward. Convenient distances along the line were selected and run, after which the direction of the measure was reversed, which reversal took place generally either about the middle of the same day, or, preferably, on different days, according to circumstances. Thus the conditions of the instrument and of the atmosphere, as well as of the observer, were different for the two measures, which was not the case when simultaneous double lines were run. The lines of sight forward and backward were nearly equal in length.

Statistical information.—Number of permanent bench-marks on the line, 29; total development of line from bench-mark A, at Mobile, to bench-mark I, at Carrollton (New Orleans), 233 kilometers, or 145 statute miles. The distance of the target or staff from the instrument was very nearly 100 meters (on the average, 104 meters, omitting exceptional lines).

Computations.—The observer furnished a field computation; the Office and check computation was made by Assistant E. Smith, while attached to the Computing Division, between January 11 and April 4, 1887. The small difference of reading of screw between the pointings for horizon and for target gives rise to the correction of staff reading $d = \mathrm{D} \tan \alpha$, where $\mathrm{D} =$ distance of instrument to target as measured by the telemeter-lines, and expressed in meters, and α the angular difference of horizon and target, and expressed in seconds of arc. The table constructed for this correction serves likewise for the correction due to inequality of collars. The correction for curvature and refraction is given by $h = \frac{\mathrm{D}^2}{2\rho}(1 - 2m)$, where $\rho =$ average radius of curvature, or 6.371×10^6 meters, and $m =$ coefficient of refraction assumed, $= 0.07$. The index correction is applied where needed, also the correction due to the expansion or contraction of the brass scales of the staves for temperatures differing from that at which they are of standard length. Range of temperature during measure, between 25° Fahrenheit and 97° Fahrenheit.

Results.—They are drawn up in tabular form for ready reference. Table I contains the individual results and the necessary data to enable one to judge of the accuracy of the measures; Table II shows the resulting heights and probable uncertainties* of the principal bench-marks between Biloxi and Carrollton above the average Gulf-level, and a comparison of the results from the two levelings, *i. e.*, that by the Mississippi River Commission and that by the Coast and Geodetic Survey; Table III exhibits the resulting heights and probable uncertainties for the line Biloxi to Mobile.

* Probable uncertainty is used here in the sense of probable error.

RESULTS OF GEODETIC SPIRIT-LEVELING.

TABLE I.—*Line of spirit-levels from Mobile,* Ala., to Carrollton† (New Orleans), La.*

Date.	Bench-marks.		Distance between bench-marks.	Distance from A.	Difference of height between bench-marks.			Discrepancy.		Height of bench-mark above initial plane A.
					Direction of measure.		Mean of both measures.	Partial.	Total accumulated.	
	From—	To—			Westerly.	Easterly.‡				
1885.			*Km.*	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
		A	------	0.000	--------	--------	-------	------	0.0	0.0000
Dec. 7, 14	A	1	0.527	0.527	−0.1788	+0.1754	−0.1771	−3.4	−3.4	−0.1771
Dec. 7	1	2	.528	1.055	−1.8543	+1.8521	−1.8532	−2.2	−5.6	−2.0303
Dec. 7	2	3	.498	1.553	−0.4055	+0.4046	−0.4050	−0.9	−6.5	−2.4353
Dec. 8	3	4	.870	2.423	−0.0348	+0.0313	−0.0330	−3.5	−10.0	−2.4683
Dec. 8	4	5	.915	3.338	+1.6111	−1.6127	+1.6119	−1.6	−11.6	−0.8564
Dec. 8	5	6	.892	4.230	+1.0068	−1.0092	+1.0080	−2.4	−14.0	+0.1516
Dec. 8	6	7	.899	5.129	+1.1285	−1.1300	+1.1292	−1.5	−15.5	+1.2808
Dec. 9	7	8	.884	6.013	+3.1342	−3.1339	+3.1340	+0.3	−15.2	+4.4148
Dec. 9	8	9	.890	6.903	−1.5744	+1.5747	−1.5746	+0.3	−14.9	+2.8402
Dec. 9	9	10	.910	7.813	+1.0765	−1.0779	+1.0772	−1.4	−16.3	+3.9174
Dec. 9	10	11	.914	8.727	−1.5674	+1.5699	−1.5686	+2.5	−13.8	+2.3488
Dec. 10	11	12	.932	9.659	−1.8930	+1.8949	−1.8940	+1.9	−11.9	+0.4548
Dec. 10	12	13	.914	10.573	+2.3201	−2.3227	+2.3214	−2.6	−14.5	+2.7762
Dec. 10	13	14	1.347	11.920	−0.8598	+0.8551	−0.8574	−4.7	−19.2	+1.9188
Dec. 11	14	15	.902	12.822	−2.2146	+2.2163	−2.2154	+1.7	−17.5	−0.2966
Dec. 11	15	16	.880	13.702	+0.4974	−0.4948	+0.4961	+2.6	−14.9	+0.1995
Dec. 11	16	17	.899	14.601	−1.3048	+1.3014	−1.3031	−3.4	−18.3	−1.1036
Dec. 12	17	18	.906	15.507	+0.6784	−0.6799	+0.6792	−1.5	−19.8	−0.4244
Dec. 12	18	19	.968	16.475	+0.6296	−0.6298	+0.6297	−0.2	−20.0	+0.2053
Dec. 12	19	20	1.436	17.911	+3.7724	−3.7731	+3.7728	−0.7	−20.7	+3.9781
Dec. 18	20	35	.755	18.666	+1.5586	−1.5582	+1.5584	+0.4	−20.3	+5.5365
Dec. 18	35	34	.854	19.520	+2.6479	−2.6444	+2.6462	+3.5	−16.8	+8.1827
Dec. 18	34	33	.908	20.428	+3.2236	−3.2229	+3.2232	+0.7	−16.1	+11.4059
Dec. 17, 18	33	32	.867	21.295	+1.8893	−1.8903	+1.8898	−1.0	−17.1	+13.2957
Dec. 17	32	31	.874	22.169	+1.0468	−1.0484	+1.0476	−1.6	−18.7	+14.3433
Dec. 17	31	30	.890	23.059	−1.0457	+1.0476	−1.0466	+1.9	−16.8	+13.2967
Dec. 17	30	29	.904	23.963	+1.2576	−1.2583	+1.2580	−0.7	−17.5	+14.5547
Dec. 16	29	28	.823	24.786	−0.5164	+0.5169	−0.5166	+0.5	−17.0	+14.0381
Dec. 16	28	27	.883	25.669	+3.0361	−3.0365	+3.0363	−0.4	−17.4	+17.0744
Dec. 16, 19	27	26	.882	26.551	+4.3922	−4.3935	+4.3928	−1.3	−18.7	+21.4672
Dec. 16	26	25	.932	27.483	+3.6822	−3.6834	+3.6828	−1.2	−19.9	+25.1500
Dec. 15	25	24	1.302	28.785	+5.3442	−5.3490	+5.3466	−4.8	−24.7	+30.4966
Dec. 15	24	23	.882	29.667	+3.4234	−3.4225	+3.4230	+0.9	−23.8	+33.9196
Dec. 15	23	22	.890	30.557	+2.3926	−2.3891	+2.3908	+3.5	−20.3	+36.3104
Dec. 15	22	21	.914	31.471	+0.6469	−0.6499	+0.6484	−3.0	−23.3	+36.9588
Dec. 19	21	A_1	−.387	31.084	−0.2445	+0.2457	−0.2451	+1.2	−22.1	+36.7137

* Bench-mark A, at custom-house, Mobile.
† Bench-mark I, at Carrollton depot, or engine-house, in suburb of New Orleans.
‡ The change of signs in this column simply indicates the reversing of the direction of the measure.

TABLE I.—*Line of spirit-levels from Mobile, Ala., to Carrollton (New Orleans), La.*—Continued.

Date.	Bench-marks.		Distance between bench-marks.	Distance from A.	Difference of height between bench-marks.			Discrepancy.		Height of bench-mark above initial plane A.
	From—	To—			Direction of measure. Westerly.	Direction of measure. Easterly.	Mean of both measures.	Partial.	Total accumulated.	
1885.			*Km.*	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
Dec. 21	21	36	.872	32.343	—0.0170	+0.0154	—0.0162	—1.6	—24.9	+36.9426
Dec. 21	36	37	.883	33.226	—1.1539	+1.1538	—1.1538	—0.1	—25.0	+35.7888
Dec. 21	37	38	.880	34.106	—0.3063	+0.3074	—0.3068	+1.1	—23.9	+35.4820
Dec. 21	38	39	1.315	35.421	—4.3898	+4.3908	—4.3903	+1.0	—22.9	+31.0917
Dec. 22	39	43	1.540	36.961	—4.2359	+4.2309	—4.2334	—5.0	—27.9	+26.8583
Dec. 22	43	42	.866	37.827	—3.4271	+3.4267	—3.4269	—0.4	—28.3	+23.4314
Dec. 22	42	41	.876	38.703	+0.5436	—0.5420	+0.5428	+1.6	—26.7	+23.9742
Dec. 22	41	40	.894	39.597	—1.2484	+1.2486	—1.2485	+0.2	—26.5	+22.7257
Dec. 23	40	44	.870	40.467	+0.6185	—0.6175	+0.6180	+1.0	—25.5	+23.3437
Dec. 23	44	B_1	—.138	40.329	+5.4421	—5.4424	+5.4422	—0.3	—25.8	+28.7859
Dec. 23	44	45	.881	41.348	—3.7388	+3.7407	—3.7398	+1.9	—23.6	+19.6039
Dec. 23	45	46	.838	42.186	—3.2441	+3.2439	—3.2440	—0.2	—23.8	+16.3599
Dec. 23	46	47	.860	43.046	—3.4718	+3.4684	—3.4701	—3.4	—27.2	+12.8898
Dec. 23	47	48	.848	43.894	—1.7188	+1.7172	—1.7180	—1.6	—28.8	+11.1718
Dec. 24	48	49	.882	44.776	—5.4672	+5.4695	—5.4684	+2.3	—26.5	+5.7034
Dec. 24	49	50	.894	45.670	—2.9131	+2.9097	—2.9114	—3.4	—29.9	+2.7920
Dec. 24	50	51	.858	46.528	—2.9084	+2.9074	—2.9079	—1.0	—30.9	—0.1159
Dec. 24	51	52	1.316	47.844	—0.9007	+0.8989	—0.8998	—1.8	—32.7	—1.0157
Dec. 26	52	53	.875	48.719	+0.5235	—0.5243	+0.5239	—0.8	—33.5	—0.4918
Dec. 26	53	54	.888	48.607	—0.6094	+0.6092	—0.6093	—0.2	—33.7	—1.1011
Dec. 26	54	55	.824	50.431	—0.4467	+0.4442	—0.4454	—2.5	—36.2	—1.5465
Dec. 26	55	56	.818	51.249	+0.0881	—0.0900	+0.0890	—1.9	—38.1	—1.4575
Dec. 28	56	57	.835	52.084	—0.4687	+0.4688	—0.4688	+0.1	—38.0	—1.9263
Dec. 28	57	58	.804	52.888	+0.6181	—0.6168	+0.6174	+1.3	—36.7	—1.3089
Dec. 28	58	59	1.250	54.138	—0.3787	+0.3818	—0.3802	+3.1	—33.6	—1.6891
1886.										
January 4	59	71	1.700	55.838	+0.5815	—0.5782	+0.5798	+3.3	—30.3	—1.1093
January 4	71	70	1.394	57.232	+0.4213	—0.4184	+0.4198	+2.9	—27.4	—0.6895
January 2	70	69	1.314	58.546	+2.2573	—2.2558	+2.2566	+1.5	—25.9	+1.5671
January 2	69	68	1.378	59.924	—0.0805	+0.0793	—0.0799	—1.2	—27.1	+1.4872
January 2	68	64	1.418	61.342	—0.4042	+0.4055	—0.4048	+1.3	—25.8	+1.0824
1885.										
Dec. 30	64	63	1.248	62.590	—0.0889	+0.0887	—0.0888	—0.2	—26.0	+0.9936
Dec. 30	63	62	.876	63.466	+0.1283	—0.1274	+0.1278	+0.9	—25.1	+1.1214
Dec. 30	62	61	.886	64.352	—0.4247	+0.4256	—0.4252	+0.9	—24.2	+0.6962
Dec. 30	61	60	.871	65.223	—0.2670	+0.2678	0.2674	+0.8	—23.4	+0.4288
1886.										
January 7	60	C_1	—.250	64.973	+0.9801	—0.9790	+0.9796	+1.1	—22.3	+1.4084
1885.										
Dec. 31	60	65	.884	66.107	—1.7165	+1.7163	—1.7164	—0.2	—23.6	—1.2876
Dec. 31	65	66	1.319	67.426	—0.8763	+ .8746	—0.8754	—1.7	—25.3	—2.1630
Dec. 31	66	67	1.309	68.735	+0.0951	—0.0943	+0.0947	+0.8	—24.5	—2.0683

TABLE I.—*Line of spirit-levels from Mobile, Ala., to Carrollton (New Orleans), La.*—Continued.

Date.	Bench-marks.		Distance between bench-marks.	Distance from A.	Difference of height between bench-marks.			Discrepancy.		Height of bench-mark above initial plane A.
	From—	To—			Direction of measure.		Mean of both measures.	Partial.	Total accumulated.	
					Westerly.	Easterly.				
1886.			*Km.*	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
January 5	67	72	1. 007	69. 742	+0. 2203	—0. 2193	+0. 2198	— 1. 0	—23. 5	— 1. 8485
January 6	72	73	. 924	70. 666	+0. 6907	—0. 6885	+0. 6896	+ 2. 2	—21. 3	— 1. 1589
January 5	73	74	. 858	71. 524	—1. 4102	+1. 4079	—1. 4090	— 2. 3	—23. 6	— 2. 5679
January 5	74	75	. 843	72. 367	+2. 5859	—2. 5875	+2. 5867	— 1. 6	—25. 2	+ 0. 0188
January 6	75	76	. 875	73. 242	+1. 7485	—1. 7480	+1. 7482	+ 0. 5	—24. 7	+ 1. 7670
January 6	76	77	1. 308	74. 550	+0. 4303	—0. 4322	+0. 4312	— 1. 9	—26. 6	+ 2. 1982
January 11	77	82	1. 170	75. 720	—0. 1567	+0. 1586	—0. 1576	+ 1. 9	—24. 7	+ 2. 0406
Jan. 11, 12	82	81	. 893	76. 613	+0. 0767	—0. 0750	+0. 0758	+ 1. 7	—23. 0	+ 2. 1164
Jan. 11, 12	81	80	. 893	77. 506	+0. 6943	—0. 6912	+0. 6928	+ 3. 1	—19. 9	+ 2. 8092
January 12	80	84	1. 042	78. 548	—0. 6786	+0. 6792	—0. 6789	+ 0. 6	—19. 3	+ 2. 1303
January 12	84	83	1. 322	79. 870	+0. 0693	—0. 0672	+0. 0682	+ 2. 1	—17. 2	+ 2. 1985
January 12	83	78	1. 356	81. 226	+1. 1286	—1. 1242	+1. 1264	+ 4. 4	—12. 8	+ 3. 3249
January 7	78	79	1. 762	82. 988	—1. 3640	+1. 3644	—1. 3642	+ 0. 4	—12. 4	+ 1. 9607
January 7	79	85	1. 224	84. 212	+0. 3535	—0. 3509	+0. 3522	+ 2. 6	— 9. 8	+ 2. 3129
January 18	85	91	. 838	85. 050	+0. 1158	—0. 1145	+0. 1152	+ 1. 3	— 8. 5	+ 2. 4281
Jan. 18, 19	91	90	1. 336	86. 386	+0. 7072	—0. 7016	+0. 7044	+ 5. 6	— 2. 9	+ 3. 1325
January 16	90	89	1. 396	87. 782	—0. 0309	+0. 0326	—0. 0318	+ 1. 7	— 1. 2	+ 3. 1007
January 16	89	88	1. 400	89. 182	+0. 1509	—0. 1494	+0. 1502	+ 1. 5	+ 0. 3	+ 3. 2509
January 14	88	87	1. 376	90. 558	—0. 0211	+0. 0268	—0. 0240	+ 5. 7	+ 6. 0	+ 3. 2269
January 14	87	86	1. 363	91. 921	—0. 2498	+0. 2472	—0. 2485	— 2. 6	+ 3. 4	+ 2. 9784
January 14	86	D_1	— . 140	91. 781	+0. 7921	—0. 7925	+0. 7923	— 0. 4	+ 3. 0	+ 3. 7707
January 19	86	92	1. 466	93. 387	—3. 4592	+3. 4627	—3. 4610	+ 3. 5	+ 6. 9	— 0. 4826
January 22	92	E_1	— . 121	93. 266	+1. 5077	—1. 5076	+1. 5076	+ 0. 1	+ 7. 0	+ 1. 0250
January 20, 21, 22	*92	93	. 982	94. 369	—1. 5716	+1. 5708	—1. 5712	— 0. 8	+ 6. 1	— 2. 0538

Date.	Bench-marks.		Distance between bench-marks.	Distance from A.	Difference of height between bench-marks.			Discrepancy.		Height of bench-mark above initial plane A.
	From—	To—			Direction of measure.		Mean of both measures.	Partial.	Total accumulated.	
					Westerly.	Easterly.				
1886.			*Km.*	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
*February 1	92	T S. 1	.074	93.461	—0.2477	+0.2484	—0.2480	+ 0.7	+7.6	—0.7306
February 1	93	T .S. 2	.151	94.520	+1.7770	....	+1.7770	....		—0.2768
Jan. 22, 26	93	94	.954	95.323	—0.5716	+0.5950	—0.5833	[+23.4]		—2.6371
Febuary 1	94	T.S. 3	.163	95.486	+0.3899	....	+0.3899	....		—2.2472

1886 T.S. 1 is the 6-foot mark of tide-staff near east end of Biloxi Bay bridge.
1886 T.S 2 is the 6-foot mark of tide-staff near B.M. 93 on north projection of draw-bridge.
1886 T.S. 3 is the 6-foot mark of tide-staff near west end of Biloxi Bay bridge.

TABLE I.—*Line of spirit-levels from Mobile, Ala., to Carrollton (New Orleans), La.*—Continued.

Date.	Bench-marks. From—	Bench-marks. To—	Distance between bench-marks.	Distance from A.	Difference of height between bench-marks. Direction of measure. Westerly.	Difference of height between bench-marks. Direction of measure. Easterly.	Difference of height between bench-marks. Mean of both measures.	Discrepancy. Partial.	Discrepancy. Total accumulated.	Height of bench-mark above initial plane A.
1886.			*Km.*	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
Jan. 21, 23	93	F_1	— .071	94.298	—1.3808	+1.3807	—1.3808	— 0.1	+ 6.0	—3.4346
January 21, 22, 26	93	G_1	1.049	95.418	+0.4252	—0.4146	+0.4199	[+10.6]	+ 6.1	—1.6339
January 26, Feb. 1	G_1	H_1	.146	95.564	—0.3425	+0.3412	—0.3418	— 1.3	+ 4.8	— 1.9757
January 26	H_1	99	1.296	96.860	+0.6016	—0.6047	+0.6032	— 3.1	+ 1.7	— 1.3725
January 26	99	100	.908	97.768	+1.2648	—1.2649	+1.2648	— 0.1	+ 1.6	— 0.1077
January 26	100	I_1	— .919	96.849	+3.0675	—3.0618	+3.0646	+ 5.7	+ 7.3	+ 2.9569
January 28	100	104	1.337	99.105	+3.0735	—3.0765	+3.0750	— 3.0	— 1.4	+ 2.9673
January 28	104	105	1.355	100.460	+0.4949	—0.4948	+0.4948	+ 0.1	— 1.3	+ 3.4621
January 28	105	103	1.759	102.219	—0.2077	+0.2076	—0.2076	— 0.1	— 1.4	+ 3.2545
January 27	103	102	1.337	103.556	+0.8430	—0.8451	+0.8440	— 2.1	— 3.5	+ 4.0985
January 27	102	101	1.324	104.880	+0.1697	—0.1711	+0.1704	— 1.4	— 4.9	+ 4.2689
January 27	101	J_1	1.272	106.152	—0.1761	+0.1810	—0.1786	+ 4.9	0.0	+ 4.0903
January 25	J_1	95	1.402	107.554	—0.8514	+0.8510	—0.8512	— 0.4	— 0.4	+ 3.2391
January 25	95	96	1.411	108.965	+0.5234	—0.5211	+0.5222	+ 2.3	+ 1.9	+ 3.7613
January 25	96	97	1.399	110.364	—0.5653	+0.5634	—0.5644	— 1.9	0.0	+ 3.1969
January 25	97	98	.902	111.266	—0.3737	+0.3693	—0.3715	— 4.4	— 4.4	+ 2.8254
January 29	98	106	1.164	112.430	+0.5191	—0.5163	+0.5177	+ 2.8	— 1.6	+ 3.3431
January 29	106	107	1.116	113.546	—0.6462	+0.6454	—0.6458	— 0.8	— 2.4	+ 2.6973
January 29	107	K_1	— .272	113.274	—0.0922	+0.0929	—0.0926	— 0.7	— 1.7	+ 2.6047
January 29	107	108	1.324	114.870	—0.8380	+0.8369	—0.8374	— 1.1	— 3.5	+ 1.8599
February 2	108	113	1.830	116.700	+1.7466	—1.7467	+1.7466	— 0.1	— 3.6	+ 3.6065
February 2	113	112	1.346	118.046	+0.2155	—0.2159	+0.2157	— 0.4	— 4.0	+ 3.8222
February 2	112	111	1.327	119.373	+0.0597	—0.0558	+0.0578	+ 3.9	— 0.1	+ 3.8800
January 30	111	110	1.152	120.525	—0.5569	+0.5562	—0.5566	— 0.7	— 0.8	+ 3.3234
January 30	110	L_1	1.344	121.869	+0.6103	—0.6085	+0.6094	+ 1.8	+ 1.0	+ 3.9328
January 30; March 9	L_1	109	1.904	123.773	+0.7204	—0.7184	+0.7194	+ 2.0	+ 3.0	+ 4.6522
Feb. 10, 26; March 9	109	121	1.322	125.095	—0.1324	+0.1303	—0.1314	— 2.1	+ 0.9	+ 4.5208
Feb. 10, 26; March 2	121	120	1.246	126.341	+0.6323	—0.6332	+0.6328	— 0.9	0.0	+ 5.1536
Feb. 10, 11, 26; Mar. 2	120	M_1	1.238	127.579	+0.4922	—0.4938	+0.4930	— 1.6	— 1.6	+ 5.6466
Feb. 10, 11, 26; Mar. 2	M_1	119	1.655	129.234	—0.1262	+0.1230	—0.1246	— 3.2	— 4.8	+ 5.5220
Feb. 9, 25; March 2	119	118	1.638	130.872	—3.7247	+3.7260	—3.7254	+ 1.3	— 3.5	+ 1.7966

TAALE I.—*Line of spirit-levels from Mobile, Ala., to Carrollton (New Orleans), La.*—Continued.

Date.	Bench marks. From—	Bench marks. To—	Distance between bench-marks.	Distance from A.	Difference of height between bench-marks. Direction of measure. Westerly.	Difference of height between bench-marks. Direction of measure. Easterly.	Difference of height between bench-marks. Mean of both measures.	Discrepancy. Partial.	Discrepancy. Total accumulated.	Height of bench-mark above initial plane A.
1886.			*Km.*	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
Feb. 9, 25; March 2	118	117	1. 344	132. 216	—1. 4550	+1. 4551	—1. 4550	+ 0. 1	— 3. 4	+ 0. 3416
Feb. 5, 25	117	N_1	1. 512	133. 728	—0. 7196	+0. 7213	—0. 7204	+ 1. 7	— 1. 7	— 0. 3788
February 5; March 3	N_1	116	. 967	134. 695	—0. 8848	+0. 8856	—0. 8852	+ 0. 8	— 0. 9	— 1. 2640
Feb. 4, 5; March 3	116	115	1. 269	135. 964	—0. 3491	+0. 3510	—0. 3500	+ 1. 9	+ 1. 0	— 1. 6140
Feb. 4, 12	115	114	1. 316	137. 280	+0. 3453	—0. 3438	+0. 3446	+ 1. 5	+ 2. 5	— 1. 2694
February 4; March 3	114	O_1	1. 227	138. 507	+0. 5086	—0. 5053	+0. 5070	+ 3. 3	+ 5. 8	— 0. 7624
February 12; March 3	O_1	I	. 554	139. 061	—1. 2594	+1. 2576	—1. 2585	— 1. 8	+ 4. 0	— 2. 0209
Feb. 8, 9, 13; Mar. 1, 8	I*	V	3. 240	142. 301	+3. 0775	—3. 0756	+3. 0766	+ 1. 9	+ 5. 9	+ 1. 0557
Feb. 9, 13	V	P_1	. 073	142. 374	+1. 7098	—1. 7099	+1. 7098	— 0. 1	+ 5. 8	+ 2. 7655
February 26	P_1†	Q_1	— . 451	141. 923	+0. 6518	—0. 6514	+0. 6516	+ 0. 4	+ 6. 2	+ 3. 4171
February 16	P_1	122	1. 309	143. 683	+0. 5189	—0. 5163	+0. 5176	+ 2. 6	+ 8. 4	+ 3. 2831
Feb. 16, 18	122	123	1. 320	145. 003	+0. 3180	—0. 3162	+0. 3171	+ 1. 8	+10. 2	+ 3. 6002
February 16	123	124	. 830	145. 833	—1. 3736	+1. 3754	—1. 3745	+ 1. 8	+12. 0	+ 2. 2257
February 17	124	126	. 900	146. 733	—0. 4406	+0. 4384	—0. 4395	— 2. 2	+ 9. 8	+ 1. 7862
February 17	126	125	1. 292	148. 025	—0. 4134	+0. 4092	—0. 4113	— 4. 2	+ 5. 6	+ 1. 3749
February 17	125	R_1	1. 282	149. 307	—0. 4147	+0. 4152	—0. 4150	+ 0. 5	+ 6. 1	+ 0. 9599
Feb. 19, 20	R_1	127	1. 278	150. 585	—2. 1458	+2. 1471	—2. 1464	+ 1. 3	+ 7. 4	— 1. 1865
Feb. 19, 20, 24	127	128	1. 260	151. 845	+0. 8514	—0. 8472	+0. 8493	+ 4. 2	+11. 6	— 0. 3372
February 20	128	129	1. 043	152. 888	—0. 2668	+0. 2673	—0. 2670	+ 0. 5	+12. 1	— 0. 6042
February 20	129	130	1. 010	153. 898	—0. 7093	+0. 7072	—0. 7082	— 2. 1	+10. 0	— 1. 3124
February 20	130	S_1	1. 002	154. 900	+0. 5116	—0. 5102	+0. 5109	+ 1. 4	+11. 4	— 0. 8015
February 22	S_1	131	1. 256	156. 156	—1. 5287	+1. 5279	—1. 5283	— 0. 8	+10. 6	— 2. 3298
February 22	131	132	1. 252	157. 408	—0. 0991	+0. 1003	—0. 0997	+ 1. 2	+11. 8	— 2. 4295

Date.	Bench-marks. From—	Bench-marks. To—	Distance between bench-marks.	Distance from A.	Difference of height between bench-marks. Direction of measure. Westerly.	Difference of height between bench-marks. Direction of measure. Easterly.	Difference of height between bench-marks. Mean of both measures.	Discrepancy. Partial.	Discrepancy. Total accumulated.	Height of bench-mark above initial plane A.
1886.			*Km.*	*Kilometers*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters,*
* February 6	T. S. E.	I	.136	139.197	+0.6761	—0.6786	+0.6774	—2.5	+1.5	—1.3435
† February 6	T. S. W.	P_1	.360	142.734	+3.5694	—3.5685	+3.5690	+0.9	+6.7	+6.3345

T. S. E. is the 6-foot mark of tide-staff near east end of bridge over Bay St. Louis; T. S. W. is the 12-foot mark of tide-staff on wharf on west side of Bay St. Louis.

TABLE I.—*Line of spirit-levels from Mobile, Ala., to Carrollton (New Orleans), La.*—Continued.

Date.	Bench-marks.		Distance between bench-marks.	Distance from A.	Difference of height between bench-marks.			Discrepancy.		Height of bench-mark above initial plane A.
	From—	To—			Direction of measure.		Mean of both measures.	Partial.	Total accumulated.	
					Westerly.	Easterly.				
1886.			*Km.*	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
February 22	132	133	.402	157.810	+0.6954	—0.6940	+0.6947	+ 1.4	+13.2	— 1.7348
February 23	133	137	1.224	159.034	—0.3702	+0.3712	—0.3707	+ 1.0	+14.2	— 2.1055
February 23	137	136	.834	159.868	—0.2598	+0.2571	—0.2584	— 2.7	+11.5	— 2.3639
Feb. 23, 24	136	135	1.250	161.118	+0.0349	—0.0390	+0.0370	— 4.1	+ 7.4	— 2.3269
Feb. 23, 24	135	134	1.266	162.384	—0.1054	+0.1043	—0.1048	— 1.1	+ 6.3	— 2.4317
Feb. 23, 24	134	T_1	1.246	163.630	—0.0630	+0.0646	—0.0638	+ 1.6	+ 7.9	— 2.4955
February 24	T_1	138	1.432	165.062	—0.1003	+0.1016	—0.1010	+ 1.3	+ 9.2	— 2.5965
March 5	138	U_1	1.052	166.114	+2.0644	—2.0642	+2.0643	+ 0.2	+ 9.4	— 0.5322
March 5	U_1	141	.560	166.674	—1.7017	+1.7020	—1.7018	+ 0.3	+ 9.7	— 2.2340
March 5	141	140	1.138	167.812	—0.4007	+0.3957	—0.3982	— 5.0	+ 4.7	— 2.6322
March 5	140	139	1.270	169.082	—0.0073	+0.0055	—0.0064	— 1.8	+ 2.9	— 2.6386
March 5, 6	139	142	1.232	170.314	+0.4247	—0.4234	+0.4240	+ 1.3	+ 4.2	— 2.2146
March 6	142	143	1.122	171.436	—0.1156	+0.1146	—0.1151	— 1.0	+ 3.2	— 2.3297
March 10	143	144	1.275	172.711	—0.0313	+0.0332	—0.0322	+ 1.9	+ 5.1	— 2.3619
Mar. 10, 11	144	145	1.182	173.893	—0.3698	+0.3742	—0.3720	+ 4.4	+ 9.5	— 2.7339
March 11	145	147	1.081	174.974	+0.0467	—0.0475	+0.0471	— 0.8	+ 8.7	— 2.6868
March 11	147	146	1.284	176.258	+1.1915	—1.1916	+1.1916	— 0.1	+ 8.6	— 1.4952
March 13, 15, 16, 17; April 14	146	155	1.184	177.442	—0.5037	+0.5057	—0.5047	+ 2.0	+10.6	— 1.9999
March 15	155	V_1	—.307	177.135	—1.1472	+1.1466	—1.1469	— 0.6	+10.0	— 3.1468
March 15	155	154	1.214	178.656	—0.2179	+0.2178	—0.2178	— 0.1	+10.5	— 2.2177
Mar. 13, 17	154	153	1.278	179.934	—0.2118	+0.2099	—0.2108	— 1.9	+ 8.6	— 2.4285
Mar. 13, 17	153	152	1.292	181.226	—0.2739	+0.2740	—0.2740	+ 0.1	+ 8.7	— 2.7025
Mar. 13, 17	152	151	1.276	182.502	+0.1862	—0.1872	+0.1867	— 1.0	+ 7.7	— 2.5158
Mar. 13, 18	151	150	1.253	183.755	+0.0320	—0.0321	+0.0320	— 0.1	+ 7.6	— 2.4838
March 12	150	149	1.078	184.833	—0.0546	+0.0529	—0.0538	— 1.7	+ 5.9	— 2.5376
March 12	149	148	1.266	186.099	—0.2429	+0.2424	—0.2426	— 0.5	+ 5.4	— 2.7802
March 18	148	156	.185	186.284	+0.9902	----------	+0.9902	--------	--------	— 1.7900
March 18	148	157	1.305	187.404	+0.2040	—0.2028	+0.2034	+ 1.2	+ 6.6	— 2.5768
March 18	157	158	1.266	188.670	—0.0795	+0.0758	—0.0776	— 3.7	+ 2.9	— 2.6544
March 18	158	159	1.281	189.951	—0.1903	+0.1895	—0.1899	— 0.8	+ 2.1	— 2.8443
March 19	159	160	1.235	191.186	+0.4023	—0.4024	+0.4024	— 0.1	+ 2.0	— 2.4419
March 19	160	161	1.239	192.425	+0.1410	—0.1385	+0.1398	+ 2.5	+ 4.5	— 2.3021
March 19	161	162	1.228	193.653	—0.1130	+0.1123	—0.1126	— 0.7	+ 3.8	— 2.4147
March 22	162	165	1.040	194.693	—0.0269	+0.0261	—0.0265	— 0.8	+ 3.0	— 2.4412
March 22	165	164	1.263	195.956	+0.3049	—0.3053	+0.3051	— 0.4	+ 2.6	— 2.1361
March 20	164	163	.704	196.660	—0.3733	+0.3734	—0.3734	+ 0.1	+ 2.7	— 2.5095
March 20	163	W_1	— .386	196.274	+0.9613	—0.9622	+0.9618	— 0.9	+ 1.8	— 1.5477

TABLE I.—*Line of spirit-levels from Mobile, Ala., to Carrollton (New Orleans), La.*—Continued.

Date.	Bench-marks.		Distance between bench-marks.	Distance from A.	Difference of height between bench-marks.			Discrepancy.		Height of bench-mark above initial plane A.
	From—	To—			Direction of measure.		Mean of both measures.	Partial.	Total accumulated.	
					Westerly.	Easterly.				
1886.			*Km.*	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
March 22	163	166	1.692	198.352	—0.3993	+0.3996	—0.3994	+ 0.3	+ 3.0	— 2.9089
March 23	166	167	1.296	199.648	+0.2242	—0.2227	+0.2234	+ 1.5	+ 4.5	— 2.6855
March 23	167	168	1.205	200.853	—0.1026	+0.1039	—0.1032	+ 1.3	+ 5.8	— 2.7887
March 23	168	169	.718	201.571	—0.0950	+0.0963	—0.0956	+ 1.3	+ 7.1	— 2.8843
March 24	169	171	1.156	202.727	+0.0246	—0.0240	+0.0243	+ 0.6	+ 7.7	— 2.8600
March 24	171	170	1.184	203.911	—0.2032	+0.1996	—0.2014	— 3.6	+ 4.1	— 3.0614
March 25	170	173	1.350	205.261	+0.4673	—0.4701	+0.4687	— 2.8	+ 1.3	— 2.5927
March 25	173	172	1.266	206.527	+0.0662	—0.0669	+0.0666	— 0.7	+ 0.6	— 2.5261
Mar. 25, 26	172	174	1.032	207.559	—0.1876	+0.1883	—0.1880	+ 0.7	+ 1.3	— 2.7141
March 26	174	175	1.151	208.710	—0.0876	+0.0872	—0.0874	— 0.4	+ 0.9	— 2.8015
March 26	175	176	.903	209.613	—0.1588	+0.1609	—0.1598	+ 2.1	+ 3.0	— 2.9613
March 27	176	177	.722	210.335	+0.0752	—0.0782	+0.0767	— 3.0	0.0	— 2.8846
March 27	177	178	1.072	211.407	+0.4107	—0.4101	+0.4104	+ 0.6	+ 0.6	— 2.4742
March 29	178	179	1.488	212.895	—0.4670	+0.4673	—0.4672	+ 0.3	+ 0.9	— 2.9414
March 29	179	180	1.158	214.053	+0.3130	—0.3108	+0.3119	+ 2.2	+ 3.1	— 2.6295
March 29	180	181	1.034	215.087	—0.0352	+0.0342	—0.0347	— 1.0	+ 2.1	— 2.6642
March 31	181	182	1.186	216.273	+0.2920	—0.2908	+0.2914	+ 1.2	+ 3.3	— 2.3728
March 31	182	183	1.086	217.359	—0.1676	+0.1674	—0.1675	— 0.2	+ 3.1	— 2.5403
April 2	183	184	1.248	218.607	—0.1646	+0.1680	—0.1663	+ 3.4	+ 6.5	— 2.7066
April 2	184	185	1.144	219.751	+0.0633	—0.0621	+0.0627	+ 1.2	+ 7.7	— 2.6439
April 2	185	186	.731	220.482	—0.2906	+0.2931	—0.2918	+ 2.5	+10.2	— 2.9357
April 3	186	187	1.237	221.719	—0.0581	+0.0577	—0.0579	— 0.4	+ 9.8	— 2.9936
April 3	187	188	1.278	222.997	+0.1706	—0.1721	+0.1714	— 1.5	+ 8.3	— 2.8222
April 3	188	189	1.170	224.167	+0.0003	—0.0004	+0.0004	— 0.1	+ 8.2	— 2.8218
April 7	189	193	.951	225.118	+0.2334	—0.2336	+0.2335	— 0.2	+ 8.0	— 2.5883
April 7	193	X_1	— .074	225.044	+0.1723	—0.1726	+0.1724	— 0.3	+ 7.7	— 2.4159
April 7	193	194	.909	226.027	—0.4409	+0.4401	—0.4405	— 0.8	+ 7.2	— 3.0288
April 7	194	195	.558	226.585	+0.2764	—0.2784	+0.2774	— 2.0	+ 5.2	— 2.7514
April 9	195	Y_1	— .706	225.879	+1.8209	—1.8227	+1.8218	— 1.8	+ 3.4	— 0.9296
April 8	195	196	1.166	227.751	—1.2271	+1.2281	—1.2276	+ 1.0	+ 6.2	— 3.9790
April 12	196	197	—1.638	226.113	+0.2197	—0.2187	+0.2192	+ 1.0	+ 7.2	— 3.7598
April 12	197	A_2	— .409	225.704	+1.4636	—1.4635	+1.4636	+ 0.1	+ 7.3	— 2.2962
April 8	196	Z_1	1.380	229.131	+0.8340	—0.8344	+0.8342	— 0.4	+ 5.8	— 3.1448
April 8	Z_1	192	.888	230.019	+0.3531	—0.3527	+0.3529	+ 0.4	+ 6.2	— 2.7919
April 6	192	191	1.162	231.181	—0.5021	+0.5010	—0.5016	— 1.1	+ 5.1	— 3.2935
April 6	191	190*	1.208	232.389	+0.9645	—0.9680	+0.9662	— 3.5	+ 1.6	— 2.3273
April 5	190	Carrollton.	— .312	232.077	+1.3748	—1.3751	+1.3750	— 0.3	+ 1.3	— 0.9523

* Number 190 is identical with the City B. M. xx stone, established by the U. S. Engineers in 1874. (See Annual Report of Mississippi River Commission for 1883, p. 129.)

TABLE I.—*Line of spirit-levels from Mobile, Ala., to Carrollton (New Orleans), La.*—Continued.

Date.		Bench-marks. From—	Bench-marks. To—	Distance between bench-marks.	Distance from A.	Difference of height between bench-marks. Direction of measure. Westerly.	Easterly.	Mean of both measures.	Discrepancy. Partial.	Total accumulated.	Height of bench-mark above initial plane A.
1886.				*Km.*	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
April	5	190	I	.686	233.075	+1.2580	−1.2582	+1.2581	−0.2	+1.4	−1.0692
April	5	I	B. M. 5*	−.090	232.985	+0.0035	−0.0040	+0.0038	−0.5	+0.9	−1.0654
April	5	I	T. G.†	−.118	232.957	+2.2257	−2.2255	2.2256	+0.2	+1.6	+1.1564

* This bench-mark is identical with B. M. 5, Burney, established by the U. S. Engineers in 1875. (See Report as above.)
† T. G. is the sixteen-foot mark of the water-gauge of the Mississippi River Commission, at Carrollton, La.

Accuracy of the results of the line of levels.

The determination of the probable errors of the resulting differences of height of the marks at Mobile and at Carrollton and of their absolute heights is based upon the observed differences of heights of the intermediate marks resulting from the forward and backward measures. The probable error of the result of spirit-leveling of precision developed in a distance of one kilometer has generally been adopted as a convenient measure for comparison of accuracy of various lines. In accordance with the method of least squares as applied to spirit-leveling we take the probable error of leveling to be proportional to $\sqrt{s}$; or, what comes to the same thing, the weight w of a result is inversely proportional to the length s, or $w=\frac{1}{s}$.

Let d = difference of results, generally expressed in millimeters, from the two independent measures, one in direct and the other in reversed direction for a distance, s, generally expressed in kilometers.

n = the number of such differences or lines of double leveling.

$m_{,}$ and $m_{,,}$ = the mean error of a *single* leveling and of *double* leveling, respectively, for one kilometer or for unit of length,

then

$$m_{,}=\sqrt{\frac{1}{2n}\left[\frac{dd}{s}\right]} \quad \text{and} \quad m_{,,}=\frac{m_{,}}{\sqrt{2}}$$

If $r_{,,}$ and r be the probable errors of a double leveling for a line of unit length and of length S, respectively, then

$$r_{,,}=0.675\ m_{,,} \quad \text{and} \quad r=0.675\ m_{,,}\sqrt{S}.$$

In case the successive marks along the line are distributed with tolerable regularity over distances averaging one kilometer, the formula and computation become simplified since $w=1$ and we have the probable error of the resulting height from the double measure over a length of one kilometer equal to $0.675\sqrt{\frac{[d^2]}{4[s]}}$ and the probable error for the whole line $S=[s]$, $r=0.675\sqrt{\frac{[d^2]}{4}}$.

On the average the temporary marks along the line were about 1 kilometer apart and the results by the two methods agreed closely.* The results independent of the probable uncertainty of the sea level are as follows:

Line.	Bench-marks.	$\left[\frac{dd'}{s}\right]$	n.	S.	$r_{\prime\prime}$.	r.
				km.	mm.	mm.
Mobile to Carrollton (New Orleans).	A to I.	819	210	233	±0.67	±10.2
Biloxi to Mobile.	F_1 to A.	426	94	94	±0.72	± 7.0
Biloxi to Carrollton (New Orleans).	F_1 to I.	393	118	139	±0.62	± 7.3

We have also $m_{\prime} = \pm 1.40^{mm}$, a quantity which may be advantageously used for comparisons.

The values for $r_{\prime\prime}$ indicate a measure of great precision and the two instruments give sensibly the same value, No. 3 having been used on the line from bench-mark P_1 to I where $r_{\prime\prime} = \pm 0.60^{mm}$. It is a general experience that the probable error r, so obtained, proves too small as shown by the discrepancies appearing at crossings and from interlacing lines of levels. This arises from the fact that in the latter case errors, known as constant or systematic errors, make themselves felt. Their presence is directly attested by the so-called accumulation error, which is found more or less developed in lines leveled in opposite (or twice in the same) direction, but which it is altogether beyond the skill of the observer, the perfections of his instrument, and the method of observing to remove entirely so as to make the successive differences appear fortuitous.

On our line, starting from Mobile, the results for the successive marks from the forward and backward measures begin to diverge, reaching from zero, December 7, to 38 millimeters on December 28, which represents the maximum divergence; after this the two results rapidly converge to accord and between the middle of January and the close of the operation on April 12 the cumulative error had practically disappeared. On the same line of levels between Biloxi and Carrollton, the results by the Mississippi River Commission (see Annual Report for 1883, p. 148) reached a divergence at the end of the line at Carrollton of 50 millimeters; not, however, until after about 60 kilometers had been run did the results begin to deviate.

In the same volume, page 70,† we have the assigned probable error of the leveling operation of 1882–'83 between Biloxi and Carrollton, viz, 8.0 millimeters, a result almost identical with our result 7.3 millimeters as given above, showing that both operations were conducted with great accuracy.

Disturbing influence of differential attraction of the sun and moon on the direction of gravity and its effect on spirit-leveling.

It is proposed to inquire into the magnitude of the deflection of the vertical depending on the variable positions of either the sun or the moon with respect to the direction of a line of levels and to estimate the effect on the resulting heights.

It may be shown that for any place on the earth's surface the disturbance of gravity in direction and intensity by the action of the sun and moon, as depending on the momentary position of either luminary and as measured by the difference of effect on the earth's center and on the point at its surface, is so small that ordinarily it can be entirely omitted in the astronomical determination of geographical positions. If, according to Helmert, to whom the investigation is due,‡

M = mass of the sun or the moon,
M_0 = mass of the earth,
p = horizontal parallax of the luminary,
ζ = its zenith distance, and
P = the disturbing effect, expressed in seconds;

* By the second or simple formula we have for $r_{\prime\prime}$ the values $\pm 0.66^{mm}$, $\pm 0.74^{mm}$, and $\pm 0.60^{mm}$ for the three line respectively. (See table above.)

†On page 53, Assistant Engineer J. B. Johnson gives for the entire line the probable error $\pm 7^{mm}$ and on the average $\pm 0.60^{mm}$ per kilometer.

‡ Mathematical and physical theories of Higher Geodesy, by Dr. F. R. Helmert, 2 vols., Leipzig, 1880–1884. Vol. II, chapters V and VII.

then

$$P = \frac{3}{2} \frac{M}{M_0} \sin^3 p \ (\sin\ 1'')^{-1},$$

and the southerly deviation of the disturbed zenith will be

$$\xi = - P \sin 2\ \zeta \cos A,$$

and the westerly deviation

$$\eta = - P \sin 2\ \zeta \sin A,$$

where A = azimuth of luminary, counted as usual from the south around by west. Introducing numerical values we have for the moon $P = 0''.0174$ and for the sun $P = 0''.0080$. These being maximum values, the influence of either body on the direction of the plumb-line is practically a vanishing quantity. The disturbance of the intensity of gravity is likewise insensible; with the latter, however, we are not here concerned.

In consequence of the disturbed direction of gravity, the position of the level-surface passing through the point will be changed, hence also the result of spirit-leveling will become affected since that operation refers everywhere to the actual level-surface during measure.

If the leveling is conducted "forward" in the southwesterly azimuth α, the direction of sight "forward" will be depressed in consequence of the disturbed vertical by the angle

$$\gamma = \xi \cos \alpha + \eta \sin \alpha = - P \sin 2\ \zeta \cos (A - \alpha) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and the correction for the staff-reading "forward," will be $+ \frac{s}{2} \gamma$, and for "backward," $- \frac{s}{2} \gamma$, hence the difference of staff-readings "backward — forward," or the correction to difference of height will be

$$s\, P \sin 2\ \zeta \cos (A - \alpha) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where s = the distance between the two positions of the staff. Here P is to be expressed in arc, viz: for the moon $\frac{1}{12\ 000\ 000}$ and for the sun $\frac{1}{23\ 000\ 000}$. Thus for any one instrumental station the effect is altogether insensible, but it may become sensible by accumulation in extended lines of levels.

If we next suppose the moon and the sun to be in the equator, or have zero declination, and the leveling to be done in the northern hemisphere, it will be noticed that, in the above expression (2), ζ in the first quadrant will be accompanied by A in the first or fourth quadrant, and ζ in the second quadrant will be accompanied by A in the second or third quadrant; hence in leveling from north to south, or for $\alpha = 0$, the expression (2) will always be positive, whereas for the case of an east and west line ($\alpha = 90^\circ$) a change of sign may take place, and consequently, to some extent, compensation will diminish the effect under consideration. The circumstance that the luminaries assume different declinations does not in the main alter the general effect.

For levelings proceeding in a north and south direction there will consequently remain some average effect on resulting difference of height and of about the same amount (in particular if the operation has extended over the space of a lunation) for every repetition of the measure, since the direction of the measure is here immaterial.

For an east and west line, on the contrary, the lunar effect may be nearly eliminated and the solar effect considerably reduced. Lines of intermediate azimuths partake of the character of each of the two cardinal directions. We may fairly estimate the actual effect on a leveling to be not more than two-thirds of the maximum effect, and generally it will be less than one-half of it and thus practically eludes recognition.

Let us take the case of a line of levels along a meridional arc of 1° in length, then for the moon the maximum disturbing or accumulated effect producible will be 0.009 meter in height and the probable actual effect 4 or 5 millimeters or less than this amount. In case of the sun being the disturbing body the effect would be about half of that produced by the moon. These effects merge themselves with the probable errors of the measure.

Dr. Helmert cites the interesting hypothetical case of a maximum difference of levels from a repeated measure, viz, an east and west line 1000 kilometers in length, measured in the summer months in the forenoon always westerly, and during the second measure in the afternoon always easterly; then the results of the two levelings may differ in consequence of the differential solar attraction by as much as 8.7 centimeters (about 3½ inches), although the mean result will not be affected.

In practice no special attention is paid to the position of the luminaries (except that the sun be above the horizon), nor is the direction of the measure in any way regulated (as was assumed in the above hypothetical case) for east and west lines with respect to morning and afternoon hours of work; thus more or less compensation is permitted to take place.

The above considerations sufficiently demonstrate that perhaps for all practical levelings the lunar and solar influence, as a disturbing force on the vertical, is of too minute an order to demand special attention and that the effect in the present state of the art of leveling is entirely concealed in the probable uncertainties of the measure itself.

There are two other effects which influence the results from spirit-leveling, viz, the effect of the spheroidal figure of the earth and the effect due to local deflections of the vertical; the former depending on the convergence of level surfaces toward the pole, the latter depending on the slopes or hypsometry of the surface and the variations in gravity. As neither circumstance has any application to the Mobile (New Orleans) line I shall here pass by their special consideration.

Connection with the Gulf level.

The line of spirit-levels is referred to the average level of the Gulf of Mexico by means of tidal observations made by direction* of the Mississippi River Commission at Biloxi, Miss., between September, 1881, and March, 1884.† Before entering upon the detail of the determination of this zero level it will be pertinent to offer a few remarks upon the tides of Mississippi Sound.

The peculiar character of the tides of Mississippi Sound, which connects quite freely with the waters of the Gulf, was early recognized and investigated by the Coast Survey. Hourly observations were made during 1848 and 1849 at Cat Island under the direction of Superintendent Bache, whose discussions of these tides will be found in Coast Survey Report for 1851, Appendix No. 7, and in Report for 1852, Appendix No. 22. These tides had previously been regarded by navigators as too irregular for analysis and prediction. It was then seen that these fluctuations belonged to the class of single-day tides, but with a remarkably small range, the average rise and fall being less than a foot and a half. In later years, after the harmonic analysis of the tides had been developed, the committee on tides appointed by the British Association for the Advancement of Science applied for the Cat Island record, comprising about thirteen months, in order to test the application of the harmonic analysis for the evaluation of the components of the tides at this place. The results are contained in the report of the committee made in 1872 and in the volume for the Southport meeting in 1883.‡

The lunar-diurnal component and the luni-solar diurnal component have each a semi-range of about half a foot; the lunar and solar semi-diurnal tides only reach about one-tenth of a foot, and there are indications of meteorological influences depending on daily and annual periods. The solar annual tide has apparently a semi-range of nearly one-third of a foot and the solar semi-annual about half this amount. In June, 1887, inquiry was made for the automatic tidal record at Biloxi, which was found to have been deposited in the archives of the Survey§ for safe-keeping; it was placed without delay in the hands of the Tidal Division of the Office with directions to work

* Supposed.

† From August, 1881, to January, 1883, the observer was W. H. Price.

‡ See also Proceedings of the Royal Society, Vol. XXXIX, London, 1886, pp. 135–207.

§ There is no explanation accompanying the rolls, and the precise location of the gauge and staff is unknown. (In a letter dated July 28, 1887, Mr. Weir says the gauge was on piles near the draw-bridge.) The gauge, there is reason to believe, had been made at the Coast and Geodetic Survey Office.

out the reading of the average or half-tide sea level, separately for each lunation and for general discussion, as time would permit.

Mr. A. S. Christie, Chief of the Tidal Division, reports the following results under date of June 27, 1887, and remarks: "The original record of the observations * * * extends from September 5, 1881, to March 1, 1884, and is rather unsatisfactory both as regards time notes and staff-readings. On this account no use has been made of the series during 1883 and 1884, and the part used—only that extending from June to December—depends upon actual staff-readings. From September, 1881, to June, 1882, the observer entered upon the rolls what he called staff-readings, but there are reasons for supposing that they were readings of a scale fixed over the gauge roller and presumed to coincide in its readings with those of the staff."

Tabular statement showing the readings of mean (average) sea level on the tide-staff established at Biloxi in connection with automatic tide-gauge No. 43. The series used consists of hourly ordinates beginning 1881, *September*, 7^d 23^h, *and extending* 472^d 11^h *to* 1882, *December*, 24^d 9^h.*

No. of group.	The group begins at the local time of full moon, as given below.			Length of group.		No. of ordinates in each group.	Sums of hourly ordinates in each group.	Mean sea level on staff for each group.
	1881.	*d.*	*h.*	*d.*	*h.*		*Feet.*	*Feet.*
1	Sept.	7	23	29	9	705	4689.8	6.65
2	Oct.	7	8		12	708	4643.2	6.56
3	Nov.	5	20		15	711	4365.2	6.14
4	Dec.	5	11		18	714	4194.9	5.88
	1882.							
5	Jan.	4	5		19	715	4293.8	6.01
6	Feb.	3	0		19	715	4284.7	5.99
7	Mar.	4	19		17	713	4401.8	6.17
8	April	3	12		15	711	4438.6	6.24
9	May	3	3		12	708	4519.7	6.38
10	June	1	15		9	705	4430.0	6.28
11	July	1	0		8	704	4333.2	6.16
12	July	30	8		7	703	4451.5	6.33
13	Aug.	28	15		8	704	4605.0	6.54
14	Sept.	26	23		10	706	4675.0	6.62
15	Oct.	26	9		11	707	4283.4	6.06
16	Nov.	24	20	29	14	710	4152.1	5.85

No further discussion of the Biloxi tides was sent in at this time.

To obtain from these results the mean staff-reading of the sea level we find for the period, June, 1882, and November, 1882, from seven lunations, during which the relation of the gauge to the staff was satisfactory, the value 6.26 feet, whereas the mean from sixteen lunations gives 6.24; this indicates that we may use the whole series for our purpose. It is evident from the run of the tabular values that they are subject to an annual inequality, whether due to the tides directly or to meteorological causes, indirectly, will be immaterial for the combination. It is quite certain that the Gulf level is affected by prevailing winds and variations in atmospheric pressure, in the rain-

* Mean local time, civil reckoning, but hours counted from 0 to 24.

fall, and evaporation ; but such effects have not been studied. Grouping the results for average sea level by lunations in the annual cycle we have:

No. of lunation.	Readings of average sea level in feet.	Mean value.	Time of year.
1 and 13	6.65 and 6.54	6.60	Beginning of September.
2 14	6.56 6.62	6.59	
3 15	6.14 6.06	6.10	
4 16	5.88 5.85	5.86	Between November, 1881, and February, 1882.
5		6.01	
6		5.99	
7		6.17	
8		6.24	
9		6.38	
10		6.28	
11		6.16	
12		6.33	August.
	Mean.	6.23	

From this combination it would appear that, in this particular case, the Gulf level was highest in the early fall and lowest during winter; the variation was about 0.67, or two-thirds of a foot nearly. For want of other annual means the probable uncertainty of the resulting value, 6.23 feet, or 1.8989 meters, can not be assigned. As an estimate, merely, I offer the value ± 0.025 meter until something better can be had. This rough estimate of uncertainty is more than double the probable error of the whole line of measure and thus indicates the desirability of supplying this information by further tidal observations which need not necessarily be automatic.

To connect our results of spirit-levels with the Gulf level we have the following measure recorded in the Annual Report of the Mississippi River Commission for 1883, page 70, viz: 8-foot mark of tide-gauge (staff) at Biloxi $0^m.2390$ above U. S. P. B. M. No. 21, which bench-mark is identical with our bench-mark F_1. Nothing could be learned in 1885–'86 of the position of this staff or gauge, hence the above measure is the only means to make the connection, though we possess rough checks incidentally supplied by Mr. Weir.* The average Gulf level is, therefore, $0^m.5395 - 0^m.2390 = 0^m.3005$ below F_1; in other words, bench-mark A at Mobile is $3^m.7351$ and bench-mark I at Carrollton (New Orleans) $2^m.6659$ above the average Gulf level.

*On p. 53 of the Annual Report Mississippi River Commission for 1883, we have the statement: "the zero of the Carrollton gauge will prove to be some 2 or 3 inches above mean tide," and pp. 60–61: elevation of the 14-foot mark of water-gauge at Carrollton $10^m.640$, and of the Coast Survey bench-mark I, $9^m.027$ (p. 129); hence difference $1^m.613$, and the zero of the staff would be $2^m.666—2^m.654=0^m.012$ above the Gulf level, which is in sufficient agreement with the statement. The zero of the Carrollton gauge was further determined in 1886, April, viz: 16-foot mark of gauge $2^m.2256$ above B. M. I, hence the zero of staff $0^m .015$ above the Gulf level, a result differing but 3^{mm} from the older measure.

According to Mr. Weir we have the following measures of the Gulf water level at $4^h\ 17^m$ p. m. on February 1, 1886: At staff east end of Biloxi bridge, at staff near draw-bridge, and at staff near west end, water level $3^m.341$ below B. M. 92, $1^m.778$ below B. M. 93, and $1^m.189$ below B. M. 94, respectively, corresponding to sea level *at that time* below the average level, $8^{cm}.9$, $9^{cm}.7$, and $9^{cm}.1$, respectively. The measures to tide water at Bay St. Louis gave similar though not quite so close checks.

TABLE II.—*Resulting heights above the average or half-tide level of the Gulf of the principal or permanent bench-marks between Biloxi, Miss., and Carrollton (New Orleans), La.,* 1885–'86, *with comparison of results obtained by the Mississippi River Commission in* 1882–'83.

Designation of mark, Coast and Geodetic Survey.	Distance from Biloxi.	1885–'86. Height of mark above Gulf.	Probable error.	1882–'83. Height of mark above Gulf.	Difference (1885-6) –(1882-3).
	km.	*m.*	*mm.*	*m.*	*mm.*
Average or half-tide level of the Gulf of Mexico	------	0.0000	*±25	------	------
F_1, same as No. 21, M. R. C., at Biloxi Bridge	0.00	0.3005	0.0	0.3005	0.0
G_1, same as No. 20, M. R. C., at Biloxi Bay	1.12	2.1012	0.7	2.1019	— 0.7
H_1, same as No. 19, M. R. C., at Biloxi Bay	1.27	1.7594	0.7	1.7574	+ 2.0
I_1, same as No. 18, M. R. C., at Biloxi	2.55	6.6920	1.0	6.6900	+ 2.0
J_1, same as No. 17, M. R. C., at Beauvoir Station	11.85	7.8254	2.1	7.8216	+ 3.8
K_1, same as No. 16, M. R. C., at Mississippi City	18.98	6.3398	2.7	6.3322	+ 7.6
L_1, same as No. 15, M. R. C., near 65 and 66 mile posts	27.57	7.6679	3.3	7.6602	+ 7.7
M_1, same as No. 14, M. R. C., at 62-mile post	33.28	9.3817	3.6	9.3548	+26.9
N_1, same as No. 13, M. R. C., at Pass Christian	39.43	3.3563	3.9	3.3253	+31.0
O_1, same as No. 12, M. R. C., at Henderson's Point	44.21	2.9727	4.1	2.9285	+44.2
P_1, same as No. 11, M. R. C., at Bay Saint Louis	48.08	6.5006	4.3	6.4517	+48.9
Q_1, same as No. 10, M. R. C., at Bay Saint Louis	47.63	7.1522	4.3	7.1027	+49.5
R_1, same as No. 9, M. R. C., near Waveland	55.01	4.6950	4.6	4.6500	+45.0
S_1, same as No. 8, M. R. C., at Toulmé Station	60.60	2.9336	4.8	2.8838	+49.8
T_1, same as No. 7, M. R. C., near Claiborne Stationa	69.33	1.2396	5.2	1.1922	+47.4
U_1, same as No. 6, M. R. C., at East Pearl River Bridge	71.82	3.2029	5.2	3.1543	+48.6
V_1, same as No. 5, M. R. C., at bridge over Rigolets	82.84	0.5883	5.6	0.5403	+48.0
W_1, same as No. 4, M. R. C., at Fort Macomb	101.98	2.1874	6.3	2.1321	+55.3
X_1, same as No. 3, M. R. C., at Fair grounds, New Orleans	130.75	1.3192	7.1	1.2640	+55.2
Y_1, same as No. 2, M. R. C., at Bayou St. John	131.58	2.8055	7.1	2.7487	+56.8
Z_1, same as No. 1, M. R. C., at White Bridge	134.83	0.5903	7.2	0.5296	+60.7
Carrollton, old court-house	137.78	2.7828	7.3	2.7372	+45.6
I, Carrollton, Babcock Engine-House, established 1875	138.78	2.6659	± 7.3	2.6166	+49.3
Hampson B. M., old, Williams', spike on machine-shop, Carrollton	138.90	2.4607	-----	2.4186	+42.1
New Hampson B. M., by Howell, near old Hampson, at Carrollton	138.90	------	-----	2.2445	------
Burney B. M., No. 5, Carrollton Depot, established 1875 by U. S. Engineers	138.69	2.6697	-----	2.6197	+50.0
City B. M. xx stone, Carrollton, 1874	138.09	1.4078	-----	1.3549	+52.9
A_2, C. S. Convent, New Orleans	131.41	1.4389	-----	------	------

* Assumed for the present; the amount must be combined with each of the probable errors of the bench-marks.

The figures in the column of differences are instructive in so far as they exhibit the amount which systematic errors do reach in two levelings conducted with equal care and skill and entitled to equal confidence.

These differences of the two operations exceed many times the probable error assigned to each. The gap between the two results steadily widens, reaching at the end of the line about 50^{cm} (2 inches) over a distance of 139^{km} (86 statute miles). It must be admitted, however, that the greater part of the difference has been developed between Biloxi and Bay St. Louis, and that between the latter place and New Orleans the two results fairly agree, considering the possibility of a small change in some of the marks with lapse of time. Thus our assigned probable errors assume more the character of relative than of absolute values. It should, however, be borne in mind that the character of the ground gone over was one exceedingly unfavorable to precise measures.

TABLE III.—*Resulting heights above the average or half-tide level of the Gulf of the permanent bench-marks between Biloxi, Miss., and Mobile, Ala.*, 1885-'86.

Designation and position of bench-marks, Coast and Geodetic Survey.	Distance from Biloxi.	Height of B. M. above Gulf.	Probable error.
	km.	*m.*	*mm.*
Average or half-tide level of the Gulf of Mexico	-----	0.0000	± 25
F_1, at Biloxi Draw-bridge, on iron caisson	0.00	+ 0.3005	0.0
E_1, east end of Biloxi Bridge, in Walker's yard	1.03	+ 4.7601	0.7
D_1, at Ocean Springs, Miss., on chimney of Franco house	2.52	+ 7.5058	1.1
C_1, at Scranton, Miss., on court-house	29.33	+ 5.1435	3.9
B_1, at Grand Bay, Ala., on chimney of Cassebry house	53.97	+32.5210	5.3
A_1, at St. Elmo Station, Ala., in yard of Adams's house	63.22	+40.4488	5.7
A, at Mobile, Ala., on custom-house, established in 1884	94.30	+ 3.7351	± 7.0

As in the preceding table the probable error for any bench-mark must be combined with that provisionally adopted for the sea-level in order to have the whole amount of probable uncertainty in the given height.

A description of the permanent bench-marks is herewith appended

Yours, respectfully,

CHAS. A. SCHOTT,
Assistant, in Charge Computing Division.

Mr. B. A. COLONNA,
Assistant, in Charge Office and Topography.

DESCRIPTION OF BENCH-MARKS.

Primary bench-mark A is situated at Mobile, Ala., on the sill of the window on the north front and near the east end of the custom-house. The B. M. is the bottom of a square hole cut in the rock. It is $0^m.215$ from extreme north edge of sill, $0^m.143$ from south wall, $0^m.145$ from east wall, and $1^m.155$ below the window.

Primary bench-mark A_1 is at St. Elmo Station, Mobile County, Ala., on the Louisville and Nashville Railroad, in the yard of and in the northwest angle of the house occupied by Mr. Adams. The B. M. is the bottom of the square cavity cut in the top of the marble stone marking the point. The stone is 6 by 4 inches on top and about $2\frac{1}{2}$ feet long, and has the letters U. S. C. S. cut upon the top.

Primary bench-mark B_1 is at Grand Bay, Mobile County, Ala., on the Louisville and Nashville Railroad. The B. M. is on the north side of the chimney at the east end of the frame dwelling owned by Mr. Oscar Cassebry, and is the center of the head of a copper bolt, $0^m.0642$ in length and $0^m.0125$ in diameter, leaded horizontally into the eighth layer of bricks above the ground, and near the middle of the third brick from the north end of the chimney.

Primary bench-mark C_1 is at Scranton, Jackson County, Miss., on the north face and near the northeast corner of the court-house. The B. M. is the center of head of copper bolt, $0^m.0642$ in length and $0^m.0125$ in diameter, leaded horizontally in the middle of the tenth brick above water-table.

Primary bench-mark D_1 is at Ocean Springs, Jackson County, Miss., in chimney on west side of store-house owned and occupied by A. Franco. The B. M. is the center of head of copper bolt,

$0^m.0642$ in length and $0^m.0125$ in diameter, leaded horizontally into the middle brick in the twenty-first layer above the ground.

Primary bench-mark E_1 is near the east end of Biloxi Bay bridge and about 68 meters south of the Louisville and Nashville Railroad track, in the yard of and near the northwest corner of the frame house owned and occupied by the Rev. J. B. Walker. The B. M. is the bottom of the square cavity cut in the top of the marble stone marking the point. The stone is 6 by 4 inches on top and about 2½ feet long, projecting about 1 inch above ground, and has the letters U. S. C. S. cut upon the top. Distance from center of bench to brick pier under northwest corner of house, $0^m.8$.

Primary bench-mark F_1, or Mississippi River Commission P. B. M. No. 21, is on the north side of the draw-bridge pier of the Biloxi Bay bridge, on the Louisville and Nashville Railroad, Mississippi. The B. M. is the top of a copper bolt leaded vertically in the concrete inside of the iron caisson. The bolt is set about half-way between cog-wheels and extreme north point of iron caisson. It measures 1 foot 4 inches to extreme north edge of caisson and 1 foot 6 inches to cog-wheels. The caisson is 30 feet in diameter and is filled with concrete. It rests on top of piles in 12 feet of water.

Primary bench-mark G_1, or Mississippi River Commission P. B. M. No. 20, is near the west end of Biloxi Bay bridge, Mississippi, on the Louisville and Nashville Railroad. The B. M. is the head of a copper bolt leaded vertically in the top of marking stone, set in the ground 4 meters north of center of track and 114 meters west of the west end of the bridge. The letters U. S. are cut upon the top of the stone.

Primary bench-mark H_1, or Mississippi River Commission P. B. M. No. 19, is 225 meters west of the west end of Biloxi Bay bridge, Mississippi, and 30 meters south of center of track of the Louisville and Nashville Railroad. The B. M. is a cross cut on the top of the marking stone (the copper bolt has been destroyed), set in the ground. Pine trees near the stone are marked with five narrow blazes.

Primary bench-mark I_1, or Mississippi River Commission P. B. M. No. 18, is at Biloxi, Miss., on the building on the southwest corner of Back Bay road (or Mule street) and Jackson street. The B. M. is the center of head of copper bolt leaded horizontally into the center of the second brick from the southeast corner of the fourteenth course above the sidewalk, in the east wall.

Primary bench-mark J_1, or Mississippi River Commission P. B. M. No. 17, is at Beauvoir Station, Miss., on the Louisville and Nashville Railroad. The B. M. is the top of a copper bolt leaded vertically into the top of the marking stone, set in the ground near the west end of the depot platform and 11 meters south of center of track. The letters U. S. are cut upon the top of the stone.

Primary bench-mark K_1, or Mississippi River Commission P. B. M. No. 16, is at Mississippi City, Harrison County, Miss., in the west wall of the county jail. The B. M. is the center of a copper bolt leaded horizontally into the center of the fifth brick of the fifteenth course above the water-table. The bricks are counted from the northwest corner of the building. The letters U. S. are cut over and B. M. under the bolt.

Primary bench-mark L_1, or Mississippi River Commission P. B. M. No. 15, is about 1,056 meters east of the New Orleans 65-mile post and about 552 meters west of the New Orleans 66-mile post, and 24 meters north of the center of track of the Louisville and Nashville Railroad. The B. M. is the top of the marking stone, set in the ground, and which has the letters U. S. cut upon the top. Three pine trees, each marked with five blazes, are near the stone.

Primary bench-mark M_1, or Mississippi River Commission P. B. M. No. 14, is 191 meters east of the New Orleans 62-mile post and 8 meters north of the center of track of the Louisville and Nashville Railroad, Mississippi. The B. M. is the top of head of copper bolt leaded vertically in top of marking stone, set in the ground, with the letters U. S. cut upon the top.

Primary bench-mark N_1, or Mississippi River Commission P. B. M. No. 13, is at Pass Christian Station, on the Louisville and Nashville Railroad, Mississippi. The B. M. is the top of head of copper bolt leaded in top of marking stone, set in the ground between the pump-house and water-tank. It is a little inside of the north line of pump-house and tank and about 3 meters from west side of pump-house. The pump-house is about 9 meters south of track. The letters U. S. are cut upon the top of the stone.

Primary bench-mark O_1, or Mississippi River Commission P. B. M. No. 12, is at Henderson's Point, Miss. The B. M. is the top of head of copper bolt, leaded in the top of marking-stone set in the ground within the northwest corner of fence surrounding plot of ground on which the tool-house of Louisville and Nashville Railroad, section No. 9, is situated. The stone is about 32 meters west of west side of house and 8 meters south of center of track. The letters U. S. are cut upon the top of the stone.

Primary bench-mark P_1, or Mississippi River Commission P. B. M. No. 11, is at Bay St. Louis, Miss. The B. M. is the top of head of copper bolt leaded in the top of marking stone set in the ground by the northeast corner of fence surrounding southwest plot of land at the intersection of the Louisville and Nashville Railroad track and Front street. It is 12 meters south of center of track and about 51 meters west of west end of bridge over Bay St. Louis. The letters U. S. are cut upon the top of the stone.

Primary bench-mark Q_1, or Mississippi River Commission P. B. M. No. 10, is at Bay St. Louis, Miss. The B. M. is the center of head of copper bolt leaded horizontally into the face of the southern brick wall of the vestibule of the Catholic church, about half way between side entrance of vestibule and main front wall, and about 1 meter above the ground.

Primary bench-mark R_1, or Mississippi River Commission P. B. M. No. 9, is at Waveland Station, Miss., on the Louisville and Nashville Railroad. The B. M. is the top of marking stone set within the southeast corner of fence surrounding the land of Henderson Winfield. The corner is at the intersection of Waveland road and lane between the lands of Mr. Shaw and Mr. Winfield. The stone is about 32 meters south of the southeast corner of station-house, and has the letters U. S. cut upon the top.

Primary bench-mark S_1, or Mississippi River Commission P. B. M. No. 8, is at Toulmé Station, Louisville and Nashville Railroad, Mississippi. The B. M. is the top of the marking stone set in the ground in the northwest corner of the front yard in which the section-house is situated. The stone is about 10 meters south of center of main track and has the letters U. S. cut upon the top.

Primary bench-mark T_1, or Mississippi River Commission P. B. M. No. 7, is near Claiborne Station, Louisville and Nashville Railroad, Mississippi. The B. M. is the center of small cross cut in top of marking stone set in the ground just north of north fence of house lot of Pat. Terril. It is 18 meters south of center of main track, 12 meters east of east end of station-house, the distance of 12 meters being measured parallel to the railroad track. The letters U. S. are cut upon the top of the stone.

Primary bench-mark U_1, or Mississippi River Commission P. B. M. No. 6, is on the high point of ground, just east of East Pearl River, in Mississippi, by the fence in front of land of Mrs. Sarah Selph, 200 meters east of the eastern pier of the iron truss bridge over the East Pearl River on the Louisville and Nashville Railroad, and 27.2 meters south of center of main railroad track. The B. M. is the top of a copper bolt leaded in the top of the marking stone, set to within 0.25 foot of its top in the highest point of ground. The stone has the date 1882, and the letters P. B. M. cut upon the top.

Primary bench-mark V_1, or Mississippi River Commission P. B. M. No. 5, is the top of a copper bolt leaded vertically in the concrete pier projecting above main pier of old draw-bridge and a little southwest of center of pier, just north of the iron truss bridge over the Rigolets on the Louisville and Nashville Railroad, Louisiana. The bolt has the letters U. S. P. B. M. cut around it.

Primary bench-mark W_1, or Mississippi River Commission P. B. M. No. 4, is on Fort Macomb, Chef Menteur, La. The B. M. is the center of head of copper bolt leaded horizontally in a brick in the wall at the right-hand side of the entrance to the fort, and has cut around it the letters and

U. S.
date 18 82
P.B.M.

Primary bench-mark X_1, or Mississippi River Commission P. B. M. No. 3, is at the Gentilly gate on the east side of the fair grounds at New Orleans, La. The B. M. is the center of head of a copper bolt leaded horizontally in the east face of the middle brick gate-post, in the fifth course of bricks above the ground, and is marked with the letters U. S.

Primary bench-mark Y_1, or Mississippi River Commission P. B. M. No. 2, is at draw-bridge across Bayou St. John, on the Esplanade road, New Orleans, La. The B. M. is the center of head of copper bolt leaded horizontally into the middle brick in the eleventh course above the ground in the northwest face of the south one of two abutments at the northwest end of draw-bridge, and is marked with the letters U. S. P. B. M.

Primary bench-mark Z_1, or Mississippi River Commission P. B. M. No. 1, is at the "white bridge" crossing the new canal, on the Carrollton road, near New Orleans, La. The B. M. is the top of a copper bolt leaded vertically in the top of the northwest portion of draw-pier of bridge. It measures $0^m.90$ to the extreme northwest edge of pier from center of B. M. and $0^m.5155$ to edge of iron track that the bridge turns on. It is marked with the letters U. S. P. B. M.

U. S. P. B. M. Carrollton is a mark of the Mississippi River Commission, and is the center of a small hole in head of copper bolt leaded horizontally in the north face of the masonry of the old court house at Carrollton, La. The bolt is in the middle, and about 0.03 foot from water-table of pillar and 2.5 feet above the ground. The letters U. S. P. B. M. are cut about the bolt.

U. S. Coast and Geodetic Survey primary bench-mark I is on the seventh district Babcock engine-house at Carrollton, La., and was established in 1875 by Assistant C. H. Boyd The engine-house is at the corner of Madison and St. Charles streets. The B. M. is the center of a small cross cut on the west end of iron door-sill of walled-up door near the northwest corner of the engine-house; it is marked with the letters and date B. M. U. S. C. S. '75, and measures $0^m.124$ to extreme west edge of sill, and $0^m.185$ to north door jamb. The Babcock seventh district engine-house is adjoining the New Orleans and Carrollton Railroad depot.

Old Hampson bench-mark (Williams) is at Carrollton, La., near corner of Madison street and River road. The B. M. is a spike driven in the wall of blacksmith shop of Carrollton and New Orleans Railroad, at northwest corner of shop. The spike is now about 6 inches below the surface of the ground, between the nineteenth and twentieth courses of bricks below the window-sill. It was established by Mr. Williams.

New Hampson bench-mark (Howell) is at Carrollton, La., near corner of Madison street and River road. The B. M. is a spike driven in the wall of blacksmith shop of Carrollton and New Orleans Railroad, at northwest corner of shop. The spike is between the twenty-first and twenty second courses of bricks, below the window-sill. It was established by Mr. Howell.

APPENDIX No. 10.—1887.

THE MAGNETIC WORK OF THE GREELY ARCTIC EXPEDITION.

Abstract of a Report by CHARLES A. SCHOTT, Assistant.

It is well known that the Expedition sent out by the Government to Lady Franklin Bay in command of Lieut. A. W. Greely, U. S. Army, was one of two expeditions to co-operate with and form part of the physical explorations proposed by the International Polar Commission. By invitation of its president, the late General Hazen, Chief Signal Officer, accepted the organization and fitting out of two parties, one under Lieutenant Greely to be sent to the shores of Lady Franklin Bay, Grinnell Land, the other, under Lieut. P. H. Ray, to go to Uglaamie, Point Barrow, Alaska. While the general responsibility, the supervision, the accounts, the selection of men and their transportation to and from the stations, remained in his own hands, General Hazen requested and received the aid of the Coast and Geodetic Survey in the special departments of terrestrial magnetism, of tides and gravitation. The assistance of the Survey by its then Superintendent, Capt. C. P. Patterson, consisted in furnishing such instruments as could be spared from its limited supply, in training the observers for their work and in providing them with the necessary instructions and forms of record for the proper performance of their duty. It so happened that Congress had already (in 1880) authorized a scientific expedition to Lady Franklin Bay, but the funds were appropriated so late in the spring of 1881 that it was found impossible to procure the needed special instruments and to give that thorough training to the corps of observers which could only be obtained by ample time for preparation. Indeed the Commission itself found it expedient to start other expeditions a year later in order to obtain a better organization of the scientific labor, and especially for the construction of suitable magnetic differential instruments.

There is no need of referring here to the general history of the two American expeditions, as we already have the official publication of the one under Lieutenant Ray, and the narrative of the Lady Franklin Bay party, in two handsome volumes, by its leader, Lieutenant Greely. By his permission we were enabled to lay at an early date before the readers of "Science" the general results of his labors during 1881-'84 in the domain of Terrestrial Magnetism. They are extracted from the manuscript, now ready for the printer, but it is not our intention to enter minutely into any details which would be here out of place, nor to forestall the judgment of scientists on the merits of the work—this must be reserved for a time after the official publication, and when the results by the several international expeditions can be compared and collated. A brief statement of facts, so far as they relate to that part of the work which was intrusted to the special direction of the U. S. Coast and Geodetic Survey, is all we propose to give at present.

The astronomical and magnetic work of the Expedition was placed in special charge of Sergeant Edward Israel, who unfortunately was one of those not permitted to return, but whose records abundantly testify to his faithfulness and painstaking industry. Copies of these records in a highly condensed form were safely brought home and were placed in the hands of C. A. Schott, Assistant

U. S. Coast and Geodetic Survey, for discussion, and for preparation for the press. This task was rendered somewhat difficult from want of sufficient explanation on the part of the observer. Fortunately Lieutenant Greely took the precaution when retreating in 1883 from his station to bring with him the magnets and pendulums, thus permitting certain supplementary observations to be made at home. This can not be too highly commended when we consider that every pound of dead weight carried necessitated leaving behind so much food to sustain the life of the party on its perilous retreat. In judging of the merits of the labors of the Expedition it should be borne in mind that all efforts had failed to succor this party, which occupied the northernmost station assigned to any of the Expeditions, and that at the time of its sailing certain magnetic instruments, needed for fully carrying out the programme adopted by the International Commission could not be obtained.

The Magnetic Observatory at Fort Conger was erected a short distance from the main house and was supplied with a new magnetometer made by Fauth & Co., of Washington, and with a dip circle of the Kew pattern, but it had no differential instruments. The observations were made on Göttingen mean time, which differs 4^h 59^m from local time and 5^h 48^m from Washington time. A small transit, loaned by the Survey, served for the determinations of time and longitude. The observations for time and latitude were made by means of the sextant, and comparisons of chronometers were made throughout the stay of the party. From a series of observations of double altitudes of the sun near (lower transit), and of circum-meridian altitudes of the sun (upper transit), the latitude was found to be $81° 44' 00''.4 \pm 5''.4$. The azimuth of the mark for absolute declination was determined on three days from observations of the sun with the theodolite, viz, $44° 44'.3 \pm 0'.8$ east of south. The longitude of the station from Greenwich was determined by means of ships' chronometers on the outward trip, and at the station by observations of moon culminations, occultations, and lunar distances, with the result 4^h 18^m $55^s.3 \pm 1^s.2$ W. of Greenwich.

The accuracy of this result is mainly due to a fine series of seventeen moon-culminations. In arc the longitude is 64° 43′ 50″ W., and the value preliminarily adopted by Lieutenant Greely for his party was 64° 45′ W., on the authority of Lieutenant Archer, R. N., as the result by the British Expedition to this place in 1875–'76.

During the first ten months of the occupation of the post a series of hourly observations of the declination were made on three days in each month. This comprises the period from August 1, 1882, to August 31, 1883, and includes 846 observations with a resulting declination 100° 13′.6 west of north. The results of the diurnal variation of the declination are stated as follows: On the yearly average the needle reached its extreme westerly deflection between 3^h and 4^h p. m. (local time), amount 45′, and its extreme easterly deflection between 0^h and 2^h a. m. (local time), amount 40′, hence the diurnal range 1° 25′. The diurnal variation is illustrated by a diagram.

The series of hourly observations of the declination at Fort Conger began with July 1, 1882, and ended with August 1, 1883; this is the period which was assigned by the International Commission to be that of close and simultaneous co-operative magnetic work obligatory on all parties. The differential measures of this series were converted into absolute values; the tabulation and discussion of this series constituted the greater part of the labor expended on the observations. The method of separating the so-called disturbances from the general record, and their treatment when separated, was left, apparently, by the Vienna Conference to the discretion of each individual party, though several methods were proposed. It is well known that there is no certain criterion of what constitutes a disturbance, and, moreover, processes that may answer in lower latitudes will be found difficult of application for stations in high magnetic latitudes. It would take too much space to explain here this rather technical subject; it may be sufficiently described, however, by stating that the mean deviation of an observed value from its respective hourly and monthly normal value was first made out. Then according to Dr. Lloyd's rule one and a half times this value, or in the case of Fort Conger 1° 06′, was considered the limiting value, and any observation differing by this or a greater amount from the normal value was designated "a disturbance." These hourly normals and (larger) disturbances were tabulated and the results were discussed. The average declination from this series is 100° 34′.5 west, and when compared with the earlier results of the British Expedition gives 9′.9 as the most probable value for the annual diminution of west declination at this place. It is shown that the effect of the presence of these (larger) disturbances was to diminish the declination by 2′.3, and that the diurnal range of the motion of the needle was increased by their influence.

The solar diurnal variation of the declination is presented in tabular and analytical form as well as by a diagram; its most characteristic feature is the occurrence of the westerly extreme soon after local noon with a deflection of 37′.9, reached earlier in summer and later in winter; the opposite extreme is reached an hour and a half after midnight with a deflection of 27′.9, also found variable with the season. Average diurnal range October to March 0° 56′, and April to September 1° 22′.

In the annual variation of this average range, December exhibits the minimum of 28′ and June the maximum of 1° 48′. The lowest reading on record was on November 16, 1882, at 8^h 35^m a. m. (Göttingen time), when the declination was 92° 51′.6 W., and the highest reading on the day following at 10^h 20^m p. m. (Greenwich time), viz, 113° 19′.8 W., showing a change of no less than 20° 28′.2 within thirty-eight hours, and it is noted that a great magnetic storm was raging between November 13 and November 19, 1882, which culminated in intensity on the 17th.

The total number of hourly observations during the year was 8749, and the number of (larger) disturbances separated from them 1169; in other words, there was one (largely) disturbed observation in every eight. The distribution of the disturbances in the diurnal and annual periods, with separation into easterly and westerly disturbances, was then analyzed and the results were tabulated, both with respect to frequency and magnitude; but for want of space we can not follow out all the results presented. We may, however, mention the following: During the year (ending August 1, 1883) the easterly disturbances exceeded in number the westerly ones in the proportion of 661 to 508, or of 1.30 to 1; in the annual variation the disturbing force was most active during November, and least during September. In the diurnal variation the easterly and the westerly disturbances follow different laws as to frequency and amount. The disturbing force deflecting the north end of the needle towards the (magnetic) east is most active two hours after midnight and least active during hours 12 to 17 (or afternoon hours); on the other hand deflections to the west appear most frequent three hours after noon and least about the hours near midnight. Respecting intensity of action easterly disturbances slightly exceed westerly ones.

The term-day and term-hour observations extend over the interval from July 1, 1882, to August 1, 1883. They were made on the 1st and 15th of each month, when the declination magnet was observed every five minutes throughout the twenty-four hours, simultaneously, at all stations taking part in the research. Besides these, observations were made every twenty seconds during one selected hour on each of the term days. The labor bestowed on this part of the work was very great, but it is expected that correspondingly valuable results may be deduced by their intercomparison after all the expeditions shall have published their observations. Not content with these labors, the magnetic observers also recorded the motion of the needle during magnetic storms and in connection with appearances of auroras.

The usual observations of oscillations and deflections were made for the determination of the magnetic intensity; the record and computations are given in detail and the results are tabulated and expressed in British, Gaussian, and C. G. S. units or dynes. For the epoch (1882–'84) the horizontal component of the magnetic force was found to be 1.118 British units or 0.05155 dyne, and it would appear from comparison with the results found by the British Exploring Expedition, 1875–'76, that this intensity did not undergo any perceptible change during the interval. The tabular values show extreme variations of about $\frac{1}{50}$ part of the force.

Hourly observations of the dip were made between September 25, 1882, and June 1, 1883. These were in a measure differential, and resulted in an average dip of 85° 01′. Combining the dip with the horizontal component, the total intensity as observed at Fort Conger becomes 12.870 British units, or 0.5934 dyne, for the epoch 1882.2. By comparison it was found that the dip had been increasing since 1875–'76 at an annual rate of 1′.6.

The dates of auroral displays are next enumerated, and extracts are given of the character of the more imposing auroras. Then follows a table of magnetic results collected during explorations by different parties and extracted from Lieutenant Greely's narrative. The paper concludes with a general collection of magnetic results obtained from the expeditions of Kane, 1853–'55; of

Hayes, 1860–'61; of Hall, 1871–'73; of Nares, 1875–'76, and from Lieutenants Crosby and Sebree, of the *Bear* and *Thetis*, in 1884. From these observations it is concluded that for the last twenty-five years, at least, the magnetic west declination has been annually decreasing about 6′ in the region of the North Water, Smith Strait and Kane Basin, and that in the region to the north of it, and including the Hall Basin, this decrease was fully 10′ per year during the past decade.

In close connection with the scheme of physical researches undertaken by the International Arctic Committee, the desirability of a new determination of the American pole of dip does not appear to have been urged. It must be admitted that the region is difficult of approach, yet the gain to our knowledge of terrestrial magnetism and its secular changes would be equally certain if it could be successfully explored. More than half a century has elapsed since Ross made his memorable and bold dash to this point, but science nowadays will demand more, and the whole region in that vicinity would have to be surveyed in order to permit the tracing out of isoclinics or the application of a suitable analytical process to bring out the facts of the case, as, in consequence of local deflection, there may be many points of vertical dip covering or distributed over a considerable area.

From the time of Hansteen, early in this century, to the present time, efforts have been made to trace out the supposed motion of the intersection of the so-called magnetic axis with the surface. While some physicists hold it to be fixed in position, others believe it to have a slow secular motion of limited extent, and still others would give to it a rapid motion with a path which will carry it clear round the geographical pole.

The time has certainly arrived when in this matter facts shall take the place of speculation. The writer has the assurance of the willingness of three distinguished American arctic explorers to undertake this task; the one thing lacking is the necessary funds to sustain the explorer, say, for two years.

Here surely is a fine field open in which to gain well-merited distinction.

APPENDIX No. 11.—1887.

INSTRUCTIONS AND MEMORANDA FOR DESCRIPTIVE REPORTS TO ACCOMPANY ORIGINAL SHEETS.

U. S. COAST AND GEODETIC SURVEY OFFICE,
Washington, April 11, 1887.

Pursuant to the recommendations made in the report of C. O. Boutelle, B. A. Colonna, Henry Mitchell, Lieut. Commander W. H. Brownson, U. S. N., E. Hergesheimer, and H. G. Ogden, Assistants U. S. Coast and Geodetic Survey—a board to whom the subject-matter was referred—each topographic or hydrographic sheet hereafter deposited in this Office will be accompanied by a descriptive report relating to the locality surveyed, and embracing such topics relative to that locality as are mentioned or suggested in the subjoined schedules of topics, to the compilation of which the members of the board above mentioned and Assistants Davidson, Rodgers, Lawson, Lieut. J. M. Hawley, U. S. N., and Lieut. G. H. Peters, U. S. N., have contributed. Manifestly no single report can cover all the topics indicated. As suggested by the board, "those points which come under the notice and observation of the officer charged with a particular survey, and which are characteristic of the locality surveyed, are to be reported on. On all such distinguishing features, especially all such as are likely to be useful and valuable in future years, *the fullest information should be sought for and given.*"

The report when received at the Office will be sent to the archives for a register number, which will always be the same as the sheet to which it refers, and the sheet must bear a reference to its report by number and date. The report will be inclosed at the Office in a suitable cover for binding, and indorsed with its title, date, and name of observer, so placed as to be readily seen.

CHIEFS OF PARTIES

in making their descriptive reports will carefully consult the following schedules of topics:

SCHEDULE OF TOPOGRAPHICAL AND PHYSICAL SUBJECTS.

1. General character and prominent geological features: Relief of country shown on sheet and its vicinity; whether it is broad and simple or broken and complex; of solid rock base or of molded drift.

2. If upon sea-coast, is the shore-line bold? Has it more than one range of breakers? Is it of sand, shingle, or rock? If of sand, is it coral or silex? Is it beaten hard and rigid, or soft? How is low-water line defined upon sheet?

3. Does a stranded ship survive the storm (this is important as involving the question of least risk to life of a shipwrecked crew; whether to stay by the ship, or at once to leave her)?

4. Are there traveling dunes? Which way do they travel? What are the general directions of fore and rear slopes? Give sections through crest. How high are they?

5. Are there shingle or other natural levees, and on what do they rest? How high is the crest, and is it horizontal? Has it bermes on fore slopes, and buttresses on rear slopes? Give sections.

State average size of shingle. Are the stones on the crest larger than those below? Where do they appear to come from?

6. Are there broken cliffs along the shore? Do they leak or show gullies of spring water transverse to the shore-line? How many such? Are the cliffs drift or sedimentary? How do they face, and what are their slopes where covered with vegetation? Are there any such scarps far back from the sea? If so, are fresh meadows or salt marshes in front of them? How does the water table lie? At what heights above the sea?

7. Does the coast recede, and at about what rate? State authority for rate given. What becomes of eroded material? Are there evidences of emergence or subsidence of shores, and what are they? If there are salt marshes, are they reclaimable? What would be the length of dike needed, and what is ratio of dike to drainable area? Can the water be sunk by sluices, and how much?

8. What is the character of vegetation? Are the trees of forest growth, or for purposes of shade and ornament? If forest, is it full grown or scrub, underbrush or clear? What is the general character, and what are the average heights of the forest trees? What kinds of fruit trees?

9. What are the proportions of arable, wooded, and grass lands? Where there are towns or villages, what first induced their settlement, and what now maintains them? What is the character of the trade or commerce, mills or factories? What are the chief means of communication, by land or water, or both? Character and condition of roads, and their grades? What railroads and canals, and the nature of their traffic? If rivers, are they navigable, and to what distance? Have they water powers, and to what extent are they used? Are all fords designated on sheet, and for how much of each year and at what times of the year or of tide are they passable? Are any of the river mouths closed in the dry season, and for how long? Are the rivers subject to periodic floods or ice-gorges? Give vertical and horizontal range of floods. Note any evidence of former beds of streams that have changed course. Are bridges strong, sound, and frequent? Are fences chiefly wood or stone?

10. Are there health or pleasure resorts on sheet? If so, notice their origin and extent.

11. If the sheet is a resurvey, note increase in wealth and population, new roads and railroads, changes in names of localities, how occasioned and whether apparently permanent.

12. Changes of coast-line and how caused, so far as traceable; present and former relations of high-water to low-water line; state how low-water line has been defined; if resurvey is of shore-line which changes rapidly (as in Florida at the St. John's and on Long Island), give all obtainable facts bearing on the changes and their causes.

13. If the resurvey is for a special purpose, as for a basis for works of construction and improvement, describe the purpose and result so far as known.

POINTS HAVING SPECIAL REFERENCE TO THE PACIFIC COAST.

14. Prominent geological features: Heights and peculiarities of shape and color of prominent rocks and cliffs which may serve as landmarks. Are the elevations of the isolated rocks and ledges shown on sheet given above high or low water mark; if the latter, what portion is visible at high water? Give sketches and views showing facial features of shore, with outlines of mountain ranges where visible.

15. Character of roads and railroads, if any; if the latter, are they temporary or permanent? Saw-mills and canneries; chutes and their character; best landings and at what stage of tide and swell.

16. Height and availability of passes in the Coast Range for transportation of heavy material; can shores be traversed on foot, horseback, or by wagons, and at what times of tide? What is the character of country inland, and beyond limit of sheet?

17. Generally, all other information useful in a new and only partially settled country.

SCHEDULE OF HYDROGRAPHICAL SUBJECTS.

1. Two reports, A and B; A to be very brief and to be submitted with the sheets.

REPORT A.

Report A to contain usual title and statistics; also

2. Specify by number, headings under which reference is made to anything not on sheet, with brief remarks needed for clear understanding. Specify whether statements are derived from personal observations or from local "sea-lore."

3. Least and greatest depths in best channel, with specific mention of shoalest parts; when there are several channels, name each with least and greatest depths; draught of vessels entering; average and greatest draught taken to particular points; necessity for pilot.

4. Permanence of channels; are changes taking place? If so, where? Any lateral movement or change of direction of axis? Special mention of places where channel crosses shifting bars; character of bottom or other causes affecting permanence.

5. Harbor improvements in progress or contemplated; by whom made?

6. Best or usual anchorages. When most used. Approximate number of vessels entering port annually. Is bottom good holding ground?

7. Dangers in or near channel; brief specification.

8. Tidal currents; set of same inshore and offshore at same time; set at ebb and flood at particular points; how long does flood run after high water, and ebb after low water? Greatest velocity? Does current run fair with or set across channel? If latter, name places.

9. Ranges in use by pilots; remarks assisting to identify range marks on sheet.

10. General remarks on character of bottom.

11. Local names not on sheet; note all cases where local names on sheet do not agree with local authorities, whether maps, charts, or other sources.

12. If a resurvey, note all past history of changes so far as obtainable; also describe changes and important differences; state where new depths are greater than old, with detailed descriptions of efforts and means employed to find former shoal water, in order that no doubt may exist about removing shoal soundings from published chart.

REPORT B.

1. Usual statistics.

2. General remarks on locality covered by sheet. Description of main object served by body of water represented on it or of which it is a part, such as character of harbor, commerce or refuge, or both; number of vessels visiting it, chief interest. If a river, its length and distance to head of navigation.

3. Descriptive remarks on shores, brief and from a nautical point of view; principal water trade; how carried; if no steamers, say so. Approximate number of vessels engaged in carrying trade.

4. What is the general aspect of coast in approaching it from sea? What is the first landfall? Landmarks in coasting or approaching entrance from either direction, along shore or from seaward; brief and explicit description of prominent objects or chief guides used by navigators.

5. General reference to life-saving stations on sheet.

6. Entrance points; characteristic features of service to mariners.

7. Ranges; light-houses; aids; whether readily picked up; are present ones sufficient? If new ones wanted, describe locality and object; note any obstruction of lights and cause; general remarks on lights, buoyage, and beacons on sheets.

8. Pilots, where found; whether generally taken; are rates compulsory? Is it usual to anchor and wait for pilot? If so, where? General remarks.

9. Quarantine regulations and boarding stations. Exact definition of limit to which entering vessel may go before receiving pratique; fees.

10. Tow-boats; where found; are they generally used? Rates of charges.

11. Anchorages, and definition of limits; if regulated by harbor rules.

12. Harbor regulations; harbor dues, and to whom payable; mention all officials or boards having to deal with questions of harbor control or police, pilotage, quarantine, wharfage; with

definite localities of their respective offices. If such regulations are in printed form, send copies with report.

13. Supplies and ship-chandler's stores; fresh water, and how delivered; coal, anthracite or bituminous; is supply limited; how put on board; nearest place where repairs to vessels or machinery may be made.

14. Hospitals available for mariners, and specially for them.

15. Docks or marine railways; number, kind, and size; facilities for using; size of vessels using them; probabilities of delay and whether depths over sill, if stated, are for mean high water.

16. Wharves; depth alongside at mean low water.

17. Time-ball, if any; where situated (street and number); any useful details.

18. Any offices specially for mariners (branch hydrographic offices)?

19. Weather service; building, street, and number where cautionary signals are shown.

20. Any special signals; ice codes, etc., used in vicinity.

21. Any station for reporting vessels.

22. Steamers; what lines, and where do they run and touch; how often? Railroads; and between what places; postal and telegraphic facilities; names of all post-offices, on or near sheet, with descriptions of mode of access to each.

23. Settlements, and relative importance; distance from entrance; steamer or railroad communications from each.

24. Tributaries and their settlements, if any.

25. Custom-house, if any, and its locality; landings, if any, and any regulations governing them.

26. Ice; how far does it reach toward entrance; degree of danger to vessels; in which month is port usually frozen to point of danger?

27. Freshets; in what month; if any, likely to be dangerous?

28. Prevailing winds; directions from which heaviest gales come; at what period of the year; direction from which danger to anchorage is to be apprehended.

29. Fog; in what months frequent? What winds bring it? What winds clear it away? Any local indications.

30. Wrecks; where usually occurring; do wrecked vessels usually go to pieces in first storm? There are places where to remain on board is safest, on others the only hope is in reaching the shore, as vessel will go to pieces. Give this outline in full.

31. General remarks on approaches; special points to be considered when making the land in this vicinity; course usually adopted when approaching from along shore or from sea; best use of lead and degree of dependence to be placed on it; approaching in thick weather; character of bottom and any other noticeable peculiarities. What colors are permanent on rocks, cliffs, dunes, and fields?

32. Outlines of all kelp-fields, so extensive on the Pacific coast, should be given, and dangers among them noted. The outline should be determined by angles from a boat specially detailed for the duty. The character of the kelp should be noted, since a vessel can forge through one species easier than another. Are submerged wrecks covered with kelp? At what season is it most conspicuous?

SCHEDULE OF STATISTICAL SUBJECTS.

1. The usual statistical information as upon printed forms now used.

2. General character of weather during season.

3. Estimate of number of miles of shore-line equivalent to a square mile of country, to obtain cost of sheet per square mile.

4. Cost per square mile and scale of survey.

5. Number and character of triangulation points. Were all recoverable? If any are lost, state reason if known.

6. Accuracy, character, and number of plane-table points, with descriptions and methods of determining them.

7. Fullness and precision of topographical details; if incomplete, why, and what is the degree of approximation in such cases? Does uncertainty arise from lack of triangulation points? What is the reason for such deficiency, if known? How is it supplied? What is the degree of precision obtained?

8. A very useful means of future identification of prominent tertiary triangulation and plane-table points, such as cupolas, church spires, and other similar objects, will be the insertion in report of sketches of all such points, with a short description of its exact locality, with its local name, owner, etc.

9. Special attention is called to the nomenclature of all points named, especially Indian names. Where the orthography is doubtful, care should be taken to obtain the best authority for the name and spelling used, that confusion and correction upon our printed charts may be avoided and the charts themselves may become the best future historical authority. Where different and doubtful spellings of apparently equal weight are found, all such should be named in the report. All changes in nomenclature, where known, should be noted.

F. M. THORN,
Superintendent.

Appendix No. 12.—1887.

GENERAL INDEX TO THE PROGRESS SKETCHES AND ILLUSTRATIONS, MAPS, AND CHARTS PUBLISHED IN THE ANNUAL REPORTS OF THE U. S. COAST SURVEY AND U. S. COAST AND GEODETIC SURVEY FROM 1844 TO 1885, INCLUSIVE.

Prepared by EDWARD GOODFELLOW, Assistant.

The arrangement of this Index will be under the following heads:

I.—General Progress Sketches showing the progress of the survey on the Atlantic, Gulf of Mexico, and Pacific coasts of the United States.

II.—Sketches Showing Progress in Sections or portions of the coast and interior.

III.—Maps and Charts.

IV.—Diagrams, Drawings, and Miscellaneous Sketches, illustrating the methods, apparatus, and results of the Survey.

Under I the order will be that of the years of the Reports. The first General Progress Sketch that was published appeared in the Report for 1859. In the Report for 1878, the single sheet which had before sufficed to exhibit the progress of the work was enlarged and published in the form of an eastern and a western sheet. In this form the publication has since been continued.

Under II and III a geographical order will be observed, beginning at Passamaquoddy Bay and ending at the Rio Grande for the Atlantic and Gulf coasts; beginning at San Diego and ending at the Aleutian Islands for the Pacific coast, and, for the Interior States, extending westward from about the eightieth meridian.

Under IV the diagrams, drawings, and miscellaneous sketches, illustrating the methods, apparatus, and results of the Survey will be indexed under subject-heads, which will be arranged in an alphabetical order.

I.—General Progress Sketches—1844 to 1885, inclusive.

Title.	Year of report.	Number of sketch.
Progress of the survey on the Atlantic, Gulf of Mexico, and Pacific coasts to November, 1859	1859	36
November, 1860	1860	37
November, 1861	1861	28
November, 1862	1862	45
November, 1863	1863	29
November, 1864	1864	37
November, 1865	1865	25
November, 1866	1866	25
November, 1867	1867	24
November, 1868	1868	28

I.—General Progress Sketches—1844 to 1885, inclusive—Continued.

Title.	Year of report.	Number of sketch.
Progress of the survey on the Atlantic, Gulf of Mexico, and Pacific coasts to November, 1869	1869	1
November, 1870	1870	1
November, 1871	1871	1
November, 1873	1872	1
November, 1873	1873	1
1875	1874	1
1875	1875	1
1878	1876	1
1878	1877	1
Sketch of general progress 1878 (eastern sheet)	1878	1a
1878 (western sheet)		1b
June 30, 1879 (eastern sheet)	1879	1
1879 (western sheet)		2
1881 (eastern sheet)	1880	1
1881 (western sheet)		2
1881 (eastern sheet)	1881	1
1881 (western sheet)		2
1882 (eastern sheet)	1882	1
1882 (western sheet)		2
1883 (eastern sheet)	1883	1
1883 (western sheet)		2
1884 (eastern sheet)	1884	1
1884 (western sheet)		2
1885 (eastorn sheet)	1885	1
1885 (western sheet)		2

II.—Sketches of Progress in Sections or Portions of the Coast and Interior—1844 to 1885, inclusive.

Section I.—*Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island, including coast and sea-ports, bays and rivers.*

Title.	Year of report.	Number of sketch.
Primary triangulation in Section No. 1, from 1844 to 1854	1854	1
1844 to 1855	1855	1
1844 to 1856	1856	1
1844 to 1857, with lines of offshore soundings	1857	1
1844 to 1858	1858	1
1844 to 1859	1859	1
1844 to 1860	1860	1
1844 to 1861	1861	1
Primary triangulation in Section No. 1, and the connection of the base-lines in Sections I and II, from 1844 to 1862	1862	1
Primary triangulation in Section No. 1, from 1844 to 1863	1863	1
1844 to 1864	1864	1
1844 to 1864	1865	1
Primary triangulation between the Hudson and Saint Croix Rivers, 1875, with subsketch, "Progress of the survey of Lake Champlain," 1874	1874	3
Primary triangulation between the Hudson and Saint Croix Rivers, 1875, with subsketch, "Progress of the survey of Lake Champlain," 1874	1875	3
Primary triangulation between the Hudson and Saint Croix Rivers, 1877	1876	5
1877	1877	3
1879	1878	3
1879	1879	5
June 30, 1881	1880	5
June 30, 1881	1881	5
Triangulation between the Saint Croix and Hudson Rivers and Lake Ontario, with subsketch, "Progress in Section No. 1," June 30, 1882	1882	3

SECTION I.—*Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island, etc.*—Continued.

Title.	Year of report.	Number of sketch.
Triangulation between the Saint Croix and Hudson Rivers and Lake Ontario, with subsketch, "Progress in Section No. 1," June 30, 1883	1883	3
Triangulation between the Saint Croix and Hudson Rivers and Lake Ontario, with subsketch, "Progress in Section No. 1," June 30, 1884	1884	3
Triangulation between the Saint Croix and Hudson Rivers and Lake Ontario, with subsketch, "Progress in Section No. 1," June 30, 1885	1885	3
Progress of the eastern section of the Survey, 1844	1844	A
1845	1845	A
Progress of Section No. 1 (eastern section), 1846	1846	A
1847	1847	A
Progress of survey of Boston Bay in Section No. 1, 1846–1847	1847	A bis
Progress in Section No. 1 in 1844, 1845, 1846, 1847, and 1848	1848	A
Progress of survey of Boston Bay, 1846, 1847, and 1848	1848	A bis
Progress in Section No. 1, 1844 to 1849	1849	A
1844 to 1850	1850	A
Progress of the survey at Richmond's Island Harbor, Maine, 1850	1850	A No. 2
Progress in Section No. 1, with subsketches, "Progress east of Portland, Me.," and "Position of Davis's South Shoal," 1844 to 1851	1851	A
Progress in Section No. 1, with subsketches, "Progress east of Portland, Me.," and "Position of Davis's South Shoal," 1844 to 1852	1852	A
Progress in Section No. 1, with subsketches, "Reconnaissance for triangulation east of Penobscot Bay" and "Position of Davis's Shoal," 1844 to 1853	1853	1
Progress in Section No. 1, with subsketch, "Davis's Shoal," 1844 to 1854	1854	1
1844 to 1855	1855	2
Progress in Section No. 1, with subsketches, "Reconnaissance for triangulation east of Penobscot Bay" and "Position of Davis's Shoal," 1844 to 1856	1856	2
Progress in Section No. 1, with subsketches, "Reconnaissance for triangulation east of Penobscot Bay" and "Position of Davis's Shoal," 1844 to 1857	1857	
Progress in Section No. 1, with subsketches, "Reconnaissance for triangulation east of Penobscot Bay" and "Position of Davis's Shoal," 1844 to 1858	1858	2
Progress in Section No. 1, with subsketches, "Reconnaissance for triangulation east of Penobscot Bay" and "Position of Davis's Shoal," 1844 to 1859	1859	2
Progress in Section No. 1, with subsketches, "Triangulation east of Penobscot Bay," "Positions of Davis's South Shoal and of Phelps's Bank and Asia Rip," 1844 to 1860	1860	2
Progress in Section No. 1 (northern part), 1852 to 1861	1861	2
(southern part), 1844 to 1861	1861	3
(northern part), 1852 to 1862	1862	2
(southern part), with sub-sketches, same as for 1860, 1844 to 1862	1862	3
(northern part), coast of Maine, with subsketch, "Rocks of Portland Harbor," 1852 to 1863	1863	2
1852 to 1864	1864	2
1852 to 1865	1865	2
1852 to 1866	1866	1
(northern part), with subsketches. Reconnaissance for connecting the Survey of the Coast with the Northeastern Boundary Survey, 1867, and rocks off Portland Harbor, surveyed in 1864, 1852 to 1867	1867	1
(northern part), with subsketches. Reconnaissance for connecting the Survey of the Coast with the Northeastern Boundary Survey, 1867, and rocks off Portland Harbor, surveyed in 1864, 1852 to 1868	1868	1
(southern part), with subsketches. Positions of Davis's Shoal, Phelps Bank, and Asia Rip, 1852 to 1868	1868	2
The Nantucket arc of meridian, and adjustment of the triangulation of Long Island Sound	1868	6
Progress in Section No. 1 (northern part), with subsketches same as in Report for 1867, 1852 to 1868	1869	2
(southern part), with subsketches same as in Report for 1868, 1852 to 1868	1869	3
(northern part), with subsketches same as in Report for 1867, 1852 to 1870	1870	2
1852 to 1871	1871	2
1852 to 1873	1872	2
(southern part), with subsketches. Progress of the survey of Lake Champlain, 1873, and Davis's, Cultivator, and George's Shoals, 1872 to 1873; 1844 to 1873	1872	3
(northern part), with subsketches same as in Report for 1867, 1852 to 1873	1873	2
(southern part), same subsketches as in Report for 1872, 1844 to 1873	1873	3
(northern part), with subsketches same as in Report for 1867, 1852 to 1875	1874	2
1852 to 1875	1875	2
1852 to 1877	1876	4

SECTION I.—*Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island, etc.*—Continued.

Title.	Year of report.	Number of sketch.
Progress in Section No. 1 (northern part), with subsketches same as in Report for 1867, 1852 to 1877	1877	2
1852 to 1879	1878	2
1852 to 1879	1879	3
(southern part), with subsketches same as in Report for 1872, 1844 to 1879	1879	4
(northern part), with subsketches as in Report for 1877, 1852 to 1881	1880	3
(southern part), with subsketches as in Report for 1872, 1844 to 1881	1880	4
(northern part), with subsketches as in Report for 1877, 1852 to 1881	1881	3
(southern part), with subsketches as in Report for 1872, 1844 to 1881	1881	4
Triangulation in eastern Massachusetts, 1843 to 1885, including Borden's survey, 1832 to 1838, and triangulation in Rhode Island, 1838 to 1885	1885	25
Triangulation in western Massachusetts, 1860 to 1885, including Borden's survey and connection with Hudson River	1885	26

SECTION II.—*Connecticut, New York, New Jersey, Pennsylvania, and Delaware, including coast, bays and rivers.*

Title.	Year of report.	Number of sketch.
Progress off the shores of New Jersey, New York, and Connecticut in 1844	1844	B
Sketches showing completion of survey of Delaware Bay and River and approaches in 1844	1844	C
Positions occupied for observations of currents in Fisher's Island Sound, New York Bay and Harbor, and East River, 1844 and 1845	1845	C^1, C^2
Progress in Delaware and Chesapeake Bays and vicinity, 1845	1845	B
Progress of part of Section No. 2 in 1846	1846	B
and part of Section No. 3 in 1846	1846	C
Progress of Section No. 2 in 1847	1847	B
Positions of buoys placed in Delaware Bay and River by Lieutenants Commanding J. R. Goldsborough and R. Bache, U. S. N., 1847	1847	B^{bis}
Progress of Section No. 2, 1844 to 1848	1848	B
Positions of buoys placed in Delaware Bay and River, etc., in 1847	1848	B^{bis}
Progress of offshore soundings, Section II, in 1844 and 1848	1848	B^{tris}
Progress of Section No. 2, 1844 to 1849	1849	B
1844 to 1850	1850	B
Progress of deep-sea soundings in Sections Nos. 2, 3, and 4, in 1849 and 1850	1850	C^2
Progress of Section No. 2, 1844 to 1851	1851	5
Triangulation and geographical positions in Section II, from New York City to Point Judith, 1851	1851	6
from New York City to Cape Henlopen, 1851	1851	7
Progress of Section No. 2, 1844 to 1852	1852	B
1844 to 1853	1853	6
with subsketch; progress of the survey of Hudson River, 1844 to 1854	1854	15
1844 to 1855	1855	7
Progress of the survey of New York Bay and Hudson River, from 1851 to 1856	1856	5
1851 to 1857	1857	11
1851 to 1858	1858	7
1851 to 1859	1859	7
in two parts, from 1851 to 1860	1860	6
1851 to 1861	1861	7
1851 to 1862	1862	11
Progress of the survey of the Connecticut River and of the resurvey of the coast of New Jersey, 1862	1862	10
Primary triangulation between Fire Island and Kent Island base-lines, Sections II and III, 1833 to 1851	1866	10
Adjustment of the triangulation of Long Island Sound and the Nantucket arc of the meridian	1868	6
Progress of the surveys of the Connecticut and Hudson Rivers	1868	7
Triangulation and geographical positions in Section II, from New York City to Point Judith, 1869	1869	4
from New York City to Cape Henlopen, 1869	1869	5
Progress of the survey of Lake Champlain, 1870	1870	3
1871	1871	3
Triangulation and geographical positions in Section II, from New York City to Point Judith, 1873	1872	4
from New York City to Cape Henlopen, 1873	1872	5
from New York City to Point Judith, 1873	1873	4

SECTION II.—*Connecticut, New York, New Jersey, Pennsylvania, and Delaware, etc.*—Continued.

Title.	Year of report.	Number of sketch.
Triangulation and geographical positions in Section II, from New York City to Cape Henlopen, 1873	1873	5
from New York City to Point Judith, 1875	1874	4
from New York City to Cape Henlopen, 1875	1874	5
from New York City to Point Judith, 1875	1875	4
from New York City to Cape Henlopen, 1875	1875	5
from New York City to Point Judith, 1877	1876	6
from New York City to Cape Henlopen, 1877	1876	7
from New York City to Point Judith, 1877	1877	4
from New York City to Cape Henlopen, 1877	1877	5
from New York City to Point Judith, 1879	1878	4
from New York City to Cape Henlopen, 1879	1878	5
Primary triangulation between the Hudson and St. Croix Rivers	1879	5
Triangulation and geographical positions between New York City and Point Judith, 1879	1879	6
Primary triangulation between Long Island and the Blue Ridge, Sections II and III, 1879	1879	7
the Hudson and St. Croix Rivers, 1881	1880	5
the Massachusetts base and Lake Ontario, June 30, 1881	1880	5[a]
Triangulation and geographical positions in Section No. II, from New York City to Point Judith, June 30, 1881	1880	6
from New York City to Cape Henlopen, June 30, 1881	1880	6[a]
Primary triangulation between Long Island and the Blue Ridge, June 30, 1881	1880	7
Progress of the triangulation and reconnaissance in Pennsylvania and New Jersey, June 30, 1881	1880	7[a]
Primary triangulation between the Hudson and St. Croix Rivers, June 30, 1881	1881	5
Massachusetts base and Lake Ontario, June 30, 1881	1881	5[a]
Triangulation and geographical positions in Section No. II, from New York City to Point Judith, June 30, 1881	1881	6
from New York City to Cape Henlopen, June 30, 1881	1881	6[a]
Primary triangulation between Long Island and the Blue Ridge, June 30, 1881	1881	7
Progress of the triangulation and reconnaissance in Pennsylvania and New Jersey, June 30, 1881	1881	7[a]
Triangulation between the St. Croix and Hudson Rivers and Lake Ontario, with subsketch of progress in Section I, June 30, 1882	1882	3
Hudson River and Cape Henry and the Ohio River, June 30, 1882	1882	4
St. Croix and Hudson Rivers and Lake Ontario, with subsketch of progress in Section I, June 30, 1883	1883	3
Hudson River and Cape Henry and the Ohio River, June 30, 1883	1883	4
St. Croix and Hudson Rivers and Lake Ontario, with subsketch of progress in Section I, June 30, 1884	1884	3
Hudson River and Cape Henry and the Ohio River, June 30, 1884	1884	4
Hudson River and Lake Ontario, June 30, 1884	1884	20
St. Croix and Hudson Rivers and Lake Ontario, with subsketch of progress in Section I, June 30, 1885	1885	3
Hudson River and Cape Henry and the Ohio River, June 30, 1885	1885	4

SECTION III.—*Maryland, District of Columbia, Virginia, and West Virginia, including bays, sea-ports, and rivers.*

Title.	Year of report.	Number of sketch.
Progress of the survey in Chesapeake Bay and its vicinity in 1844	1844	D
Chesapeake and Delaware Bays and vicinity in 1845	1845	B
Section No. 3 (southern section), and part of Section No. 2, in 1846	1846	C
Progress of Section No. 3 in 1846–1847	1847	C
the years 1844 to 1848	1848	C
the years 1844 to 1849	1849	C
Progress of deep-sea soundings in Sections 2, 3, and 4, in 1849 and 1850	1850	C[2]
Progress of Section No. 3, from 1844 to 1850	1850	C
1843 to 1851	1851	10
1843 to 1852	1852	C
1843 to 1853	1853	9
1843 to 1854	1854	17
1843 to 1855	1855	10
1843 to 1856	1856	7
Progress in Section No. III, from 1843 to 1857	1857	16
1843 to 1858	1858	8
1843 to 1859	1859	9
1843 to 1860	1860	8
1843 to 1861	1861	10
1843 to 1862	1862	13
1843 to 1863	1863	10
Primary triangulation between Fire Island and Kent Island base-lines, Sections II and III, from 1833 to 1851	1866	10
Progress in Section No. III, from 1843 to 1868	1868	8
1843 to 1868	1869	6
1843 to 1870	1870	4
Primary triangulation between Long Island and the Blue Ridge, Sections II and III, 1870	1870	5
Progress in Section No. III, from 1843 to 1871	1871	4
Primary triangulation between Long Island and the Blue Ridge, Sections II and III, 1871	1871	5
Progress in Section No. III, from 1843 to 1873	1872	6
1843 to 1873	1873	6
1843 to 1875	1874	6
1843 to 1875	1875	6
1843 to 1877	1876	8
Primary triangulation between the Maryland and Georgia base-lines (northern part), 1877	1876	10
Progress in Section No. III, from 1843 to 1877	1877	6
Primary triangulation between the Maryland and Georgia base-lines (northern part), 1877	1877	8
Progress in Section No. III, from 1843 to 1879	1878	6
Primary triangulation between the Maryland and Georgia base-lines (northern part), 1879	1878	8
Progress in Section No. III, from 1843 to 1879	1879	8
Primary triangulation between the Maryland and Georgia base-lines (northern part), 1879	1879	10
Progress in Section No. III, from 1843 to 1881	1880	8
Primary triangulation between the Maryland and Georgia base-lines (northern part), June 30, 1881	1880	10
Progress in Section No. III, from 1843 to 1881	1881	8
Primary triangulation between the Maryland and Georgia base-lines (northern part), June 30, 1881	1881	10
Triangulation between the Hudson River and Cape Henry and the Ohio River, June 30, 1882	1882	4
June 30, 1883	1883	4
June 30, 1884	1884	4
June 30, 1885	1885	4

SECTION IV.—*North Carolina, including coasts, sounds, sea-ports, and rivers.*

Title.	Year of report.	Number of sketch.
Progress of Section No. 4 in 1845 to 1846	1846	4
1846 to 1847	1847	D
1846, 1847, and 1848	1848	D
1846, 1847, 1848, and 1849	1849	D
Progress of deep-sea soundings in Sections 2, 3, and 4, in 1849	1849	C^2
1849 and 1850	1850	C^2
Section IV, 1845 to 1850	1850	D
the survey of Beaufort Harbor in 1850	1850	D^5
Section IV, 1845 to 1851	1851	13
deep-sea soundings in Sections II, III, and IV, 1849 to 1851	1851	16
the survey of Cape Fear River and Frying-Pan Shoals, North Carolina, 1851	1851	18
Section IV, 1845 to 1852	1852	D
the survey of Cape Fear and vicinity, 1852	1852	D^2
Section IV, 1845 to 1853	1853	17
the survey of Cape Fear and vicinity	1853	18
Section IV, 1845 to 1854	1854	20
the survey of Cape Fear and vicinity, 1854	1854	21
Section No. IV, 1845 to 1855	1855	14
1845 to 1856	1856	13
1845 to 1857	1857	25
1845 to 1858	1858	10
1845 to 1859	1859	15
1845 to 1860	1860	10
1845 to 1861	1861	11
1845 to 1862	1862	21
1850 to 1866	1866	13
1845 to 1867	1867	8
1845 to 1868	1868	14
1845 to 1868	1869	7
1845 to 1870	1870	6
1845 to 1871	1871	6
1845 to 1873	1872	7
1845 to 1873	1873	7
1845 to 1875	1875	7
Primary triangulation between the Maryland and Georgia base lines (southern part), 1875	1874	9
Progress in Section No. IV, 1845 to 1875	1875	7
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1875	1875	9
Progress in Section No. IV, 1845 to 1877	1876	9
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1877	1876	11
Progress in Section No. IV, 1845 to 1877	1877	7
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1877	1877	9
Progress in Section No. IV, 1845 to 1879	1878	7
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1879	1878	9
Progress in Section No. IV, 1845 to 1879	1879	9
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1879	1879	11
Progress in Section No. IV, 1845 to 1881	1880	9
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1881	1880	11
Progress in Section No. IV, 1845 to 1881	1881	9
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1881	1881	11
Progress in Section No. IV, 1845 to 1882	1882	5
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1882	1882	6
Progress in Section No. IV, 1845 to 1883	1883	5
Triangulation between the Maryland and Georgia base-lines (southern part) with extension westward and triangulation in Tennessee	1883	6
Progress in Section No. IV, June 30, 1884	1884	5
Triangulation between the Maryland and Georgia base-lines (southern part) with extension westward and triangulation in Tennessee	1884	6
Triangulation between the Maryland and Georgia base-lines (southern part) June 30, 1885, with extension westward and triangulation in Tennessee	1885	5

SECTION V.—*South Carolina and Georgia, including coast, sea-water channels, sounds, harbors, and rivers.*

Title.	Year of report.	Number of sketch.
Progress of section No. 5, 1847 to 1848	1848	E
with subsketch, showing work in Charleston Harbor, 1849, 1847 to 1849	1849	E
Progress of the survey at North Edisto River and entrance, South Carolina, 1850	1850	E^2
Savannah, Ga	1850	E^3
Progress of Section No. 5, 1847 to 1850	1850	E
with subsketch, Charleston Harbor, 1849	1850	E^{bis}
1847 to 1851	1851	E
Progress of the survey in the vicinity of Savannah, Ga., 1850 to 1851	1851	E^2
at North and South Edisto Rivers, and at St. Helena Sound, 1851	1851	E^3
of Section V, 1847 to 1852	1852	E
in the vicinity of Savannah, Ga., 1850 to 1852	1852	E^2
of North and South Edisto Rivers and St. Helena Sound, South Carolina, 1852	1852	E^3
of Section V, 1847 to 1853	1853	20
in the vicinity of Savannah, 1850 to 1853	1853	23
of Section V, 1847 to 1854	1854	27
in the vicinity of Savannah, Ga., 1850 to 1854	1854	28
of Section V, 1847 to 1855	1855	18
1847 to 1856	1856	17
1847 to 1857	1857	31
1847 to 1858	1858	14
1847 to 1859	1859	16
1847 to 1860	1860	13
Progress in Section No. V, 1847 to 1861	1861	13
with map of coast of South Carolina from Charleston to Hilton Head, and seven plans and views of forts on the South Carolina coast, 1847 to 1862, and 1862	1862	25
1847 to 1866	1866	15
Triangulation in Section V to accompany table of geographical positions, 1868	1868	15
Triangulation from Ossabaw Island to Cumberland Island (subsketch), 1869	1869	8
1870	1870	7
Triangulation in Section No. V, 1847 to 1873	1872	8
Primary triangulation in the vicinity of Atlanta, Ga., 1872 and 1873	1872	11
1872 and 1873	1873	11
Triangulation in Section No. V, 1847 to 1873	1873	8
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1875	1874	9
Progress in Section No. V, 1847 to 1875	1874	10
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1875	1875	9
Progress in Section No. V, 1847 to 1875	1875	10
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1877	1876	11
Progress in Section No. V, 1847 to 1877	1876	12
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1877	1877	9
Progress in Section No. V, 1847 to 1877	1877	10
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1879	1878	9
Progress in Section No. V, 1847 to 1879	1878	10
Primary triangulation between the Maryland and Georgia base-lines (southern part), 1879	1879	11
Progress in Section No. V, 1847 to 1879	1879	12
Primary triangulation between the Maryland and Georgia base-lines (southern part)	1880	11
Progress in Section No. V, 1847 to 1881	1880	12
Primary triangulation between the Maryland and Georgia base-lines (southern part)	1881	11
Progress in Section No. V, June 30, 1881	1881	12
Primary triangulation between the Maryland and Georgia base-lines (southern part)	1882	6
Progress of the survey in Section No. V, 1847 to 1882	1882	7
Triangulation between the Maryland and Georgia base-lines (southern part), with extension westward and triangulation in Tennessee	1883	6
Progress in Section No. V, 1847 to 1883	1883	7
Triangulation between the Maryland and Georgia base-lines (southern part), with extension westward and triangulation in Tennessee	1884	6
Triangulation between the Maryland and Georgia base-lines (southern part), with extension westward and triangulation in Tennessee, June 30, 1885	1885	5

SECTION VI.—*Peninsula of Florida, from St. Mary's River, on the east coast, to and including the Anclote Keys, on the west coast, with the coast approaches, reefs, keys, sea-ports, and rivers.*

Title.	Year of report.	Number of sketch.
Progress of Section No. VI. Reconnaissance of Florida Keys, Biscayne Bay, and Card's Sound, 1849	1849	F
Proposed base at Cape Sable, Florida, 1850	1850	F^3
Cape Florida, 1850	1850	F^4
Progress in Section No. VI, with subsketch, reconnaissance of the Dry Tortugas, 1849 and 1850	1850	F
with a general reconnaissance of the western coast of Florida, 1848 to 1851	1851	F
Progress of the survey of Key Biscayne, Key West, Dry Tortugas, Bahia Honda, etc., 1849 to 1851	1851	F^2
Progress in Section VI, with a general reconnaissance of the western coast of Florida, 1848 to 1852	1852	F
Progress of the survey of Key Biscayne, Key West, Dry Tortugas, Bahia Honda, etc., 1849 to 1852	1852	F^2
Progress in Section VI, with a general reconnaissance of the western coast of Florida, and subsketch of progress, 1848 to 1853, north of the St. John's River, 1853	1853	24
Progress of the survey of Key Biscayne, Key West, Dry Tortugas, Bahia Honda, etc., 1849 to 1853	1853	26
in Section VI, with a general reconnaissance of the coast of Florida, and subsketch of Tortugas Island, showing position of shoal, etc., 1848 to 1854 and 1854	1854	31
of the Florida Reefs, 1849 to 1854	1854	32
in Section VI, with a general reconnaissance of the coast of Florida, 1848 to 1855, and subsketches, Tortugas Island, 1854, and St. John's River, 1855	1855	26
of the Florida Reefs, 1849 to 1855	1855	27
Progress in Section VI, with a general reconnaissance of the coast of Florida, 1848 to 1856, and subsketch of St. John's River, 1856	1856	25
Progress of the Survey in Section No. VI, from Cape Florida to Tortugas Islands, 1845 to 1856	1856	26
with a general reconnaissance of the coast of Florida, 1848 to 1857, and subsketch Tortugas Island, 1854	1857	39
from Cape Florida to Tortugas Islands, 1845 to 1857	1857	40
with a general reconnaissance of the coast of Florida, 1848 to 1858, and subsketches St. John's River, Tortugas Island, and Charlotte Harbor, 1854 and 1858	1858	16
from Cape Florida to Tortugas Islands, 1845 to 1858	1858	17
with a general reconnaissance of the coast of Florida, 1848 to 1859, and subsketches, St. John's River, vicinity of Saint Augustine and Charlotte Harbor, 1859	1859	20
from Cape Florida to Tortugas Islands, 1845 to 1859	1859	21
with a general reconnaissance of the coast of Florida, 1848 to 1860, and subsketches, St. John's River and Charlotte Harbor, 1860	1860	15
from Cape Florida to Tortugas Islands, 1845 to 1860	1860	16
with a general reconnaissance of the coast of Florida, 1848 to 1861, and subsketches of vicinity St. John's River, Indian River, and Charlotte Harbor, 1861	1861	14
from Cape Florida to Tortugas Islands, 1845 to 1861	1861	15
1845 to 1862	1862	32
1845 to 1863	1863	13
Sketch of triangulation in Sections VI, VII, and VIII, to accompany table of geographical positions, 1868	1868	17
Progress of the survey in Section No. V and in Section No. VI (upper part), 1870	1870	7
Progress sketch Section VI, east coast of Florida (upper sheet), 1871	1871	7
west coast of Florida, 1873	1872	10
east coast of Florida, 1873	1872	9
east coast of Florida, 1873	1873	9
west coast of Florida, 1873	1873	10
east coast of Florida, Amelia Island to Halifax River, 1875	1874	11^a
east coast of Florida, Halifax River to Cape Canaveral, 1875	1874	11^b
west coast of Florida, Tampa Bay and vicinity, 1875	1874	12
east coast of Florida, Amelia Island to Halifax River, 1875	1875	11^a
east coast of Florida, Halifax River to Cape Canaveral, 1875	1875	11^b
west coast of Florida, Tampa Bay and vicinity, 1875	1875	12
east coast of Florida, Amelia Island to Halifax River, 1877	1876	13^a
east coast of Florida, Halifax River to Cape Canaveral, 1877	1876	13^b
west coast of Florida, Tampa Bay and vicinity, 1877	1876	14
east coast of Florida, Amelia Island to Halifax River, 1877	1877	11
east coast of Florida, Halifax River to Cape Canaveral, 1877	1877	12
west coast of Florida, Tampa Bay and vicinity, 1877	1877	13
east coast of Florida, Amelia Island to Halifax River, 1879	1878	11
east coast of Florida, Halifax River to Cape Canaveral, 1879	1878	12
west coast of Florida, Tampa Bay and vicinity, 1879	1878	13
east coast of Florida, Amelia Island to Halifax River, 1879	1879	13

SECTON VI.—*Peninsula of Florida, from St. Mary's River, on the east coast, etc.*—Continued.

Title.	Year of report.	Number of sketch.
Progress sketch Section VI, east coast of Florida, Halifax River to Cape Canaveral, 1878	1879	14
east coast of Florida, Indian River to Cape Florida, 1879	1879	15
west coast of Florida, Tampa Bay and vicinity, or Charlotte Harbor to Anclote Keys, 1879	1879	16
east coast of Florida, Amelia Island to Halifax River, June 30, 1881	1880	13
east coast of Florida, Halifax River to Cape Canaveral, June 30, 1881	1880	14
east coast of Florida, Indian River to Cape Florida, June 30, 1881	1880	15
west coast of Florida, Tampa Bay and vicinity, or Charlotte Harbor to Anclote Keys, June 30, 1881	1880	16
east coast of Florida, Amelia Island to Halifax River, June 30, 1881	1881	13
east coast of Florida, Halifax River to Cape Canaveral, June 30, 1881	1881	14
east coast of Florida, Indian River to Cape Florida, June 30, 1881	1881	15
west coast of Florida, Tampa Bay and vicinity, or Charlotte Harbor to Anclote Keys, June 30, 1881	1881	16
east coast of Florida, Amelia Island to Halifax River, June 30, 1882	1882	8
east coast of Florida, Halifax River to Cape Canaveral, June 30, 1882	1882	9
east coast of Florida, Indian River to Cape Florida, June 30, 1882	1882	10
west coast of Florida, Tampa Bay and vicinity, or Charlotte Harbor to Anclote Keys, June 30, 1882	1882	11
east coast of Florida, Amelia Island to Halifax River, June 30, 1883	1883	8
east coast of Florida, Halifax River to Cape Canaveral, June 30, 1883	1883	9
east coast of Florida, Indian River to Cape Florida, June 30, 1883	1883	10
west coast of Florida, Tampa Bay and vicinity, or Charlotte Harbor to Anclote Keys, June 30, 1883	1883	11
east coast of Florida, Indian River to Cape Florida, June 30, 1884	1884	7a
west coast of Florida, Cape Sable to Charlotte Harbor, June 30, 1884	1884	7b
west coast of Florida, Charlotte Harbor to Anclote Keys, June 30, 1884	1884	8
east coast of Florida, Amelia Island to Halifax River, June 30, 1885	1885	6
west coast of Florida, Cape Sable to Charlotte Harbor, June 30, 1885	1885	7

SECTION VII.—*Peninsula of Florida, west coast, from Anclote Keys to Perdido Bay, including coast approaches, ports, and rivers.*

Title.	Year of report.	Number of sketch.
Progress in Section No. VII in the year 1849. Reconnaissance of Pensacola and Perdido Bays, and plan of triangulation	1849	G
Do	1850	G
Do	1851	G
Progress of the survey in Section VII, 1849 to 1852	1852	G
1849 to 1853	1853	29
1849 to 1854	1854	35
Progress of the survey in part of Section VII, 1849 to 1855	1855	32
Progress of the survey in Section No. VII, 1849 to 1856	1856	30
with subsketch Cedar Keys, 1857, 1849 to 1857	1857	44
1858, 1849 to 1858	1858	19
1859, 1849 to 1859	1859	23
1860, 1849 to 1860	1860	25
1861, 1849 to 1861	1861	16
Sketch of triangulation in Sections VI, VII, and VIII to accompany table of geographical positions, 1, 1868	1868	17
Progress of the survey in Section No. VII from 1849 to 1868, with subsketch Cedar Keys, 1861, 1869	1869	10
1849 to 1870	1870	8
1849 to 1871	1871	8
1849 to 1873	1872	10
1849 to 1873	1873	10
Progress of the survey in Section No. VII, west coast of Florida, from St. Joseph's Bay to Mobile Bay, 1875:		
With subsketch Cedar Keys, 1861 and 1874	1874	13
1861 and 1874	1875	13
1877	1876	15
1877	1877	14
1879	1878	14
1879	1879	17
June 30, 1881	1880	17
June 30, 1881	1881	17
June 30, 1882	1882	12
June 30, 1883	1883	12

SECTION VIII.—*Alabama, Mississippi, Louisiana, and Arkansas, including Gulf coasts, ports, and rivers.*

Title.	Year of report.	Number of sketch.
Progress of the survey in Section VIII, Gulf of Mexico, 1846	1846	E
1846 to 1847	1847	E
1846 to 1848	1848	F
1846 to 1849	1849	H
1846 to 1850	1850	H
1846 to 1851	1851	H
1846 to 1852	1852	H
1846 to 1853	1853	31
with subsketches of profiles of bottom of the Gulf, 1854, and positions of temperature observations, 1854, 1846 to 1854	1854	37
1846 to 1855	1855	36
Progress of the survey in Section No. VIII, 1846 to 1856	1856	33
1846 to 1857	1857	47
1846 to 1858	1858	22
1846 to 1859	1859	26
1846 to 1860	1860	28
1846 to 1861	1861	18
with subsketches, plan of Fort Jackson, showing effect of bombardment, and reconnaissance of the Mississippi River below Forts Jackson and St. Philip, 1862	1862	35
Sketch of triangulation in Sections VI, VII, VIII, 1868	1868	17
Progress of the survey in section No. VIII, 1846 to 1869	1869	11
1846 to 1870	1870	9
1846 to 1871	1871	9
1846 to 1873	1872	12
1846 to 1873	1873	12
1846 to 1875	1874	14
1846 to 1875	1875	14
1846 to 1877	1876	16
1846 to 1877	1877	15
1846 to 1879	1878	15
1846 to 1879	1879	18
Progress of the triangulation of the Mississippi River, Delta to Memphis, 1879	1879	19
to June 30, 1881	1880	19
survey in section No. VIII, to June 30, 1881	1880	18
triangulation of the Mississippi River, Delta to Memphis, to June 30, 1881	1881	19
survey in section No. VIII, 1846 to 1881	1881	18
triangulation of the Mississippi River, Delta to Memphis, to June 30, 1882	1882	13
to June 30, 1883	1883	13
Progress sketch Sections VIII and IX, Mississippi River to Galveston, with subsketch, vicinity of the Rio Grande, June 30, 1884	1884	9
Progress sketch Sections VIII and IX, Mississippi River to Galveston, with subsketch, vicinity of the Rio Grande, June 30, 1885	1885	8

SECTION IX.—*Texas and Indian Territory, including Gulf coast, bays, and rivers.*

Title.	Year of report	Number of sketch.
Progress in section No. 9, 1848	1848	G
1848 and 1849	1849	I
1848 to 1850	1850	I
1848 to 1851	1851	I
1848 to 1852	1852	I
1848 to 1853	1853	I
with subsketch, progress of the survey of Rio Grande and vicinity, 1848 to 1854	1854	39
Progress of the survey in Section No. IX, with subsketch of progress on the Rio Grande River and vicinity, 1853 and 1854, 1848 to 1855	1855	30
Progress of the survey in Section No. IX, with subsketch of progress on the Rio Grande River and vicinity, 1853 and 1856, 1848 to 1856	1856	41
Progress of the survey in Section No. IX, with subsketch of progress on the Rio Grande River and vicinity, 1853 and 1856, 1848 to 1857	1857	53
Progress of the survey in Section No. IX, with subsketch of progress on the Rio Grande River and vicinity, 1853 and 1856, 1848 to 1858	1858	24

SECTION IX.—*Texas and Indian Territory, including Gulf coast, bays, and rivers*—Continued.

Title.	Year of report.	Number of sketch.
Progress of the survey in Section No. IX, 1848 to 1859	1859	28
1848 to 1860	1860	32
1848 to 1861	1861	19
1848 to 1866	1866	19
1848 to 1871	1871	9
1848 to 1871	1872	13
1848 to 1871	1873	13
1848 to 1875	1874	16
1848 to 1875	1875	16
1848 to 1877	1876	17
1848 to 1877	1877	16
1848 to 1879	1878	16
1848 to 1879	1879	20
1848 to 1881	1880	20
1848 to 1881	1881	20
1848 to 1882	1882	14
1848 to 1883	1883	14
Progress sketch, Sections VIII and IX, Mississippi River to Galveston, with subsketch vicinity of the Rio Grande, June 30, 1884	1884	9
Progress sketch, Sections VIII and IX, Mississippi River to Galveston, with subsketch vicinity of the Rio Grande, June 30, 1885	1885	8

SECTION X.—*California, including the coast, bays, harbors, and rivers.*

Title.	Year of report.	Number of sketch.
Progress of the survey of the Bay of San Francisco, California, 1850	1850	J
Reconnaissance of the western coast of the United States, from Monterey to the Columbia River, 1850	1850	J[2]
Progress of the survey of the western coast, 1849 to 1851	1851	J
in the Bay of San Francisco, 1851	1851	J[9]
in the Bay of San Diego, 1851	1851	J[10]
of the western coast of the United States, 1849 to 1852	1852	J
of San Francisco Bay and vicinity, 1850 to 1852	1852	J[3]
of the western coast, 1849 to 1853	1853	42
of San Francisco Bay and vicinity, 1850 to 1853	1853	47
of the Bay of San Diego, 1853	1853	47
of the western coast of the United States, with subsketches of progress in the Bay of San Diego, San Pedro and vicinity, Columbia River, and Strait of Rosario and vicinity, 1850 to 1854	1854	41
Pulgas base, vicinity of San Francisco Bay, California, 1854	1854	45
Progress of the survey of the western coast, 1849 to 1855	1855	42
with subsketches of progress, Bay of San Diego, San Pedro and vicinity, and Columbia River, 1850 to 1855	1855	43
Progress of the survey in Section No. X, from San Diego to Point Sal, 1850 to 1856	1856	44
Point Sal to Tomales Bay, 1850 to 1856	1856	45
San Diego to Point Sal, 1850 to 1857	1857	56
Point Sal to Tomales Bay, 1850 to 1857	1857	57
San Diego to Point Sal, 1850 to 1858	1858	29
Point Sal to Tomales Bay, 1850 to 1858	1858	30
Progress of the survey from San Diego to Point Conception, 1850 to 1859	1859	30
Point Sal to Tomales Bay, 1850 to 1859	1859	31
San Diego to Point Conception, 1850 to 1860	1860	33
Point Sal to Bodega Head,* with subsketches Bodega Head to Haven's Anchorage and Coquille Rock, Oregon, 1850 to 1860	1860	34
San Diego to San Luis Obispo Bay, 1850 to 1861	1861	20
Point Sal to Haven's Anchorage, 1850 to 1861	1861	21
San Diego to San Luis Obispo Bay, 1850 to 1862	1862	37
Point Sal to Haven's Anchorage, 1850 to 1862	1862	38
San Diego to Point Conception, and thence to Bodega Head, with subsketch Koos Bay, Oregon, 1850 to 1863	1863	24
Point Sur to Bodega Head, with subsketch Coquille River, Oregon, 1850 to 1865	1865	21
Point Sur to Bodega Head, and thence to Haven's Anchorage, 1850 to 1866	1866	21

* In some of these progress sketches the actual limits of coast-line shown do not correspond to the titles; in such cases the actual limits are given in this list.

SECTION X.—*California, including the coast, bays, harbors, and rivers*—Continued.

Title.	Year of report.	Number of sketch.
Progress of the survey in Section No. X, 1868	1868	23
from San Diego to San Luis Obispo Bay, 1850 to 1869	1869	13
San Diego to Point Sal, with subsketch of station, San Buenaventura, 1850 to 1870	1870	10
Bodega Head to the Oregon line, 1870	1870	11
San Diego to San Luis Obispo Bay, 1850 to 1871	1871	10
Bodega Head to the Oregon line, 1871	1871	11
San Diego to San Luis Obispo Bay, 1850 to 1873	1872	14
Point Sal to Bodega Head, 1850 to 1873	1872	15
Bodega Head to the Oregon line, 1873	1872	16
San Diego to San Luis Obispo Bay, 1850 to 1873	1873	14
Point Sal to Bodega Head, 1850 to 1873	1873	15
Bodega Head to the Oregon line, 1873	1873	16
San Diego to San Luis Obispo Bay, 1850 to 1875	1874	17
Point Sal to Bodega Head, and thence to Haven's Anchorage, 1850 to 1875	1874	18
Bodega Head to the Oregon line, 1875	1874	19
San Diego to San Luis Obispo Bay, 1850 to 1875	1875	17
Point Sal to Bodega Head, and thence to Haven's Anchorage, 1850 to 1875	1875	18
Bodega Head to the Oregon line, 1875	1875	19
San Diego to San Luis Obispo Bay, 1850 to 1877	1876	18
Point Sal to Bodega Head, and thence to Haven's Anchorage, 1850 to 1877	1876	19
Bodega Head to the Oregon line, 1877	1876	20
San Diego to San Luis Obispo Bay, 1850 to 1877	1877	17
Point Sal to Bodega Head, and thence to Haven's Anchorage, 1850 to 1877	1877	18
Bodega Head to the Oregon line, 1877	1877	19
San Diego to San Luis Obispo Bay, 1850 to 1879	1878	17
Point Sal to Bodega Head, with diagram of primary triangulation to the line Lola-Round Top, 1850 to 1879	1878	18
Bodega Head to the Oregon line, 1879	1878	19
San Diego to San Luis Obispo Bay, 1850 to 1879	1879	22
Point Sal to Bodega Head, with diagram of primary triangulation to line Lola-Round Top, 1850 to 1879	1879	23
Tomales Bay to the Oregon line, 1879	1879	24
Progress of the transcontinental triangulation and reconnaissance eastward from the Pacific coast, 1879	1879	30
Progress of the survey in Section No. X, from San Diego to San Luis Obispo Bay, 1850 to 1881	1880	22
Point Sal to Bodega Head, with diagram of primary triangulation to line Lola-Round Top, 1850 to 1881	1880	23
Bodega Head to the Oregon line, June 30, 1881	1880	24
Progress of the transcontinental triangulation and reconnaissance eastward from the Pacific coast, June 30, 1881	1880	30
Progress of the survey in Section No. X, from San Diego to San Luis Obispo Bay, 1850 to 1881	1881	22
Point Sal to Bodega Head, with diagram of primary triangulation to line Lola-Round Top, 1850 to 1881	1881	23
Bodega Head to the Oregon line, June 30, 1881	1881	24
Progress of the transcontinental triangulation and reconnaissance eastward from the Pacific coast, June 30, 1881	1881	30
June 30, 1882	1882	24
Progress of the survey in Section No. X, from San Diego to San Luis Obispo Bay, 1850 to 1882	1882	15
Point Sal to Bodega Head, with diagram of primary triangulation to line Lola-Round Top, 1850 to 1882	1882	16
Tomales Bay to the Oregon line, June 30, 1882	1882	17
San Diego to San Luis Obispo Bay, 1850 to 1883	1883	15
Point Sal to Bodega Head, with diagram of primary triangulation to line Lola-Round Top, 1850 to 1883	1883	16
Tomales Bay to the Oregon line, June 30, 1883	1883	17
Progress of the transcontinental triangulation and reconnaissance eastward from the Pacific coast, June 30, 1883	1883	23
Progress of the survey in Section No. X, from San Diego to San Luis Obispo Bay, 1850 to 1884	1884	10
Point Sal to Bodega Head, with diagram of primary triangulation to line Lola-Round Top, June 30, 1884	1884	11
Tomales Bay to the Oregon line, June 30, 1884	1884	12
Progress of the transcontinental triangulation and reconnaissance eastward from the Pacific coast, June 30, 1884	1884	18
June 30, 1885	1885	16
Progress of the survey in Section No. X, from San Diego to San Luis Obispo Bay, June 30, 1885	1885	9
Point Sal to Bodega Head, with diagram of primary triangulation to the line Lola-Round Top, June 30, 1885	1885	10
Tomales Bay to the Oregon line, June 30, 1885	1885	11

SECTION XI.—*Oregon and Washington Territory, including coast, interior bays, ports, and rivers.*

Title.	Year of report.	Number of sketch.
Reconnaissance of the western coast of the United States from Monterey to the Columbia River, 1850	1850	J²
Progress of the survey of the western coast, 1849 to 1851	1851	J
western coast, 1849 to 1852	1852	J
Columbia River, 1852	1852	K
Columbia River, 1852	1853	49
western coast, 1849 to 1853	1853	42
on the western coast of the United States, with subsketches of progress on the Columbia River, and on the Strait of Rosario and vicinity, 1850 to 1854	1854	41
on the western coast, with subsketch of progress on the Columbia River, 1850 to 1855	1855	43
of Washington Sound and vicinity, 1855	1855	44
in Section No. XI, from Tillamook Bay to the Boundary, with subsketches, entrance to Umpquah River, and Port Orford, Oregon, 1850 to 1856	1856	51
of the western coast, 1849 to 1856	1856	60
in Section No. XI, from Tillamook Bay to the Boundary, 1850 to 1857	1857	63
1851 to 1858	1858	33
1851 to 1859	1859	34
1851 to 1860	1860	36
1851 to 1861	1861	24
in Section No. XI, from Tillamook Bay to the Boundary, with subsketch Koos Bay, Oregon, 1851 to 1862	1862	42
in Section No. XI, from Tillamook Bay to the Boundary, with subsketch Koos Bay, Oregon, 1863, 1851 to 1868	1868	24
in Section No. XI, from the California line to Tillamook Bay, 1870	1870	11
from Tillamook Bay to the Boundary, with subsketch Koos Bay, 1851 to 1870	1870	12
1851 to 1871	1871	12
from the California line to Tillamook Bay, 1871	1871	11
1873	1872	16
from Tillamook Bay to the Boundary, with subsketch Koos Bay, 1851 to 1873	1872	16bis
in Section No. XI, from the California line to Tillamook Bay, 1873	1873	16
from Tillamook Bay to the Boundary, with subsketch Koos Bay, 1851 to 1873	1873	16bis
1851 to 1875	1874	20
from the California line to Tillamook Bay, 1875	1874	19
1875	1875	19
from Tillamook Bay to the Boundary, with subsketch Koos Bay, 1851 to 1875	1875	20
1851 to 1877	1876	21
from the California line to Tillamook Bay, 1877	1876	20
1877	1877	19
from Tillamook Bay to the Boundary, with subsketch Koos Bay, 1851 to 1877	1877	20
from the California line to Tillamook Bay, 1879	1878	19
from Tillamook Bay to the Boundary, 1851 to 1879	1878	20
1851 to 1879	1879	25
from the California line to Tillamook Bay, 1879	1879	24
June 30, 1881	1880	24
from Tillamook Bay to the Boundary, 1851 to 1881	1880	25
1851 to 1881	1881	25
from the California line to Tillamook Bay, June 30, 1881	1881	24
June 30, 1882	1882	17
from Tillamook Bay to the Boundary, 1851 to June 30, 1882	1882	18
1851 to 1883	1883	18
from the California line to Tillamook Bay, June 30, 1883	1883	17
June 30, 1884	1884	12
from Tillamook Bay to the Boundary, June 30, 1884	1884	13
from the California line to Cape Falcon or False Tillamook, June 30, 1885	1885	11
from Tillamook Bay to the Boundary, June 30, 1885	1885	12

SECTION XII.—*Alaska, including the coast and the Aleutian Islands.*

Title.	Year of report.	Number of sketch.
Explorations in Alaska, 1874	1874	21
1875	1875	21
Sketch of the southeast coast of Alaska, 1882	1882	19
1883	1883	19
1884	1884	14
1885	1885	13

SECTION XIII.—*Kentucky and Tennessee.*

Title.	Year of report.	Number of sketch.
Triangulation in Tennessee, part of progress sketch, entitled "Primary Triangulation between the Maryland and Georgia base-lines" (southern part), 1877	1877	9
Reconnaissance for triangulation in Kentucky and Indiana, 1877	1877	24
1879	1878	23
Triangulation and reconnaissance in Tennessee, 1879	1878	24
shown on progress sketch of primary triangulation between the Maryland and Georgia base-lines (southern part), 1879	1878	9
1879	1879	11
Reconnaissance for triangulation in Kentucky and Indiana, 1879	1879	26
Triangulation and reconnaissance in Tennessee, 1879	1879	27
shown on progress sketch of primary triangulation between the Maryland and Georgia base-lines (southern part)	1880	11
Reconnaissance for triangulation in Kentucky and Indiana, June 30, 1881	1880	26
Triangulation and reconnaissance in Tennessee, June 30, 1881	1880	27
Do	1881	27
Reconnaissance for triangulation in Kentucky and Indiana, June 30, 1881	1881	26
Triangulation and reconnaissance in Tennessee, shown on progress sketch of primary triangulation between the Maryland and Georgia base lines (southern part)	1881	11
Do	1882	6
Reconnaissance for triangulation in Kentucky and Indiana, June 30, 1882	1882	20
Triangulation and reconnaissance in Tennessee, June 30, 1882	1882	21
Triangulation between the Maryland and Georgia base-lines (southern part), with extension westward and triangulation in Tennessee	1883	6
Reconnaisance and triangulation in Kentucky and Indiana, June 30, 1883	1883	20
Triangulation between the Maryland and Georgia base-lines (southern part), with extension westward and triangulation in Tennessee	1884	6
Reconnaisance and triangulation in Kentucky and Indiana, June 30, 1884	1884	15
Triangulation between the Maryland and Georgia base-lines (southern part), with extension westward and triangulation in Tennessee, June 30, 1885	1885	5
Progress of the triangulation from West Virginia to Colorado along the 39th degree of latitude, including part of the triangulation in Kentucky, June 30, 1885	1885	15

SECTION XIV.—*Ohio, Indiana, Illinois, Michigan, and Wisconsin.*

Title.	Year of report.	Number of sketch.
Geodetic connection of the Atlantic and Pacific coast triangulations, Illinois and Missouri, 1875	1874	15
Missouri and Illinois, 1877	1877	22
Reconnaissance for triangulation in Kentucky and Indiana, 1877	1877	24
Triangulation and reconnaissance in Wisconsin, 1877	1877	23
1878	1878	22
Reconnaissance for triangulation in Kentucky and Indiana, 1879	1878	23
Geodetic connection of the Atlantic and Pacific coast triangulations, Missouri and Illinois, 1879	1878	21
Do	1878	29
Reconnaissance for triangulation in Kentucky and Indiana, 1879	1879	26
Triangulation and reconnaissance in Wisconsin, 1879	1879	28
Reconnaissance for triangulation in Kentucky and Indiana, June 30, 1881	1880	26
Progress of the triangulation and reconnaissance in Ohio, June 30, 1881	1880	27[a]
Triangulation and reconnaissance in Wisconsin, June 30, 1881	1880	28
Geodetic connection of the Atlantic and Pacific coasts, Illinois and Missouri, June 30, 1881	1880	29
Do	1881	29
Progress of the triangulation and reconnaissance in Ohio, June 30, 1881	1881	27[a]
Reconnaissance for triangulation in Kentucky and Indiana, June 30, 1881	1881	26
Triangulation and reconnaissance in Wisconsin, June 30, 1881	1881	28
Geodetic connection of the Atlantic and Pacific coasts, Illinois and Missouri, June 30, 1881	1881	29
Triangulation between the Hudson River and Cape Henry and the Ohio River, June 30, 1882	1882	4
Reconnaissance for triangulation in Kentucky and Indiana, June 30, 1882	1882	20
Triangulation and reconnaissance in Wisconsin, June 30, 1882	1882	22
Geodetic connection of the Atlantic and Pacific coasts, Illinois and Missouri, with subsketches, continuation eastward into Indiana and westward into Kansas, June 30, 1882	1882	23
Triangulation between the Hudson River and Cape Henry and the Ohio River, June 30, 1883	1883	4
Reconnaissance and triangulation in Kentucky and Indiana, June 30, 1883	1883	20
Wisconsin, June 30, 1883	1883	21
Geodetic connection of the Atlantic and Pacific coasts, June 30, 1883	1883	22
Triangulation between the Hudson River and Cape Henry and the Ohio River, June 30, 1884	1884	4
Reconnaissance and triangulation in Kentucky and Indiana, June 30, 1884	1884	15
Wisconsin, June 30, 1884	1884	16
Geodetic connection of the Atlantic and Pacific coasts, June 30, 1884	1884	17
Triangulation between the Hudson River and Cape Henry and the Ohio River, June 30, 1885	1885	4
Reconnaissance and triangulation in Wisconsin, June 30, 1885	1885	14
Progress of the triangulation in parts of Sections III, XIII, XIV, XV, and XVI, from West Virginia to Colorado, along the 39th degree of latitude, June 30, 1885	1885	15

SECTION XV.—*Missouri, Kansas, Iowa, Nebraska, Minnesota, and Dakota.*

Title.	Year of report.	Number of sketch.
Geodetic connection of the Atlantic and Pacific coast triangulations:		
Section from Saint Louis westward, 1875	1874	15
Do	1875	15
Missouri and Illinois, 1877	1877	22
Missouri and Illinois, 1879	1878	21
Do	1879	29
Geodetic connection of the Atlantic and Pacific coasts:		
Illinois and Missouri, June 30, 1881	1880	29
Do	1881	29
Illinois and Missouri, with subsketches, continuation eastward into Indiana and westward in Kansas, June 30, 1882	1882	23
Do ... June 30, 1883	1883	22
Do ... June 30, 1884	1884	17
Progress of the triangulation in parts of Sections III, XIII, XIV, XV, and XVI, from West Virginia to Colorado, along the 39th degree of latitude, June 30, 1885	1885	15

SECTION XVI.—*Nevada, Utah, Colorado, Arizona, and New Mexico.*

Title.	Year of report.	Number of sketch.
Progress of the transcontinental triangulation and reconnaissance eastward from the Pacific coast:		
1879	1879	30
June 30, 1881	1880	30
June 30, 1881	1881	30
June 30, 1882	1882	24
June 30, 1883	1883	23
Geodetic connection of the Atlantic and Pacific coasts, June 30, 1883	1883	22
June 30, 1884	1884	17
Progress of the transcontinental triangulation and reconnaissance eastward from the Pacific coast, June 30, 1884	1884	18
Progress of the triangulation from West Virginia to Colorado along the 39th degree of latitude, June 30, 1885	1885	15
Progress of the transcontinental triangulation and reconnaissance eastward from the Pacific coast, June 30, 1885	1885	16

III.—MAPS AND CHARTS PUBLISHED IN THE ANNUAL REPORTS FROM 1844 TO 1885, INCLUSIVE.

Under this heading, a geographical order will be observed, beginning at Passamaquoddy Bay and ending at the Rio Grande for the Atlantic and Gulf coast, and beginning at San Diego and ending at the Aleutian Islands for the Pacific coast.

Under the sub-headings, which will include successive portions of the coast, the maps and charts relating thereto will be arranged alphabetically for greater convenience of reference.

III[1].—*Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island, including coast and sea-ports, bays, and rivers.*

Title.	Year of report.	Number of map or chart.
Alden's Rock, Portland, Me., 1853	1853	2
Atlantic coast of the United States, sheet No. I, Cape Sable to Sandy Hook, 1864	1863	18
II, Nantucket to Cape Hatteras, 1863	1862	24
1863	1863	19
Barnstable Harbor, Massachusetts, 1861	1861	5
1861	1862	6
Bass River Harbor, Massachusetts, preliminary chart, 1854	1854	11
Booth Bay Harbor, Maine, 1864	1864	6
Boston Bay and approaches, Massachusetts, coast chart No. 10	1864	9
Boston Harbor, Massachusetts, 1857	1857	7
edition of 1863	1863	5
1867	1867	4
1872	1869	17
Bristol Harbor, Rhode Island, 1862	1862	7
1864	1864	11
Burlington, Vt., 1873	1871	20
Camden and Rockport Harbors, Maine, 1864	1864	4
Cape Ann and Jeffries Bank to Gay Head and Davis's Bank, General chart of the coast No. 2, preliminary edition, 1858	1858	5
Cape Ann to Gay Head, General chart of the coast No. II, 1873	1870	13
Cape Cod Bay, Coast chart No. 10, 1872	1870	16
Cape Cod Harbor, comparative map of, showing physical changes between 1835 and 1867	1867	5
Cape Small Point, Maine, to Cape Cod, Massachusetts, Preliminary chart, sea-coast of the United States, 1858	1858	4
No. 3, 1865	1865	6
Casco Bay, Maine, Preliminary coast chart No. 8, 1863	1863	4
1870	1868	4
Coaster's Harbor and approaches, Rhode Island, 1862	1862	8
Damariscotta River, Maine, preliminary chart, 1866	1865	4
Damariscotta and Medomak Rivers, Maine, 1872	1870	19
Davis's New South and Old South Shoals, Nantucket, preliminary sketch, 1846	1846	8
1846 and 1847	1847	Atlas
Davis's New South Shoal and other dangers of recent discovery, 1846 to 1848	1848	Atlas

III[1].—*Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island, etc.*—Continued.

Title.	Year of report.	Number of map or chart.
Davis's South Shoal and other dangers recently discovered 1846 to 1849	1850	A[3]
1846 to 1851	1851	A[2]
1846 to 1852	1852	A[2]
1846 to 1853	1853	4
Dutch Island Harbor, Narragansett Bay, Rhode Island, 1862	1862	9
Eastport Harbor, Maine, preliminary chart, 1864	1864	3
Edgartown Harbor and Cotamy Bay, Massachusetts, 1871	1871	36
1872	1872	23
Eggemoggin Reach, Maine, reconnaissance of eastern part of, with subsketch showing position of the reach, 1854	1854	3
Fox Islands Thoroughfare, Maine, 1868	1868	3
From Monomoy and Nantucket Shoals to Muskeget Channel, Preliminary coast chart No. 12, 1860	1860	3
From Muskeget Channel to Buzzard's Bay and entrance to Vineyard Sound, Massachusetts, Preliminary coast chart No. 13, 1860	1860	4
From entrance to Buzzard's Bay, Massachusetts, to Block Island Sound, Rhode Island, Preliminary coast chart No. 14, 1860	1860	5
From Monomoy and Nantucket Shoals to Muskeget Channel, Massachusetts, Coast chart No. 11, edition of 1874	1871	15
From Muskeget Channel to Buzzard's Bay and entrance to Vineyard Sound, Coast chart No. 12, edition of 1874	1871	16
From entrance to Buzzard's Bay, Massachusetts, to Block Island Sound, Rhode Island, 1860	1871	17
Gloucester Harbor, Massachusetts, preliminary chart, 1854	1854	7
Greenwich Bay, Rhode Island, 1867	1867	6
Holmes Hole Harbor, 1847	1851	4
Inside passage between Bath and Booth Bay, Maine, 1867	1866	4
Ipswich and Annisquam Harbors, Massachusetts, preliminary chart, 1855	1855	4
1857	1857	5
Isles of Shoals, New Hampshire, 1864	1864	7
Kennebec River, Maine, mouth of, preliminary chart, 1857	1857	4
from entrance to Bath, preliminary chart, 1858	1858	3
1861	1861	4
Kennebec and Sheepscot Rivers, Maine, 1862	1862	4
edition of 1866	1865	5
Lynn Harbor, Massachusetts, 1859	1859	5
edition of 1864	1864	8
Minot's Ledge off Boston Harbor, with profile views of Outer and Inner Minots, 1853	1853	3
Monomoy Harbor, Massachusetts, preliminary chart, 1854	1854	10
Shoals, Massachusetts, preliminary chart, 1856	1856	4
and Nantucket Shoals to Muskeget Channel, Preliminary coast chart No. 12, 1860	1860	3
Coast chart No. 11, 1874	1871	15
Monomoy. Comparative map from the Coast Survey of 1853 and 1868, with subsketches showing Champlain's map of Chatham, 1606, and Coast Survey map of Chatham, 1872	1871	33
Mount Hope Bay, Rhode Island, preliminary chart, 1861	1861	6
Muskeget Channel, preliminary chart, 1854	1854	14
1855	1855	6
Massachusetts, 1859	1859	6
to Buzzard's Bay and entrance to Vineyard Sound, Preliminary coast chart No. 13, 1860	1860	4
Coast chart No. 12, edition of 1874	1871	16
Nantucket Harbor, Massachusetts, edition of 1866	1865	7
Shoals, Massachusetts, preliminary chart, 1854	1854	12
1864	1863	6
Narragansett Bay (in two sheets), upper part, 1873	1870	20
lower part, 1873	1870	21
Newport Harbor and approaches, Rhode Island, 1864	1864	12
Penobscot Bay to Kennebec Entrance, Maine, Coast chart No. 5, 1873	1870	18
Physical map of Mitchell's Falls, Merrimack River, Massachusetts, 1867	1867	2
Plymouth Harbor, Massachusetts, preliminary chart, 1854	1854	9
Plymouth, Kingston, and Duxbury Harbors, 1875, with copies of Champlain's sketch, 1605, and plan by Blaskowitz about 1774	1876	22
Portland Harbor, Maine, preliminary chart, with subsketch of the approaches to the harbor, 1854	1854	4
chart showing the Commissioner's wharf-line, 1855	1855	3
preliminary chart, with subsketch showing approaches to the harbor, 1859	1859	4
1862	1862	5
1866	1866	5
Port of Providence, R. I., 1865	1865	8

III[1].—*Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island, etc.*—Continued.

Title.	Year of report.	Number of map or chart.
Portsmouth Harbor, New Hampshire, preliminary chart, 1854	1854	6
1866	1866	6
Provincetown Harbor, Massachusetts, 1857	1857	9
Rockland Harbor and vicinity, Maine, 1863	1863	3
Rockport Harbor, Massachusetts, 1858	1858	6
Sea-coast of Massachusetts, from Saughkonnet River to Plymouth, preliminary chart, 1856	1856	3
Sea-coast of the United States, from Cape Small Point, Maine, to Cape Cod, Massachusetts, Preliminary chart No. 3, 1858	1858	4
Sea-coast of the United States, from Cape Small Point, Maine, to Cape Cod, Massachusetts, Preliminary chart No. 3, 1865	1865	6
Sea-coast of the United States, from Portland, Me., to Race Point, Massachusetts, Preliminary chart No. 3, 1857	1857	5
Sea-coast of the United States, from Plymouth, Mass., to Saughkonnet River, Rhode Island, Preliminary chart No. 4, 1857	1857	8
Seguin Island to Kennebunkport, Me., Preliminary coast chart No. 8, 1859	1859	3
Sippican Harbor, Massachusetts, 1864	1864	10
1866	1866	8
Southwest Harbor and Somes Sound, Maine, 1872	1870	18
Sow and Pigs Reef, off Cuttyhunk Island, Massachusetts, sketch showing proposed site for light-house, with subsketch of reef, 1853	1853	5
Stellwagen's Bank, Massachusetts Bay, preliminary chart, 1854	1854	8
second edition, 1855	1855	5
St. George's River and Muscle Ridge Channel, Maine, 1864	1865	3
1873	1871	18
Tenant's Harbor, Maine, 1866	1866	3
Warren River, Rhode Island, 1866	1866	9
Wells to Cape Ann, Coast chart No. 8, 1867	1867	3
Wickford Harbor, Rhode Island, 1868	1868	5
Winter Harbor, Maine, 1867	1866	2
Wood's Hole Harbor, Massachusetts, 1857	1857	10
York River and Cape Neddick Harbors, Maine, 1854	1854	5

III^{2}.—*Connecticut, New York, New Jersey, Pennsylvania, and Delaware, including coast, bays, and rivers.*

Title.	Year of report.	Number of map or chart.
Absecom (now Absecon) Inlet, New Jersey, 1864	1864	16
Atlantic coast of the United States, Sheet No. I, Cape Sable to Sandy Hook, 1864	1863	18
II, Nantucket to Cape Hatteras, 1863	1862	24
1863	1863	19
Barnegat Inlet, New Jersey	1865	10
Buttermilk Channel, New York Harbor, sketch of, 1849	1849	B^2
Cape May to Cape Henry, General chart of the coast No. IV, 1862	1862	14
Cape May to Isle of Wight, with subsketch of the Delaware Breakwater, Coast chart No. 27	1866	11
Delaware River, from the Navy-yard to Fort Mifflin Light-house, 1871	1871	24
changes in, between Bridesburgh and Kensington, from 1843 to 1878	1880	38
between Kensington and Kaighn's Point, from 1843 to 1878	1880	39
Kaighn's Point and Horseshoe, from 1843 to 1878	1880	40
Horseshoe and Fort Mifflin, from 1843 to 1878	1880	41
Delaware and Chesapeake Bays, and the sea-coast from Cape May to Cape Henry, general chart of, edition of 1866	1865	11
Delaware, Maryland, and part of Virginia, sea-coast of, 1852	1852	C^2
Hempstead Harbor, Long Island, 1859	1859	8
Hudson River, New York, from Teller's Point to the mouth, preliminary chart, 1855	1855	8
Albany to New Baltimore, map of comparison, showing changes in the river since 1852, 1856	1856	6
Sheet No. 2, from Haverstraw to Poughkeepsie, preliminary chart, 1861	1861	9
3, Poughkeepsie to Glasco, preliminary chart, 1862	1862	12
1, from New York to Haverstraw, 1863	1863	8
Long Island, eastern part of the southern coast of, 1857	1857	13
middle part of the southern coast of, 1857	1857	12
Long Island Sound, eastern part of, second edition, 1856	1864	13
middle part of, 1855	1864	14
western sheet, with subsketch, continuation from Throg's Neck to the city of New York, 1855	1864	15
New Haven Harbor, 1872	1871	21
New York Bay and Harbor, preliminary chart, 1857	1857	14
Coast chart No. 21, 1861	1861	8
Coast chart No. 20, 1866	1865	9
New York Entrance, 1867	1867	7
New York, Bay and Harbor of, 1874	1871	22
New York Entrance	1871	23
Phelps Ledge and Great Eastern Rock, off Montauk Point, sketch showing position of, 1863	1863	7
Plattsburgh and Cumberland Bay, Lake Champlain, N. Y., 1873	1871	19
Proposed sites for range-beacons, entrance to New York Harbor, 1851	1851	B^5
Romer and Flynn's Shoals, New York Bay, 1853	1853	7
Sandy Hook, sketch showing progressive changes in, from 1778 to 1850, 1850	1850	B^3
1779 to 1851, 1851	1851	B^4
1779 to 1853, 1853	1853	8
1779 to 1855, 1855	1855	9
Soundings off the sea-coast of Delaware and Maryland, preliminary sketch, 1850	1850	C^3

III³.—*Maryland, District of Columbia, Virginia, and West Virginia, including bays, sea-ports, and rivers.*

Title.	Year of report.	Number of map or chart.
Atlantic coast of the United States (Sheet No. II), Nantucket to Cape Hatteras, 1863	1862	24
1863	1863	19
Cape Charles and vicinity, preliminary sketch, 1853	1853	12
Cape May to Cape Henry, General chart of the coast No. IV, 1862	1862	14
1862	1871	13
Cape Henry to Cape Lookout, General chart of the coast No. V, 1867	1866	14
Cherrystone Inlet, preliminary sketch, 1853	1853	13
Chesapeake Bay, Entrance to, reconnaissance of, 1851	1851	11
Sheet No. 1, from the head of the Bay to the mouth of Magothy River, 1857	1857	17
2, from mouth of Magothy River to the mouth of the Hudson (or Choptank) River, 1857	1857	18
3, from mouth of the Hudson (or Choptank) River to the mouth of the Potomac River, 1857	1857	19
4, from the Potomac River to the entrance to Pocomoke Sound, preliminary chart, 1859	1859	10
5, from the entrance to Pocomoke Sound to the mouth of York River, preliminary chart, 1859	1859	11
6, from the mouth of York River to the entrance to the Bay, preliminary chart, 1859	1859	12
Coast chart No. 36 1863	1862	15
from head of Bay to Magothy River, Coast chart No. 31, 1861	1864	17
Magothy River to Choptank River, Coast chart No. 32, 1862	1864	18
Choptank River to Potomac River, Coast chart No. 33, 1862	1864	19
Chincoteague Inlet and shoals in vicinity, sea-coast of Virginia, preliminary chart, 1852	1852	C^3
Delaware and Chesapeake Bays, and the sea-coast from Cape Henlopen to Cape Charles, 1855	1855	12
Cape May to Cape Henry, General chart of, edition of 1866	1865	11
Fishing or Donoho's Battery, Chesapeake Bay, sketch showing proposed site for light at, 1851	1851	12
Hampton Roads and Elizabeth River, Virginia, preliminary chart, 1857	1857	23
Isle of Wight to Chincoteague Inlet, Coast chart No. 28, 1866	1866	12
James River, Virginia, from Richmond to City Point, including the Appomattox River from Petersburgh to the Junction, preliminary chart, 1855	1855	13
Metomkin Inlet, Virginia, 1862	1862	16
Norfolk Harbor, Virginia, 1857	1857	24
North Landing River, head of Currituck Sound, Virginia and North Carolina, 1861	1861	12
Patapsco River and the approaches, 1856	1856	8
1870	1868	9
Patuxent River, Maryland (lower part), preliminary chart, 1859	1859	13
Potomac River, from entrance to Piney Point, 1862	1864	20
Piney Point to Lower Cedar Point, 1862	1864	21
Lower Cedar Point to Indian Head, 1862	1864	22
Indian Head to Georgetown, 1864	1864	23
Entrance to Piney Point, 1868	1868	10
Piney Point to Lower Cedar Point, 1868	1868	11
Lower Cedar Point to Indian Head, 1862	1868	12
Indian Head to Georgetown, 1864	1868	13
Pungoteague Creek, Virginia, 1853	1853	14
Rappahannock River, Virginia, from Fredericksburgh to near Moss Neck, 1856	1856	9
Moss Neck to Port Royal, 1856	1856	10
Port Royal to Saunders's Wharf, 1856	1856	11
Saunders's Wharf to Occupacia Creek, 1856	1856	12
Deep Creek to Occupacia Creek, preliminary chart, 1857	1857	21
entrance to Deep Creek, preliminary chart, 1857	1857	20
Sea-coast of Delaware, Maryland, and part of Virginia, 1852	1852	C^3
Sea-coast of Virginia, from Gargathy Inlet to Great Machipongo Inlet, preliminary chart, 1853	1853	10
Great Machipongo Inlet to Cape Henry, preliminary chart, 1854	1854	19
(part of) and entrance to Chesapeake Bay, preliminary chart, 1855	1855	11
Ship and Sand Shoal Inlets, coast of Virginia, preliminary chart, 1854	1854	18
Soundings off sea-coast of Delaware and Maryland, preliminary sketch, 1850	1850	C^3
St. Mary's River, Cornfield Harbor, and Point Lookout, Maryland, 1859	1859	14
Wachapreague, Machipongo, and Metomkin Inlets, coast of Virginia, preliminary sketch, 1853	1853	11
York River, Virginia, from entrance to King's Creek, preliminary chart, 1857	1857	22
King's Creek to West Point, preliminary chart, 1858	1858	9

III[4].—*North Carolina, including coast, sounds, sea-ports, and rivers.*

Title.	Year of report.	Number of map or chart.
Albemarle Sound, North Carolina, preliminary chart, 1855	1855	15
Atlantic coast of the United States, Sheet No. II, Nantucket to Cape Hatteras, 1863	1862	24
1863	1863	19
Sheet No. III, Cape Hatteras to Mosquito Inlet, 1863	1863	20
Beaufort Harbor, North Carolina, hydrographic reconnaissance, 1850	1850	D^2
preliminary sketch, 1851	1851	D^5
with subsketch of Lookout Bight, preliminary chart, 1854	1854	23
1857	1857	28
comparative chart, showing changes in the entrance, 1854 to 1857	1857	29
resurvey in June and July, 1862, 1862	1863	11
Cape Fear River and Frying Pan Shoals, progress of survey of, 1851	1851	D^6
North Carolina, lower part, preliminary chart, 1855	1855	16
from near Federal Point to Wilmington, preliminary chart, 1856	1856	15
entrances, comparative chart, 1857	1857	33
bars, comparative chart, 1851 to 1858	1858	13
Cape Hatteras and cove for anchorage, 1849	1849	D^3
Cape Lookout Shoals (reconnaissance), 1864	1864	25
1866	1865	12
Core Sound and Straits, North Carolina, 1864	1864	24
Entrances to Cape Fear River and New Inlet, preliminary chart, 1853	1853	19
with subsketch of Frying Pan Shoals, 1866	1865	13
Frying Pan Shoals and Cape Fear River, sketch of, 1851	1851	D^7
and entrances to Cape Fear River, North Carolina, preliminary chart, 1857	1857	32
General chart of the coast No. V, from Cape Henry to Cape Lookout, 1867	1866	14
Hatteras Inlet, harbor of refuge, reconnaissance, 1849	1849	D^4
1850	1850	D^3
reconnaissance, 1850	1851	D^3
fourth edition, 1853	1852	D^5
Hatteras and Ocracoke Inlets, North Carolina, preliminary surveys, 1857	1857	28
Hatteras Inlet, North Carolina, preliminary chart, 1862	1862	23
Hatteras Shoals, preliminary sketch, 1850	1850	D^4
1850	1851	D^2
Neuse River, North Carolina, 1874	1871	25
New Inlet Bar, northern entrance to Cape Fear River, comparative chart, surveys of, 1852 to 1858	1858	12
New River and Bar, North Carolina, reconnaissance in November, 1851	1852	D^4
Ocracoke Inlet, North Carolina, 1852	1852	D^3
Oregon Inlet, North Carolina, 1862	1862	22
Port of New Berne, North Carolina, 1867	1867	9
Sea-coast of North Carolina, from Cape Hatteras to Ocracoke Inlet, preliminary chart, 1856	1856	14
Sea-coast of the United States, from Cape Hatteras to Ocracoke Inlet, and from Cape Lookout to Bogue Inlet, North Carolina, Preliminary chart No. II, 1857	1857	26, 27
to Cape Lookout, preliminary chart, 1858	1858	11
Wimble Shoals, coast of North Carolina, 1854	1854	22
1870	1869	18

III[5].—*South Carolina and Georgia, including coast, sea-water channels, sounds, harbors, and rivers.*

Title.	Year of report.	Number of map or chart.
Atlantic coast of the United States, Sheet No. III, Cape Hatteras to Mosquito Inlet, 1863	1863	20
Beaufort River, Station Creek, Story and Harbor Rivers, forming inside passage between Port Royal and St. Helena Sounds, South Carolina, preliminary chart, 1864	1864	26
Beaufort River, Station Creek, Story and Harbor Rivers, forming inside passage between Port Royal and St. Helena Sounds, South Carolina, edition of 1873, 1873	1870	24
Bull's Bay, harbor of refuge, coast of South Carolina, reconnaissance, 1849	1849	E[2]
second edition, 1851	1851	E[6]
Bull's Bay, South Carolina, preliminary chart, 1857	1857	35
1859	1859	17
Calibogue Sound and Skull Creek, forming inside passage from Tybee Roads to Port Royal Sound, South Carolina, 1862	1862	27
Cape Roman Shoals, South Carolina, preliminary sketch, 1853	1853	21
Cape Romain to Amelia Island, General chart of the coast No. VII, 1874	1871	14
Changes on Charleston Bar, sketch of, from 1850 to 1855, published in 1856	1855	21
Charleston Harbor, map of comparison of Maffitt's Channel, 1850 to 1854, 1854	1854	30
1850 and 1855, 1855	1855	20
1850, 1855, and 1856, 1856	1856	19
Charleston Harbor and its approaches, preliminary chart, 1856	1856	18
1858	1858	15
1866	1865	14
Coast of South Carolina, from Long Island to Hunting Island, including Charleston Harbor and St. Helena Sound, Coast chart 53, 1866	1865	15
Coast of South Carolina and Georgia, from Hunting Island to Ossabaw Island, including Port Royal Sound and Savannah River, Coast chart 55, 1873	1870	15
Doboy Bar and Inlet, Georgia, reconnaissance of, 1855	1855	25
Doboy and Altamaha Sounds, Georgia, 1871	1869	19
Entrance to Bull and Combahee Rivers, South Carolina, 1871	1870	23
Entrance to Savannah River, Georgia, reconnaissance of, 1851	1851	E[5]
North Edisto River, preliminary sketch, 1851	1851	E[7]
preliminary chart, 1853	1853	22
preliminary chart, new edition, 1856	1856	20
Port Royal Entrance and Beaufort Harbor, South Carolina, reconnaissance of, 1855	1855	22
Port Royal Entrance, Beaufort, Chechessee, and Colleton Rivers, South Carolina, 1859	1859	18
1862	1862	26
preliminary chart, 1863	1863	12
Romerly Marshes, Georgia, reconnaissance of, 1855	1855	24
Sapelo Sound, Georgia, preliminary chart, 1859	1859	19
Savannah River, reconnaissance of approaches to the city of Savannah, including Front and Back Rivers, 1851	1851	E[4]
Savannah River, Georgia, preliminary chart, 1855	1855	23
and Wassaw Sound, 1867	1866	16
Sea-coast of South Carolina, preliminary chart, 1856	1856	21
Sea-coast of the United States from Cape Roman, South Carolina, to Tybee Island, Georgia, Preliminary chart No. 14, 1857	1857	34
St. Andrew's Shoals, at the entrance of St. Andrew's Sound, Georgia, reconnaissance of, 1850	1850	E[4]
St. Catherine's Sound, Georgia, 1867	1867	10
St. Helena Sound, South Carolina, 1857	1857	36
St. Simon's Sound and Brunswick Harbor, preliminary chart, 1856	1856	22
St. Simon's Sound and Brunswick Harbor, Georgia, 1857	1857	37
Wassaw Sound, Wilmington and Tybee Rivers, Georgia, preliminary chart, 1864	1864	27
Winyah Bay and Cape Roman Shoals, South Carolina, preliminary survey, 1854	1854	29
and Georgetown Harbor, South Carolina, preliminary chart, 1855	1855	19

III[6].—*Coast of Florida, from St. Mary's River, on the east coast, to and including the Anclote Keys, on the west coast, with the coast approaches, reefs, keys, sea-ports, and rivers.*

Title.	Year of report.	Number of map or chart.
Atlantic coast of the United States, Sheet No. III, Cape Hatteras to Mosquito Inlet, 1863	1863	20
IV, Mosquito Inlet to Key West, 1863	1863	21
1863	1868	16
Caloosa Entrance, Florida, 1867	1866	18
Cape Canaveral Shoals, eastern coast of Florida, reconnaissance of, 1850	1850	F^2
Charlotte Harbor, Florida, main entrance to, preliminary chart, 1863	1864	28
Coffin's Patches, Florida Reefs, reconnaissance of, 1854	1854	33
Florida Reefs, from Key Biscayne to Carysfort Reef, preliminary chart, 1855	1855	29
positions of beacons on, with plan of beacons, 1855	1855	30
from Key Biscayne to Pickles Reef, preliminary chart of, 1856	1856	29
preliminary chart of, showing the approaches to Key West Harbor, 1857	1857	42
from Key Biscayne to Carysfort Reef, Coast chart No. 68, 1858	1858	18
from Newfound Harbor to Boca Grande Key, Preliminary coast chart No. 71, 1859	1859	22
edition of 1862	1862	34
from the Elbow to Lower Matecumbe Key, Preliminary coast chart No. 69, 1863	1863	15
from Long Key to Newfound Harbor Key, Preliminary coast chart No. 70, 1863	1863	16
western end of, including the Tortugas Keys, preliminary chart, 1864	1863	17
Gulf coast of the United States, eastern part, Key West to the Rio Grande, 1863	1863	22
Indian River Inlet, Florida, surveyed in 1861	1870	25
Key West Harbor and approaches, preliminary chart, 1851	1851	F^5
second edition, 1852	1852	F^3
Legaré Anchorage, Florida Reefs, 1855	1855	28
1857	1857	43
Mosquito Inlet, coast of Florida, reconnaissance of, 1851	1851	F^3
Rebecca Shoal, proposed site of beacon on, 1851	1851	F^6
St. Augustine Harbor, Florida, preliminary chart, 1862	1862	33
St. John's River, entrance to, preliminary chart, 1853	1853	25
from entrance to Brown's Creek, preliminary chart, 1856	1856	27
from Brown's Creek to Jacksonville, preliminary chart, 1856	1856	28
comparative chart of, 1853 and 1857, 1857	1857	41
St. Mary's Bar and Fernandina Harbor, Florida, preliminary chart of, 1856	1856	23
comparative chart of, 1843 and 1856, 1856	1856	24
St. Mary's River and Fernandina Harbor, Florida, 1857	1857	38
edition of 1862	1862	31
1869	1869	20
Straits of Florida, from Key Biscayne to the Marquesas Keys, General chart of the coast No. X, preliminary edition, 1862	1863	14
General chart of the coast No. X, 1868	1867	11
1868	1870	14
Tampa Bay, Florida, reconnaissance of, 1855	1855	31
Turtle Harbor, Florida Reefs, preliminary survey, 1854	1854	33

III[7].—*Peninsula of Florida, west coast, from Anclote Keys to Perdido Bay, including coast approaches, ports, and rivers.*

Title.	Year of report.	Number of map or chart.
Apalachicola Bay, Florida, preliminary chart of, 1858	1858	21
Apalachicola River, Florida, preliminary survey of the mouth of, 1857	1857	45
Cedar Keys, coast of Florida, reconnaissance of vicinity of, 1851	1851	F^4
Channel No. IV, 1852	1852	G^2
and approaches, preliminary chart of, 1854	1854	36
1855	1855	33
Florida, 1861	1861	17
edition of 1871	1869	21
Gulf coast of the United States, Key West to the Rio Grande (eastern part), Key West to the Mississippi River, 1863	1863	22
from Pensacola to the Passes of the Mississippi, 1870	1868	18
Ocilla River, Florida, 1855	1855	34
Pensacola Bay, Florida, preliminary chart of entrance to, 1857	1857	46
St. Andrew's Bay, Florida, preliminary chart of, 1855	1855	35
St. George's Sound, Florida, preliminary reconnaissance of the middle or main and west entrances to, 1853	1853	G^2
eastern part of, 1858	1858	20
1859	1859	25
St. Mark's Bar and Channel, reconnaissance of, 1852	1852	G^3
St. Mark's River, preliminary chart of, 1856	1856	32
Waccasassa Bay, Florida, preliminary chart of, 1856	1856	31

III[8].—*Alabama, Mississippi, Louisiana, and Arkansas, including Gulf coasts, ports, and rivers.*

Title.	Year of report.	Number of map or chart.
Atchafalaya Bay, Louisiana, preliminary chart of, 1858	1858	23
Barataria Bay, Louisiana, preliminary reconnaissance of the entrance to, 1853	1853	34
Biloxi Bay, Mississippi, preliminary chart of, 1855	1855	37
Cat Island, reconnaissance of the harbor south of, 1847	1847	E^{tris}
Grand Bay, including the entrance of Horn Island Pass, 1851	1851	H^7
Grand Island Pass, Mississippi, 1857	1857	52
Grand Pass, the entrance to Timballier Bay, preliminary reconnaissance of, 1853	1853	35
Gulf coast of the United States, Key West to the Rio Grande, western part, from Terrebonne Bay to the Rio Grande, 1863	1863	23
from Pensacola to the Passes of the Mississippi, 1870	1868	18
Horn Island Channel, Mississippi Sound, reconnaissance of, 1846	1846	9
Horn Island Pass, Mississippi Sound, 1852	1852	H^4
1853	1853	32
Mississippi City Harbor, Mississippi, 1857	1857	50
Mississippi River, Rodney, St. Joseph, Bruinsburgh, reconnaissance for the use of the Mississippi Squadron, 1864	1864	29
Grand Gulf, Turner's Point, New Carthage, reconnaissance for the use of the Mississippi Squadron, 1864	1864	30
from the Passes to Grand Prairie, Coast chart No. 94, 1874	1871	26
Mississippi Sound (eastern part) from Bon Secours Bay to Round Island, Preliminary coast map No. 91, 1860	1860	29
Mobile Bay, soundings at entrance of, 1847	1847	E^{bis}
preliminary sketch of, 1851	1851	H^{10}
1852	1852	H^2
Alabama, 1856	1856	48
Pascagoula River, Mississippi, entrance to, 1853	1853	33
Pass Christian Harbor, Mississippi Sound, 1851	1851	H^9
Pass Fourchon, Louisiana, reconnaissance of, 1854	1854	38
Passes of the Mississippi, Louisiana, 1867	1867	12
Rigolets, Louisiana, preliminary chart of the, 1859	1859	27
Reconnaissance of the Northeast and Southeast Passes and Pass à l'Outre, Delta of the Mississippi, Louisiana, showing the changes since 1839, 1851	1851	H^8
the Passes of the Delta of the Mississippi, Louisiana, showing the changes since 1839, 1852	1852	H^3
entrances to Vermillion Bay and Calcasieu River, Louisiana, 1855	1855	40
the Southwest Pass, Mississippi River, Louisiana, 1862	1862	36
Sea-coast of Alabama and part of Mississippi, preliminary chart, 1856	1856	34
the United States from Mobile Bay, Alabama, to Lake Bogue (Borgne?), Louisiana, Preliminary chart No. 26, 1857	1857	49
Ship Island Shoal, preliminary chart, 1853	1853	36
St. Louis Bay and Shieldsborough Harbor, 1857	1857	51

III^{9}.—*Texas and Indian Territory, including Gulf coast, bays, and rivers.*

Title.	Year of report.	Number of map or chart.
Aransas Pass, coast of Texas, 1851	1851	I^{3}
Texas, reconnaissance of, 1853	1853	41
Brazos River Entrance, Texas, preliminary chart, 1858	1858	27
Brazos Santiago, Tex., 1867	1866	20
Coast of Texas from Galveston to Corpus Christi, 1867	1867	14
Corpus Christi Pass, 1869	1869	12
Galveston Bay, preliminary sketch showing proposed Light-house sites, 1851	1851	I^{2}
second edition, 1852	1852	I^{2}
Galveston Entrance, 1853	1853	39
Bay, Texas, with subsketches of Clopper's Bar and Red Fish Bar, preliminary chart, fourth edition, 1855	1855	41
Entrance, Texas, 1856	1856	43
Bay to Oyster Bay, Texas, Preliminary coast chart 106, 1858	1858	25
edition of 1870	1868	19
Entrance, Texas, 1867	1867	13
Gulf coast, Key West to Rio Grande, western part, from Terrebonne Bay to the Rio Grande, 1863	1863	23
Matagorda Bay Entrance, with subsketches of parts of Matagorda and Lavaca Bays, preliminary chart, 1857	1857	55
Entrance, Texas, preliminary chart, 1860	1859	29
Texas, Coast chart No. 107, 1872	1869	22
Oyster Bay to Matagorda Bay, Texas, Preliminary coast chart 107, 1858	1858	26
Reconnaissance of the coast of Texas between Matagorda and Corpus Christi Bays, with subsketches, 1858	1858	28
Rio Grande Entrancé, Texas, preliminary survey, 1854	1854	40
Sabine Pass, reconnaissance of, 1853	1853	38
San Luis Pass, Texas, preliminary chart, 1853	1853	40
Sea-coast of Texas in the vicinity of Galveston, preliminary chart, 1856	1856	42
Sea-coast of the United States from Galveston Bay to Matagorda Bay, Preliminary chart No. 31, 1857	1857	54

III^{10}.—*Coasts of California, Oregon, and Washington Territory, including bays, sounds, harbors, and rivers.*

Title.	Year of report.	Number of map or chart.
Anacapa Island and Smith's or Blunt's Island, reconnaissance sketches, 1854	1854	43
and southeast end of Santa Cruz Island, California, preliminary surveys, 1856	1856	48
Bodega Bay, California, 1862	1862	41
1864	1864	36
Cape Flattery and Neéah Harbor, Washington, 1853	1853	52
Cape Hancock or Disappointment, showing site proposed for a Light-house, 1851	1851	K^{2}
Cape Orford and Reef, Oregon, 1869	1869	16
City of San Francisco and its vicinity, 1853	1852	I^{6}
1859	1858	31
Columbia River, Oregon Territory, preliminary survey of the mouth of, 1850	1850	K
1850	1851	K
with view of entrance, 1851	1851	K^{2}
entrance to, 1854	1854	48
sheet No. 1, 1870	1868	26
Cortez Bank, California, 1853	1853	44
preliminary chart of, 1856	1856	46
Country between San Diego and Colorado River, geological map, 1855	1855	60
Crescent City Harbor, California, 1859	1859	33
Destruction Island, Washington Territory, 1866	1866	23
Drake's Bay, California, preliminary chart, 1860	1860	35
Eastern entrance to Santa Barbara Channel, California, with subsketch Point Hueneme, preliminary chart, 1857	1857	59
Entrance to Koos Bay, Oregon, preliminary chart, 1861	1861	26
1862	1862	43
Gray's Harbor, Washington Territory, preliminary chart, 1862	1862	44
Half Moon Bay, California, preliminary chart, 1863	1863	25
Humboldt Bay, California, preliminary survey, 1851	1851	J^{3}
1858	1858	32
Koos Bay, Oregon, 1865	1865	24

III.[10]—*Coasts of California, Oregon, and Washington Territory, etc.*—Continued.

Title.	Year of report.	Number of map or chart.
Mare Island Straits, California, 1851	1851	J^2
1857	1857	61
Monterey Harbor, California, 1852	1852	J^3
Monterey Bay, California, preliminary chart, 1857	1857	60
Pacific coast from Point Pinos to Bodega Head, California, preliminary chart, 1862	1862	40
published in 1862, edition of 1865	1864	35
published in 1862, edition of 1866	1865	22
Petaluma and Napa Creeks, California, 1861	1861	22
Point Conception, coast of California, 1851	1851	J^3
Point Pinos, Bay of Monterey, California, 1851, with subsketch of Point Pinos in 1847	1851	J^4
Point Reyes and Drake's Bay, California, preliminary survey, 1855	1855	47
vicinity, geological map, 1855	1855	57
Point Sal, California, 1867	1867	15
Port Gamble, Washington Territory, reconnaissance of, 1856	1856	55
1858	1858	35
Port Ludlow, Washington Territory, preliminary survey, 1856	1856	54
Port Madison, Washington Territory, 1868	1868	27
Port Orford or Ewing Harbor, Oregon Territory, 1854	1854	46
Port Townshend, Washington Territory, reconnaissance of, 1854	1854	52
Port Townshend, Washington Territory, 1858	1858	36
Preliminary surveys of harbors on the western coast of the United States, Santa Cruz and Año Nuevo Harbors, 1854	1854	44
Crescent City Harbor, Shelter Cove, Mendocino City, Cal., and Port Orford or Ewing Harbor, Oregon, 1854	1854	46
Puget Sound, Washington Territory, 1867	1867	17
1867	1871	28
Reconnaissance of Bellingham Bay, Washington Territory, 1856	1856	58
Blakely Harbor, Washington Territory, 1856	1856	59
Canal de Haro and Strait of Rosario and approaches, with subsketches of Admiralty Inlet and Puget Sound, 1854	1854	51
Canal de Haro and Strait of Rosario and approaches, with subsketch of Admiralty Inlet and Puget Sound, 1858	1858	34
Catalina Harbor and anchorage on northeast side of island, 1852	1852	T^4
Duwamish Bay and Seattle Harbor, 1854	1854	53
entrance and part of Coquille River, Oregon, 1861	1861	25
False Dungeness Harbor, 1853	1853	53
1853, and of New Dungeness Harbor, Washington Territory, 1856	1856	53
Grenville Harbor, Washington Territory, 1854	1854	50
the harbors of Santa Cruz, San Simeon, Coxo, and San Luis Obispo, California, 1852	1852	J^9
Olympia Harbor, Washington Territory, 1856	1856	56
Semi-ah-moo Bay, Washington Territory, 1858	1858	37
Steilacoom Harbor, Washington Territory, 1856	1856	57
Washington Sound and its approaches, Washington Territory, 1862, with a subsketch, Admiralty Inlet and Puget Sound, 1858	1861	27
Washington Sound and its approaches, Washington Territory, 1862, with a subsketch, Admiralty Inlet and Puget Sound, 1858	1863	28
the western coast of the United States from Monterey to the Columbia River, Sheet No. 1, Monterey to Cape Mendocino, third edition	1851	J^{12}
western coast of the United States from Monterey to the Columbia River, Sheet No. 2, Cape Mendocino to Umpquah River	1851	J^{13}
western coast of the United States from Monterey to the Columbia River, Sheet No. 3, Umpquah River to Cape Hancock or Disappointment	1851	J^{14}
western coast of the United States from San Francisco to San Diego, 1852	1852	J^9
1853	1853	43
the Umpquah River, 1854	1854	42
Umpquah River to the boundary, 1855	1855	48
Gray's Harbor to entrance of Admiralty Inlet, 1853	1853	51
(lower sheet), San Francisco to San Diego, 1853, edition of 1864	1864	32
(middle sheet), San Francisco to Umpquah River, 1854, edition of 1864	1864	33
(upper sheet), Umpquah River to the Boundary, 1855, edition of 1864	1864	34

III^{10}.—*Coasts of California, Oregon, and Washington Territory, etc.*—Continued.

Title.	Year of report.	Number of map or chart.
St. George's Reef and Crescent City, Cal., 1872	1869	15
San Antonio Creek, California, 1857	1857	62
San Clemente, Prisoner's, and Cuyler's Harbors, California, reconnaissance of, 1852	1852	J^{7}
San Clemente Island, reconnaissance of the southeast end of, 1856	1856	47
San Diego Entrance and approaches, with a general sketch of San Diego Bay and Los Coronados, 1853	1853	45
San Diego Bay, California, 1857	1857	58
San Francisco Bay, California, showing sites proposed for Light-houses, 1851	1851	J^{6}
preliminary chart of entrance to, 1856	1856	49
upper part of, 1862	1862	39
Peninsula, 1869	1869	14
San Luis Obispo Bay and approaches, California, 1876, re-issued 1879	1877	21
San Pablo Bay, California, preliminary chart, 1856	1856	50
with continuation of Straits of Karquines, 1863	1863	26
San Pedro Harbor, California, reconnaissance of, 1852	1852	J^{5}
anchorage and vicinity of Santa Barbara, Cal., preliminary survey, 1855	1855	45
Harbor, California, preliminary chart, 1859	1859	32
Santa Barbara, Cal., preliminary sketch, 1853	1853	46
Shilshole Bay, Washington Territory, 1867	1867	18
Shoalwater Bay, Washington Territory, preliminary survey, 1853	1853	50
1856	1856	52
South Farallon Island, Pacific Ocean, 1855	1855	46
Suisun Bay, California, 1867	1866	22
1872	1870	26
Tillamook Bay, Oregon, 1867	1867	16
Tomales Bay, California, preliminary chart, 1861	1861	23
1863	1863	27
Tracks of Coast Survey vessels in search of Falmouth Shoal, 1871 and 1873	1871	27
Trinidad Bay, California, reconnaissance of 1851	1851	J^{5}
Umpquah River, Oregon, preliminary survey of entrance to, 1854	1854	47
Vicinity of the Golden Gate, geological map, 1855	1855	58
Monterey Bay, California, geological map, 1855	1855	59
Washington Sound and approaches, Washington Territory, 1866	1866	24
Yaquina River Entrance, Oregon, 1868	1868	25

III^{11}.—*Alaska, including the coast and the Aleutian Islands.*

Title.	Year of report.	Number of sketch.
Alaska and adjacent territory, 1869	1867	20
Alaska Peninsula and part of the Aleutian Islands, with tidal diagrams	1872	17
Aleutian Islands, 1873	1873	17
Explorations in Alaska, 1874	1874	21
1874	1875	21
Illiouliouk and Captain's Harbors, Unalaska Island, 1869	1867	23
Mount St. Elias and Coast Range to Cape Spencer, 1874	1875	22
Northwest coast of America, Sheet No. 1, Cape Flattery to Dixon Entrance, 1868	1868	20
2, Dixon Entrance to Cape St. Elias, 1868	1868	21
3, Icy Bay to Seven Islands (Semidi Islands), 1868	1868	22
Sitka Harbor, Alaska, 1869	1867	21
St. Paul Harbor, Kadiak Island, Alaska, 1869	1867	22

III[12].—*Interior States.*

Title.	Year of report.	Number of map or chart.
Diagram accompanying map in sixteen sheets of the Tennessee River, 1865	1865	19
Ohio River from Mound City to Cairo, 1864	1863	31
Mississippi River, from Cairo, Ill., to St. Mary's, Mo., in six sheets:		
Sheet No. 1, from 1 to 25 miles above Cairo, 1865	1865	16
2, from 25 to 41 miles above Cairo, 1865	1865	16
3, from 41 to 61 miles above Cairo, 1865	1865	17
4, from 62 to 78 miles above Cairo, 1865	1865	17
Sheets Nos. 5 and 6, from 78 to 96 and from 96 to 115 miles above Cairo, 1865	1865	18

IV.—Diagrams, Drawings, and Miscellaneous Sketches, illustrating the Methods, Apparatus, and Results of the Survey, and published in its Annual Reports from 1844 to 1885, inclusive.

NOTE.—Under this heading the arrangement is by subject heads, as follows:

IV$_{1}$.—*Apparatus and instruments.*

IV$_{2}$.—*Astronomical observations.*

IV$_{3}$.—*Azimuth determinations.*

(*See* Time, latitude, longitude, and azimuth observations, under IV$_{1}$, and IV$_{34}$, Time, latitude, longitude, and azimuth determinations.)

IV$_{4}$.—*Base-lines and base measurements, diagrams relating to and showing results of*

IV$_{5}$.—*Current observations and stations.*

IV$_{6}$.—*Deep sea soundings.*

IV$_{7}$.—*Drawing paper, tests of.*

IV$_{8}$.—*Drawings, topographical.*

(*See* Topography and topographical drawings.)

IV$_{9}$.—*Eclipses, solar.*

(*See* Solar eclipses.)

IV$_{10}$.—*Geodesic leveling.*

IV$_{11}$.—*Geodetic surveys, methods and results.*

IV$_{12}$.—*Geographical positions.*

IV$_{13}$.—*Geological maps.*

IV$_{14}$.—*Gravity research.*

IV$_{15}$.—*Gulf Stream explorations.*

IV$_{16}$.—*Harbor and river improvements.*

IV$_{17}$.—*Hydrography.*

IV$_{18}$.—*Hypsometry.*

IV$_{19}$.—*Instruments and apparatus.*

(*See* Apparatus and instruments.)

IV$_{20}$.—*Isogonic, isoclinic, and isodynamic maps, charts, and diagrams.*

(*See* Magnetic declination, dip, and intensity.)

IV$_{21}$.—*Latitude determinations.*

(*See* Time, latitude, longitude, and azimuth determinations.)

IV$_{22}$.—*Longitudes, chronometric.*

IV$_{23}$.—*Longitudes, telegraphic.*

IV$_{24}$.—*Magnetic declination, dip, and intensity.*

IV$_{25}$.—*Meteorological researches.*

IV$_{26}$.—*Miscellaneous.*

IV$_{27}$.—*Oyster-bed surveys and explorations.*

IV$_{28}$.—*Physical hydrography.*

IV$_{29}$.—*Project limits for charts.*

IV_{30}.—*Projections.*
IV_{31}.—*Solar eclipses.*
IV_{32}.—*Telegraphic longitudes.*
(*See* Longitudes, telegraphic, and also that sub-heading under the general heading "Apparatus and instruments.")
IV_{33}.—*Tidal observations, discussions, and results.*
IV_{34}.—*Time, latitude, longitude, and azimuth determinations.*
IV_{35}.—*Topography and topographical drawings and sketches.*
IV_{36}.—*Transits of Venus and Mercury.*
IV_{37}.—*Triangulation.*

IV_{1}.—*Apparatus and instruments.*

The sketches and diagrams classified under this general heading will be found indexed under the following subheadings:

Base apparatus.
Currents.
Deep-sea sounding apparatus.
Deep-sea temperature and density apparatus.
Electrotyping and engraving apparatus.
Geodesic leveling instruments and apparatus.
Geodetic signaling apparatus.
Geodetic signals, tripods, and scaffolds.
Gravity research.
Gulf Stream explorations, instruments, and apparatus.
Hydrographic work, signals, instruments, and apparatus.
Hypsometry.
Longitudes, telegraphic.
Magnetic declination, dip, and intensity.
Meteorological researches, apparatus, and instruments.
Physical hydrography.
Solar eclipses.
Tidal observations.
Time, latitude, longitude, and azimuth observations.
Topography and topographic surveys.

Title.	Date of publication.	Year of report.	Number of illustration.
BASE APPARATUS.			
Base apparatus, primary—drawings of the apparatus for measuring base-lines, arranged and constructed in 1845-'46, A. D. Bache, Superintendent. (Illustration to Appendix 35, 1854)	1855	1854	54
Base apparatus for measurement of preliminary base-lines, devised by C. O. Boutelle, Assistant. (Illustration to Appendix 41, 1855)	1856	1855	53
Base apparatus—contact slide, for measuring subsidiary base-lines, devised by J. E. Hilgard, Assistant, and Joseph Saxton. (Illustration to Appendix 60, 1856)	1856	1856	64
Base apparatus—contact slide, etc., as above, with improvements. (Illustration to Appendix 45, 1857)	1858	1857	69
Base bar, 6-meter standard (illustration of experiments on length and expansion of. Appendix 26, 1862)	1864	1862	49
Base apparatus, primary—drawings of 1854, illustrating apparatus as arranged and constructed in 1845-'46. (Republished from Report of 1854 as illustration to Appendix 12, Report for 1873)	1875	1873	18
Base apparatus—contact slide, perfected form of, designed by J. E. Hilgard, Assistant. (Illustration to Appendix 17, 1880; faces page 344)	1882	1880	82
Base apparatus, primary—new 5-meter compensation apparatus for primary base-lines, from designs submitted by Charles A. Schott, Assistant. (Illustrations to Appendix 7, 1882)	1883	1882	26, 27
(See also wood-cuts, pages 108, 110, 111, 120, and 127.)			
Yolo base-line, California, 1881—sketches showing parts of apparatus employed in measurement and in comparisons with standard bar	1883	1882	29, 30
CURRENTS.			
Float for observation of surface currents (Patterson). (Illustration to Appendix 20, 1849)	1850	1849	15
Current indicator (Craven)	1855	1854	55
Subcurrent apparatus, improved form of (Mitchell). (Illustration to Appendix 26, 1859)	1860	1859	40
Surface and subsurface current floats (Marindin). (Illustration to Appendix 9, 1877, page 107)	1880	1877	....
Apparatus for observation of deep-sea currents (Pillsbury). (Illustration to Appendix 14, 1885; faces page 496)	1886	1885	36
(See also Sigsbee's "Deep-sea Sounding and Dredging," pages 123 to 130, and illustration 5, facing page 50, volume published by the Coast and Geodetic Survey in 1880.)			
DEEP-SEA SOUNDING APPARATUS.			
Specimen-box for deep-sea soundings (Craven). (Illustration to Appendix 54, 1854)	1855	1854	56
Specimen-box for deep-sea soundings (Sands). (Illustration to Appendix 56, 1855)	1856	1855	55
Deep-sea sounding apparatus (Sands)—Burt's sounding nipper, Massey's sounding indicator. (Illustrations to Appendix 46, 1857)	1858	1857	70

IV₁.—*Apparatus and instruments*—Continued.

Title.	Date of publication.	Year of report.	Number of illustration.
DEEP-SEA SOUNDING APPARATUS—continued.			
Deep-sea sounding apparatus used by Berryman on steamer *Arctic* (see page 34, 1857)	1858	1857	7a
Improved deep-sea sounding apparatus (Trowbridge). (Appendix 34, 1859)	1860	1859	39
Handy method of detaching shot in deep-sea soundings (Sigsbee). (Illustration to Appendix 14, 1874, facing page 152, 1874)	1877	1874	23
(See also volume published by the Survey in 1880, separately from annual report, with title "Deep-sea Sounding and Dredging (Sigsbee)," 41 plates, 13 wood-cuts.)			
DEEP-SEA TEMPERATURE AND DENSITY APPARATUS.			
Metallic thermometer for deep-sea temperatures (Saxton). (See page 39, 1848)	1849	1848	Dtris Diag. 4
Metallic thermometer for deep-sea temperatures (Saxton). (Appendix 17, 1860)	1861	1860	19
Ocean salinometer (Hilgard). (Illustration to Appendix 16, page 154, 1874)	1877	1874	....
Optical densimeter for ocean water (Hilgard). (Illustration to Appendix 10, page 110, 1877)	1880	1877	....
Drop-cylinder water-cup (Hilgard, Collins). (Illustration to Appendix 14, page 185, 1877)	1880	1877	....
Ocean salinometer. (Illustration to Appendix 14, page 188, 1877; see Appendix 16, 1874, also)	1880	1877	....
The Siemens electrical deep-sea thermometer (illustrations to Appendix 18, 1882):			
Wheatstone's bridge, page 455; galvanometer, page 456.			
Diagram showing connection of sinker and its resistance coil with the two insulated wires of the cable (follows page 457)	1883	1882	48
Diagram showing Wheatstone bridge apparatus and connections (follows page 457)	1883	1882	49
ELECTROTYPING AND ENGRAVING APPARATUS.			
Electrotype apparatus, Coast Survey Office (illustration to Appendix 55, 1851), plan of laboratory, arrangement of batteries, etc	1852	1851	58
Engraving pantograph (Sorensen's) in use by the Coast Survey. (Illustration to Appendix 5, 1867)	1869	1867	27
GEODESIC LEVELING INSTRUMENTS AND APPARATUS.			
Geodesic leveling instrument. (Faces page 202, 1879; illustration to Appendix 15, 1879)	1881	1879	52
Target and leveling rod for geodesic leveling instrument. (Faces page 203, 1879)	1881	1879	53
Geodesic micrometer level No. 1 (side view). (Illustration to Appendix 11, 1880; follows page 144)	1882	1880	46
Geodesic micrometer level No. 1, micrometer screw (front view). (Illustration to Appendix 11, 1880; follows page 144)	1882	1880	47
GEODETIC SIGNALING APPARATUS.			
Revolving heliotrope for geodetic purposes (Sands). (Illustration to Appendix 59, 1855)	1856	1855	55
Heliotrope, usual form. (Illustration to Appendix 11, 1866)	1869	1866	27
Form of reflector for use as a signal in triangulation (Hilgard). (Illustration to Appendix 10, 1867)	1869	1867	26
Magnesium reflector light for geodetic night signals as used in 1879 (Boutelle). (Illustration to Appendix 8, 1880; precedes page 109)	1882	1880	37
(See other illustrations to this Appendix, pages 106 and 108)	....	1880	36
GEODETIC SIGNALS, TRIPODS, AND SCAFFOLDS.			
Tripod and scaffold for primary triangulation (Boutelle) Stand and signal for secondary triangulation (Farley) Illustrations to Appendix 57, 1855	1856	1855	52
Plans of tripod and scaffold for signal. (Illustration to Appendix 7, 1868. See page 113, 1868)	1871	1868	....
Form of signal designed for and erected on Mount Shasta, California (Schott). (Illustration to face page 56, 1876)	1879	1876	25
See also in connection with Appendix 7, 1868, a reprint of that Appendix with additions, but not published in any report. (Illustrations on pages 8, 9, and 10. Title of paper, "Field Work of the Triangulation")	1880	1877	....
Sketches showing system of braces for a tripod and scaffold with floor 96 feet high. (Faces page 208 of report for 1882, Appendix 10)	1883	1882	31
Sketches showing plans of floor of scaffold, etc. (Follows page 208)	1883	1882	32
GRAVITY RESEARCH, APPARATUS FOR.			
Geneva wooden stand, Bessel reversible pendulum, and Geneva pendulum support. (Illustrations to Appendix 15, 1876, facing page 204)	1879	1876	26 27 28
GULF STREAM EXPLORATIONS—APPARATUS AND INSTRUMENTS.			
Metallic thermometer for deep-sea temperatures (Saxton):			
See page 39, 1848	1849	1848	Dtris Diag. 4
See also Appendix 17, 1860	1861	1860	19

IV.—*Apparatus and instruments*—Continued.

Title.	Date of publication	Year of report.	Number of illustration.
GULF STREAM EXPLORATIONS—APPARATUS AND INSTRUMENTS—continued.			
Float for observation of surface currents (Patterson). (Illustrations to Appendix 20, 1849)	1850	1849	15
Current indicator (Craven)	1855	1854	55
Specimen box for deep-sea soundings (Craven). (Illustration to Appendix 54, 1854)	1855	1854	56
Specimen box for deep-sea soundings (Sands). (Illustration to Appendix 56, 1855)	1856	1855	55
Deep-sea sounding apparatus (Sands). Burt's sounding nipper and Massey's sounding indicator. (Illustration to Appendix 46, 1857)	1858	1857	70
Deep-sea sounding apparatus used on steamer *Arctic* (Berryman). (See page 34, 1857)	1858	1857	71
Improved deep-sea sounding apparatus (Trowbridge). (Appendix 34, 1859)	....	1859	39
Improved form of subcurrent apparatus (Mitchell). (Illustration to Appendix 26, 1859)	1860	1859	40
Handy method of detaching shot in deep-sea soundings (Sigsbee). (Illustration to Appendix 14, 1874, facing page 152)	1877	1874	23
Ocean salinometer (Hilgard). (Illustration to Appendix 16, 1874, page 154)	1877	1874	....
Optical densimeter for ocean water (Hilgard). (Illustration to Appendix 10, page 110, 1877)	1880	1877	....
Drop-cylinder water-cup (Hilgard, Collins). (Illustration to Appendix 14, page 185, 1877). Also ocean salinometer (Hilgard), republished from Appendix 16, 1874, page 188, 1877)	1880	1877	....
(For full set of illustrations of apparatus and instruments employed by Sigsbee see volume prepared by that officer and published by the Survey in 1880, with the title "Deep-sea Sounding and Dredging." Forty-one illustrations—heliotypes or lithographs—and thirteen wood-cuts.)			
The Siemens electrical deep-sea thermometer. (Illustrations to Appendix 18, 1882. Wheatstone's bridge, page 455; galvanometer, page 456:			
Diagram showing connection of sinker and its resistance coil with the two insulated wires of the cable. (Follows page 457)	1883	1882	48
Diagram showing Wheatstone bridge apparatus and connections	1883	1882	49
Apparatus devised by Lieut. J. E. Pillsbury, U. S. N., Assistant, for observations of deep-sea currents. (Illustration to Appendix 14, 1885, faces page 496)	1886	1885	36
HYDROGRAPHIC WORK—SIGNALS, INSTRUMENTS, AND APPARATUS.			
Current float (Patterson). (Appendix 20, 1849)	1850	1849	15
Self-registering tide-gauge, devised by Joseph Saxton. (Appendix 38, 1853)	1854	1853	54
Current-indicator (Craven)	1855	1854	55
Gas-pipe tripod with revolving ball (Sands). (Illustration to Appendix 60, 1854)	1856	1855	54
Sea-coast tide-gauge (Mitchell). (Illustrations to Appendix 53, 1854)	1855	1854	57
Tide-gauge for exposed situations off the coast (Mitchell). (Illustration to Appendix 50, 1857)	1858	1857	72
Tide-gauge (Trenchard). (Illustration to Appendix 49, 1857)	1858	1857	72
Improved form of subcurrent apparatus and improved form of pile for securing a tide-gauge or hydrographic signal on coasts exposed to a heavy sea (Mitchell). (Illustrations to Appendix 26, 1859)	1860	1859	40
Specimen cup for shallow soundings (Mitchell). (Illustration to Appendix 39, 1860)	1861	1860	40
New form of dividers devised for the graphical decomposition of tidal curves (J. R. Gilliss). Appendix 40, 1860)	1861	1860	40
Self-registering tide-gauge, latest forms, with improvements (Avery). (Illustrations to Appendix No. 8, 1876, pages 133, 134, 135, 136, and 137—1876)	1879	1876	....
Drop-cylinder water cup (Hilgard and Collins) and ocean salinometer (Hilgard). (Illustrations to Appendix 14, 1877, pages 185 and 188)	1880	1877	....
Surface and subsurface current floats (Marindin). (Illustration to Appendix 9, 1877, page 107)	1880	1877	....
Device for water signal (Hanus). (Page 34, 1883)	1884	1883	....
Instruments devised for sketching inshore line (Fillmore). (Page 133, 1884)	1885	1884	....
NOTE.—For illustrations of instruments, apparatus, etc., used in special branches of hydrographic work, see under heads of Currents, Deep-sea sounding and deep-sea temperature and density apparatus, Gulf Stream explorations, Physical hydrography, and Tidal observations.			
HYPSOMETRY—INSTRUMENTS AND APPARATUS.			
See "Geodesic leveling."			
LONGITUDES, TELEGRAPHIC—APPARATUS AND INSTRUMENTS.			
Diagram of apparatus for the determination of longitudes by the electro-magnetic telegraph. (Illustration to Appendix 21, 1856)	1856	1856	65
Diagrams illustrating experiments on induction time in electro-magnets (Dean). (Illustration to Appendix 20, 1864)	1866	1864	39
Improvement on the Hipp chronograph (Eimbeck). (Illustration to Appendix 18, 1872, page 267)	1875	1872	....
Diagrams illustrating apparatus for the determination of personal equation. (Appendix 17, 1874, faces page 161)	1877	1874	24
Diagram showing arrangement of apparatus upon an observing table, etc. (Page 162)	1877	1874	....

IV$_1$.—*Apparatus and instruments*—Continued.

Title.	Date of publication.	Year of report.	Number of illustration.
LONGITUDES, TELEGRAPHIC—APPARATUS AND INSTRUMENTS—continued.			
Diagrams (wood-cuts) to illustrate Appendix 18, 1874. Transatlantic Longitudes: Page 166, reticule of transit at St. Pierre; Page 167, reticule of transit at Brest; Page 168, circuit-breaking apparatus on chronometer; Page 175, arrangements of connections for recording time-signals on chronographs at Brest, Greenwich, Paris	1877	1874	....
Diagram of telegraphic apparatus for longitude work, showing electrical connections. (Illustration to Appendix 7, 1880, faces page 94)	1882	1880	34
Diagram of telegraphic apparatus for longitude work, showing switch-board. (Follows No. 34)	1882	1880	35
Disposition and connection of telegraphic instruments. (Illustration to Appendix 14, 1880, follows page 241)	1882	1880	66
Disposition and connection of telegraphic instruments and chronograph. (Follows No. 66)	1882	1880	67
MAGNETIC DECLINATION, DIP, AND INTENSITY—APPARATUS AND INSTRUMENTS.			
Plan of magnetic observatory at Key West, Fla., with arrangement of magnetographs. (Appendix 26, 1860)	1861	1860	23
Theodolite magnetometer. (Illustration to Appendix 18, 1865)	1867	1865	29
Theodolite magnetometer. (Illustration to Appendix 14, 1872)	1875	1872	20
Dip circle. (Illustration to Appendix 14, 1872)	1875	1872	21
Magnetometer. (Illustration to Appendix 16, 1875, page 255)	1878	1875	27
Alt-azimuth and magnetometer. (Illustration to Appendix 16, 1875, page 259)	1878	1875	28
Dip circle. (Illustration to Appendix 16, 1875, page 264)	1878	1875	29
Dip circle, Kew Observatory pattern. (Illustration to Appendix 16, 1875, page 265)	1878	1875	29B
Magnetometer with theodolite. (Weber's design.) (Illustration to Appendix No. 8, 1881; faces page 158)	1883	1881	34
Magnetometer. Illustration to Appendix No. 8, 1881 (Lamont's design)	1883	1881	35
Alt-azimuth and magnetometer. (Appendix 8, 1881)	1883	1881	36
Dip circle. (Kew pattern; Appendix, 8, 1881; precedes page 159)	1883	1881	37
Plan of magnetic house at Point Barrow, Alaska. (Illustration to Appendix 13, 1883, page 327)	1884	1883	....
Arrangement of Brooke differential magnetometers at Point Barrow. (Page 329, 1883)	1884	1883	....
Bifilar and vertical-force magnetometers. (Pages 330, 331, 1883)	1884	1883	....
United States Polar Magnetic Station, Ooglaamie, Alaska. (Illustration to Appendix 13, 1883, page 335, 1883)	1884	1883	....
METEOROLOGICAL RESEARCHES—APPARATUS AND INSTRUMENTS.			
Apparatus for observations of atmospheric electricity at Sherman Station, Union Pacific Railroad, July and August, 1872. (Illustration to Appendix 8, 1872; opposite page 86)	1875	1872	....
PHYSICAL HYDROGRAPHY—APPARATUS AND INSTRUMENTS.			
Metallic thermometer for deep-sea temperatures (Saxton)	1849	1848	[illegible] Diag. 4
Current-float, Patterson. (Appendix 20, 1849)	1850	1849	15
Self-registering tide-gauge devised by Joseph Saxton. (Appendix 38, 1853)	1854	1853	54
Current indicator (Craven)	1855	1854	55
Specimen box for deep-sea soundings (Craven). (Illustration to Appendix 54, 1854)	1855	1854	56
Sea-coast tide-gauge (Mitchell). (Illustrations to Appendix 53, 1854)	1855	1854	57
Specimen box for deep-sea soundings (Sands). (Illustration to Appendix 56, 1855)	1856	1855	55
Deep-sea sounding apparatus (Sands); Burt's sounding nipper; Massey's sounding apparatus. (Illustrations to Appendix 46, 1857)	1858	1857	70
Deep-sea sounding apparatus used by Berryman on steamer *Arctic*. (See page 34, 1857)	1858	1857	71
Tide-gauge for exposed situations off the coast (Mitchell). (Illustration to Appendix 50, 1857)	1858	1857	72
Tide-gauge (Trenchard). (Illustration to Appendix 49, 1857)	1858	1857	72
Improved deep-sea sounding apparatus (Trowbridge). (Appendix 34, 1859)	1860	1859	39
Subcurrent apparatus, improved form of (Mitchell). (Illustration to Appendix 26, 1859)	1860	1859	40
Metallic thermometer for deep-sea temperatures (Saxton). (Illustration to Appendix 17, 1860. Republished from report of 1848. See page 39, 1848)	1861	1860	19
Specimen cup for shallow soundings (Mitchell). (Illustration to Appendix 39, 1860)	1861	1860	40
New form of dividers devised for the graphical decomposition of tidal curves (Gilliss). (Illustration to Appendix 40, 1860)	1861	1860	40
Handy method of detaching shot in deep-sea soundings (Sigsbee). (Illustration to Appendix 14, 1874, facing page 152)	1877	1874	23
Ocean salinometer (Hilgard). (Illustration to Appendix 16, 1874, page 154)	1877	1874	....
Self-registering tide-gauge; latest forms, with improvements (Avery). (Illustrations to Appendix 8, 1876, pages 133, 134, 135, 136, and 137)	1879	1876	....

IV₁.—*Apparatus and instruments*—Continued.

Title.	Date of publication.	Year of report.	Number of illustration.
PHYSICAL HYDROGRAPHY—APPARATUS AND INSTRUMENTS—continued.			
Surface and subsurface current-floats (Marindin). (Illustrations to Appendix 9, 1877, page 107)	1880	1877	....
Optical densimeter for ocean water (Hilgard). (Illustration to Appendix 10, page 110, 1877)	1880	1877	....
Drop-cylinder water-cup (Hilgard, Collins). (Illustration to Appendix 14, 1877, page 185)	1880	1877	....
Ocean salinometer (Hilgard). (Illustration to Appendix 14, 1877, page 185.) Reproduced from report for 1874, page 154; page 188, 1877	1880	1877	....
NOTE.—The instruments, apparatus, and appliances employed by Sigsbee in his investigations for the Coast Survey in physical hydrography (deep-sea sounding and dredging) are fully described and figured in the volume prepared by that officer and published by the Survey in 1880—title, "Deep-Sea Sounding and Dredging." Number of illustrations 54, of which 41 are heliotypes or lithographs and 13 wood-cuts.			
The Siemens electrical deep-sea thermometer. (Illustration to Appendix 18, 1882. Wheatstone's bridge, page 455; galvanometer, page 456):			
Diagram showing connection of sinker and its resistance coil with the two insulated wires of the cable. (Follows page 457)	1883	1882	48
Diagram showing Wheatstone bridge apparatus and its connections	1883	1882	49
Apparatus devised by Pillsbury for observations of deep-sea currents. (Illustration to Appendix 14, 1885; faces page 496)	1886	1885	36
SOLAR ECLIPSES—APPARATUS AND INSTRUMENTS.			
Device for exposure of photographic plate in observation of total solar eclipse August 7, 1869, at Springfield, Ill. (Illustration to Appendix No. 8, 1869, page 148)	1872	1869	....
Apparatus for controlling driving clock of equatorial in observation of total solar eclipse of December 22, 1870, at Jerez de la Frontera, Spain. (Illustration to Appendix 16, 1870, page 142)	1873	1870	....
Apparatus devised for production of an artificial corona December 22, 1870. Illustration to Appendix 16. 1870, page 167)	1873	1870	28, Fig. I
Eye-piece of equatorial. (Page 171)	1873	1870	28, Fig. III
Apparatus for measurement of amount of light remaining during totality. (Page 172)	1873	1870	28, Fig. IV
TELEGRAPHIC LONGITUDES—APPARATUS AND INSTRUMENTS.			
See "Longitudes, telegraphic."			
TIDAL OBSERVATIONS—APPARATUS AND INSTRUMENTS.			
Self-registering tide-gauge (Saxton). (Illustration to Appendix 38, 1853)	1854	1853	54
Sea-coast tide-gauge (Mitchell). (Illustration to Appendix 53, 1854)	1855	1854	57
Tide-gauge (Trenchard). (Illustration to Appendix 49, 1857)	1858	1857	72
Tide-gauge for exposed situations off the coast (Mitchell). (Illustration to Appendix 50, 1857)	1858	1857	72
New form of dividers devised for the graphical decomposition of tidal curves (J. R. Gilliss). (Illustration to Appendix 40, 1860)	1861	1860	40
Self-registering tide-gauge. Latest forms with improvements (Avery). (Illustrations to Appendix 8, 1876, pages 133, 134, 135, 136, and 137)	1879	1876	....
Maxima and minima tide-predicting machine (Ferrel). (Illustrations to Appendix, 1883, Nos. 27 to 31, inclusive. No. 27 faces page 272; the other plates follow in numerical order)	1884	1883	27-31
TIME, LATITUDE, LONGITUDE, AND AZIMUTH OBSERVATIONS—APPARATUS AND INSTRUMENTS.			
Diagram of apparatus for the determination of longitudes by the electro-magnetic telegraph. (Illustration to Appendix 21, 1856)	1856	1856	65
Diagrams illustrating experiments in induction time in electro-magnets (Dean). (Illustration to Appendix 20, 1864)	1866	1864	39
Portable transit. (Illustration to Appendix 9, 1866)	1869	1866	29
Zenith telescope. (Illustration to Appendix 10, 1866)	1869	1866	28
Thirty-inch theodolite. (Illustration to Appendix 11, 1866)	1869	1866	26
Twelve-inch repeating circle and heliotrope. (Illustration to Appendix 11, 1866)	1869	1866	27
Meridian and equal altitude instrument (Davidson). (Illustration to Appendix No. 8, 1867)	1869	1867	28
New form of mercurial horizon (Lane). (Illustration to Appendix No. 16, 1871, page 191)	1874	1871	....
Improvement on the Hipp chronograph (Eimbeck). (Illustration to Appendix 18, 1872, page 267)	1875	1872	....
Improved clamp for the telescope of the theodolite (Davidson). (Illustration to Appendix 15, 1874, page 153)	1877	1874	....
Diagrams illustrating apparatus for the determination of personal equation. (Illustration to Appendix 17, 1874, faces page 161)	1877	1874	24
Diagram showing arrangement of apparatus upon an observing table, etc. (Page 162)	1877	1874	....

IV₁.—*Apparatus and instruments*—Continued.

Title.	Date of publication.	Year of report.	Number of illustration.
TIME, LATITUDE, LONGITUDE, AND AZIMUTH OBSERVATIONS—APPARATUS AND INSTRUMENTS—continued.			
Diagrams (wood-cuts) to illustrate Appendix No. 18, 1874. Transatlantic Longitudes:			
Reticule of transit at St. Pierre. (Page 166)			
Reticule of transit at Brest. (Page 167)			
Circuit-breaking apparatus on chronometer. (Page 168)	1877	1874	....
Arrangements of connections for recording time-signals on chronographs at Brest, Greenwich, Paris. (Page 175)			
Apparatus for recording a mean of observed times (C. S. Peirce). (Illustration to Appendix 15, 1875):			
Recording relay (special form, page 250)	1878	1875	26
Diagram of apparatus (opposite page 250)			
Improved open vertical clamp for the telescopes of theodolites and meridian instruments (Davidson). (Illustration to Appendix 13, 1877, page 182)	1880	1877	....
The Davidson meridian instrument. (Illustration to Appendix 7, 1879, faces page 106)	1881	1879	35
Diagram of telegraphic apparatus for longitude work, showing electrical connections. (Illustration to Appendix 7, 1880, faces page 94)	1882	1880	34
Diagram of telegraphic apparatus for longitude work showing switch-board. (Follows No. 34)	1882	1880	35
Disposition and connection of telegraphic instruments. (Illustration to Appendix 14, 1880, follows page 241)	1882	1880	66
Disposition and connection of telegraphic instruments and chronograph. (Illustration to Appendix 14, 1880; follows No. 66)	1882	1880	67
Illustrations to Appendix 14, 1880, on the determination of time, longitude, latitude, and azimuth:			
Forty-six inch (117cm.) transit. (Follows page 227)	1882	1880	62
Portable transit. (Follows page 227)	1882	1880	63
Meridian transit, or transit and equal-altitude instrument	1882	1880	64
Prismatic transit and zenith telescope	1882	1880	65
Zenith telescope. (Follows page 259)	1882	1880	68
Thirty-inch theodolite. (Follows page 286)	1882	1880	69
Twenty-inch (50cm.) theodolite. (Follows page 286)	1882	1880	70
Eight to twelve- inch (20 to 30cm.) theodolite	1882	1880	71
Four-inch (10cm.) alt-azimuth, heliotrope, and azimuth mark. (Precedes page 287)	1882	1880	72
TOPOGRAPHY AND TOPOGRAPHIC SURVEYS—APPARATUS AND INSTRUMENTS.			
Telemeter rod, diagram showing graduation. (Illustration to Appendix 22, 1865; page 228)	1867	1865	....
Plane table, alidade and declinatoire, latest and most approved forms. (Illustrations to Appendix 13, 1880. (Follows page 172)	1882	1880	49, 50
Telemeter rod, divisions of. (Illustration to Appendix 13, 1880; follows page 190)	1882	1880	58
Stadia measurements. (Illustration to Appendix 13, 1880; follows page 192)	1882	1880	59
VARIOUS DIAGRAMS RELATING TO APPARATUS AND INSTRUMENTS.			
Illustration to Appendix No. 11, 1877—An examination of three new 20-inch theodolites. (Page 122)	1880	1877	....
Illustration to Appendix No. 12, 1879—Plan for an automatic connection to the graduating engine of the Coast Survey. (Page 197, 1879)	1881	1879	50

IV₂.—*Astronomical observations.*

Title.	Date of publication.	Year of report.	Number of illustration.
Illustrations to Appendix 21, 1860—Report on the expedition to Labrador to observe the total solar eclipse of July 18, 1860:			
Diagrams relating to instructions to observers. (Pages 234, 236)	1861	1860	....
Sketch showing appearance of cusp. (Page 242)	1861	1860	....
Sketch of Eclipse Harbor, Labrador	1861	1860	38
Outline of coast of Labrador and sketch showing geology of that coast. (Appendix 41, 1860)			
Diagrams illustrating phenomena of eclipse	1861	1860	39
Illustration to Appendix 19, 1861—Solar spots observed at Gunstock Station, N. H., and at Washington, D. C., in connection with the solar eclipse of July 18, 1860	1862	1861	29
Illustrations to Appendix 8, 1869. Total solar eclipse, August 7, 1869:			
Location of station and observers of solar eclipse at Falmouth, Ky. (Pages 130, 131.)	1872	1869	....
Diagram of solar spots at Shelbyville, Ky. (Page 137)	1872	1869	....
Diagram of solar spots at Shelbyville, Ky. (Page 139)	1872	1869	....
Diagram of solar spots, with outline of corona. (Pages 142, 143)	1872	1869	....

IV$_2$.—*Astronomical observations*—Continued.

Title.	Date of publication.	Year of report.	Number of illustration.
Illustrations to Appendix 8, 1869. Total solar eclipse, August 7, 1869—Continued.			
Sketches of Baily's beads before totality and prominences on western limb of sun, as observed at Springfield, Ill., August 7, 1869. (Pages 150, 151)	1872	1869	....
Sketches showing bisection of solar spots, solar protuberances, etc. (Pages 156, 157)	1872	1869	....
Diagram showing path of the total eclipse of August 7, 1869 (astronomical day, August 8)	1872	1869	24
Diagrams illustrating the corona and other phenomena of eclipse as observed at stations in Alaska, Illinois, Virginia, and Tennessee	1872	1869	25
Diagrams illustrating phenomena of eclipse as observed at Des Moines and Cedar Falls, Iowa, and Saint Louis, Mo	1872	1869	26
Diagrams and sketches illustrating reports of observation of the total solar eclipse of December 22, 1870. Appendices 16 and 16*, 1870:			
Sketch of location of station at Carlentini, Sicily. (Page 129, 1870)	1873	1870	....
Tracings of corona; observation at Jerez, Spain. (Page 149)	1873	1870	....
Sketch to illustrate note on page 165	....	....	....
Sketches. (Pages 167, 168, 171, 172)	....	....	....
Diagram showing station near Jerez, etc	1873	1870	28
Sketch of corona as seen at Catania, Sicily	1873	1870	29
Illustrations to Appendix 8, 1872—Report of astronomical and meteorological observations made at Sherman, Wyoming Territory:			
Curves of daily variations (atmospheric). (Faces page 80) Curves of hourly oscillations (atmospheric). (Faces page 82) Part of solar spectrum. (Fig. 1, page 159) Spectrum of sun-spots. (Fig. 2, page 164) Spectrum of solar prominence. (Fig. 3, page 167) Forms of solar prominences. (Page 168)	1875	1872	....
Sherman station, sketch showing location of observatory, etc	1875	1872	18
Sketch showing location of transit of Venus station of 1769 at San José del Cabo, Lower California. (Illustration to Appendix 10, 1874)	1877	1874	22
Illustration to Appendix 13, 1875—Report of Transit of Venus Expedition to Japan. (Page 223)	1878	1875	....
Illustration to Appendix 14, 1875—Report of Transit of Venus Expedition to Chatham Island; sketch showing station of observation at Whangaroa Harbor. (Faces page 232)	1878	1875	25
Diagrams illustrating Appendix No. 6—Report for 1878. Observations of the Transit of Mercury, May 6, 1878:			
Sketch showing location of observing station. (Faces page 82)	1881	1878	27
Sketch showing positions of planet Mercury during observations at Summit station. (Faces page 86)	1881	1878	28
Illustrations to Appendix 20, 1882—The total solar eclipse of January 11, 1880, as observed at Santa Lucia, Cal.:			
Diagram of disks of sun and moon and of cusps of sun and disk of moon. (Faces page 468)	1883	1882	51
Sketches of corona, protuberances, etc	1883	1882	52

IV$_3$.—*Azimuth determinations.*

See "Time, latitude, and azimuth determinations."

IV_4.—*Base-lines and base-measurements—Diagrams relating to and showing results of.*

Title.	Date of publication.	Year of report.	Number of illustration.
Illustration to Appendix 26, Report for 1857. Diagrams showing profile and cross-sections of Epping base, Maine; also plans of monument, etc	1858	1857	3
Progress sketch No. 1 to Report for 1862, showing the triangulation connecting the Epping, Massachusetts, and Fire Island primary base-lines	1864	1862	1
NOTE.—For other sketches showing this connection see heading II and Section I.			
Sketch showing the primary triangulation between Fire Island and Kent Island base-lines, 1833 to 1851. (Illustration to Appendix 8 and supplement, Report for 1866)	1869	1866	10
Atlanta base-line and primary triangulation connected therewith. (See Appendix No. 12, 1873)	1875	1873	11
Maryland and Georgia base-lines, primary triangulation between*	1879	1876	10, 11
Illustrations to Appendix No. 8, Report for 1882. Report of the measurement of the Yolo base-line, California:			
Sketch showing markings of stone placed at end of bar to mark its projection beyond base station. (Page 142)	1883	1882	....
Yolo base-line. Topographical sketch. Profile and connection with the main triangulation	1883	1882	28
Yolo base-line. Plans and vertical sections of subsurface marks at southeast base. Views of trestle bridges and platforms, and of parts of apparatus	1883	1882	29
Plan showing party at work; sketch showing portable base-bar, comparing beam, and fractional bar-measure	1883	1882	30
Diagrams illustrating the results of the discussion for length of the Yolo base, California. (See Appendix 11, 1883; faces page 288)	1884	1883	32
Sketches illustrating Appendix 9, 1885. Results deduced from the geodetic connection of the Yolo base-line with the primary triangulation of California	1886	1885	....
Diagram of triangulation immediately connecting with Yolo base, page 442. Progress sketch —, 1885, No. 16	1886	1885	16

* For additional sketches showing this triangulation see heading II and Sections III, IV, and V.

IV_5.—*Current observations and stations.*

Title.	Date of publication.	Year of report.	Number of illustration.
Sketch showing positions occupied in making observations on currents in New York Bay and Harbor and the East River. (See pages 17, 18, 1845)	1846	1845	C^2
Sketch showing current stations occupied in Fisher's Island Sound	1846	1845	C^1
Chart showing course and velocity of tidal current at ebb in Boston Harbor from observations in 1847-'48. (See Appendix 8, 1851)	1852	1851	A^3
Tidal currents of Nantucket Shoals. (Illustration to Appendix 48, 1854)	1855	1854	13
Tidal currents of Long Island Sound and approaches. (Illustration to Appendix 50, 1854)	1855	1854	16
Sketches showing the current stations occupied in and near New York Harbor Entrance, and diagrams showing velocity of currents in same localities, and also the set of currents in Sandy Hook Bay. (Illustration to Appendix 27, 1858)	1859	1858	39
Diagram presenting a general scheme of currents in New York Harbor and its approaches from observations 1857-1858. (Illustration to Appendix 13, 1867, page 168)	1869	1867	....
Diagrams to illustrate Appendix 10, 1871, on the location of harbor-lines	1874	1871	35
Current stations, Middle Ground Shoal, New York Harbor. (Illustration to Appendix 16, 1872)	1875	1872	22
Diagram of transverse curves of maximum velocities of ebb and flood currents in Fore River, Portland, 1873. (Illustration to Appendix No. 8, Report on "Physical Survey of Portland Harbor;" faces page 102, 1873)	1875	1873	....
Curves of velocity and density at South Pass Bar, Mississippi River. (Illustration to Appendix No. 11, 1875; faces page 190)	1878	1875	24
Flood and ebb currents in the vicinity of the United States Navy-Yard, New York. (Illustration to Appendix 11, 1876)	1879	1876	23
Illustrations to Appendix No. 10, 1879. Physical hydrography of the Gulf of Maine:			
Currents at entrance to Gulf of Maine. (Diagram facing page 175)	1881	1879	40
Diagram (page 181) showing varying courses and velocities of current on the eastern slope of George's Bank. (See page 182)	1881	1879	....
Chart of currents in Bering Sea and adjacent waters, 1881. (Illustration to Appendix 16, 1880)	1882	1880	81
Illustrations to Appendix No. 14, Report for 1885. Report on deep-sea current work in the Gulf Stream:			
Chart showing locality of cross-section A for observation of Gulf Stream currents. (Faces page 500)	1886	1885	37

IV$_5$.—*Current observations and stations*—Continued.

Title.	Date of publication.	Year of report.	Number of illustration.
Illustrations to Appendix No. 14, Report for 1885. Report on deep-sea current work in the Gulf Stream—Continued.			
Chart showing positions of current stations, cross-section A, Gulf Stream	1886	1885	38
Variation in velocity of currents with changes in moon's declination	1886	1885	39
Curves from observations of currents, Gulf Stream, and declination and phase of moon at times of observation (No. 40)	1886	1885	40, 41
Curves of observations of currents, Gulf Stream	1886	1885	42
Curves of observations of currents, Gulf Stream	1886	1885	43
Curves of observations of currents, Gulf Stream	1886	1885	44
Curves of observations of currents, Gulf Stream	1886	1885	45
Curves of observations of currents, Gulf Stream	1886	1885	46

IV$_6$.—*Deep-sea soundings.*

Title.	Date of publication.	Year of report.	Number of illustration.
Sketch showing the progress of offshore soundings, Section II (Montauk Point to Delaware entrance,) in 1844 and 1848	1849	1848	B tris
Sketch showing the progress of deep-sea soundings in Sections II, III, and IV, 1849 to 1851	1852	1851	D4
Sketch of the Gulf of Mexico, showing lines of deep-sea soundings and profiles of bottom, scale 1-2400000 (see page 89, Report 1855)	1856	1855	38
Sketch of the Gulf of Mexico, showing lines of deep-sea soundings and profiles of bottom, scale 1-2400000 (see page 66, Report 1856)	1856	1856	40
Curves illustrating the descent of the sounding weight and line in deep-sea soundings (see Appendix No. 37, Report 1858)	1859	1858	38
Diagrams to illustrate Appendix No. 5, 1866:			
Sections of soundings across the Florida Channel from Sand Key Light to El Moro Light, April and May, 1866	1869	1866	17
Diagram showing rates of outrun of line (page 139)	1869	1866	....
Soundings taken in February and March, 1872, across the Yucatan Channel (see page 32, Report for 1872)	1875	1872	24
Deep-sea soundings in the Gulf of Mexico and Caribbean Sea, scale 1-8000000 (see Appendix No. 6, pages 100 to 102)	1881	1879	21
Deep-sea soundings, etc. (same sketch), (see pages 27, 28, Report for 1880)	1882	1880	21
Deep-sea soundings, etc. (same sketch), (see pages 29, 30, Report for 1881)	1883	1881	21
Depths and temperatures observed in the western part of the North Atlantic Ocean, between 1881 and 1883 (illustration to Appendix 19, 1882)	1883	1882	50

IV$_7$.—*Drawing paper, tests of.*

Title.	Date of publication.	Year of report.	Number of illustration.
Diagrams illustrating the contraction and expansion of backed antiquarian and parchment drawing paper from experiments made in April and May, 1861 (illustration to Appendix No. 15, 1861)	1862	1861	....

IV$_8$.—*Drawings, topographical.*

See "Topography and Topographical drawings."

IV$_9$.—*Eclipses, solar.*

See "Solar eclipses."

IV_{10}.—*Geodesic leveling.*

Title.	Date of publication.	Year of report.	Number of illustration.
Diagrams illustrating Appendix 34, Report of 1854 (pages 96, 98)	1855	1854	....
Illustrations to Appendix No. 11, 1871.* Comparison of methods of determining heights by leveling, vertical angles, and barometric measures (pages 161 and 170, 1871)	1874	1871	....
Diagrams to illustrate Appendix No. 11, Report for 1880. On geodesic leveling on the Mississippi River:			
Diagram of stations (faces page 144)	1882	1880	45
For other diagrams see "Apparatus and instruments."			
Diagrams illustrating Appendix No. 11, 1882. Results of the transcontinental line of geodetic spirit-leveling, etc.:			
Wood-cut (page 520) showing reading point of tide-gauge and water-level at Sandy Hook, N. J	1883	1882	....
Wood-cut (page 556) showing inscription on bench-mark at East Saint Louis, Mo	1883	1882	....
Diagram (facing page 556) showing route of line and position of principal bench-marks between Sandy Hook and Saint Louis	1883	1882	32½
Hypsometric measures at Mount Diablo and Martinez East, California, March and April, 1880 (illustration to Appendix 12, 1883)	1884	1883	33
Illustrations to Appendix 10, 1884. Results of a trigonometrical determination of the heights of the stations forming the Davidson quadrilaterals (pages 401 and 404, 1884)	1885	1884	....

* Reprinted with same illustrations as Appendix 16 to the Report for 1876. Illustrations on pages 348, 353, 1876.

IV_{11}.—*Geodetic surveys, methods and results.*

Title.	Date of publication.	Year of report.	Number of sketch.
Illustrations to Appendix No. 33, Report for 1854. Comparison of methods of reduction of horizontal angles, etc.:			
Progress sketch, Section I	1855	1854	A bis
Sketches, Illustration No. 58	1855	1854	58
Sketch showing the primary triangulation between the Fire Island and Kent Island base-lines, illustration to Appendix No. 8, 1866. Report on the geodetic connection of the two primary base-lines in New York and Maryland	1869	1866	10
Diagram to illustrate Appendix No. 9, 1867. On the use of railways for geodetic purposes	1869	1867	26
Illustrations to Appendix No. 7, Report for 1868. Field work of the secondary triangulation:			
Reduction to center of station (diagram, page 119); Computation of spherical excess (diagram, page 123); Three-point problem (diagrams, page 130); Rectangular co-ordinates on a plane projection (page 131); Measurement of base-line, crossing a creek, etc. (page 137)	1871	1868	....
NOTE.—This paper was reprinted with additions to both text and illustrations in 1877, but was then printed separately, not appearing as an appendix to any Annual Report. For the illustrations to the third edition see Report for 1882.			
Sketch illustrating the adjustment of the triangulation of Long Island Sound and the Nantucket arc of the meridian (see Appendices Nos. 8 and 9, 1868)	1871	1868	6
Diagram showing station errors in latitude and azimuth on the Nantucket arc (page 151, 1868)	1871	1868	....
Diagrams on pages 268, 273, 274, to illustrate Appendix 15, Report for 1868	1871	1868	....
Illustrations to Appendix No. 7, 1869. Local deflections of the zenith in the vicinity of Washington City:			
Diagram (page 115, 1869)	1872	1869	....
Topographical sketch, showing hypsometrical features of country surrounding Washington	1872	1869	23
Diagram illustrating Appendix 21, 1870. On the theory of errors of observation	1873	1870	27
Diagrams (pages 164 and 170, Report 1871) to illustrate Appendix 11, 1871. Comparison of methods of determining heights, etc	1874	1871	....
Diagrams (pages 186 and 188, Report 1871) to illustrate Appendix 15. On the adaptation of triangulations to the various conditions of configuration, etc., of the surface of a country	1874	1871	....
Illustration to Appendix 12, 1873. Primary triangulation, vicinity of Atlanta	1875	1873	11
Illustration to Appendix 13, 1873. Note on intervisibility of stations (page 137, 1873)	1875	1873	....
Diagrams (pages 282, 285, 288, and 289) to illustrate Appendix No. 17, Report of 1875	1878	1875	....
Diagrams (pages 315 and 316, Report for 1875) to illustrate Appendix 19. Formulæ and factors for the computation of geodetic latitudes, longitudes, and azimuths	1878	1875	....
Sketch and drawing to illustrate Appendix 10, 1875. Report on Mount St. Elias and Mount Fairweather and some adjacent mountains (following page 160, 1875)	1878	1875	....

IV$_{11}$.—*Geodetic surveys, methods and results*—Continued.

Title.	Date of publication.	Year of report.	Number of sketch.
Illustrations to papers on hypsometry—Appendices 16, 17, 18, and 19, Report for 1876:			
To Appendix No. 16 (pages 348 and 353) } To Appendix No. 17 (page 362) } To Appendix No. 18 (pages 369 and 381) }	1879	1876	....
Diagrams to illustrate Appendix 20, Report for 1876. On the adaptation of triangulations, etc. (reprinted with additions from the Report for 1871; see pages 393, 394, 396, and 397 of 1871)	1879	1876	....
Diagrams showing the triangulation referred to in Appendix 6, 1877. The Pamplico-Chesapeake arc of the meridian, etc. (see progress sketches 6 and 7, Report 1877)	1880	1877	....
Diagram (page 119, Report for 1878) to illustrate Appendix 8, 1878. On the adjustment of the primary triangulation between the Kent Island and Atlanta base-lines	1881	1878	....
Diagram showing apparent local deflections of the vertical for the oblique arc along the Atlantic coast from Atlanta, Ga., to Calais, Me. (illustration to Appendix No. 8, 1879)	1881	1879	36
Illustration showing route of lines of geodesic leveling between Fort Adams and Red River Landing, on the Mississippi River (faces page 144, Report of 1880, Appendix No. 11)	1882	1880	45
Diagrams illustrating Appendix No. 9, 1882. Field work of the triangulation (third edition; see pages 156, 157, 158, 167, 172, 184, 185, and 191, Report for 1882)	1883	1882	....
Illustrations to Appendix No. 11, 1882. Results of the transcontinental line of geodetic spirit-leveling from Sandy Hook to Saint Louis:			
Sketch showing marking of bench-mark on page 556	1883	1882	....
Route diagram, showing position of principal bench-marks (facing page 556)	1883	1882	32½
Illustration to Appendix 11, 1883. Results for the length of the Yolo base (faces page 288)	1884	1883	32
Illustration to Appendix 12, 1883. Results of observations for atmospheric refraction in California, etc. (follows page 321)	1884	1883	33
Diagrams showing the triangulation between the Hudson River and Lake Ontario, to illustrate Appendix 9, Report for 1884 (faces page 390)	1885	1884	20
Illustrations to Appendix No. 10, 1884. Results of a trigonometrical determination of the heights of the stations forming the Davidson quadrilaterals:			
Diagram of stations, page 401 } Diagram of stations, page 404 }	1885	1884	....
Sketch showing triangulation, etc	1885	1884	18
Illustrations to Appendix No. 10, 1885. On geodetic reconnaissance (diagrams, pages 476 and 478); sketches of triangulation, Boston Bay and vicinity Edisto base, South Carolina (following page 480)	1886	1885	27, 28

IV$_{12}$.—*Geographical positions.*

Title.	Date of publication.	Year of report.	Number of illustration.
Sketches to illustrate Appendix 7, Report for 1853. List of geographical positions determined by the U. S. Coast Survey since July, 1850	1854	1853	A–K
Sketches to illustrate Appendix 8, 1855. List of geographical positions, etc	1856	1855	A–J
Sketches to illustrate Appendix 25, 1857. List of geographical positions, etc	1858	1857	1, 2, 11, 16, 25, 31, 40, 44, 47, 53, 57, 63
Sketches to illustrate Appendix 20, 1859. List of geographical positions, etc	1860	1859	2, 7, 9, 16, 20, 21, 23, 26, 28, 31, 34
NOTE.—Lists of geographical positions are published also as appendices to the annual reports for 1851, 1864, 1865, 1868, and 1874, but without special reference to progress sketches.			
Illustrations to Appendix No. 8, 1885. Geographical positions of trigonometrical points in the States of Massachusetts and Rhode Island:			
Triangulation in eastern Massachusetts and in Rhode Island	1886	1885	25
Triangulation in western Massachusetts and connection with the Hudson River	1886	1885	26

IV$_{13}$.—*Geological maps.*

Title.	Date of publication.	Year of report.	Number of illustration.
Illustrations to Appendix No. 65, Report for 1855. On the physical geography and geology of the coast of California from Bodega Bay to San Diego:			
Map of Point Reyes and vicinity, California	1856	1855	57
Map of the vicinity of the Golden Gate	1856	1855	58
Map of the vicinity of Monterey Bay, California	1856	1855	59
Map of the country between San Diego and the Colorado River, California	1856	1855	60
Sketch showing the geology of the coast of Labrador (to illustrate Appendix 42, Report for 1860)	1861	1860	38
Illustration to Appendix No. 12, Report for 1880. Report on the blue clay of the Mississippi River. Geological map of the Mississippi embayment (follows page 170)	1882	1880	48
Geology of the sea bottom in the approaches to New York Bay (illustration to Appendix No. 13, 1884; faces page 438)	1885	1884	24

IV$_{14}$.—*Gravity research.*

Title.	Date of publication.	Year of report.	Number of illustration.
Illustrations to Appendix No. 15, Report for 1876. Measurements of gravity at initial stations in America and Europe:			
Pendulum station, Stevens Institute, Hoboken (facing page 204)	1879	1876	26^a
Sketch showing Geneva wooden stand, Bessel's reversible pendulum, and Geneva pendulum support (facing page 205)	1879	1876	26, 27, 28
Rates of the meridian clock of the Paris Observatory (facing page 208)	1879	1876	29
Pendulum at Kew, correction to chronometers (faces page 212)	1879	1876	30
Pendulum at Hoboken, June, 1877, corrections of chronometers after applying mean rates (faces page 224)	1879	1876	31
Pendulum at Hoboken (diagrams 32 to 35, inclusive; follow page 224)	1879	1876	32, 33, 34, 35
Pendulum at Hoboken, decrement of arc (follows page 254)	1879	1876	35
Pendulum at Hoboken, heavy end down and heavy end up (diagrams, following page 272)	1879	1876	37^a, 37^b
Pendulum at Hoboken (diagram, facing page 318)	1879	1876	37^c
Illustration (page 198, Report for 1876) to Appendix No. 14. Note on the theory of the economy of research (practical application of theory at close of appendix to gravity research)	1879	1876	....
Diagram (page 444, Report for 1881) to illustrate Appendix 15. On the deduction of the ellipticity of the earth from pendulum experiments	1883	1881	....
Diagrams (pages 457, 458, Report for 1881) to illustrate Appendix 16, 1881	1883	1881	....

IV$_{15}$.—*Gulf Stream explorations.*

Title.	Date of publication.	Year of report.	Number of illustration.
Diagram illustrating the progress of exploration of the Gulf Stream in 1846 (Appendix No. 4, 1846) } Do }	1847	1846	6, 7
Sketch showing the positions and comparisons of the observations in and across the Gulf Stream in 1846 and 1847 (see pages 30–33, 1847)	1848	1847	D^{bis}
Sketch showing the positions and comparisons of the observations in and across the Gulf Stream in 1845, 1846, 1847, and 1848 (see pages 38–41, 1848)	1849	1848	D^{bis}
Sketches showing mean curves of temperature and comparisons of temperature curves	1849	1848	D^{tris}
Diagram of mean curves showing temperatures at same depth in different positions (see pages 38–41, Report for 1848)	1849	1848	D^{tris}
Sketch showing positions and comparison of observations of temperature in the Gulf Stream in 1845, 1846, 1847, 1848, and 1853	1854	1853	15
Diagram of the results of the Gulf Stream explorations, 1853 (see pages 46 to 52, Report for 1853)	1854	1853	16
Sketch showing the positions and comparison of observations of temperature in the Gulf Stream in 1845, 1846, 1847, and 1848, and in 1853 and 1854 (illustration to Appendix 47, 1854)	1855	1854	24
Diagrams showing the results of the Gulf Stream explorations from observations made in 1845, 1846, 1847, 1848, and 1853 (illustration to Appendix 47, 1854)	1855	1854	25
Gulf Stream sketch, showing the axis and limits of the Stream as determined from observations of temperature in the Coast Survey, and the limits as marked by Dr. Franklin in 1769 and 1770 (see pages 53 to 55, Report for 1855)	1856	1855	17

IV_{15}.—*Gulf Stream explorations*—Continued.

Title.	Date of publication.	Year of report.	Number of illustration.
Diagrams showing the results of the Gulf Stream explorations from observations made in 1845, 1846, 1847, 1848, 1853, 1855, 1858, and 1859 (to illustrate Appendix 25, 1859)	1860	1859	35
Illustrations to Appendix 17, Report for 1860:			
Diagrams showing the results of the Gulf Stream explorations, etc	1861	1860	19
Do	1861	1860	20
Chart of the Gulf Stream, showing its axis and limits as determined from explorations between 1845 and 1860	1861	1860	21
Diagrams illustrating Gulf Stream explorations in 1860	1861	1860	22
Sections of soundings across the Florida Channel from Sand Key Light to El Moro Light, 1866 (illustration to Appendix No. 5, 1866)	1869	1866	17
Section of the Gulf Stream on a line N. 8° W. from Chorrera, Cuba (illustration to Appendix 15, 1867)	1869	1867	25
Soundings across the Yucatan Channel from Mugeres Island, Yucatan, to Cape San Antonio Light-House, Cuba (see page 32, Report for 1872)	1875	1872	24
Deep-sea soundings in the Gulf of Mexico and Caribbean Sea (references to this chart, pages 46 to 50, 1879)	1881	1879	21
Deep-sea soundings in the Gulf of Mexico and Caribbean Sea (references to this chart, pages 27, 28, 1880)	1882	1880	21
Deep-sea soundings in the Gulf of Mexico and Caribbean Sea (references on pages 29, 30, 1881)	1883	1881	21
Depths and temperatures observed in the western part of the North Atlantic Ocean between 1881 and 1883, including also lines run by H. M. S. *Challenger* in 1873 (illustration to Appendix 19, 1882)	1883	1882	50
Illustrations to Appendix No. 14, Report for 1885. Report on deep-sea current work in the Gulf Stream: (for illustration 36 see Apparatus and Instruments):			
Chart showing locality of cross-section A, between Fowey Rocks and Gun Cay (faces page 500)	1886	1885	37
Positions of current stations on cross-section A	1886	1885	38
Profile of bottom, cross-section A, and variations in velocity of currents	1886	1885	39
Declination and phase of moon at times of observation	1886	1885	40
Curves of observation of currents, station 1^b	1886	1885	41
Curves of observation of currents at stations $1\frac{1}{2}^a$, 1^c, 1^d, and 1^e	1886	1885	42
Curves of observation of currents at station 1^f, and vertical curves	1886	1885	43
Curves of observation of currents at stations 1, 1^a, $1\frac{1}{2}$, and 2	1886	1885	44
Curves of observation of currents at stations 5, 5^a, and 5^b, and vertical curve at station 5^a	1886	1885	45
Curves of observation of currents at stations 3^a, 3, 4, and 4^a	1886	1885	46
NOTE.—Numbers 38 to 46, inclusive, are bound in with and follow 37.			

IV_{16}.—*Harbor and river improvements.*

Title.	Date of publication.	Year of report.	Number of illustration.
Sketches to illustrate Appendix No. 18, Report for 1875. Observations on certain harbor and river improvements, collected on a voyage from Hong-Kong, via Suez, to New York	1878	1875	30

IV_{17}.—*Hydrography.*

The diagrams and sketches coming under this general heading will be found classified as follows:

Under *Apparatus and instruments*, such as have been or are now employed in observations for Currents, Deep-sea soundings, Deep-sea temperatures and densities, Gulf Stream explorations, Hydrographic work, Physical hydrography and Tides.

Also under the following general headings:

IV_5.—*Current observations and stations.*
IV_6.—*Deep-sea soundings.*
IV_{15}.—*Gulf Stream explorations.*
IV_{25}.—*Meteorological researches.*
IV_{27}.—*Oyster-bed surveys and explorations.*
IV_{28}.—*Physical hydrography.*
IV_{33}.—*Tidal observations, discussions, and results.*

IV_{18}.—*Hypsometry.*

Title.	Date of publication.	Year of report.	Number of illustration.
Diagram to illustrate Appendix No. 17, 1876. Observations of atmospheric refraction (Contribution No. II, page 362, 1876)	1879	1876	....
Diagrams to illustrate Appendix No. 18, 1876. On atmospheric refraction and adjustment of hypsometric measures (Contribution No. III, pages 369 and 384, 1876)	1879	1876	....
Diagram to illustrate Appendix No. 10, Report for 1881. Barometric hypsometry and reduction of the barometer to sea level (faces page 268, 1881)	1883	1881	38
Illustrations to Appendix No. 10, 1884. Results of a trigonometrical determination of the heights of the stations forming the Davidson quadrilaterals (pages 401 and 404, 1884)	1885	1884	....
NOTE.—For other sketches and diagrams illustrating papers relating to the determination of heights by geodesic leveling, by vertical angles, or by the barometer, see under IV_1, *Apparatus and instruments*, the sub-heading "Geodesic leveling instruments and apparatus," and also the general heading, IV_{10}, *Geodesic leveling.*			

IV_{19}.—*Instruments and apparatus.*

See "IV_1.—Apparatus and instruments."

IV_{20}.—*Isogonic, isoclinic, and isodynamic maps, charts, and diagrams.*

See "IV_{24}.—Magnetic declination, dip, and intensity."

IV_{21}.—*Latitude determinations.*

See "IV_{34}.—Time, latitude, and azimuth determinations."

IV_{22}.—*Longitudes—chronometric.*

Title.	Date of publication.	Year of report.	Number of illustration.
Diagrams illustrative of the determination of the difference of longitude between Charleston and Savannah by chronometer exchanges, Appendix 30, 1857	1858	1857	67

IV_{23}.—*Longitudes—telegraphic.*

Title.	Date of publication.	Year of report.	Number of illustration.
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and 1877 (see page 10, Report 1876)	1879	1876	3
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and 1878	1881	1878	26
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and 1879	1881	1879	32
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and 1880	1882	1880	32
Illustration to Appendix No. 6, Report for 1880. Telegraphic longitudes: (diagram showing connections adjusted in June, 1880; faces page 92)	1882	1880	33
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and July, 1881	1883	1881	32
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and July, 1882	1883	1882	25
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and June 30, 1883	1884	1883	24
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and June 30, 1884	1885	1884	19
Illustration to Appendix No. 11, Report for 1884. Telegraphic longitudes (diagram showing connections adjusted), data to July, 1884; faces page 430	1885	1884	21
Map showing longitude stations and connections determined by means of the electric telegraph between 1846 and June 30, 1885	1886	1885	17

IV_{24}.—*Magnetic declination, dip, and intensity.*

Title.	Date of publication.	Year of report.	Number of illustration.
Diagrams to illustrate the secular variation of the magnetic declination (see Appendix 48, 1855)	1856	1855	51
Lines of equal magnetic declination on the coast of the United States for the year 1850 (Appendix 47, 1855)	1856	1855	56
Lines of equal magnetic declination on the coast of the United States for the year 1850 (Appendix 28, 1856, also diagram, page 213)	1856	1856	61
Diagrams to illustrate the secular variation in the magnetic inclination (Appendix 32, 1856)	1856	1856	63
Lines of equal magnetic dip and horizontal intensity for the year 1850 (Appendix 28, 1856)	1856	1856	62
Diagram to illustrate the gradual loss of magnetism of the several magnets in use on the Survey of the Coast between the years 1845 and 1857 (to illustrate Appendix 32, 1857)	1858	1857	68
Diagram, page 194, Report for 1858, to illustrate Appendix 25, 1858. Rediscussion and development of an intermediate period in the secular change of the magnetic declination at Hatboro', Pa	1859	1858	....
Discussion of the magnetical and meteorological observations made at the Girard College, Philadelphia, in the years 1840 to 1845 (to illustrate Appendix No. 22, 1859)	1860	1859	37
Lines of equal magnetic variation for the year 1858 projected on a polyconic development of the sphere	1860	1859	38
Illustrations to Appendices 23 and 24, 1860. Discussion of the magnetic and meteorological observations at Girard College, Philadelphia, 1840 to 1845	1861	1860	7
Illustrations to Appendix 26, 1860. Variations to the magnetic declination and of horizontal force and temperature at Key West, Fla., March, 1860	1861	1860	23
Lines of equal magnetic declination on the Atlantic coast from Virginia to Florida for the epoch 1860. Also for the Gulf of Mexico for the same epoch. (To illustrate Appendices 23 and 24, Report for 1861)	1862	1861	30
Chart of isomagnetic lines of Pennsylvania for 1842. (Illustration to Appendix 19, 1862)	1864	1862	47
Illustration to Appendices 15, 16, and 17, 1862. Discussion of the magnetic and meteorological observations at Girard College, Philadelphia, 1840–1845	1864	1862	48
Illustration to Appendices 19, 20, and 21, Report for 1863. Discussion of the Girard College magnetic and meteorological observations, 1840–1845	1864	1863	30
Illustrations to same discussion continued in Report for 1864, Appendices 16, 17, and 18	1866	1864	38
Diagrams to illustrate Appendix No. 18, Report for 1865. Results of magnetical observations made at Eastport, Me., between 1860 and 1864. (Pages 167, 170, 172, and 174, 1865)	1867	1865	....
Magnetic declination, isogonic lines for the year 1870	1867	1865	27
Curves of equal annual change of magnetic declination in the eastern part of the United States for the period 1860 to 1870. (Nos. 27 and 28, illustrations to Appendix No. 19, 1865)	1867	1865	28
Illustrations to Appendix 15, 1870, on results of observations for daily variations of the magnetic declination at Fort Steilaccom, Washington, and at Camp Date Creek, Arizona. (Faces page 114, 1870)	1873	1870	....
Kew observatory magnetographs. (To illustrate Appendix No. 8, 1872)	1875	1872	19
Diagrams to illustrate Appendix 9, 1874. On results of magnetic observations, both absolute and differential, at Key West. (Pages 122, 126, and 128 of 1874)	1877	1874	....
Chart showing positions of magnetic stations occupied between 1833 and 1877	1879	1876	2
Lines of equal magnetic declination in the United States for the year 1875. (Illustration to Appendix No. 21, 1876)	1879	1876	24
Chart showing positions of magnetic stations occupied between 1844 and 1878	1881	1878	25
Chart showing positions of magnetic stations occupied between 1844 and 1879	1881	1879	31
Illustrations to Appendix No. 9, 1879. On the secular change of magnetic declination in the United States and at some foreign stations:			
Secular change of the magnetic declination at Paris, France; at New York, N. Y.; at San Francisco, Cal., and at Sitka, Alaska. (Faces page 167)	1881	1879	38
Annual change of the magnetic declination for the epoch 1880. (Faces page 169)	1881	1879	37
Secular change of the Agonic line of the North Atlantic between 1500 and 1900. (Faces page 170)	1881	1879	39
Illustration to Appendix 19, 1880. Secular change of the Agonic line of the North Atlantic between 1500 and 1900. (Faces page 415)	1882	1880	64
Chart showing positions of magnetic stations occupied between 1844 and 1880	1882	1880	31
Chart showing positions of magnetic stations occupied between 1844 and July, 1881	1883	1881	31
Illustrations to Appendix 12, Report for 1882:			
Secular variation of the magnetic declination at New York, Baltimore, San Francisco, and Sitka	1883	1882	33
Secular variation of the magnetic declination at Paris, France. (Follows No. 33)	1883	1882	36
Annual change of the magnetic declination for the epoch 1885. (Faces page 269)	1883	1882	34
Secular change in the position of the Agonic line of the North Atlantic between 1500 and 1900. (Faces page 270)	1883	1882	35
Illustrations to Appendix No. 13, Report for 1882. Distribution of the magnetic declination in the United States at the epoch January, 1885:			
Disturbed isogonics, isoclinics, and isodynamics. (Faces page 281, of 1885)	1883	1882	37
Isogonic chart for 1885, eastern sheet	1883	1882	38
Isogonic chart for 1885, western sheet	1883	1882	39
Isogonic chart for 1885, Alaska and adjacent regions	1883	1882	40

IV$_{24}$.—*Magnetic declination, dip, and intensity*—Continued.

Title.	Date of publication.	Year of report.	Number of illustration.
Illustrations to Appendix No. 13, 1883:			
Diagram (page 327), plan of magnetic house at Point Barrow, Alaska	1884	1883	....
Diagram (page 329) showing arrangement of instruments	1884	1883	....
Diagrams showing parts of instruments and location of observing station. (Pages 330, 331, 335)	1884	1883	....
Solar diurnal variation of the declination. (Page 347)	1884	1883	....
Solar diurnal variation of the horizontal force. (Page 356)	1884	1883	....
Diurnal variation in the whole deflecting force acting in a horizontal plane. (Page 357)	1884	1883	....
Solar diurnal variation of the magnetic vertical force observed at Ooglaamie, Alaska. (Page 363)	1884	1883	....
Distribution of magnetic declination at Point Barrow, Alaska, 1883. (Follows page 365)	1884	1883	....
Map showing positions of magnetic stations occupied between 1844 and 1885	1886	1885	18
Illustrations to Appendix 6, 1885. The geographical distribution and secular variation of the magnetic dip and intensity in the United States:			
Type curves of the secular variation of the dip and of the total intensity. (Faces page 264)	1886	1885	19
Type curves of the secular variation of the horizontal intensity. (Faces page 270)	1886	1885	20
Secular variation in direction of a freely suspended magnetic needle 1820-1885. (Faces page 272)	1886	1885	21
Isoclinic map of the United States for the year 1885.0	1886	1885	22
Isodynamic (horizontal intensity) map of the United States for the year 1885.0	1886	1885	23
Isodynamic (total intensity) map of the United States for the year 1885.0	1886	1885	24

IV$_{25}$.—*Meteorological researches.*

Title.	Date of publication.	Year of report.	Number of illustration.
Diagrams showing the effect of wind in raising or depressing the mean level of water in Albemarle Sound. (Illustration to Appendix 43, 1856)	1856	1856	16
Diagrams representing the quantity of the winds in different months, and their effect on the level of the sea at Cat Island, Mississippi Sound, from observations in 1848. (Illustrations to Appendix 45, 1856)	1856	1856	39
Diagrams of winds at Key West, Fla., Fort Morgan, Ala., and Galveston, Tex. (To illustrate Appendix 44, 1856)	1856	1856	37
Diagrams of winds at San Diego and San Francisco, Cal., and Astoria, Oregon, 1857. (To illustrate Appendix 36, 1857)	1858	1857	66
Diagram (page 97 of Report for 1871) to illustrate Appendix 6, 1871. Report on meteorological effects on tides. (Also one illustration)	1874	1871	34
Curves of the daily variations of temperature, height of barometer, etc., at Sherman Station, 1872. (Illustration to Appendix 8, 1872; faces page 80)	1875	1872	....
Curves of hourly oscillations of temperature, etc. (Illustration to Appendix 8, 1872; faces page 82)	1875	1872	....
Diagrams to illustrate Appendix 20, 1875. Meteorological researches for the use of the Coast Pilot. (Pages 375 and 378, 1875. Also illustrations numbered as in last column)	1878	1875	31 to 37
Diagrams to illustrate Appendix 10, 1878. Meteorological researches for the use of the Coast Pilot:			
To face page 188, No. 33	1881	1878	33
To face page 203, No. 34			34
To face page 209, No. 35			35
To face page 222, No. 36			36
To face page 253, No. 38			38
To face page 258, No. 37			37
Illustration to Appendix 10, Report for 1881. On barometric hypsometry. (To face page 268)	1883	1881	38

IV$_{26}$.—*Miscellaneous.*

Title.	Date of publication.	Year of report.	Number of illustration.
Diagram showing injury to the boilers of the steamer *Hetzel*. (Illustration to Appendix 70, 1856)	1856	1856	67
Illustrations to Appendix 21, 1864. Trajectory of ricochet shot. (Pages 221, 222, 1864)	1866	1864	....
Illustration to Appendix 14, 1869. Solution of three-point problem	1872	1869	26
Illustration to Appendix 21, 1870. On the theory of errors of observations	1873	1870	27
Gauge of letters to be used on the publication scales of U. S. Coast Survey maps and charts. (Reference on page 66, Report for 1871)	1874	1871	29
Illustration to Appendix 18, 1880. On the landfall of Columbus	1882	1880	83

IV_{27}.—*Oyster-bed surveys and explorations.*

Title.	Date of publication.	Year of report.	Number of illustration.
Illustrations to Appendix No. 11, Report for 1881. On the oyster beds of James River, Virginia, and of Tangier and Pocomoke Sounds, Maryland and Virginia:			
Cluster of oysters and sponge (faces page 323)	1883	1881	39
Cluster of oysters and sponge (faces page 325)	1883	1881	40
Cluster of oysters and sponge (faces page 327)	1883	1881	41
Specimen tile (faces page 331)	1883	1881	42
Specimen tile (faces page 333)	1883	1881	43
Specimen tile (faces page 335)	1883	1881	44
Approximate limits of oyster beds James River, from Newport News to Deep-Water Light	1883	1881	45
Approximate limits of oyster beds, upper part of Tangier Sound	1883	1881	46
Approximate limits of oyster beds, lower part of Tangier Sound and Pocomoke River	1883	1881	47
Profiles of bottom; oyster beds in Tangier and Pocomoke Sounds (facing pages 283, 285, 287, 289, 291, 293, and 301)	1883	1881	48-54
Curves showing differences of densities of water in the sounds and changes in the densities (following page 352)	1883	1881	55-62
Drawing of Astyris (faces page 347)	1883	1881	63

IV_{28}.—*Physical hydrography.**

Title.	Date of publication.	Year of report.	Number of illustration.
Diagram showing the progressive changes in Sandy Hook from 1779 to 1851. (See page 45, Report for 1851)	1852	1851	8
Diagram showing the progressive changes in Sandy Hook from 1779 to 1853. (See page 38, 1853)	1854	1853	8
Diagram showing the progressive changes in Sandy Hook from 1779 to 1855. (Illustration to Appendix No. 23, Report for 1855)	1856	1855	9
Illustration to Appendix 17, 1857. Comparative chart of Cape Fear River Entrances, North Carolina	1858	1857	33
Comparative chart of New Inlet Bar, the northern entrance to Cape Fear River	1859	1858	12
Comparative chart of Cape Fear River bars. (Illustrations to Appendix 13, 1858)	1859	1858	13
Illustrations to Appendix No. 13, Report for 1867. On the Tides and Currents of Hell Gate:			
General scheme of tidal interference (page 160). Tidal curves in Hell Gate, etc. (page 164). Intervals and heights of tides and curves of half-monthly inequalities (page 165). Restoration of level in Hell Gate between gauges at Hell Gate Ferry and Pot Cove, 1857 (page 166). General scheme of currents in New York Harbor and its approaches, from observations in 1857, 1858 (page 168)	1869	1867	....
Physical map of Mitchell's Falls, Merrimack River, Massachusetts. (To illustrate Appendix No. 14, 1867)	1869	1867	2
Comparative map of Cape Cod (or Provincetown) Harbor, showing physical changes between the surveys of 1835 and 1867. (To illustrate Appendix No. 12, 1867)	1869	1867	5
Illustration to Appendix No. 5, Report for 1869. On the Reclamation of Tide-lands, and its relation to navigation. (Faces page 104)	1872	1869	....
Harbors of refuge compared. (Illustrations to Appendix No. 15, 1869)	1872	1869	28
Reports concerning harbors on Martha's Vineyard and Nantucket	1874	1871	36
Illustrations to Appendix No. 8, Report for 1871. On the Harbor of New York; its condition May, 1873. Diagram, page 111, 1871:			
Diagram showing changes in the bottom of New York Harbor in the vicinity of the Middle Ground Shoal	1874	1871	30
Diagram of currents, Gedney's Channel, etc	1874	1871	31
Diagram of currents in Hudson River, etc	1874	1871	32
Comparative maps of Monomoy and Chatham. (To illustrate Appendix No. 9, Report for 1871)	1874	1871	33
Illustration to Appendix No. 10, 1871. Hints and suggestions on the location of harbor lines	1874	1871	35
Sketch to illustrate Appendix 15, 1869. Edgartown Harbor and Cotamy Bay	1874	1871	36

*For illustrations of instruments and appliances used in physical hydrographic work see under the general heading IV_1, *Apparatus and Instruments*, the sub-headings, "Currents," "Deep-sea sounding apparatus," "Deep-sea temperature and density apparatus," "Gulf Stream explorations," "Hydrographic work," "Physical hydrography," and "Tidal observations."

Diagrams and sketches relating to special branches of physical hydrography will be found indexed under the general headings—

IV_5.—*Current observations and stations.*
IV_6.—*Deep-sea soundings.*
IV_{15}.—*Gulf Stream explorations.*
IV_{27}.—*Oyster-bed surveys, etc.*
IV_{32}.—*Tidal observations, discussions, and results.*

IV_{28}.—*Physical hydrography*—Continued.

Title.	Date of publication.	Year of report.	Number of illustration.
Diagrams to illustrate report on the harbors of Alaska and the tides and currents in their vicinity (Appendix 10, 1872)	1875	1872	17
Sketch to illustrate Appendix No. 16, 1872. The Middle Ground Shoal, New York Harbor	1875	1872	22
Chart of Edgartown Harbor and Cotamy Bay, Mass. (To illustrate Appendix 17, 1872.) Report on shore-line changes at that harbor	1875	1872	23
Illustration to Appendix No. 8, 1873. Report on the Physical Survey of Portland Harbor, Maine. (Faces page 102)	1875	1873	....
Illustration to Appendix No. 9. Additional report concerning the changes in the neighborhood of Chatham and Monomoy. (Faces page 106)	1875	1873	....
Diagram on page 110, Report for 1873. Appendix 10. Note concerning changes in the submerged contours off Sandy Hook	1875	1873	....
Illustration to Appendix No. 11, 1875. Report concerning recent observations at South Pass Bar, Mississippi River. (Faces page 190)	1878	1875	24
Illustration to Appendix 9, 1876. Changes in the Harbor of Plymouth, Mass	1879	1876	22
Flood and ebb currents in the vicinity of the United States Navy-yard, East River, New York. (To illustrate Appendix No. 11, 1876)	1879	1876	23
Illustrations to Appendix No. 9, 1878. On a physical survey of the Delaware River in front of Philadelphia. (Facing pages 124, 127, 128, and 134)	1881	1878	29, 30, 31, 32
Illustrations to Appendix No. 10, Report for 1879:			
Physical hydrography of the Gulf of Maine, currents at entrance to Gulf of Maine, and tides of Cape Cod. (Faces page 175)	1881	1879	40
Tides of Nantucket and tides of Cape Sable	1881	1879	41
Illustration to Appendix No. 13, 1879. Addendum to a report on a physical survey of the Delaware River. (Faces page 199)	1881	1879	51
Illustrations to Appendix No. 9, 1880. Comparison of the surveys of the Delaware River in front of Philadelphia, 1843 and 1878:			
Sketch A. (Faces page 110)	1882	1880	42
Sketch B. (Faces page 112)	1882	1880	43
Changes in Delaware River between Bridesburgh and Kensington	1882	1880	38
Changes in Delaware River between Kensington and Kaighn's Point	1882	1880	39
Changes in Delaware River between Kaighn's Point and Horseshoe	1882	1880	40
Changes in Delaware River between Horseshoe and Fort Mifflin	1882	1880	41
Mississippi River, Louisiana, sketch of areas covered by comparisons of surveys in 1866, 1872, 1875, 1876, 1877. (Illustration to Appendix No. 10, 1880, faces page 134)	1882	1880	44
Bering Strait, surface and vertical isotherms, to illustrate Appendix 16, 1880. (Faces page 340)	1882	1880	80
Chart of currents in Bering Sea and adjacent waters. (Appendix 16, 1880)	1882	1880	81
Illustrations to Appendix 15, Report for 1882:			
Comparison of the survey of Delaware River of 1819 with more recent surveys			41
Sketch No. 41. (Faces page 432) } Cross-sections Delaware River	1883	1882	42
Sketches Nos. 42 and 43. (Follow No. 41) }			43
Bend effects, Mississippi River. (Illustration to Appendix No. 16, Report for 1882; faces page 436)	1883	1882	44
Depths and temperatures observed in the western part of the North Atlantic Ocean between 1881 and 1883. (Illustration to Appendix 19, 1882)	1883	1882	50
The Estuary of the Delaware. (Sketch to illustrate Appendix No. 8, Report for 1883; faces page 239)	1884	1883	25
Diagram (— page 241), showing mean depths, widths, and sectional areas, to illustrate same Appendix	1884	1883	....
Delaware River, at Cherry Island Flats, showing changes in depths between 1841 and 1881. (To illustrate Appendix 12, 1884)	1885	1884	22
Delaware River, from Reedy Island to Liston's Point, showing changes in depth between 1840 and 1881. (To illustrate Appendix 12, 1884)	1885	1884	23
Geology of the sea-bottom in the approaches to New York Bay. (Illustration to Appendix No. 13, 1884; faces page 438)	1885	1884	24
Photograph from a relief model of the Depths of the Sea in the Bay of North America and Gulf of Mexico. (Faces page 620, 1884; to illustrate Appendix No. 17, Report for 1884)	1885	1884	25
Illustrations to Appendix No. 12, Report for 1885. Comparisons of transverse sections in the Delaware River between Old Navy-yard and east end of Petty's Island for the years 1819, 1843, and 1878. (Six diagrams, following page 488, of 1885)	1886	1885	29, 30, 31, 32, 33, 34
Illustrations to Appendix No. 14, Report for 1885. Report on Deep-sea Current work in the Gulf Stream. Ten diagrams and sketches. For full list see IV_8, *Current observations and stations.* Sketch No. 36 shows the apparatus devised for the work, and is referred to under IV_1, *Apparatus and instruments*, and sub-heading "Currents"	1886	1885	37, 38, 39, 40, 41, 42, 43, 44, 45, 46

IV$_{29}$.—*Project limits for charts.*

Title.	Date of publication.	Year of report.	Number of illustration.
Sketch showing the arrangement of general coast charts (1–400000) and preliminary charts (1–200000) in progress of publication. (See pages 22 and 23, Report for 1857)	1858	1857	64
Diagram showing limits of finished maps (1–80000) on the coast of the Atlantic and Gulf of Mexico in progress of publication, 1858. (See pages 29 and 30, Report for 1858)	1859	1858	40

IV$_{30}$.—*Projections.*

Title.	Date of publication.	Year of report.	Number of illustration.
Map of the world on a polyconic development of the sphere. (Illustration to Appendix No. 58, Report for 1856)	1856	1856	65
Diagram (page 177, Report for 1865) to illustrate Appendix No. 20. Projection table for a map of North America	1867	1865	....
Diagram illustrating the mode of constructing the conic projection for plane-table work, scale 1–10000. (To illustrate Appendix 22, 1865; faces page 207)	1867	1865	....
The World on a quincuncial projection. (Illustration to Appendix 15, Report for 1877)	1880	1877	25
Diagram showing the mode of constructing the conic projection for plane-table work, scale 1–10000. (To illustrate Appendix 13, 1880; faces page 198)	1882	1880	60
Six diagrams, illustrating Appendix 15, 1880. A comparison of the relative value of the polyconic projection with some others	1882	1880	73–78
One chart, to illustrate same Appendix. Atlantic coast from Nantucket to Cape Hatteras. Straight lines and great circle lines drawn on projection	1882	1880	79

IV$_{31}$.—*Solar eclipses.*

Title.	Date of publication.	Year of report.	Number of illustration.
Illustrations to Appendices Nos. 21, 41, 42, Report for 1860. On the total solar eclipse of July 18, 1860, as observed at Aulezavik Island, coast of Labrador:			
Sketches, pages 234, 236, and 242	1861	1860	....
Sketch showing astronomical and magnetic stations, etc., Eclipse Harbor	1861	1860	38
Diagrams illustrating phenomena of the eclipse	1861	1860	39
Solar spots observed at Gunstock Station, New Hampshire, and at Washington, D. C., in connection with observations of the solar eclipse of July 18, 1860. (Illustration to Appendices Nos. 19 and 25, Report for 1861)	1862	1861	29
Illustrations to Appendix No. 8, Report for 1869. Reports of observations of the eclipse of the sun of August 7, 1869:			
Sketches showing points of observation at Falmouth, Ky. (pages 130, 131) }			
Sketches showing solar spots (pages 137, 139, 142) }	1872	1869	....
Sketches, various (pages 143, 148, 150, 151, 156, 157, and 158) }			
Sketch of the path of the total eclipse, August 7–8, 1869	1872	1869	24
Illustrations to reports on observations of the total eclipse of August 7, 1869	1872	1869	25
Do	1872	1869	26
Diagrams illustrating Appendix No. 16, Report for 1870. Reports of observations upon the total solar eclipse of December 22, 1870:			
Diagrams or sketches on pages 129, 142, 149, 165, 167, 168, 171, and 172	1873	1870	....
Diagrams illustrating the reports on the eclipse of December 22, 1870	1873	1870	28
Corona as seen at Catania, Sicily, December, 1870	1873	1870	29
Illustrations to Appendix No. 20, 1882. The total solar eclipse of January 11, 1880, as observed at Mount Santa Lucia, California:			
Cusps of sun, outline of disk, etc. (Faces page 468)	1883	1882	51
Sketches of corona, protuberances, etc. (Follows No. 51)	1883	1882	52

IV$_{32}$.—*Telegraphic longitudes.*

See "Longitudes—telegraphic," and also that sub-heading under the general heading "Apparatus and instruments."

IV_{33}.—*Tidal observations, discussions, and results.*

Title.	Date of publication.	Year of report.	Number of illustration.
Mean daily tidal curves from observations made in July, 1847, and January, 1848, at Fort Morgan, Mobile Point, Alabama, and in January, 1848, and June, 1848, at Cat Island, Mississippi Sound. (See page 50, 1848)	1849	1848	F^{bis}
Curves of high water at Mobile Point and Cat Island and of prevailing winds at Cat Island	1850	1849	H^{tris}
Chart showing normal course and velocity of the tidal current at ebb in Boston Harbor	1852	1851	A^3
Diagrams relating to tides at Cat Island, Louisiana	1852	1851	35
Sketch showing the observed and computed tidal curves at Cat Island, Mississippi Sound, in 1848 and 1849. (Illustration to Appendix No. 22, Report for 1852)	1853	1852	H^v
Illustrations to Appendix No. 27, Report for 1853. On the tides at Key West, Fla.:			
Type curves of tides at Key West	1854	1853	27
Diagrams relating to tides at Key West	1854	1853	28
Illustrations to Appendices Nos. 28 and 29, Report for 1853. On the tides of the western coast of the United States; tides at Rincon Point, San Francisco, Cal	1854	1853	48
Approximate cotidal lines of the Atlantic coast of the United States. (Illustration to Appendix No. 45, 1854)	1855	1854	26
Tidal currents of Nantucket Shoals. (Illustration to Appendix No. 48, 1854)	1855	1854	13
Tidal currents of Long Island Sound and approaches. (Illustration to Appendix No. 50, Report 1854)	1855	1854	16
Curves of observation of tides at Rincon Point, San Diego, and Astoria, western coast United States. (To illustrate Appendix 46, 1854)	1855	1854	49
Approximate cotidal lines of the Pacific coast of the United States. (Illustration to Appendix 50, 1855)	1856	1855	49
Diagrams illustrating earthquake waves of December 23, 1854, at San Francisco, San Diego, and Astoria, from curves recorded on self-registering tide-gauges. (Illustration to Appendix 51, 1855)	1856	1855	50
Diagram (page 127, Report for 1856) to illustrate Appendix 17	1856	1856	....
Diagrams of heights and luni-tidal intervals of diurnal and semi-diurnal tides in the Gulf of Mexico. (To illustrate Appendix 35, 1856)	1856	1856	35
Approximate cotidal lines of the Gulf of Mexico. (Illustration to Appendix 35, 1856)	1856	1856	36
Type curves of tides in the Gulf of Mexico. (Illustration to Appendix 36, 1856)	1856	1856	38
Tides of the Pacific coast. (Diagram showing general form, page 165, 1857)	1858	1857	....
Approximate cotidal lines, sailing lines, and lines of equal height of tide, Atlantic coast. (Illustration to Appendix No. 33, 1857)	1858	1857	65
Diagrams, pages 284 of 1858 and 145 of 1859, showing general form of Pacific coast tides. (This diagram appears also in later reports)	1859 1860	1858 1859	....
Cotidal lines of diurnal and of semi-diurnal tides for the eastern part of the Gulf of Mexico. (Illustration to Appendix No. 9, 1862)	1864	1862	46
Diagram (republished from Report of 1855) illustrating earthquake waves recorded at tidal stations on the Pacific coast. (Appendices 51 of 1855 and 24 of 1862)	1864	1862	50
Tidal observations at Papeete, on the island of Tahiti, in 1856. (To illustrate Appendix No. 9, 1864)	1866	1864	40
Type curves of the tides on the western coast of the United States. (Illustration to Appendix No. 11, 1865)	1867	1865	26
Tides at Cat Island, Louisiana, 1848. (To illustrate Appendix No. 18, Report for 1866; reprinted from the Report of 1861)	1869	1866	30
Illustrations to Appendix 13, Report for 1867. Report on the tides and currents of Hell Gate. (Diagrams on pages 160, 164, 165, 166, 168, Report for 1867)	1869	1867	....
Diagram of curves of tides at Sitka, Alaska, 1867. (To illustrate Appendix No. 6, Report for 1868)	1871	1868	29
Tides of Boston Harbor, July, 1858. (To accompany Appendix No. 6, 1871; also diagram, page 97, 1871)	1874	1871	34
Diagrams relating to the tides at Iliuliuk Harbor, Unalaska, and between Akutan Pass and Iliuliuk. (Illustration to Appendix 10, 1872)	1875	1872	17
Tide-station at Pulpit Cove, Penobscot Bay, Maine. (Illustration to Appendix 11, Report for 1878. Faces page 268)	1881	1878	39
Illustrations to Appendix No. 10, Report for 1879. Physical hydrography of the Gulf of Maine:			
Tides of Cape Cod. (Faces page 175)	1881	1879	40
Tides of Nantucket and tides of Cape Sable. (Faces page 179)	1881	1879	41
Illustrations to Appendix No. 17, Report for 1882. Discussion of the tides of the Pacific coast:			
Sketch showing tide-station at San Diego Bay, California. (Faces page 450)	1883	1882	45
Sketches showing tide-stations at Astoria, Oregon, and at Port Townshend, Wash. Ter., following 45.	1883	1882	46, 47
Sketch showing position of tide-gauge at Sandy Hook. (To illustrate Appendix No. 9, Report for 1883. (Faces page 247)	1884	1883	26
NOTE.—For diagrams in Report of 1883, Nos. 27 to 31, inclusive, illustrating the Tide-Predicting Machine, see reference under general heading *Apparatus and instruments*, and sub-heading "Tidal observations."			
Sketch showing positions of tide-gauges at Governor's Island and Sandy Hook, New York Harbor. (Illustration to Appendix No. 13, Report for 1885. Faces page 490)	1886	1885	35

IV_{34}.—*Time, latitude, longitude, and azimuth determinations.*

NOTE.—For lists of diagrams and sketches illustrating the appliances and instruments employed in the Survey for the determination of time, latitude, longitude, and azimuth, see sub-heading under general heading *Apparatus and instruments*.

Title.	Date of publication.	Year of report.	Number of illustration.
Diagrams illustrative of the determination of the difference of longitude (by exchanges of chronometers) between Savannah, Ga., and Fernandina, Fla. (To illustrate Appendix 30, 1857)	1858	1857	67
Diagram to illustrate Appendix No. 20, Report for 1864. On experiments made for determining eduction time of relay magnets or telegraphic repeaters	1866	1864	39
Diagram (page 57, Report for 1866) to illustrate Appendix 9. Determination of time by means of the transit instrument	1869	1866	....
Diagram (page 87, Report for 1866) to illustrate Appendix 11. Determination of the astronomical azimuth of a direction	1869	1866	....
Diagrams (page 123, Report for 1867) to illustrate Appendix No. 6. On the longitude between America and Europe, from signals through the Atlantic cable	1869	1867	....
Diagram (page 151, Report for 1868). Local deflections in latitude and azimuth. To illustrate Appendix No. 9)	1871	1868	....
Diagram (page 115, Report for 1869) and sketch (No. 23) to illustrate Appendix No. 7. Local deflections of the zenith in the vicinity of Washington City	1872	1869	....
Diagram (foot of page 211, Report for 1874) to illustrate discussion of deviation of transit in azimuth. Part of Appendix No. 18. Transatlantic longitudes	1877	1874	....
Diagrams (pages 315 and 316, Report for 1875) to illustrate Appendix No. 19. Formulæ and factors for the computation of geodetic latitudes, longitudes, and azimuths	1878	1875	....
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and 1877. (See page 10, Report 1876)	1879	1876	3
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and 1878	1881	1878	26
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and 1879	1881	1879	32
Oblique arc along the Atlantic coa t from Atlanta, Ga., to Calais, Me. Apparent local deflections of vertical in plane of prime vertical and in latitude or plane of meridian. (Illustration to Appendix 8, 1879)	1881	1879	36
Telegraphic longitudes. Diagram showing connections adjusted in June, 1880. (Illustration to Appendix No. 6, Report for 1880. Faces page 92)	1882	1880	33
Diagrams (pages 208 and 266, Report for 1880) to illustrate Appendix No. 14. On the determination of time, longitude, latitude, and azimuth	1882	1880	....
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and 1880	1882	1880	32
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and July, 1881	1883	1881	32
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and July, 1882	1883	1882	25
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and June 30, 1883	1884	1883	24
Chart showing longitude stations and connections determined by means of the electric telegraph between 1846 and June 30, 1884	1885	1884	19
Diagrams (pages 323 and 324, Report for 1884) to illustrate Appendix No. 7. Formulæ and factors for the computation of geodetic latitudes, longitudes, and azimuths (third edition)	1885	1884	....
Telegraphic longitudes. Diagrams showing connections adjusted; data to July, 1884. (To illustrate Appendix No. 11, Report for 1884. Faces page 430)	1885	1884	21
Map showing longitude stations and connections determined by means of the electric telegraph between 1846 and June 30, 1885	1886	1885	17

IV_{35}.—*Topography and topographical drawings and sketches.*

Title.	Date of publication.	Year of report.	Number of illustration.
Views of parts of the coast of Labrador from Aulezavik Island southward. (Illustration to Appendix No. 42, Report for 1860)	1861	1860	38
Diagrams to illustrate Appendix No. 22, Report for 1865. On the plane table and its use in topographical surveying:			
Page 207: Mode of constructing conic projection	1867	1865	....
Pages 210, 212, 213, and 214: Adjustments of plane table, etc.			
Facing page 215: Three-point problem, various cases			
Facing page 222: To illustrate mode of constructing profile from plan			
To illustrate solutions of three-point and two-point problems	1867	1865	31
Specimen of plane-table sheet	1867	1865	32
To illustrate Appendix No. 14, Report for 1869. Solution of the three-point problem, with application to the plane table. (Figures on plate 26)	1872	1869	26
Styles of lettering for charts of various scales	1874	1871	29
Sketches of Mount St. Elias and Mount Fairweather. (To illustrate Appendix 10, 1875. Follow page 160)	1878	1875	22, 23
Illustrations to Appendix No. 11, Report for 1879. On the preparation of standard topographical drawings. (These illustrations follow page 190):			
Blocking of cities, large buildings, suburban villas and grounds (Newport, R. I.)	1881	1879	42
Sparsely settled town, salt marsh, pine woods, ditches, etc. (Brunswick, Ga.)	1881	1879	43
Railroads, canals, iron bridges, rocky cliffs, mid-river drift, etc. (Harper's Ferry, Va.)	1881	1879	44
Heavy oak woods, reclaimed marsh, and orchards, Delaware River	1881	1879	45
Rice dikes and ditches, Santee River, South Carolina	1881	1879	46
Eroded drift banks, with bowlders set free, and deciduous woods (Gay Head)	1881	1879	47
Sand and shingle beaches, eroded earth banks, roads, fences, dwellings, etc. (Nahant)	1881	1879	48
Sand beach with low dunes, fresh-water pond, meadow-grass, sage-brush, etc. (south coast California)	1881	1879	49
Illustrations to Appendix No. 13, Report for 1880. A treatise on the plane table and its use in topographical surveying:			
Diagrams illustrating methods of placing plane table in position, the three-point problem, and determination of position by resection. (Facing page 176; following pages 180 and 182)	1882	1880	51 to 56, inclusive.
Position of a fourth point by resection on three fixed points, and two-point problem. (Diagram facing page 184)	1882	1880	57
Measurements of distance with telemeter. (Diagram facing page 192)	1882	1880	59
Mode of constructing the conic projection, etc. (Faces page 198)	1882	1880	60
Delineation of hill curves. (Faces page 200)	1882	1880	61
Illustrations to Appendix No. 7, Report for 1881. Type forms of topography, Columbia River (diagrams on pages 124 and 125); upper part of the Dalles, Columbia River	1883	1881	33
Illustrations to Appendix No. 14, 1883. Report on the preparation of standard topographical drawings (second series):			
Railroad tunnel, water-worn rocks, drift middle sands, river dam, etc., Potomac River. (Faces page 368; the other drawings follow in numerical order)	1884	1883	35
Erosion of soft stratified rock and gulch, Santa Cruz, Cal	1884	1883	36
Rounded summit of a granite mountain (Brown's Mountain, Mount Desert Island), with views	1884	1883	37
Abraded rock faces of a granite mountain (Robinson's Mountain, Mount Desert Island), with views	1884	1883	38
Fresh-water lakes and cliff of a granite mountain (Echo Mountain, Mount Desert Island), with views	1884	1883	39
Crest, face, and talus of a granite-cliff (Eagle Cliff, Mount Desert Island), with view	1884	1883	40
Eruptive rock promontory (Cape Disappointment), with view	1884	1883	41
Erosion of eruptive rocks, basaltic escarpments, and river torrent (the Dalles of the Columbia River)	1884	1883	42
NOTE.—The remaining illustrations, Nos. 43 to 50, inclusive, are here republished, having first appeared as illustrations Nos. 42 to 49, inclusive, to Appendix No. 11, Report for 1879. They form the first series of standard topographical drawings, while Nos. 35 to 42, Report for 1883, form the second series.			

IV_{36}.—*Transits of Venus and Mercury.*

Title.	Date of publication.	Year of report.	Number of illustration.
Transit of Venus station of 1769, at San José del Cabo, Lower California. (Illustration to Appendix No. 10, Report 1874. Faces page 131)	1877	1874	22
Diagram to illustrate Appendix 13, 1875. Report on the Transit of Venus expedition to Japan (page 223)	1878	1875	....
Whangaroa Harbor, Chatham Island, showing American station for observation of Transit of Venus, 1874. (Illustration to Appendix 14, 1875. Faces page 232)	1878	1875	25
Diagrams to illustrate Appendix No. 6, 1878. Observations of the Transit of Mercury, May 6, 1878, made at Summit Station, Central Pacific Railroad, California:			
Sketch showing locality of station, etc. (Faces page 82)	1881	1878	27
Diagrams showing phases of transit. (Face page 86)	1881	1878	28

IV_{37}.—*Triangulation.*

Diagrams illustrating the triangulation of the Survey, and its methods, instruments, discussions, and results will be found indexed under the following headings:

I and II.—GENERAL PROGRESS SKETCHES and PROGRESS SKETCHES.

IV_1.—APPARATUS AND INSTRUMENTS, and sub-headings *Geodetic signaling apparatus* and *Geodetic signals, tripods, and scaffolds.*

IV_{11}.—GEODETIC SURVEYS, METHODS AND RESULTS.

IV_{12}.—GEOGRAPHICAL POSITIONS.

APPENDIX No. 13.—1887.

ADDENDUM TO A REPORT ON THE ESTUARY OF THE DELAWARE.

By HENRY MITCHELL, Assistant.

COAST AND GEODETIC SURVEY,
Washington, D. C.

SIR: In the Annual Report Coast and Geodetic Survey for 1885, page 33, an extract is made from my annual report which refers to a table computed by Mr. J. A. Sullivan, the last work executed for us by that gentleman.

This table is a valuable extension of one printed under the title "Estuary of the Delaware," on page 245 of the Annual Report Coast and Geodetic Survey for 1883.

To preserve this valuable table, which is likely to be useful for reference, I suggest that it be printed.

Very respectfully, yours,

HENRY MITCHELL.

Mr. F. M. THORN,
Superintendent Coast and Geodetic Survey.

Estuary of the Delaware: Physical elements.

Nautical miles from Fort Mifflin Light-house.	Number of sections per mile.	Low water. Mean width per mile.	Low water. Mean area per mile.	Low water. Mean depth per mile.	Half-tide. Mean width per mile.	Half-tide. Mean area per mile.	Half-tide. Mean depth per mile.	Mean. Maximum depth per mile.	Remarks.
		Feet.	*Square feet.*	*Feet.*	*Feet.*	*Square feet.*	*Feet.*	*Feet.*	
1	20	5,026.50	80,676.80	16.05	5,341.00	96,228.05	18.02	33.6	
2	24	4,617.92	83,856.23	18.16	5,074.27	98,394.51	19.39	27.5	Maiden Island.
3	26	4,971.54	78,770.88	15.84	5,597.70	94,766.91	16.93	43.7	Upper end Tinicum Island.
4	19	5,247.63	85,661.20	16.32	6,144.21	102,743.30	16.72	37.4	
5	23	4,726.09	89,384.25	18.91	5,334.78	104,475.55	19.58	30.7	
6	23	5,369.51	99,634.05	18.56	5,996.24	116,682.70	19.46	32.2	Lower end Tinicum Island.
7	21	4,672.86	95,456.28	20.43	5,404.29	110,571.99	20.46	40.7	Chester Island Bar begins.
8	22	5,682.73	101,399.27	17.84	6,499.32	119,681.34	18.41	34.5	Chester Island Bar ends.
9	22	4,777.27	104.012.57	21.77	5,177.27	118,944.39	22.98	30.7	Schooner Ledge.
10	22	5,513.64	99,761.50	18.09	6,131.36	117,229.00	19.12	25.5	
11	23	5.817.83	102,553.15	17.63	6,432.17	120,928.15	18.81	26.6	
12	22	5,915.91	109,503.39	18.51	6,502.05	128,130.32	19.71	28.5	
13	23	5.911.74	115,110.43	19.47	6,341.30	133,490.00	21.05	26.9	
14	22	6,515.45	120,126.86	18.44	7,018.64	140,474.36	20.01	25.9	
15	20	6,244.50	119,272.28	19.10	6,624.50	138,575.78	20.92	26.8	
16	20	7,278.00	129,549.95	17.80	7,557.50	151,803.20	20.09	26.8	
17	21	9,656.19	136,725.76	14.16	10,143.33	166,425.05	16.47	25.1	
18	21	8,604.76	136,032.95	15.81	9,211.43	162,757.24	17.67	25.0	Christiana Creek.
19	22	5,652.21	127,867.73	22.62	6,414.09	145,967.27	22.76	42.4	Deep-Water Point.
20	20	6,273.00	136,933.00	21.82	7,072.25	156,950.87	22.19	41.2	
21	20	8,203.50	150,090.85	18.30	8,606.00	175,305.10	20.37	30.4	
22	22	8,090.91	158,676.61	19.61	8,514.55	183,584.80	21.56	27.9	
23	16	8,363.13	167,726.34	20.06	8,651.87	193,248.84	22.34	31.2	
24	11	10,868.18	182,036.82	16.75	11,195.45	215,132.27	19.22	27.7	
25	13	14,193.08	188,652.77	13.29	14,486.92	231,672.77	15.99	30.6	
26	11	14,707.27	185,784.55	12.63	15,500.00	231,094.55	14.91	36.9	Fort Delaware begins.
27	12	11,366.67	173,368.42	14.99	12,833.33	209,968.42	16.36	38.9	Fort Delaware ends.
28	12	13.576.67	188,596.96	13.89	13,881.67	229,784.46	16.55	29.0	
29	14	15,122.86	201,425.36	13.32	15,457.14	247,295.36	16.00	26.1	
30	13	10,923.08	202,626.38	18.55	11,327.69	236,002.54	20.83	41.5	
31	12	11,440.83	213,694.71	18.68	11,811.67	248,657.46	21.05	48.5	Reedy Island begins.
32	13	11,626.92	227,567.15	19.57	12,156.92	263,242.92	21.65	37.2	
33	13	16,303.08	251,780.58	15.44	16,775.38	301,413.27	17.97	24.8	Reedy Island ends.
34	12	19,549.58	265,266.33	13.57	19,949.58	324,515.08	16.27	23.8	
35	12	18,307.08	266,148.04	14.54	18,707.08	321,669.29	17.20	23.2	
36	12	16,421.67	267,409.75	16.28	16,821.67	317,274.75	18.86	26.8	
37	13	17,106.92	279,638.31	16.35	17,506.92	331,559.08	18.94	27.8	

Estuary of the Delaware: Physical elements—Continued.

Nautical miles from Fort Mifflin Light-house.	Number of sections per mile.	Low water.			Half-tide.			Mean.	Remarks.
		Mean width per mile.	Mean area per mile.	Mean depth per mile.	Mean width per mile.	Mean area per mile.	Mean depth per mile.	Maximum depth per mile.	
		Feet.	*Square feet.*	*Feet.*	*Feet.*	*Square feet.*	*Feet.*	*Feet.*	
38	13	19,313.85	301,862.92	15.63	19,713.85	360,404.46	18.28	26.1	
39	13	21,269.23	316,901.31	14.90	21,669.23	381,309.00	17.60	23.2	Collins Beach.
40	13	22,346.15	330,488.46	14.79	22,746.15	398,126.92	17.53	23.9	
41	13	22,784.62	347,881.54	15.27	23,184.62	416,835.38	17.98	27.6	
42	12	23,033.33	382,670.00	16.61	23,433.33	452,369.17	19.30	30.3	
43	11	25,032.73	373,298.45	14.91	25,432.73	448,996.64	17.65	30.1	
44	13	23,153.85	387,284.46	16.73	23,553.85	457,346.00	19.42	34.0	
45	13	22,582.31	395,178.69	17.50	22,982.31	463,525.62	20.17	38.8	Bombay Hook.
46	13	25,313.85	416,380.08	16.45	25,713.85	492,921.62	19.17	40.4	Cohansey Light-house.
		549,676.75	8,974,724.37	785.94	572,631.46	10,658,475.75	873.92	1,438.4	
		11,949.49	195,102.70	17.09	12,448.51	231,705.99	19.0	31.3	Arithmetical mean of 46 miles.
			16.33	------	----------	18.61	------	-------	Mean from mean area of 46 miles divided by mean width of 46 miles.
47	8	33,400.00	498,048.75	14.91	33,800.00	598,848.75	17.72	42.0	
48	8	32,037.50	530,118.75	16.55	32,437.50	626,831.25	19.32	41.7	
49	7	31,471.43	562,348.57	17.87	31,871.43	657,362.86	20.63	41.7	
50	8	35,212.50	610,938.75	17.35	35,612.50	717,176.25	20.11	46.6	
51	7	46,657.14	700,545.71	15.01	47,057.14	841,117.14	17.87	47.1	
52	7	52,157.14	768,792.86	14.74	52,557.14	825,864.28	17.62	50.5	Mahon's Ditch.
		780,612.46	12,645,517.76	882.37	805,967.17	15,025,676.28	987.19	1,708.0	
		15,011.78	243,183.03	16.97	15,499.37	288,955.31	18.98	32.8	Arithmetical mean of 52 miles.
			16.20	------	----------	18.64	------	-------	Mean from mean area of 52 miles divided by mean width of 52 miles.

Estuary of the Delaware: Physical elements—Continued.

Nautical miles from Fort Mifflin Light-house.	Low water.					Half-tide.				
	Mean of chords of mean depth per mile.	Mean area below mean depth per mile.	Mean area above mean depth per mile.	Mean ratio below mean depth per mile.	Mean ratio above mean depth per mile.	Mean of chords of mean depth per mile.	Mean area below mean depth per mile.	Mean area above mean depth per mile.	Mean ratio below mean depth per mile.	Mean ratio above mean depth per mile.
	Feet.	*Square feet.*	*Square feet.*	*Feet.*	*Feet.*	*Feet.*	*Square feet.*	*Square feet.*	*Feet.*	*Feet.*
1	2,508	20,051	60,626	7.99	12.06	2,838	22,807	73,421	8.04	13.75
2	2,778	13,885	69,971	5.00	15.15	3,095	19,110	79,285	6.17	15.62
3	1,837	26,102	52,669	14.21	10.58	2,087	29,890	64,877	14.32	11.59
4	1,894	23,261	62,400	12.28	11.89	2,362	28,960	73,783	12.26	12.01
5	2,473	16,701	72,683	6.75	15.38	2,927	23,070	81,406	7.88	15.26
6	2,738	15,937	83,697	5.82	15.59	3,436	22,439	94,244	6.53	15.72
7	2,395	21,289	74,167	8.89	15.87	2,950	29,336	81,236	9.94	15.03
8	2,614	22,528	78,871	8.62	13.88	3,588	30,322	89,359	8.45	13.75
9	3,145	12,574	91,439	4.00	19.14	3,511	18,597	100,348	5.30	19.38
10	3,330	16,492	83,269	4.95	15.10	3,517	22,883	94,346	6.51	15.39
11	2,843	20,203	82,350	7.11	14.15	3,277	25,664	95,265	7.83	14.81
12	3,086	18,685	90,819	6.05	15.35	3,831	24,832	103,298	6.48	15.89
13	4,037	15,689	99,422	3.89	16.82	4,342	21,657	111,833	4.99	17.64
14	4,318	21,540	98,587	5.00	15.13	4,503	28,068	112,406	6.23	16.01
15	4,189	20,440	98,832	4.88	15.83	4,336	25,436	113,140	5.87	17.08
16	4,420	22,966	106,584	5.20	14.64	4,599	26,150	125,653	5.69	16.63
17	6,084	29,509	107,217	4.85	11.10	6,300	34,072	132,353	5.41	13.05
18	5,820	24,942	111,091	4.29	12.91	6,113	31,403	131,354	5.14	14.26
19	3,060	31,776	96,092	10.38	17.00	3,459	41,006	104,962	11.85	16.36
20	3,267	36,500	100,433	11.17	16.01	3,604	45,369	111,582	12.59	15.78
21	4,629	29,746	120,345	6.43	14.67	4,812	34,189	141,116	7.10	16.40
22	5,330	23,925	134,752	4.49	16.65	5,667	29,796	153,789	5.26	18.16
23	5,467	27,670	140,056	5.06	16.75	5,701	31,897	161,352	5.59	18.65
24	6,955	33,142	148,895	4.77	13.70	7,273	36,941	178,191	5.08	15.92
25	7,039	45,223	143,429	6.42	10.11	7,173	47,347	184,325	6.60	12.72
26	6,840	59,892	125,892	8.76	8.56	7,216	65,579	165,515	9.09	10.68
27	5,076	50,344	123,025	9.92	10.64	5,823	56,748	150,220	10.26	11.71
28	6,406	48,839	139,758	7.63	10.29	6,580	51,076	178,708	7.76	12.88
29	7,657	58,347	143,079	7.62	9.47	7,751	60,862	186,433	7.85	12.06
30	4,902	59,007	143,619	12.04	13.15	5,016	62,652	173,350	12.49	15.30
31	4,836	71,378	142,316	14.76	12.53	5,113	74,514	174,144	14.57	14.74
32	5,931	49,920	177,647	8.42	15.29	6,371	55,436	207,807	8.70	17.10
33	9,375	47,426	204,355	5.06	12.53	9,736	51,922	249,491	5.33	14.88
34	11,747	57,591	207,675	4.90	10.62	11,951	61,044	263,471	5.11	13.21
35	11,193	56,378	209,770	5.04	11.46	11,473	60,336	261,334	5.26	13.97
36	9,286	56,172	211,238	6.05	12.86	9,653	60,107	257,168	6.23	15.20
37	8,495	54,292	225,347	6.39	13.17	9,009	57,846	273,713	6.42	15.63

Estuary of the Delaware: Physical elements—Continued.

Nautical miles from Fort Mifflin Light-house.	Low water.					Half-tide.				
	Mean of chords of mean depth per mile.	Mean area below mean depth per mile.	Mean area above mean depth per mile.	Mean ratio below mean depth per mile.	Mean ratio above mean depth per mile.	Mean of chords of mean depth per mile.	Mean area below mean depth per mile.	Mean area above mean depth per mile.	Mean ratio below mean depth per mile.	Mean ratio above mean depth per mile.
	Feet.	*Square feet.*	*Square feet.*	*Feet.*	*Feet.*	*Feet.*	*Square feet.*	*Square feet.*	*Feet.*	*Feet.*
38	9,873	58,721	243,142	5.95	12.59	10,400	62,461	297,944	6.00	15.11
39	11,684	57,945	258,957	4.96	12.18	12,234	61,544	319,765	5.03	14.76
40	11,854	64,397	266,092	5.43	11.98	12,117	67,546	330,581	5.57	14.56
41	10,746	70,108	277,773	6.52	12.15	10,918	73,165	343,670	6.70	14.82
42	10,547	71,017	311,653	6.73	13.53	10,797	74,406	377,964	6.89	16.13
43	11,271	90,943	282,356	8.07	11.28	11,559	94,059	354,938	8.14	13.96
44	9,405	102,948	284,335	10.95	12.28	9,605	105,903	351,443	11.03	14.96
45	8,772	122,768	272,411	14.00	12.06	8,999	125,770	337,755	13.98	14.70
46	9,755	128,091	288,289	13.13	11.39	9,957	130,610	362,311	13.12	14.09
	281,907	2,027,300	6,947,425	340.83	615.47	297,579	2,247,827	8,410,649	362.64	687.30
	6,128	44,072	151,031	7.41	13.38	6,469	48,866	182,840	7.88	14.94
	--------	7.19	12.64	------	------	--------	7.55	14.69		
47	13,142	139,189	358,860	10.59	10.74	13,531	141,910	456,939	10.49	13.52
48	13,782	125,309	404,810	9.09	12.64	14,311	128,844	497,988	9.00	15.36
49	11,590	125,004	437,344	10.79	13.90	11,899	128,194	529,169	10.77	16.60
50	12.940	135,244	475,695	10.45	13.51	13,189	137,856	579,320	10.45	16.27
51	19,497	167,151	533,395	8.57	11.43	19,780	169,345	671,772	8.56	14.28
52	18,107	162,927	605,866	9.00	11.52	18,413	165,040	760,824	8.96	14.48
	370,965	2,882,124	9,763,395	399.31	689.31	388,702	3,119,016	11,906,661	420.87	777.81
	7,134	55,425	187,758	7.68	13.26	7,475	59,981	228,974	8.09	14.96
	--------	7.77	12.51	------	------	--------	8.02	14.77		

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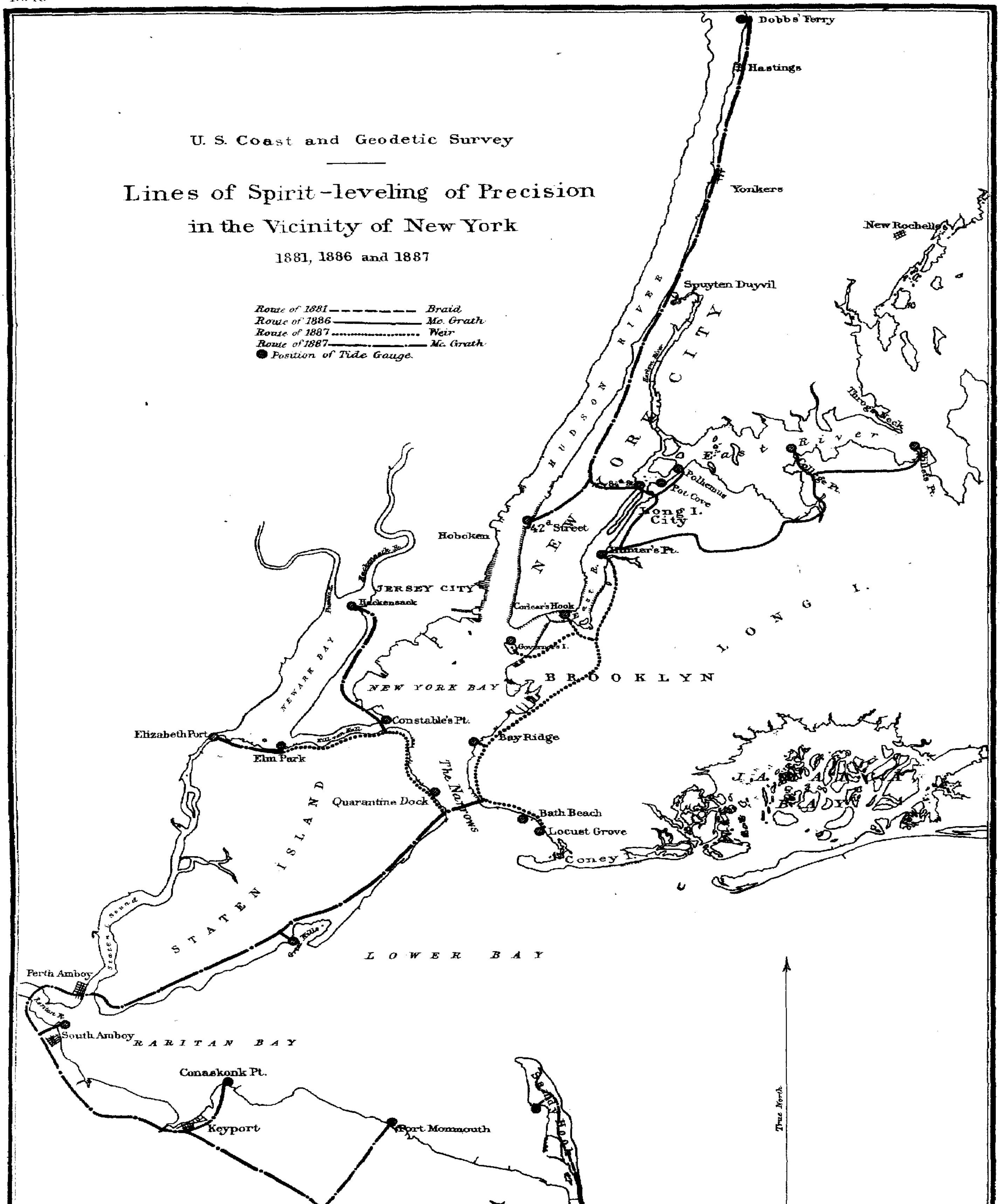


U. S. Coast and Geodetic Survey
Lines of Spirit-leveling of Precision
in the Vicinity of New York
1881, 1886 and 1887
Route of 1881 Braid
Route of 1886 Mc. Grath
Route of 1887 Weir
Route of 1887 Mc. Grath
Position of Tide Gauge
Dobbs' Ferry
Hastings
Yonkers
New Rochelle
Spuyten Duyvil
HUDSON RIVER
NEW YORK CITY
East River
Throgs Neck
Polhemus
Pot Cove
Long I. City
Hunter's Pt.
42d Street
Hoboken
JERSEY CITY
Hackensack
Corlear's Hook
NEWARK BAY
NEW YORK BAY
BROOKLYN
LONG I.
Constable's Pt.
Elizabeth Port
Elm Park
Bay Ridge
The Narrows
Quarantine Dock
STATEN ISLAND
Bath Beach
Locust Grove
Coney I.
JAMAICA BAY
LOWER BAY
Perth Amboy
South Amboy
RARITAN BAY
Conaskonk Pt.
Keyport
Port Monmouth
Red Bank
True North
Kilometers
Statute Miles

APPENDIX No. 14.—1887.

REPORT OF THE RESULTS OF SPIRIT-LEVELING OF PRECISION ABOUT NEW YORK BAY AND VICINITY IN 1886 AND 1887.

Observations by Assistant JOHN B. WEIR and Subassistant J. E. McGRATH. Discussion by CHARLES A. SCHOTT, Assistant.

COMPUTING DIVISION, COAST AND GEODETIC SURVEY,
March 9, 1888.

DEAR SIR: I herewith respectfully submit a report of the results of spirit-leveling of precision about New York Bay and vicinity in 1886 and 1887, made in connection with the hydrographic resurvey of the approaches to New York.

Route-line of levels.—In 1886 the levels were carried from Astoria, near Hell Gate, to Hunter's Point; thence via Winfield to Flushing, and passing Strattonport and Whitestone, they terminate at Willet's Point, opposite Throg's Neck, at the western end of Long Island Sound. There are several branch lines and offsets connecting with tide-gauges, also a crossing of the East River at Eighty-fourth street. These route-lines are shown on the accompanying map (Illustration No. 43), together with other features, for ready reference to any of the elevations determined.

In 1887 the main line was fully developed from Red Bank, N. J., where it taps the line of spirit-levels coming from Sandy Hook, a portion of Assistant A. Braid's line of 1881,* to Hunter's Point, crossing on the way Arthur Kill at Perth Amboy, and the Narrows at Forts Tompkins and Wadsworth. After skirting Brooklyn the route connects at Hunter's Point with the preceding year's work. The line is again taken up at Eighty-fourth street, New York, whence it crosses Manhattan Island to the Hudson River at Forty-second street, the eastern shore of which it follows as high up as Dobbs' Ferry, a distance of about 19 statute miles. On this line there are likewise numerous branch lines connecting with tide-water. Among these are lines to Port Monmouth and to Conaskonk Point via Keyport, N. J.; to Great Kills, Staten Island; to Constable Hook and Elizabethport, N. J., to head of Newark Bay, New Jersey; to Gravesend Bay, Long Island, to Governor's Island and other places as shown on the map.

Distance along the line of levels from Red Bank, N. J., to Dobbs' Ferry, N. Y., 116.5 kilometers (72.4 statute miles); length of branches and offsets, 78.5 kilometers (48.8 statute miles); total development of leveling, 195.0 kilometers (or 121.2 statute miles).

Observers and dates of leveling.—The observations of 1886 were made by Subassistant John E. McGrath, aided by H. P. Ritter as recorder, two rodmen and two men for general work; the lines were run between October 16 and November 22. The observations of 1887 were made in part by Assistant John B. Weir, aided by Subassistant J. E. McGrath and extra Observer W. B. Fairfield, and, after Mr. Weir's assignment to other duty, by Mr. McGrath, assisted by John Nelson, Aid, who had joined the party a short time before the change, which took place June 7, 1887. Work was commenced April 19 and terminated September 5. About one-third of the season's work was done under the charge of the first observer, the remaining two-thirds under his successor.

Instruments.—In 1886 the lines were run with geodetic level No. 1. This instrument is described in Appendix No. 11, Coast and Geodetic Survey Report for 1880, and illustrated on Plates Nos. 46 and 47 of that report. Metric rods A, and B were used in connection with this instrument. For description of rods and targets see Appendix No. 15, Coast and Geodetic Survey Report for 1879.

* Coast and Geodetic Survey Report for 1882, Appendix No. 11, page 529.

Two instruments were employed in 1887, viz, Nos. 2 and 3; they are described and figured in Appendix No. 15, Coast and Geodetic Survey Report for 1879, and Plate No. 52. Rods E and F were used; these rods and targets are of the same pattern as rods A, and B.

Instrumental constants—Seasons of 1886 *and* 1887.

	Level No. 1.	Level No. 2.	Level No. 3.
Aperture of telescope.	3.5^{cm}	4.3^{cm}	4.3^{cm}
Focal length of telescope.	40.7^{cm}	41.0^{cm}	41.0^{cm}
Magnifying power of telescope.	26	37	37
Value of one division of striding-level.	5″.62	3″.37	3″.09
Date of determination by J. B. Weir.	July 7, 1886.	Apr. 2, 1887.	Apr. 4, 1887.
Collar inequality, object-end larger.*	—0″.56	{ +0″.725 +1″.490	{ —0″.026 +0″.800
Date of determination (Nos. 2 and 3 by J. E. McG.).	1886.†	Apr. 1, Sept. 19, 1887.	Apr. 1, Sept. 19, 1887.
Angular distance of (horizontal) telemeter threads.	16′ 46″.6	{ 16′ 39″.3 Jan. 19, 1887.	{ 14′ 00″.7 Jan. 19, 1887.
Value of 1 turn or 100 divisions of micrometer screw.	{ 443″.3 442″.9	{ [254″.3 255″.1] ‡ 259″.6	{ 255″.6 257″.5 260″.6
Date of determination and observer.	{ T., Aug. 10, Sept. 15, 1877. B., May 21, 23, 1879.	McG. and W., Apr. 8, 1887.	{ T., March, 1879. W., June 16 and 17, 1880. McG. and W., Apr. 8, 1887.
Value adopted.	443″.1	257″.5	257″.5
Weight of instrument.	23 p. or 10.4 kg.	45 p. or 20.4 kg.	45 p. or 20.4 kg.

* A minus sign indicates object-end smaller.

† Record not given and not recovered; determined by Assistant A. Braid at the office before sending the instrument into the field July 7-9, 1886. J. B. Weir found 0″.54.

‡ Record not given and not recovered.

Spider-threads were used in the diaphragms in preference to lines on glass; the telemeter threads were nearly equidistant from the middle thread. Level No. 1 had 4 horizontal threads, distance between the upper and the middle and between the lower and the middle as given in the preceding table; level No. 2 had 4 and level No. 3 had 2 threads, with distances of the extreme lower one from the middle as given in the table. The value of 1 turn of the micrometer for instruments 2 and 3, as used in the computation, was 257″.5, and *increasing* turns for all instruments correspond to elevating the eye-end of the telescope. Respecting the correction for inequality of collars, attention was paid to the change due to wear during the progress of the work.

The comparisons of the rod meters with the standard remain as given in the report on the levels of the Mobile-New Orleans line, Appendix No. 9, Coast and Geodetic Survey Report for 1887; accordingly rods A,, B, E, F were of standard length at 67°.0 Fah. (19°.4 C.), 71°.7 Fah. (22°.1 C.), 62°.1 Fah. (16°.7 C.), and at 66°.1 Fah. (18°.9 C.), respectively. The index errors of A, and B do not come into consideration, since in 1886 one line was run with A, exclusively and the other with B, and the rods were always placed on the top of the benches or other points of reference. Rods E and F were used in 1887. Their index corrections were found as follows: Rod E, projection beyond zero, 62^{mm}.3; Rod F, 60^{mm}.1, as determined April 4 and September 20, 1887, showing a wear of but 0^{mm}.3.

Methods of observing.—When running the lines of levels in 1886 the manner of procedure was as follows: After the instrument was adjusted and leveled, rod A, was observed as backsight, and immediately afterwards, while A, was being carried forward, a backsight was taken on rod B which had been placed near A,, then foresight readings were made first on A, and immediately after on B near by. Thus two parallel lines were run simultaneously, a method abandoned the next season as not affording a complete check, the conditions of the instrument and of the atmosphere being the same for each line. The average distance from staff to staff was rather over 200 meters, but the instrument generally was not placed midway between. A, and B were kept close together within a few meters.

In 1887, when running the main line between Stapleton, Staten Island, at the Narrows, and Hunter's Point, Assistant Weir made the backward measures, starting from Hunter's Point with level No. 3, and Subassistant McGrath made the forward measures over the same ground, starting from Stapleton with level No. 2, both observers using the same bench-marks for the determination of the probable uncertainty of the results. This is considered the most perfect arrangement for securing two absolutely independent measures. A few unavoidable exceptions to this rule occur on side lines or offsets, but in all cases *two* lines were run for a check. Between Red Bank and Stapleton the forward measurement was run partly by McGrath using level No. 2 and partly by Nelson using level No. 3, and the backward measurement was run in the same way with tolerable regularity.

From Eighty-fourth street, New York, to Dobbs' Ferry both forward and backward measurements were run with level No. 3, but how much of share each observer had does not fully appear from the record.

All side lines and offsets were leveled twice, governed more by expediency than by systematic method.

The average distance from staff to staff when grades did not force shorter sights was about 190 meters, and the instrument as a rule was about midway between the two staves. Rods E and F were used during the entire season.

Two instruments were employed for the crossings of Arthur Kill and at the Narrows. In the latter case the individual results for difference in height of the two bench-marks, Nos. 70 and 71, located on opposite sides, are reasonably accordant; the distance between these benches was 1450 meters, or but 159 meters short of a statute mile, as determined by triangulation.

In the handling of the instrument a change was made in the method formerly pursued; instead of setting the bubble of the level against a selected division of the tube and recording the corresponding micrometer reading, the bubble is now set exactly in the middle of the tube. The successive operations are then as follows: Reading of micrometer for bubble in middle, reading of micrometer for backsight on target, reversal of levels on collars, readings for target and level as before, inversion of telescope about its axis (to correct for collimation error), with repetition of operations similar to above four readings, reversal of instrument 180° in azimuth, with repetition of the operations similar to above eight operations for the foresights.

Computations.—Each observer furnished a complete reduction of his work; at the Office a second and more elaborate computation was made in accordance with the general rule of the Survey. The levels of 1886 were computed by L. A. Bauer, who also reduced those made in 1887 by Assistant Weir, while Subassistant McGrath's levels of 1887 were computed by Mr. Weir while temporarily attached to the Computing Division since about the middle of October last. The means of the readings of the horizon and the target are made out and the corrections to the latter for micrometric difference, for inequality of collars, for refraction and curvature, are severally applied, and the difference of elevation of two stations is further corrected for expansion or contraction of the brass scales when their temperature differs from the standard temperature at which they are of normal length; the index correction of the staves is applied whenever needed. The reduction is facilitated by tables depending on the instrumental constants and other data of the measures. The results being collated and any appreciable difference corrected or explained, the probable errors of the operation are deduced and the final results are tabulated and reported on.

Resulting elevations.—They are given in the usual tabular form and require but little additional explanation. The initial plane of reference is the average or roughly so-called half-tide level of the Atlantic Ocean based upon tidal observations made at Sandy Hook, N. J., between the years 1876 and 1881, as discussed in Appendix No. 11, Coast and Geodetic Survey Report for 1882. We have transferred from the same report for convenience of reference the few results of 1881 of the common line, Sandy Hook to Red Bank, N. J., bench-mark E, at which place the levels of 1886-'87 connect with those of 1881, *i.e.*, with the average sea level. The separate results, however, required to be combined anew. The leveling of 1881 was carried out under instructions, which demanded the running of two simultaneous parallel lines, but also obliged the observer to run for a limited distance an independent *third* line in a direction the opposite of the two parallel lines, in order that the efficiency of the method of running parallel lines might be tested. Subsequently, experience having decided in favor of two independent lines, run in opposite directions, the work of 1887 was carried out by this more satisfactory method; that of 1886, however, had inadvertently been conducted by the old method. In the following table of results we have consequently presented the individual measures between the tide-house mark and the bench-mark at Red Bank, combined in accordance with the principle now recognized as the best. The average sea level adopted here is the same as that on which the 1881 line is based, and is the result of the discussion by the harmonic analysis of tidal observations at Sandy Hook during the six years 1876 to 1881.*

For convenience of reference the tabular results are given first for the main line from Sandy Hook to Dobbs' Ferry, arranged in five sections; this is followed by the branch lines and offsets.

Results of geodetic spirit-leveling in the vicinity of New York, 1886–'87, main line from Sandy Hook, N. J., to Dobbs' Ferry, Hudson River, New York.

SECTION I.—FROM SANDY HOOK, N. J., TO RED BANK, N. J.

Date, 1881.		Bench-marks.		Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks.			Discrepancy.		Height of mark above average sea level.
		From—	To—			Direction of measure. Forward.	Direction of measure. Backward.	Mean.	Partial.	Total accumulated.	
July.				*Km.*	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
.....			T.H	......	0.000	......	......	......	......	0.0	+ 3.4881
..	12	T.H	A	0.415	0.415	......	− {0.0104 0.0156	−0.0130	......	......	+ 3.4751
15	12	A	B	0.202	0.617	−0.6103	−0.6134	−0.6118	+ 3.1	+ 3.1	+ 2.8633
15	12	B	6	0.235	0.852	−1.3445	−1.3468	−1.3456	+ 2.3	+ 5.4	+ 1.5177
15	12	6	5	3.078	3.930	+0.4430	+0.4398	+0.4414	+ 3.2	+ 8.6	+ 1.9591
15	11	5	II	2.170	6.100	+0.3657	+0.3606	+0.3632	+ 5.1	+13.7	+ 2.3223
15	11	II	4	1.009	7.109	+0.9694	+0.9671	+0.9682	+ 2.3	+16.0	+ 3.2905
13		4	7	1.960	9.069	−0.6481	−0.6442	−0.6462	− 3.9	+12.1	+ 2.6443
13		7	8	1.900	10.969	−0.4906	−0.4879	−0.4892	− 2.7	+ 9.4	+ 2.1551
16	18	8	10	2.553	13.522	−0.4384	−0.4462	−0.4423	+ 7.8	+17.2	+ 1.7128
16	18	10	11	1.450	14.972	+2.6433	+2.6576	+2.6504	−14.3	+ 2.9	+ 4.3632
16	18	11	12	2.268	17.240	+0.1399	+0.1434	+0.1417	− 3.5	− 0.6	+ 4.5049
16	16	12	13	2.054	19.294	−1.3567	−1.3571	−1.3569	+ 0.4	− 0.2	+ 3.1480
19 } *11 }	19	13	V	2.420	21.714	−2.0880	−2.0884	−2.0882	+ 0.4	+ 0.2	+ 1.0598
*11	19	V	14	1.659	23.373	+5.7308	+5.7276	+5.7292	+ 3.2	+ 3.4	+ 6.7890
20	22	14	15	2.282	25.655	+2.4976	+2.5044	+2.5010	− 6.8	− 3.4	+ 9.2900
20	22	15	16	1.498	27.153	+1.1776	+1.1853	+1.1814	− 7.7	−11.1	+10.4714
23	..	16	E	0.361	27.514	{ +1.2583 +1.2570 }	......	+1.2562	......	−11.1	+11.7276

* August.

SECTION II.—FROM RED BANK TO SOUTH AMBOY, N. J.

1887. August.											
3	3	E	174	0.527	28.041	− 2.6643	− 2.6555	− 2.6649	+ 1.2	− 9.9	+ 9.0627
3	3	174	173	1.059	29.100	− 0.8939	− 0.8963	− 0.8951	+ 2.4	− 7.5	+ 8.1676
4	1	173	172	1.191	30.291	+ 9.4440	+ 9.4430	+ 9.4435	+ 1.0	− 6.5	+17.6111
4	1	172	171	0.931	31.222	+ 7.2014	+ 7.1960	+ 7.1987	+ 5.4	− 1.1	+24.8098
4	1	171	170	0.878	32.100	+ 4.4879	+ 4.4894	+ 4.4886	− 1.5	− 2.6	+29.2984
4	1	170	169	1.057	33.157	+ 0.3163	+ 0.3200	+ 0.3182	− 3.7	− 6.3	+29.6166
4	July 30	169	160	0.848	34.005	+ 2.9234	+ 2.9232	+ 2.9233	+ 0.2	− 6.1	+32.5399
July.											
26	23	160	159	0.460	34.465	− 0.9464	− 0.9485	− 0.9474	+ 2.1	− 4.0	+31.5925
26	23	159	158	1.222	35.687	−10.2608	−10.2614	−10.2611	+ 0.6	− 3.4	+21.3314

* These observations were continued to September, 1884, but the reduction and discussion of these additional observations were still incomplete at the date of writing, hence could not be made available for this report.

***Results of geodetic spirit-leveling in the vicinity of New York, 1886–'87, etc.*—Continued.**

SECTION II.—FROM RED BANK TO SOUTH AMBOY, N. J.—Continued.

Date, 1887.		Bench-marks.		Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks.			Discrepancy.		Height of mark above average sea level.
		From—	To—			Direction of measure.		Mean.	Partial.	Total accumulated.	
						Forward.	Backward.				
July.				Km.	Km.	Meters.	Meters.	Meters.	Mm.	Mm.	Meters.
26	23	158	157	1.274	36.961	+ 1.7085	+ 1.7063	+ 1.7074	+ 2.2	− 1.2	+23.0383
26	22	157	156	1.076	38.037	+ 2.3965	+ 2.4015	+ 2.3990	− 5.0	− 6.2	+25.4378
26	21	156	155	1.194	39.231	− 5.6802	− 5.6775	− 5.6788	− 2.7	− 8.9	+19.7590
27	21	155	154	1.138	40.369	+ 0.9406	+ 0.9439	+ 0.9422	− 3.3	−12.2	+20.7012
27	21	154	• 153	0.818	41.187	− 3.5908	− 3.5920	− 3.5914	+ 1.2	−11.0	+17.1098
27	21	153	152	1.250	42.437	− 7.7103	− 7.7108	− 7.7106	+ 0.5	−10.5	+ 9.3992
27	21	152	144	1.239	43.676	+ 0.3922	+ 0.3939	+ 0.3930	− 1.7	−12.2	+ 9.7922
18	21	144	143	1.142	44.818	+ 4.5412	+ 4.5353	+ 4.5382	+ 5.9	− 6.3	+14.3304
18	13	143	142	0.870	45.688	+ 3.0917	+ 3.0932	+ 3.0924	− 1.5	− 7.8	+17.4228
18	13	142	141	0.432	46.120	− 2.2364	− 2.2399	− 2.2382	+ 3.5	− 4.3	+15.1846
18	13	141	140	0.692	46.812	− 3.3353	− 3.3361	− 3.3357	+ 0.8	− 3.5	+11.8489
18	13	140	139	0.792	47.604	− 4.7251	− 4.7256	− 4.7254	+ 0.5	− 3.0	+ 7.1235
19	13	139	138	1.113	48.717	− 5.4446	− 5.4423	− 5.4434	− 2.3	− 5.3	+ 1.6801
19	12	138	137	0.615	49.332	+ 0.4752	+ 0.4738	+ 0.4745	+ 1.4	− 3.9	+ 2.1546
19	12	137	136	0.568	49.900	+ 1.0914	+ 1.0936	+ 1.0925	− 2.2	− 6.1	+ 3.2471
19	12	136	135	0.707	50.607	+ 0.1419	+ 0.1460	+ 0.1440	− 4.1	−10.2	+ 3.3911
19	12	135	134	0.461	51.068	− 1.4197	− 1.4201	− 1.4199	+ 0.4	− 9.8	+ 1.9712
19	12	134	133	0.727	51.795	+ 2.4056	+ 2.4119	+ 2.4088	− 6.3	−16.1	+ 4.3800
19	12	133	132	0.961	52.756	+ 0.7078	+ 0.7094	+ 0.7086	− 1.6	−17.7	+ 5.0886
19	11	132	VIII (1881)	0.267	53.023	− 0.6568	− 0.6513	− 0.6540	− 5.5	−23.2	+ 4.4346

SECTION III.—FROM SOUTH AMBOY, N. J., TO FORT WADSWORTH, STATEN ISLAND, NEW YORK.

July.											
28	11	VIII (1881)	131	0.269	53.292	− 2.0898	− 2.0874	− 2.0886	− 2.4	−25.6	+ 2.3460
9	9	131	F (1881)	0.702	53.994	− 0.0137	− 0.0149	− 0.0143	+ 1.2	−24.4	+ 2.3317
9	9	F (1881)	130*a*	0.270	54.264	+ 1.6426	+ 1.6432	+ 1.6429	− 0.6	−25.0	+ 3.9746
9	9	130*a*	130	0.771	55.035	+ 2.9441	+ 2.9431	+ 2.9436	+ 1.0	−24.0	+ 6.9182
11	9	130	129	0.916	55.951	− 3.9694	− 3.9735	− 3.9714	+ 4.1	−19.9	+ 2.9468
11	9	129	126	0.854	56.805	− 1.1904	− 1.1933	− 1.1918	+ 2.9	−17.0	+ 1.7550
7	8	126	127	0.541	57.346	+ 0.4533	+ 0.4519	+ 0.4526	+ 1.4	−15.6	+ 2.2076
8	8	127	105	0.273	57.619	+13.9356	+13.9345	+13.9350	+ 1.1	−14.5	+16.1426
June.											
20	17	105	104	0.804	58.423	− 5.7726	− 5.7714	− 5.7720	− 1.2	−15.7	+10.3706
20	17	104	103	0.420	58.843	− 2.6506	− 2.6562	− 2.6534	+ 5.6	−10.1	+ 7.7172
20	17	103	102	0.567	59.410	− 3.1334	− 3.1351	− 3.1342	+ 1.7	− 8.4	+ 4.5830
20	17	102	101	0.784	60.194	− 2.9168	− 2.9187	− 2.9178	+ 1.9	− 6.5	+ 1.6652
20	17	101	100	0.797	60.991	+ 5.1940	+ 5.1908	+ 5.1924	+ 3.2	− 3.3	+ 6.8576
20	16	100	99	0.913	61.904	− 0.4631	− 0.4665	− 0.4648	+ 3.4	+ 0.1	+ 6.3928
20	16	99	98	0.764	62.668	+ 5.1859	+ 5.1856	+ 5.1858	+ 0.3	+ 0.4	+11.5786
21	16	98	97	0.803	63.471	+ 4.2012	+ 4.2023	+ 4.2018	− 1.1	− 0.7	+15.7804
21	16	97	96	0.834	64.305	+ 7.1442	+ 7.1453	+ 7.1448	− 1.1	− 1.8	+22.9252
21	16	96	93	0.954	65.259	+ 3.9744	+ 3.9752	+ 3.9748	− 0.8	− 2.6	+26.9000
11	10	93	92	0.774	66.033	− 5.1337	− 5.1308	− 5.1322	− 2.9	− 5.5	+21.7678
11	10	92	91	1.060	67.093	− 6.2311	− 6.2316	− 6.2314	+ 0.5	− 5.0	+15.5364
11	10	91	N	1.054	68.147	+ 6.0894	+ 6.0945	+ 6.0920	− 5.1	−10.1	+21.6284
11	10	N	90	0.366	68.513	+ 0.2801	+ 0.2781	+ 0.2791	+ 2.0	− 8.1	+21.9075
13	10	90	89	1.249	69.762	− 2.8054	− 2.8072	− 2.8063	+ 1.8	− 6.3	+19.1012
14	10	89	88	1.202	70.964	− 4.4438	− 4.4424	− 4.4431	− 1.4	− 7.7	+14.6581
14	9	88	87	1.148	72.112	− 1.1474	− 1.1458	− 1.1466	− 1.6	− 9.3	+13.5115
14	9	87	86	1.078	73.190	− 4.3927	− 4.3913	− 4.3920	− 1.4	−10.7	+ 9.1195
14	9	86	84	1.630	74.820	− 1.8439	− 1.8482	− 1.8460	+ 4.3	− 6.4	+ 7.2735
15	9	84	83	0.869	75.689	+13.5560	+13.5560	+13.5560	0.0	− 6.4	+20.8295
15	8	• 83	82	1.042	76.731	+ 9.8766	+ 9.8714	+ 9.8740	+ 5.2	− 1.2	+30.7035

***Results of geodetic spirit-leveling in the vicinity of New York, 1886–'87, etc.*—Continued.**

SECTION III.—FROM SOUTH AMBOY, N. J., TO FORT WADSWORTH, STATEN ISLAND, NEW YORK—Continued.

Date, 1887.		Bench-marks.		Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks.			Discrepancy.		Height of mark above average sea level.
		From—	To—			Direction of measure. Forward.	Direction of measure. Backward.	Mean.	Partial.	Total accumulated.	
				Km.	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
June.											
15	8	82	81	0.959	77.690	−14.1057	−14.1118	−14.1088	+ 6.1	+ 4.9	+16.5947
15	8	81	55	0.924	78.614	−14.1070	−14.1046	−14.1058	− 2.4	+ 2.5	+ 2.4889
May.											
26	25	55	54	0.729	79.343	+ 9.1531	+ 9.1567	+ 9.1549	− 3.6	− 1.1	+11.6438
26	25	54	51	0.617	79.960	− 0.9826	− 0.9808	− 0.9817	− 1.8	− 2.9	+10.6621
24	24	51	52	0.422	80.382	+ 7.8112	+ 7.8145	+ 7.8128	− 3.3	− 6.2	+ 8.4749
24	24	52	53	0.364	80.746	+ 7.1056	+ 7.1060	+ 7.1058	− 0.4	− 6.6	+25.5807
June.											
1	7	53	72	0.321	81.067	−19.9074	−19.9070	−19.9072	− 0.4	− 7.0	+ 5.6735
1	1	72	70	0.108	81.175	+ 6.9965	+ 6.9951	+ 6.9958	+ 1.4	− 5.6	+12.6693

SECTION IV.—FROM FORT WADSWORTH, STATEN ISLAND, TO HUNTER'S POINT, LONG ISLAND.

Date, 1887.		From—	To—	Distance between bench-marks.	Distance from initial mark.	Forward.	Backward.	Mean.	Partial.	Total accumulated.	Height of mark above average sea level.
July.											
		70	71	1.450	82.625	− 0.1398	− 0.1398	− 0.1398	0.0	− 5.6	+12.5295
1	1	71	124	0.096	82.721	− 0.0446	− 0.0448	− 0.0447	+ 0.2	− 5.4	+12.4848
1	1	124	125	0.433	83.154	+ 0.0747	+ 0.0747	+ 0.0747	0.0	− 5.4	+12.5595
1	1	125	L	0.271	83.425	− 1.5064	− 1.5087	− 1.5076	+ 2.3	− 3.1	+11.0519
1	1	L	44	0.360	83.785	+ 2.4644	+ 2.4649	+ 2.4646	− 0.5	− 3.6	+13.5165
May.											
18	14	44	43	0.441	84.226	+ 8.5579	+ 8.5568	+ 8.5574	+ 1.1	− 2.5	+22.0739
May.											
18	14	43	28	0.678	84.904	+ 0.9811	+ 0.9790	+ 0.9800	+2.1	−0.4	+23.0539
April.											
30	29	28	27	0.649	85.553	+ 0.5295	+ 0.5296	+ 0.5296	−0.1	−0.5	+23.5835
30	29	27	26	0.629	86.182	+ 1.0806	+ 1.0791	+ 1.0798	+1.5	+1.0	+24.6633
30	29	26	*25	0.517	86.699	+ 1.9033	+ 1.9042	+ 1.9038	−0.9	+0.1	+26.5671
30	29	25	24	0.714	87.413	+ 1.8236	+ 1.8254	+ 1.8245	−1.8	−1.7	+28.3916
30	29	24	23	0.743	88.156	− 5.4158	− 5.4136	− 5.4147	−2.2	−3.9	+22.9769
May.	Apr.										
2	29	23	22	0.634	88.790	− 4.1772	− 4.1801	− 4.1786	+2.9	−1.0	+18.7983
2	29	22	21	0.486	89.276	− 9.5488	− 9.5518	− 9.5503	+3.0	+2.0	+ 9.2480
2	29	21	20	0.997	90 273	+ 1.3694	+ 1.3683	+ 1.3688	+1.1	+3.1	+10.6168
2	28	20	19	0.679	90.952	+ 6.0156	+ 6.0161	+ 6.0158	−0.5	+2.6	+16.6326
2	28	19	18	0.606	91.558	− 5.4751	− 5.4775	− 5.4763	+2.4	+5.0	+11.1563
2	28	18	17	0.670	92.228	− 4.9730	− 4.9715	− 4.9722	−1.5	+3.5	+ 6.1841
2	28	17	16	0.717	92.945	+ 2.7039	+ 2.7053	+ 2.7046	−1.4	+2.1	+ 8.8887
2	27	16	1	0.514	93.459	+ 5.9986	+ 5.9979	+ 5.9982	+0.7	+2.8	+14.8869
Apr.											
19	27	1	2	0.495	93.954	+ 4.3714	+ 4.3731	+ 4.3722	−1.7	+1.1	+19.2591
19	27	2	3	0.340	94.294	+ 7.5087	+ 7.5113	+ 7.5100	−2.6	−1.5	+26.7691
20	27	3	4	0.496	94.790	− 6.0480	− 6.0460	− 6 0470	−2.0	−3.5	+20.7221
20	27	4	5	0.619	95.409	− 4.0504	− 4.0518	− 4.0511	+1.4	−2.1	+16.6710
20	27	5	6	0.597	96.006	− 1.7784	− 1.7786	− 1.7785	−0.2	−2.3	+14.8925
20	27	6	7	0.576	96.582	− 4.5240	− 4.5261	− 4.5250	+2.1	−0.2	+10.3675
20	27	7	8	0.628	97.210	+ 6.3902	+ 6.3901	+ 6.3902	+0.1	−0.1	+16.7577
20	26	8	9	0.582	97.792	+ 5.9094	+ 5.9091	+ 5.9092	+0.3	+0.2	+22.6669
20	26	9	10	0.818	98.610	− 3.3536	− 3.3535	− 3.3536	−0.1	+0.1	+19.3133
20	26	10	11	0.665	99.275	−10.1484	−10.1467	−10.1476	−1.7	−1.6	+ 9.1657
21	25	11	12	1.265	100.540	− 6.9247	− 6.9276	− 6.9262	+2.9	+1.3	+ 2.2395
21	25	12	13	1.660	102.200	+ 5.9450	+ 5.9413	+ 5.9432	+3.7	+5.0	+ 8.1827
21	25	13	14	1.178	103.378	− 3.5799	− 3.5736	− 3.5768	−6.3	−1.3	+ 4.6059
22	22	14	15	1.074	104.452	− 2.9346	− 2.9361	− 2.9354	+1.5	+0.2	+ 1.6705
22	22	15	H.'s Pt. B. M. 8	0.857	105.309	+ 0.1142	+ 0.1147	+ 0.1144	−0.5	−0.3	+ 1.7849

Results of geodetic spirit-leveling in the vicinity of New York, 1886–'87, etc.—**Continued.**

SECTION V.—FROM HUNTER'S POINT, LONG ISLAND, TO DOBB'S FERRY, NEW YORK.

Date.		Bench-marks.		Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks.			Discrepancy.		Height of mark above average sea level.
		From—	To—			Direction of measure. Forward.	Direction of measure. Backward.	Mean.	Partial.	Total accumulated.	
*Oct., 1886.				*Km.*	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
23		H.'s Pt. B. M. 8	39	1.001	106.310	+ 1.6778	+ 1.6796	+ 1.6787	−1.8	−2.1	+ 3.4636
23		39	37	0.506	106.816	− 0.4916	− 0.4951	− 0.4933	+3.5	+1.4	+ 2.9703
22		37	30	1.386	108.202	+ 2.2036	+ 2.1974	+ 2.2005	+6.2	+7.6	+ 5.1708
22		30	29	0.161	108.363	+ 1.8617	+ 1.8604	+ 1.8610	+1.3	+8.9	+ 7.0318
20		29	6	1.513	109.876	− 3.4378	− 3.4310	− 3.4344	−6.8	+2.1	+ 3.5974
19		6	4	0.549	110.425	− 1.8303	− 1.8308	− 1.8305	+0.5	+2.6	+ 1.7669
19		4	5	0.608	111.033	+ 0.4996	+ 0.5003	+ 0.4999	−0.7	+1.9	+ 2.2668
*Aug., 1887.											
12	16	5	177	0.778	111.811	+13.6272	+13.6249	+13.6260	+2.3	+4.2	+15.8928
12	16	177	178	0.840	112.651	+14.2646	+14.2633	+14.2640	+1.3	+5.5	+30.1568
12	16	178	179	0.654	113.305	+ 1.7328	+ 1.7327	+ 1.7328	+0.1	+5.6	+31.8896
12	16	179	180	0.510	113.815	+ 1.8496	+ 1.8478	+ 1.8487	+1.8	+7.4	+33.7383
	Sept.										
16	1	180	186	1.086	114.901	− 6.7420	− 6.7440	− 6.7430	+2.0	+9.4	+26.9953
	Aug.										
16	20	186	187	0.841	115.742	−10.3300	−10.3296	−10.3298	−0.4	+9.0	+16.6655
17	20	187	188	0.938	116.680	− 7.5135	− 7.5107	− 7.5121	−2.8	+6.2	+ 9.1534
17	20	188	189	1.115	117.795	− 0.1973	− 0.1955	− 0.1964	−1.8	+4.4	+ 8.9570
17	19	189	190	1.007	118.802	+ 0.5577	+ 0.5562	+ 0.5570	+1.5	+5.9	+ 9.5140
17	19	190	192	1.126	119.928	+22.8389	+22.8397	+22.8393	−0.8	+5.1	+32.3533
17	19	192	193	0.668	120.596	+14.6907	+14.6909	+14.6908	−0.2	+4.9	+47.0441
18	19	193	194	0.700	121.296	+ 4.3998	+ 4.4023	+ 4.4010	−2.5	+2.4	+51.4451
18	19	194	195	0.640	121.936	+13.0073	+13.0072	+13.0072	+0.1	+2.5	+64.4523
18	19	195	196	0.660	122.596	− 9.3794	− 9.3770	− 9.3782	−2.4	+0.1	+55.0741
18	19	196	197	0.446	123.042	−14.9788	−14.9773	−14.9780	−1.5	−1.4	+40.0961
18	19	197	198	0.435	123.477	−16.9177	−16.9227	−16.9202	+5.0	+3.6	+23.1759
18	19	198	199	0.293	123.770	− 8.8573	− 8.8595	− 8.8584	+2.2	+5.8	+14.3175
23	26	199	200	0.600	124.370	− 4.7398	− 4.7372	− 4.7385	−2.6	+3.2	+ 9.5790
23	26	200	201	0.614	124.984	− 2.3590	− 2.3594	− 2.3592	+0.4	+3.6	+ 7.2198
23	26	201	202	0.419	125.403	+ 2.7982	+ 2.7961	+ 2.7972	+2.1	+5.7	+10.0170
23	26	202	203	0.754	126.157	− 3.1270	− 3.1250	− 3.1260	−2.0	+3.7	+ 6.8910
23	26	203	204	0.819	126.976	− 4.1509	− 4.1471	− 4.1490	−3.8	−0.1	+ 2.7420
23	25	204	205	1.062	128.038	+ 0.3965	+ 0.3952	+ 0.3958	+1.3	+1.2	+ 3.1378
23	25	205	206	1.093	129.131	− 1.2699	− 1.2682	− 1.2690	−1.7	−0.5	+ 1.8688
24	25	206	207	1.249	130.380	+ 0.5335	+ 0.5322	+ 0.5328	+1.3	+0.8	+ 2.4016
24	25	207	208	1.256	131.636	− 0.0095	− 0.0094	− 0.0094	−0.1	+0.7	+ 2.3922
24	25	208	209	1.293	132.929	− 0.1037	− 0.1007	− 0.1022	−3.0	−2.3	+ 2.2900
24	25	209	210	1.327	134.256	+ 0.0684	+ 0.0685	+ 0.0684	−0.1	−2.4	+ 2.3584
24	25	210	211	1.291	135.547	− 0.1782	− 0.1735	− 0.1758	−4.7	−7.1	+ 2.1826
27	31	211	212	0.992	136.539	+ 0.2559	+ 0.2555	+ 0.2557	+0.4	−6.7	+ 2.4383
27	31	212	213	0.776	137.315	− 0.1564	− 0.1552	− 0.1558	−1.2	−7.9	+ 2.2825
27	31	213	214	0.763	138.078	+ 0.3064	+ 0.3043	+ 0.3054	+2.1	−5.8	+ 2.5879
27	31	214	215	0 806	138.884	− 0.2147	− 0.2160	− 0.2154	+1.3	−4.5	+ 2.3725
27	30	215	216	0.823	139.707	− 0.2407	− 0.2410	− 0.2408	+0.3	−4.2	+ 2.1317
27	30	216	217	0.708	140.415	− 0.1009	− 0.1012	− 0.1010	+0.3	−3.9	+ 2.0307
29	30	217	218	0.826	141.241	+ 2.1836	+ 2.1847	+ 2.1842	−1.1	−5.0	+ 4.2149
29	30	218	219	0.667	141.908	− 1.2733	− 1.2764	− 1.2748	+3.1	−1.9	+ 2.9401
29	30	219	220	0.685	142.593	− 0.6380	− 0.6384	− 0.6382	+0.4	−1.5	+ 2.3019
29	30	220	221	0.775	143.368	− 0.3476	− 0.3490	− 0.3483	+1.4	−0.1	+ 1.9536
29	30	221	222	0.493	143.861	+ 1.4768	+ 1.4763	+ 1.4766	+0.5	+0.4	+ 3.4302
29	29	222	T.B.M. (1885–'86)	0.132	143.993	− 0.4572	− 0.4580	− 0.4576	+0.8	+1.2	+ 2.9726
30	30	T.B.M. (1885–'86)	V	0.041	144.034	− 0.0694	− 0.0690	− 0.0692	−0.4	+0.8	+ 2.9034

* For the short distance between Hunter's Point and foot of Eighty-fourth street, New York City, and including the crossing of the East River, the figures in the columns "Forward" and "Backward" do not correspond to this designation. They refer to two separate but simultaneous measures, as explained in the preface. The effect on the total accumulated discrepancy is small.

***Results of geodetic spirit-leveling in the vicinity of New York, 1886–'87, etc.*—Continued.**

RESULTS FROM BRANCH LINES AND OFFSETS.

[Line from B. M. "A" (1881) to 8-foot mark of tide-staff of 1886 at Sandy Hook, N. J.]

Date, 1887.	Bench-marks.		Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks.			Discrepancy.		Height of mark above average sea level.
	From—	To—			Direction of measure.		Mean.	Partial.	Total accumulated.	
					Forward.	Backward.				
August.			*Km.*	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
		A (1881)	....	0.415	....	....	....	....	......	+ 3.4751
5	A (1881)	T	0.021	0.436	− 0.1947	− 0.1952	− 0.1949	+ 0.5		+ 3.2802
5	A (1881)	B (1881)	0.023		− 0.6071	− 0.6076	− 0.6074	+ 0.5		+ 2.8677
5	B (1881)	175	0.159		− 1.0881	− 1.0874	− 1.0878	− 0.7		+ 1.7799
5	175	U	0.194		+ 0.0917	+ 0.0908	+ 0.0913	+ 0.9		+ 1.8712

[Line from B. M. "B" (1881) to primary B. M. "U".]

Date, 1887.	From—	To—	Distance between bench-marks.	Distance from initial mark.	Forward.	Backward.	Mean.	Partial.	Total accumulated.	Height of mark above average sea level.
August.										
		B (1881)	....	0.617	....	....	....	....	+ 3.1	+ 2.8627
5	B (1881)	175	0.159	0.776	− 1.0881	− 1.0874	− 1.0878	− 0.7		+ 1.7749
5	175	U	0.194	0.970	+ 0.0917	+ 0.0908	+ 0.0913	+ 0.9		+ 1.8662

[Line from B. M. "C" (1881) to primary B. M. "U".]

Date, 1887.	From—	To—	Distance between bench-marks.	Distance from initial mark.	Forward.	Backward.	Mean.	Partial.	Total accumulated.	Height of mark above average sea level.
August.										
		C (1881)	....	0.707	....	....	....	....	....	+ 5.9531
5	C (1881)	176	1.319		− 4.7978					
5	176	175	0.594		+ 0.6524					
5	175	U	0.194		+ 0.0917					
Hence	C (1881)	U			− 4.0537					

[Same line.]

Date, 1887.	From—	To—	Distance between bench-marks.	Distance from initial mark.	Forward.	Backward.	Mean.	Partial.	Total accumulated.	Height of mark above average sea level.
September.										
2	C (1881)	223	0.537	....	− 0.3042	− 0.3025	− 0.3034	− 1.7	....	+ 5.6497
2	223	U	1.369		− 3.7578	− 3.7589				
Hence	C (1881)	U			− 4.0620	− 4.0614				
Mean	C (1881)	U			− 4.0579	− 4.0614	− 4.0596	+ 4.1		+ 1.8935
Mean height of U.										+ 1.8770
Mean U to 8-ft. mark of tide-gauge.			0.182		− 0.6116	− 0.6117	− 0.6117	+ 0.1		+ 1.2653

[Line from main line at B. M. 160 to tidal B. M. and tide-gauge at Port Monmouth, N. J.]

Date, 1887.	From—	To—	Distance between bench-marks.	Distance from initial mark.	Forward.	Backward.	Mean.	Partial.	Total accumulated.	Height of mark above average sea level.
July.										
23 30	160	161	0.887	34.892	+ 2.1759	+ 2.1717	+ 2.1738	+ 4.2	− 1.9	+34.7137
23 30	161	162	0.308	35.200	−11.5411	−11.5440	−11.5426	+ 2.9	+ 1.0	+23.1711
28 30	162	163	0.813	36.013	− 5.0740	− 5.0704	− 5.0722	− 3.6	− 2.6	+18.0989
28 30	163	164	0.493	36.506	− 1.2197	− 1.2212	− 1.2204	+ 1.5	− 1.1	+16.8785
28 29	164	165	0.655	37.161	− 6.3762	− 6.3748	− 6.3755	− 1.4	− 2.5	+10.5030
28 29	165	166	0.922	38.083	− 4.5841	− 4.5876	− 4.5858	+ 3.5	+ 1.0	+ 5.9172
28 29	166	167	1.030	39.113	− 3.2408	− 3.2487	− 3.2448	+ 7.9	+ 8.9	+ 2.6724
28 29	167	168	1.063	40.176	− 1.4010	− 1.4042	− 1.4026	+ 3.2	+12.1	+ 1.2698
29 28	168	8 ft. of gauge	0.209	40.385	+ 0.4054	+ 0.4052	+ 0.4053	+ 0.2	+12.3	+ 1.6751
29 28	8 ft. of gauge	S	0.197	40.582	+ 1.8805	+ 1.8810	+ 1.8808	− 0.5	+11.8	+ 3.5559
29 28	8 ft. of gauge	T. B. M. (1886) at Port Monmouth.	0.197	40.582	+ 1.9021	+ 1.9026	+ 1.9014	− 0.5	+11.8	+ 3.5765

Results of geodetic spirit-leveling in the vicinity of New York, 1886–'87, *etc.*—Continued.

RESULTS FROM BRANCH LINES AND OFFSETS—Continued.

[Line from main line at B. M. 144 to permanent B. M. "R" and tidal B. M. of 1886 at Conaskonk Point, New Jersey.]

Date, 1887.		Bench-marks.		Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks.			Discrepancy.		Height of mark above average sea level.
		From—	To—			Direction of measure.		Mean.	Partial.	Total accumulated.	
						Forward.	Backward.				
July.				*Km.*	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
11	16	144	146	0.780	44.456	− 2.5786	− 2.5765	− 2.5776	− 2.1	−14.3	+ 7.2146
14	16	146	147	0.836	45.292	+ 3.0208	+ 3.0188	+ 3.0198	+ 2.0	−12.3	+10.2344
14	16	147	148	0.831	46.123	− 6.7658	− 6.7650	− 6.7654	− 0.8	−13.1	+ 3.4690
14	16	148	R	0.620	46.743	+ 3.5155	+ 3.5122	+ 3.5138	+ 3.3	− 9.8	+ 6.9828
14	16	R	149	0.877	47.620	− 2.2310	− 2.2358	− 2.2334	+ 4.8	− 5.0	+ 4.7494
15	15	149	150	1.042	48.662	− 2.7011	− 2.7027	− 2.7019	+ 1.6	− 3.4	+ 2.0475
15	15	150	151	1.057	49.719	+ 0.3784	+ 0.3806	+ 0.3795	− 2.2	− 5.6	+ 2.4270
15	15	151	T. B. M.(1886)	0.435	50.154	+ 1.5311	+ 1.5355	+ 1.5333	− 4.4	−10.0	+ 3.9603

[Line from main line at B. M. No. 144 to B. M. VI (1870 and 1881) of transcontinental line of levels.]

July.											
13	18	144	145	0.315	43.991	− 0.2195	− 0.2195	− 0.2195	+ 0.0	−12.2	+ 9.5727
18	18	145	VI (1870, 1881)	0.322	44.313	+ 7.2877	+ 7.2867	+ 7.2872	+ 1.0	−11.2	+16.8599

[Line from main line at B. M. 132 to tidal B. M. and tide-gauge at South Amboy, N. J.]

July.											
11		132	T. B. M.	0.910	53.666	− 2.8987	− 2.9015	− 2.9001	+ 2.8	−14.9	+ 2.1885
11		T. B. M.	14.567-foot mark of gauge (1886)	0.050	53.716	− 1.0368	− 1.0382	− 1.0375	+ 1.4	−13.5	+ 1.1510

[Line from main line at B. M. 129 to B. M. of Geological Survey of New Jersey at Perth Amboy, N. J.]

July.											
9		129	G. S. B. M.	0.774	56.725	+15.5964	+15.5980	+15.5972	− 1.6	−21.5	+18.5440

[Line from main line at B. M. 127 to tide-gauge at Tottenville.]

July.											
8		127	12.935-foot mark of gauge.	0.440	57.786	+ 0.4566	+ 0.4565	+ 0.4566	+ 0.1	−15.5	+ 2.6642

[Line from main line at B. M. "N" to permanent B. M. and tidal B. M. at Great Kills, Staten Island.]

June.											
11	13	N	94	0.600	68.747	+ 3.5124	+ 3.5128	+ 3.5126	− 0.4	−10.5	+25.1410
11	13	94	95	0.583	69.330	−10.0922	−10.0979	−10.0950	+ 5.7	− 4.8	+15.0460
11	13	95	β	0.654	69.984	−12.6089	−12.6154	−12.6122	+ 6.5	+ 1.7	+ 2.4338
11	11	β	T. B. M. (1886)	0.078	70.062	− 0.4656	− 0.4650	− 0.4653	− 0.6	+ 1.1	+ 1.9685
11	13	β	O	0.061	70.045	− 0.7458	− 0.7458	− 0.7458	0.0	+ 1.7	+ 1.6880

Results of geodetic spirit-leveling in the vicinity of New York, 1886–'87, *etc.*—Continued.

RESULTS FROM BRANCH LINES AND OFFSETS—Continued.

[Line from main line at B. M. 55 to tidal B. M. of 1886 at Elizabethport, N. J.]

Date, 1887.	Bench-marks.		Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks.			Discrepancy.		Height of mark above average sea level.
	From—	To—			Direction of measure. Forward.	Direction of measure. Backward.	Mean.	Partial.	Total accumulated.	
May.			*Km.*	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
25 26	55	56	0.680	79.294	+ 0.8538	+ 0.8528	+ 0.8533	+ 1.0	+ 3.5	+ 3.3422
25 26	56	57	0.593	79.887	− 0.6267	− 0.6232	− 0.6250	− 3.5	0.0	+ 2.7172
25 26	57	58	0.580	80.467	+ 2.9300	+ 2.9315	+ 2.9308	− 1.5	− 1.5	+ 5.6480
25 26	58	59	0.337	80.804	+ 7.6822	+ 7.6814	+ 7.6818	+ 0.8	− 0.7	+13.3298
25 26	59	60	0.410	81.214	+ 7.7955	+ 7.7946	+ 7.7950	+ 0.9	+ 0.2	+21.1248
27 28	60	61	0.433	81.647	− 6.0191	− 6.0208	− 6.0200	+ 1.7	+ 1.9	+15.1048
27 28	61	62	0.412	82.059	− 4.9711	− 4.9721	− 4.9716	+ 1.0	+ 2.9	+10.1332
27 28	62	63	0.493	82.552	+ 0.0353	+ 0.0374	+ 0.0364	− 2.1	+ 0.8	+10.1696
27 28	63	64	0.440	82.992	− 0.4376	− 0.4364	− 0.4370	− 1.2	− 0.4	+ 9.7326
27 28	64	65	0.783	83.775	− 1.5466	− 1.5492	− 1.5479	+ 2.6	+ 2.2	+ 8.1847
27 28	65	66	0.537	84.312	− 6.8495	− 6.8488	− 6.8492	− 0.7	+ 1.5	+ 1.3355
27 28	66	67	0.612	84.924	+ 2.5931	+ 2.5934	+ 2.5932	− 0.3	+ 1.2	+ 3.9287
27 28	67	68	0.510	85.434	+ 0.2293	+ 0.2318	+ 0.2306	− 2.5	− 1.3	+ 4.1593
27 28	68	69	0.362	85.796	+ 2.5199	+ 2.5194	+ 2.5196	+ 0.5	− 0.8	+ 6.6789
June.										
2	69	73	0.658	86.454	− 3.5724	− 3.5708	− 3.5716	− 1.6	− 2.4	+ 3.1073
2	73	74	0.721	87.175	+ 0.2628	+ 0.2620	+ 0.2624	+ 0.8	− 1.6	+ 3.3697
2	74	75	0.465	87.640	+ 0.1284	+ 0.1284	+ 0.1284	0.0	− 1.6	+ 3.4981
2	75	76	0.689	88.329	+ 0.4285	+ 0.4244	+ 0.4264	+ 4.1	+ 2.5	+ 3.9245
4	76	77	0.791	89.120	+ 0.8040	+ 0.8075	+ 0.8058	− 3.5	− 1.0	+ 4.7303
4	77	78	0.842	89.962	− 2.2425	− 2.2440	− 2.2432	+ 1.5	+ 0.5	+ 2.4871
4	78	79	0.768	90.730	+ 1.2005	+ 1.1971	+ 1.1988	+ 3.4	+ 3.9	+ 3.6859
4	79	80	0.566	91.296	+ 2.7971	+ 2.7938	+ 2.7954	+ 3.3	+ 7.2	+ 6.4813
30	80	120	0.274	91.570	− 5.4664	− 5.4665	− 5.4664	+ 0.1	+ 7.3	+ 1.0149
30	120	121	0.345	91.915	+ 0.3728	+ 0.3695	+ 0.3712	+ 3.3	+10.6	+ 1.3861
30	121	122	0.236	92.151	+ 0.0766	+ 0.0707	+ 0.0736	+ 5.9	+16.5	+ 1.4597
30	122	123	0.275	92.426	− 0.3720	− 0.3720	− 0.3720	0.0	+16.5	+ 1.0877
30	123	T. B. M. at Elizabethport.	0.150	92.576	+ 2.6709	+ 2.6710	+ 2.6710	− 0.1	+16.4	+ 3.7587

[Line from secondary line at B. M. 76 to tide-gauge and tidal B. M. at Elm Park, N. J.]

June.										
2	76	T. B. M. (1886)	0.130	88.329		− 0.5819				
2	76	8-foot mark	0.157	88.486	− 2.8676					
2	8-foot mark	T. B. M.	0.173		+ 2.2856					
Mean	76	T. B. M. (1886)	0.157	88.459	− 0.5820	− 0.5819	− 0.5820	− 0.1		+ 3.3425

[Line from secondary line at B. M. 64 to B. M. "Q" and tide-gauge of 1886 at Hackensack bridge, New Jersey.]

July.										
2 2	64	106	0.344	83.336	− 7.7657	− 7.7629	− 7.7643	− 2.8	− 3.2	+ 1.9683
June.										
18 18	106	107	0.501	83.837	+ 0.4351	+ 0.4351	+ 0.4351	0.0	− 3.2	+ 2.4034
18 18	107	108	0.323	84.160	− 0.0985	− 0.0995	− 0.0990	+ 1.0	− 2.2	+ 2.3044
22 29	108	109	0.947	85.107	− 0.1641	− 0.1657	− 0.1649	+ 1.6	− 0.6	+ 2.1395
22 29	109	110	0.889	85.996	+ 5.8466	+ 5.8436	+ 5.8451	+ 3.0	+ 2.4	+ 7.9846
22 29	110	111	0.976	86.972	− 1.4474	− 1.4474	− 1.4474	0.0	+ 2.4	+ 6.5372
22 29	111	112	1.072	88.044	+ 4.2404	+ 4.2382	+ 4.2393	+ 2.2	+ 4.6	+10.7765
22 28	112	113	1.041	89.085	+ 3.0267	+ 3.0238	+ 3.0252	+ 2.9	+ 7.5	+13.8017
24 28	113	114	1.116	90.201	− 2.1178	− 2.1172	− 2.1175	− 0.6	+ 6.9	+11.6842

***Results of geodetic spirit-leveling in the vicinity of New York*, 1886–'87, *etc.*—Continued.**

RESULTS FROM BRANCH LINES AND OFFSETS—Continued.

[Line from secondary line at B. M. 64 to B. M. "Q" and tide-gauge of 1886 at Hackensack bridge, New Jersey—Cont'd.]

Date, 1887.		Bench-marks. From—	Bench-marks. To—	Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks. Direction of measure. Forward.	Difference of height between bench-marks. Direction of measure. Backward.	Difference of height between bench-marks. Mean.	Discrepancy. Partial.	Discrepancy. Total accumulated.	Height of mark above average sea level.
June.				*Km.*	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
24	28	114	115	0.699	90.900	− 2.0188	− 2.0175	− 2.0182	− 1.3	+ 5.6	+ 9.6660
24	28	115	116	1.063	91.963	+14.4137	+14.4102	+14.4120	+ 3.5	+ 9.1	+24.0780
24	27	116	117	0.673	92.636	−12.5233	−12.5248	−12.5240	+ 1.5	+10.6	+11.5540
24	27	117	118	0.719	93.355	− 5.6025	− 5.6017	− 5.6021	− 0.8	+ 9.8	+ 5.9519
25	27	118	119	0.452	93.807	− 2.9403	− 2.9402	− 2.9402	− 0.1	+ 9.7	+ 3.0117
25	27	119	Q	0.446	94.253	+ 1.0269	+ 1.0261	+ 1.0265	+ 0.8	+10.5	+ 4.0382
25	27	Q	8-foot mark	0.758	95.011	− 2.5494	− 2.5477	− 2.5486	− 1.7	+ 8.8	+ 1.4896

[Line from secondary line at B. M. 108 to permanent B. M. P, tidal B. M. and tide-gauge at Constable's Hook, New Jersey.]

Date	From—	To—	Distance between bench-marks	Distance from initial mark	Forward	Backward	Mean	Partial	Total accumulated	Height
June.										
22	108	8-foot mark	0.157	84.317	−1.2215	−1.2222	−1.2219	+0.7		+1.0825
22	8-ft. mark	P.	0.045	84.362	+1.8377	+1.8386	+1.8382	−0.9		+2.9207
22	8-ft. mark	T. B. M.	0.116	84.433	+1.6174	+1.6177	+1.6176	−0.3		+2.7001

[Line from main line at B. M. 51 to tidal B. M. and tide-gauge at Quarantine, Staten Island.]

Date	From—	To—	Distance between bench-marks	Distance from initial mark	Forward	Backward	Mean	Partial	Total accumulated	Height
May.										
24	51	T. B. M.	0.444	80.404	−8.1439	−8.1441	−8.1440	+.02		+2.5181
24	T. B. M.	10-ft. mark	0.180	80.584	−0.7293	−0.7305	−0.7299	+1.2		+1.7882

[Line from main line at B. M. 70 to primary B. M. M.]

Date	From—	To—	Distance between bench-marks	Distance from initial mark	Forward	Backward	Mean	Partial	Total accumulated	Height
June.										
7	70	M.	0.054	81.229	−0.5431	−0.5432	−0.5432	+0.1		+12.1261

[Line from main line at B. M. 44 to tidal B. M's and tide-gauges at Locust Grove, Bath Beach, L. I.]

Date		From—	To—	Distance between bench-marks	Distance from initial mark	Forward	Backward	Mean	Partial	Total accumulated	Height
May.											
18	14	44	45	0.701	84.486	−3.7532	−3.7554	−3.7543	+2.2	− 1.4	+9.7622
18	14	45	46	0.455	84.941	−6.4949	−6.4932	−6.4940	−1.7	− 3.1	+3.2682
18	14	46	47	0.991	85.932	−2.4998	−2.4928	−2.4963	−7.0	−10.1	+0.7719
18	14	47	48	0.715	86.647	+7.1401	+7.1371	+7.1386	+3.0	− 7.1	+7.9105
17	14	48	49	0.520	87.167	−1.9752	−1.9760	−1.9756	+0.8	− 6.3	+5.9349
17	14	49	50	0.516	87.683	+0.9053	+0.9098	+0.9076	−4.5	−10.8	+6.8425
17	17	50	T. B. M.	0.458	88.141	−4.0708	−4.0712	−4.0710	+0.4	−10.4	+2.7715
17	17	T. B. M.	15.2-ft. mark	0.251	88.392	−1.4037	−1.4049	−1.4043	+1.2	− 9.2	+1.3672

[Line from secondary line at B. M. 48 to primary B. M. K.]

Date	From—	To—	Distance between bench-marks	Distance from initial mark	Forward	Backward	Mean	Partial	Total accumulated	Height
May.										
17	48	K.	0.100	86.747	+0.3859	+0.3863	+0.3861	−0.4		+8.2966

[Line from secondary line at B. M. 49 to tidal B. M. and tide-gauge at Bath Beach.]

Date	From—	To—	Distance between bench-marks	Distance from initial mark	Forward	Backward	Mean	Partial	Total accumulated	Height
May.										
17	49	0.0-ft. mark.	0.249	87.416	−2.6061	−2.6084	−2.6072	+2.3		+3.3277
17	0.0-ft. mark	T. B. M., out on pier.	0.164	87.580	−0.6143	−0.6159	−0.6151	+1.6		+2.7126
17	0.0-ft. mark	Permanent B. M.	0.096	87.512	−0.7698	−0.7696	−0.7697	−0.2		+2.5580

Results of geodetic spirit-leveling in the vicinity of New York, 1886–'87, etc.—Continued.

RESULTS FROM BRANCH LINES AND OFFSETS—Continued.

[Line from main line at B. M. 25 to tidal B. M. and tide-gauge at Bay Ridge.]

Date, 1887.	Bench-marks.		Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks.			Discrepancy.		Height of mark above average sea level.
	From—	To—			Direction of measure. Forward.	Direction of measure. Backward.	Mean.	Partial.	Total accumulated.	
May.			*Km.*	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
13	25	42	0.587	88.000	−13.5498	−13.5541	−13.5520	+4.3	+4.4	+13.0151
	42	T. B. M.	0.595	88.595	−11.1013	−11.1015	−11.1014	+0.2	+4.6	+ 1.9137
	T. B. M.	8-foot mark.	0.206	88.801	− 0.4692	− 0.4704	− 0.4698	+1.2	+5.8	+ 1.4439

[Line from secondary line at B. M 42 to J.]

May. 13	42	J	0.088	88.088	+0.2528	+0.2524	+0.2526	+0.4		+13.2677

[Line from main line at B. M. 22 to primary B. M. A.]

May. 2	22	A	0.070	88.860	+1.2178	+1.2177	+1.2178	+0.1		+20.0161

[Line from main line at B. M. 16 to tidal B. M.'s and tide-gauge on Governor's Island.]

May.										
4 5	16	29	0.682	93.627	−5.9982	−5.9946	−5.9964	−3.6	−1.5	+ 2.8923
4 5	29	30	0.590	94.217	+6.4766	+6.4762	+6.4764	+0.4	−1.1	+ 9.3687
4 4	30	31	0.483	94.700	+2.3239	+2.3221	+2.3230	+1.8	+0.7	+11.6917
4 4	31	32	0.582	95.282	−8.1826	−8.1845	−8.1836	+1.9	+2.6	+ 3.5081
19 19	32	a	0.619	95.901	−1.5117	−1.5038	−1.5078	−7.9	−5.3	+ 2.0003
11 11	a	41	0.486	96.387	+0.1043	+0.1043	+0.1043	0.0	−5.3	+ 2.1046
12 12	41	B.M.,1 (1873)	0.385	96.772	+1.5582	+1.5583	+1.5582	−0.1	−5.4	+ 3.6628
12 12	B.M.,1 (1873)	H	0.690	97.462	−1.2499	−1.2524	−1.2512	+2.5	−2.9	+ 2.4116
12 12	H	I	0.069	97.531	+0.1875	+0.1872	+0.1874	+0.3	−2.6	+ 2.5990
12 12	B.M.,1 (1873)	B.M.,2 (1875)	0.231	97.003	+4.7768	+4.7750	+4.7759	+1.8	−3.6	+ 8.4387
12 12	H	9.8-ft. mark	0.065	97.527	−0.7695	−0.7700	−0.7698	+0.5	−2.4	+ 1.6418
19 19	a	40	0.108	96.009	−0.0355	−0.0358	−0.0357	+0.3	−5.0	+ 1.9646
11 11	40	G	0.061	96.070	+0.8993	+0.8995	+0.8994	−0.2	−5.2	+ 2.8640

[Line from main line at B. M. 1 to permanent B. M. C on Hall of Records building, Brooklyn, N. Y.]

May.										
5	1	33	0.578	93.937	−1.4751	−1.4795	−1.4773	+4.4	+7.2	+13 4096
5	33	C	0.780	94.717	+3.6314	+3.6321	+3.6318	−0.7	+6.5	+17.0414

[Line from main line at B. M. 4 to tide-gauge and tidal B. M. at Corlear's Hook. Also to permanent B. M.'s D, E, and F.]

May.										
6	4	34	0.557	95.347	−8.2842	−8.2847	−8.2844	+0.5	−3.0	+12.4377
6	34	35	0.348	95.695	−8.5456	−8.5458	−8.5457	+0.2	−2.8	+ 3.8920
6	35	36	0.683	96.378	−0.1695	−0.1728	−0.1712	+3.3	+0.5	+ 3.7208
6	36	37	0.338	96.716	−1.9124	−1.9133	−1.9129	+0.9	+1.4	+ 1.8079
6	37	38	0.583	97.299	+0.5268	+0.5268	+0.5268	0.0	+1.4	+ 2.3347
9 10	38	T.B.M. (1886)	0.334	97.633	−0.0290	−0.0269	−0.0280	−2.1	−0.7	+ 2.3067
10	38	8-foot mark	0.312	97.611	−1.2968	−1.2929	−1.2948	−3.9	−2.5	+ 1.0399
9 10	T. B. M. (1886)	E	0.076	97.709	+1.7442	+1.7416	+1.7429	+2.6	+1.9	+ 4.0496
6	35	D	0.058	95.753	+0.1893	+0.1896	+0.1894	−0.3	−3.1	+ 4.0814
10	37	F	0.053	96.769	+1.3308	+1.3304	+1.3306	+0.4	+1.8	+ 3.1385

***Results of geodetic spirit-leveling in the vicinity of New York*, 1886–'87, *etc*.—Continued.**

RESULTS FROM BRANCH LINES AND OFFSETS—Continued.

[Line from main line at Hunter's Point B. M. to tide-gauge at Hunter's Point.]

Date, 1887.	Bench-marks.		Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks.			Discrepancy.		Height of mark above average sea level.
	From—	To—			Direction of measure.		Mean.	Partial.	Total accumulated.	
					Forward.	Backward.				
April.			*Km.*	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
22	H.'s Pt. B. M. 8	8-foot mark	0.147	105.309	−0.9753	−0.9747	−0.9750	−0.6	−0.9	+0.8099
May.										
3	H.'s Pt. B. M. 8	Primary B. M. B	0.111	105.420	+0.6038	+0.6032	+0.6035	+0.6	+0.3	+2.3884

[Line from main line at B. M. 180 to tide-gauge and B. M.'s at foot of west end of Forty-second street, New York.]

August.										
13 15	180	181	0.894	114.709	− 6.0921	− 6.0940	− 6.0930	+ 1.9	+ 9.3	+27.6453
13 15	181	182	1.012	115.721	− 3.3961	− 3.3947	− 3.3954	− 1.4	+ 7.9	+24.2499
13 15	182	183	0.653	116.374	− 2.6715	− 2.6722	− 2.6718	+ 0.7	+ 8.6	+21.5781
13 15	183	184	0.954	117.328	− 7.8987	− 7.9002	− 7.8994	+ 1.5	+10.1	+13.6787
13 15	184	185	0.928	118.256	− 9.5556	− 9.5596	− 9.5576	+ 4.0	+14.1	+ 4.1211
13 15	185	T. B. M. (1885)	0.227	118.483	− 1.0742	− 1.0738	− 1.0740	− 0.4	+13.7	+ 3.0471
15	T. B. M. (1885)	T. B. M. (1886)	0.064	118.547	+ 1.5137	+ 1.5129	+ 1.5133	+ 0.8	+14.5	+ 4.5604
15	T. B. M. (1886)	8-foot mark	0.307	118.854	− 3.5521	− 3.5531	− 3.5526	+ 1.0	+15.5	+ 1.0078

[Line from main line at B. M. 222 to tide-gauge at Dobbs' Ferry.]

August. 29	222	8-foot mark	0.191	144.072	− 2.0588	− 2.0589	− 2.0588	+ 0.1		+ 1.3714

[Line from main line at B. M. 29 (1886) to tidal B. M. at Ravenswood, Long Island.]

					First measure(A).	Second measure(B).	Mean.			
1886. October.										
22	29 (1886)	T. B. M. 7 (1886)	0.329	108.692	− 4.0301	− 4.0277	− 4.0289	− 2.4		+ 3.0029
22	T. B. M. 7 (1886)	T. B. M. (1857)	0.041	108.733	− 0.5624	− 0.5627	− 0.5625	+ 0.3		+ 2.4404

Results of geodetic spirit-leveling in the vicinity of New York, 1886–'87, etc.—Continued.

RESULTS FROM BRANCH LINES AND OFFSETS—Continued.

[Line from main line at B. M. 39 (1886) to tidal B. M. at College Point.]

Date, 1886.	Bench-marks. From—	Bench-marks. To—	Distance between bench-marks.	Distance from initial mark.	Difference of height between bench-marks. First measure (A).	Second measure (B).	Mean.	Discrepancy. Partial.	Total accumulated.	Height of mark above average sea level.
October.			*Km.*	*Km.*	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*	*Meters.*
23	39	9	1.344	107.654	+ 0.4565	+ 0.4542	+ 0.4553	+ 2.3	*+ 2.3	+ 3.9189
November.										
4	9	2	0.789	108.443	− 2.1347	− 2.1387	− 2.1367	+ 4.0	+ 6.3	+ 1.7822
5	2	25	6.288	114.731	+ 6.7017	+ 6.7144	+ 6.7080	−12.7	− 6.4	+ 8.4902
8	25	34	2.682	117.413	− 0.9283	− 0.9334	− 0.9308	+ 5.1	− 1.3	+ 7.5594
9	34	42	1.619	119.032	− 4.4291	− 4.4245	− 4.4268	− 4.6	− 5.9	+ 3.1326
9	42	46	1.042	120.074	− 1.2520	− 1.2530	− 1.2525	+ 1.0	− 4.9	+ 1.8801
10	46	10	0.128	120.202	+ 0.6666	+ 0.6704	+ 0.6685	− 3.8	− 8.7	+ 2.5486
10	10	50	1.063	121.265	− 0.1111	− 0.1087	− 0.1099	− 2.4	−11.1	+ 2.4387
10	50	11	1.420	122.685	+10.0915	+10.0887	+10.0901	+ 2.8	− 8.3	+12.5288
10	11	58	0.248	122.933	+ 2.6791	+ 2.6794	+ 2.6792	− 0.3	− 8.6	+15.2080
11	58	65	0.946	123.879	− 8.0168	− 8.0204	− 8.0186	+ 3.6	− 5.0	+ 7.1894
11	65	T. B. M., College Point.	0.385	124.264	− 4.2989	− 4.2996	− 4.2992	+ 0.7	− 4.3	+ 2.8902

* Since the accumulated discrepancies in the work of 1886 depend on the differences between the first (A) and second (B) measures, and not as in 1887 on the differences between the forward and backward measures, a new start had to be made with Station No. 39, adopting 0.0 for it. The accumulated discrepancy from Sandy Hook to this station was only about 2 millimeters.

[Line from secondary line at B. M. 11 (1886) to Willet's Point.]

Date, 1886.	From—	To—	Distance between bench-marks.	Distance from initial mark.	First measure (A).	Second measure (B).	Mean.	Partial.	Total accumulated.	Height of mark above average sea level.
November.										
11	11	12	0.647	123.332	− 2.0790	− 2.0831	− 2.0810	+ 4.1	− 4.2	+10.4478
12	12	76	1.225	124.557	− 4.7413	− 4.7439	− 4.7426	+ 2.6	− 1.6	+ 5.7052
15	76	82	1.033	125.590	+15.8687	+15.8690	+15.8688	− 0.3	− 1.9	+21.5740
15	82	87	0.820	126.410	− 3.7623	− 3.7615	− 3.7619	− 0.8	− 2.7	+17.8121
16	87	90	0.871	127.281	+ 0.3741	+ 0.3798	+ 0.3769	− 5.7	− 8.4	+18.1890
16	90	91	0.205	127.486	− 2.9094	− 2.9090	− 2.9092	− 0.4	− 8.8	+15.2798
16	91	99	1.065	128.551	−11.7573	−11.7555	−11.7564	− 1.8	−10.6	+ 3.5234
17	99	T. B. M., Willet's Point.	1.110	129.661	− 0.4861	− 0.4891	− 0.4876	+ 3.0	− 7.6	+ 3.0358

[Line from main line at B. M. 6 (1886) to B. M. 1 (1886) or T. B. M. at Pot Cove.]

Date, 1886.	From—	To—	Distance between bench-marks.	Distance from initial mark.	First measure (A).	Second measure (B).	Mean.	Partial.	Total accumulated.	Height of mark above average sea level.
October.										
22	6	2	0.471	110.347	+ 0.5601	+ 0.5554	+ 0.5577	+ 4.7		+ 4.1551
22	2	1 (T. B. M.)	0.216	110.563	− 1.2680	− 1.2653	− 1.2666	− 2.7		+ 2.8885

[Line from main line at B. M. 6 (1886) to B. M. 4*a* or T. B. M. at Polhemus.]

Date, 1886.	From—	To—	Distance between bench-marks.	Distance from initial mark.	First measure (A).	Second measure (B).	Mean.	Partial.	Total accumulated.	Height of mark above average sea level.
November.										
1	6	4*a* T. B. M.	2.313	112.189	− 1.5509	− 1.5529	− 1.5519	+ 2.0		− 2.0455

Accuracy of the preceding results for heights.

The probable errors of the resulting heights are based as usual upon the observed differences of heights resulting from the forward and backward independent measures for a number of bench-marks in the line of levels. For comparison of the accuracy reached in various lines it is customary to compute the probable error of the measures for one kilometer as the unit of distance, and in accordance with the method of least squares as applied to spirit-leveling, we take the probable error of leveling to be proportional to $\sqrt{s}$, or what comes to the same thing, we take the weight w of a result to be inversely proportional to the distance s; hence, $w = \frac{1}{s}$.

Let d = difference of the results deduced from the forward and backward independent measures for any mark at the distance s. d is generally expressed in millimeters and s in kilometers.

n = the number of such differences or the number of separate lines composing the whole distance between the initial and terminal points.

$m_{,}$ and $m_{,,}$ = the mean error of a single leveling and of a double leveling, respectively, of one kilometer or for unit of length.

Then,

$$m_{,} = \sqrt{\frac{1}{2n}\left[\frac{dd}{s}\right]} \quad \text{and} \quad m_{,,} = \frac{m_{,}}{\sqrt{2}}$$

If $r_{,,}$ and r are the respective probable errors of double leveling for a line of unit length (one kilometer) and for a line of length S, then

$$r_{,,} = 0.675\, m_{,,} \quad \text{and} \quad r = 0.675\, m_{,,}\sqrt{S} \quad \text{or} \quad r_{,,}\sqrt{s}$$

In case the successive marks are distributed over the line with tolerable regularity at distances of one kilometer, the above formulæ become simplified, since $w=1$ nearly, and the probable error of a resulting difference of height from a double measure of a length of one kilometer becomes $0.675\sqrt{\frac{[dd]}{4[s]}}$, and consequently the probable error for a terminal point at the distance $S = [s]$ will be $r = 0.675\sqrt{\frac{[dd]}{4}}$. In the present case the more exact formulæ first given have been applied with the following results for probable error arising *purely* from the operation of spirit-leveling:

Starting point.	Terminal point.	Distance.		$\left[\frac{dd}{s}\right]$	n	$r_{,,}$	r
		Km.	*St. m.*			*mm.*	*mm.*
Sandy Hook T. H.	South Amboy, B. M. VIII.	53.0	32.9	832	46	±1.44	±10.4
Sandy Hook T. H.	Fort Wadsworth, Narrows, B. M. 70.	81.2	50.4	1221	83	1.29	11.7
Sandy Hook T. H.	Hunter's Point, L. I., B. M. 8.	105.3	65.4	1426	118	1.17	12.0
Sandy Hook T. H.	Dobbs' Ferry, Hudson River, B. M. V.	144.0	89.5	1821	167	1.11	13.4
Sandy Hook T. H.	Elizabethport, N. J., T. B. M., 1886.	92.6	57.5	1483	104	±1.27	±12.3
Sandy Hook T. H.	Willet's Point, L. I., T. B. M., 1886.	129.7	80.5	*1868	136	1.25	14.2

* All differences between first and second lines, work of 1886, were increased by one-fourth part to allow for the circumstance that differences derived from parallel simultaneous lines do not give the whole discrepancy, since the state of the atmosphere and the condition of the instrument are the same for both lines; the fraction ¼ is an approximate allowance.

The probable error of pure leveling (mean, forwards and backwards) of one kilometer on the average for the whole line is but ±1.11 millimeters; for the older line between Sandy Hook and Hagerstown, Md., run by Assistant A. Braid in 1881 by means of spirit-level No. 1, we found ±1.03 millimeters for parallel simultaneous lines (Coast and Geodetic Survey Report for 1882, p. 522), which, when referred to two independent lines, must be increased by about one-fourth, hence $r_{,,} = \pm 1.28$ millimeters; for the difficult line between Mobile, Ala., and New Orleans, La., Assistant Weir reached in 1885-'86, with levels No. 1 and No. 3, the extraordinary low value $r_{,,} = \pm 0.67$ millimeters. (See Coast and Geodetic Survey Report for 1887, p. 196.)

We have also for our line the mean error of a single measure for one kilometer $m_{,} = \pm 2.33$ millimeters, which quantity may advantageously be used for comparisons.

As far as the figures in column "Accumulated discrepancy" show, our results appear to be free of any error always tending in the same way; thus at the close of the line the total accumulation is but eight-tenths of a millimeter, and nowhere does it rise beyond 25.6 millimeters; in other words, nowhere do the two independent lines give results separated by more than 1 inch.

To find the probable error of any of the bench-marks above the average sea-level the probable error of the determination of the latter or ± 9.1 millimeters must be combined with that arising from the leveling operation proper; thus for the probable error of the resulting height of the mark at Dobbs' Ferry we have

$$\sqrt{(9.1)^2 + (13.4)^2} = \pm 16^{mm}.2$$

(about two-thirds of an inch), and similarly for the mark at Willet's Point,

$$\sqrt{(9.1)^2 + (14.2)^2} = \pm 16^{mm}.9$$

The absolute height of any of the bench-marks determined by our levels may therefore be considered known as being subject to no greater probable error than $\pm$ 17 millimeters, or two-thirds of an inch.

The operation of spirit-leveling formed part of the new hydrographic survey of the port of New York and approaches, prosecuted during 1886 and 1887, and the resulting heights of the many bench-marks herewith presented are intended to serve as permanent results of reference and remain available for any engineering works that demand an accurate knowledge of the height of the sea level. *Additional* tidal observations may hereafter change all the results by a small constant correction.

The many tidal stations established in 1886 had for their object the investigation of the tidal laws in these waters, and their connection with the spirit-levels will serve to show how far the average sea-level may be assumed to be the same within the limits of the inquiry. This report contains the means for making this comparison.

The remaining pages contain descriptions of the bench-marks, but for many of the places the records at the Survey Office contain additional information and rough sketches of the locality. Copies of these descriptions may be had on application.

Yours, respectfully,

CHARLES A. SCHOTT,
Assistant.

Mr. B. A. COLONNA,
Assistant in charge Office and Topography.

LOCATION AND DESCRIPTION OF BENCH-MARKS IN THE MAIN LINE AND BRANCHES OF SPIRIT LEVELS, SANDY HOOK TO DOBBS' FERRY.

SECTION I.—*Sandy Hook to Red Bank, N. J.*

T. H.—The tide-house bench-mark of 1881. It is a heavy line on the northwest corner post, inside the tide-house at Sandy Hook. It is the first or starting mark to which the average height of the ocean has been referred. [The tidal observations at this place commenced in October, 1875, and came to a close in September, 1884; a short revival between April and October, 1885, not proving satisfactory, the station was abandoned in consequence of certain difficulties attending the locality. A new tidal station was established in 1886 on an adjacent wharf, which is referred to further on.—SCH.]

A and B of 1881.—Sandy Hook, N. J.; are cedar posts 8 feet long and 8 inches in diameter, sunk in the ground with ends projecting about 4 inches. In the center of each post is a copper nail surrounded by five others in form of a pentagon. These posts are 12 meters apart and bear ENE. from the steamer landing and nearly northeast from the tide-house, and are distant from the latter about 500 meters. They are also 95 meters NW. of the railroad red engine-house, and are in the edge of the cedars where the ground is elevated a few feet above the marsh. [Description of 1881; for new bench-mark T of 1886 see further on.]

C of 1881.—A cross on the head of a copper bolt inserted in the wall of the main light-house tower at Sandy Hook. It is a few inches west of the northwest angle of the tower and 9¼ inches above the sloping ledge near its base.

II.—A heavy granite post, which projects about 2 feet above the surface of the ground, on the east side of the track of the New Jersey Southern Railroad, about three-quarters of a mile north of Highland Station. [Description of 1881.]

V.—A square cavity cut on the south pier of the Oceanport draw-bridge, about 1½ miles north of the Branchport Station, New Jersey Central Railroad. [Description of 1881.—SCH.]

E.—Red Bank, N. J.; a marble post near the southeast corner of the house of Rev. B. F. Leipser. The house stands on the southwest corner of Monmouth and Pearl streets. [Description of 1881.]

Description of this bench-mark by J. E. McGrath in 1887.—Since the establishment of the bench-mark in 1881 the property changed ownership and now belongs to Mr. Van Dyke Reed. The new porch, resting on a brick foundation, is flush with the east edge of the bench-mark and covers about one-third of it; the bricks of the foundation do not rest on the marble post, which is over 5 feet long and projects above the ground about 5 inches.

Primary bench-mark T of 1886.—A marble post about 4 feet long, the upper part dressed and the letters "U. S C. S." carved in the upper surface; in the center of the face there is a small cavity, about half an inch in dimensions. This mark is on the western slope of the high ridge at Sandy Hook, just east of the New Jersey Southern Railroad wharf. It is below the crest of the ridge, sheltered by vegetation, and 375 feet west of the western corner of the round-house of the railroad, and 2 feet 7½ inches WSW. of bench-mark A of 1881 (described above), and is also 41 feet WNW. of bench-mark B of 1881.

Primary bench-mark U of 1886.—A copper nail in the top of the highest horizontal brace of the platform upon which the house containing the self-registering tide-gauge of 1886 at Sandy Hook is erected. The copper nail is surrounded by a circlet of nine copper tacks; the bench is 4 feet 1½ inches east of the eastern edge of the door of tide-house and south and east of the tide-gauge walk. A tide-staff is near the mark.

SECTION II.—*From Red Bank, N. J., to South Amboy, N. J.*

Permanent bench-mark S.—At Port Monmouth, established July 29, 1887; is a cross on the east of a brick whose upper surface was the tidal bench-mark established in 1886. The brick is in the highest course of the pier, which supports the NE. corner of the piazza of Captain Bowman's house; on its east face is a small cross and the center of this cross is the bench-mark. This mark is 0.0216 meter lower than the upper surface of the brick.

Port Monmouth tidal bench-mark.—Was established by Assistant H. L. Marindin in 1886; it is on the top of the brick foundation (NE. corner) of the wooden piazza of Captain Bowman's frame house. The top of the brick pier is the bench-mark and is 14.105 feet above the zero of the gauge.

Primary bench mark R.—Keyport, N. J.; established July 14, 1887; is situated on the east end of stone door-sill of the First National Bank; the mark is the center of a cross cut in the east corner of the sill.

Conaskonk Point tidal mark.—Was established by Assistant Marindin in 1886; the mark is the top of a nail driven in a silver poplar tree near the Monmouth House. B. M. above zero of gauge, 17.027 feet.

VI, Mattawan, N. J.—First established by Subassistant C. Ferguson in July, 1870; in connection with the line of levels between Keyport, N. J., and the Delaware River at Gloucester, opposite Philadelphia; it was again reached in the transcontinental line starting from Sandy Hook in 1881, but was then supposed by Assistant Braid to have the appearance of having been slightly disturbed. The mark is the center of a triangle cut on a flag-stone in front of Benjamin Tuttle's house on Main street.

Tidal bench-mark at South Amboy, N. J.—It was established by Assistant Marindin in 1886, on the slip in the Pennsylvania coal-yard. The bench-mark is the top of the great sill upon which the uprights rest that carry the rails along the side of the slip. It is on the east side of the yard. The foot of the upright just at the bench-mark has a small three-sided piece cut out of it and three nails are driven in the sill. A copper nail in the center of this triangle is the mark; the letters "B. M." are cut on the upright.

VIII of 1881.—Near South Amboy; the center of a triangle cut on stone wall at crossing of Camden and Amboy branch of Pennsylvania Railroad and of New Jersey Central Railroad.

F of 1881.—Raritan Bay; the bottom surface of a square cavity cut on the pier at the north end of draw-bridge between South and Perth Amboy.

SECTION III.—*From South Amboy, N. J., to Fort Wadsworth, Narrows.*

State Geological Survey bench-mark, Perth Amboy, N. J.—A granite post located in a triangular grass-plot in the public park in the center line of High street, 97.75 feet southwesterly from its intersection with the center line of Market street. (See description in Report of State Geologist for 1886.)

Primary bench-mark N, Staten Island.—It is situated on a rock a little south of Gifford station on the Staten Island Railroad, on the west side of the track, about 125 meters from the station. It was established June 10, 1887.

Primary bench-mark O, Staten Island.—Is situated on a rock at Great Kills, and is a cross cut on a large stone in the bottom course of rough sea-wall in front of Fitzgerald's Hotel. The stone is the second one inland from the southeast corner of the wall. Mark established June 13, 1887.

Great Kills tidal bench-mark, Staten Island.—The bench-mark is on the post that supports the NE. corner of the barn at Great Kills belonging to Mr. Fitzgerald. The post selected is at the extreme corner and about 1 foot above the ground. The east side is flattened and the middle of the line joining the flattened side with the bevel running to the round portion is the datum line. The letters "B. M." are cut above this line. Established by Assistant Marindin in 1886. B. M. 13.879 feet above zero of gauge.

Primary bench-mark M, Fort Wadsworth, Staten Island.—Is situated on the top layer of granite masonry which surrounds gun No. 5, water battery, a little south of the fort. The bench-mark is a small black spot near the corner of the stone, nearly under gun No. 5, or the second one south of the embankment. Mark established June 7, 1887.

Quarantine Dock, Staten Island.—A cross cut on the upper surface of the coping on the north end of the old sea-wall and about forty paces south of the Quarantine boat-house. The letters "U. S. C. & G. S." are cut near it. The tide-gauge mark was established in 1885 by Assistant Marindin and the new gauge of 1886 refers to the same datum level. The bench-mark is 12.30 feet above the zero of the tide-staff.

Constable's Hook, N. J.—At the crude-oil docks of the Standard Oil Company on Constable's Hook, Kill Van Kull. The bench-mark is the top of the SE. corner of a stringer upon which the one-story brick warehouse of the company is built; the brick above the mark has a rude cross scratched in its face. The mark is 13.276 feet above the zero of the tide-gauge, and was established by Assistant Marindin in 1886.

Primary bench-mark P, Constable's Hook, N. J.—A cross on a copper bolt leaded in a brick at the cooper workshops of the Standard Oil Company. This brick is on the second buttress east of the door on the south side of the shop. This shop is just in the rear of the covered dock called Crude-Oil Dock No. 3.

Primary bench-mark Q, Bergen, N. J.—A cross and cavity cut in the upper surface of a large granite stone forming the south end of the top course of masonry in the west abutment of small iron bridge of the Central Railroad of New Jersey, crossing the Morris Canal. The mark is on the SE. corner of the stone and shows the letters "U. S."

Tidal bench-mark, Elm Park, Staten Island.—The mark is a small cross cut on a stone in the foundation wall of the house attached to the Elm Park cottage. The horizontal line marks the reference plane. This stone is the second from the top and the second from the north face of the wall; the cross is near the lower left-hand edge of the stone. Established by Assistant Marindin in 1886.

Tidal bench-mark, Elizabethport, N. J.—Is a cross cut in a brick at the SE. corner of Worrall & Company's foundry at Elizabethport. It is in the seventh course of brick from the ground and marked "U. S." Established by Assistant Marindin in 1886. The bench-mark is 18.858 feet above zero of gauge.

SECTION IV.—*From the Narrows to Hunter's Point, Long Island, N. Y.*

Primary bench-mark L, Fort Hamilton, Long Island, N. Y.—A cross cut in the granite stone on the northwest corner of the wall on its west side and near the gate for wagon-road entrance opposite the Ocean House. It is about 1½ feet above the ground and 4 inches from the high offset of the retaining wall. Established in May, 1887.

Tidal bench-mark, Locust Grove, Bath Beach, Long Island.—This bench-mark is the corner of a granite stone in the revetment wall, marked just below the corner with an indistinct cross. The mark is on the left-hand side in going out on the pier. Established by Assistant Marindin in 1886.

Hydrographic bench-mark, Bath wharf, Long Island.—This temporary bench-mark consists of three copper tacks driven in a cross-piece of the wharf, the upper tack corresponding with 2-foot mark of gauge. A second and permanent mark is located at the SW. corner of wooden bulkhead around the grounds of the children's summer-house. The mark is about 12 meters north of the inner end of wharf. It is a large galvanized spike driven in the bulkhead, and has three copper tacks in a triangle around it and on each side of it. The 2.3-foot mark of gauge corresponds with the center of galvanized spike triangle. Established by Lieutenant Hanus, U. S. N., 1885.

Primary bench-mark K, Bath Beach.—The mark is situated on the north side of the second house (chalet style) from the corner of Bay Thirteenth street on Coopsy avenue, Bath Beach. The mark is the center of a cross on a copper bolt leaded in the fifth brick above window-ledge and on the north side of the window, east side of the house. Established in May, 1887.

Bench-mark No. 25, Bay Ridge, Long Island.—The mark is situated in Bay Ridge at the SE. corner of Fourth avenue and Sixty-seventh street, two blocks below the Brooklyn city line. It is a granite post 6 by 6 inches, with about 3 inches projecting above ground; it is marked by a square and cross on its upper surface. The stone is inside the sidewalk at the NW. corner of Lumbey's lot. Established in April, 1887.

Tidal bench-mark at Bay Ridge, Long Island.—The mark is the NW. corner of the blue-stone slab forming the top of the lowest step leading from Mr. Langley's place to the Bay shore. A flight of six stone steps comes down to the iron gate; on the lowest step a rude cross marks the bench. Established by Assistant Marindin in 1886; mark 9.521 feet above the zero of the gauge.

Primary bench-mark J, Bay Ridge, Long Island.—The mark or cross is situated on coping stone on top of and at north corner of the tunnel of the Manhattan Beach Railroad under Second avenue and between Sixty-fifth and Sixty-sixth streets, just outside the Brooklyn city limits. Established in May, 1887.

Primary bench-mark A, Brooklyn, N. Y.—Is situated on the stone step at the door SE. corner of St. Michael's school on Fourth avenue, just north of Forty-third street, Brooklyn. It is a cross cut in the NW. corner of the large step. Established in May, 1887.

Primary bench-mark G, Atlantic Dock, Brooklyn.—Is situated on the seaward face of one of the stone store buildings on Atlantic Dock and facing Buttermilk Channel. It is a cross cut on the south end of the fourth stone above the foundation in the space between the two iron doors of store No. 22, and directly under the number. Established in May, 1887.

Hydrographic marks, corner of drive-way and of ordnance building, Governor's Island.—The marks were established in 1873 by Assistant Marindin and by Lieutenant Handy, U. S. N., in 1875. The first mark is on the NE. face of the retaining wall of the terrace or drive-way in front of head-quarters, and the lower edge of the rectangular notch is the mark called "B. $M._1$". The mark is 2.4 feet above the ground. On August 28, 1875, B. $M._2$ was established on the SE. corner of the underpinning to the ordnance building; the letters "U. S." are cut into the stone below the mark. B. $M._1$ is 16.899 and B. $M._2$ is 32.498 feet above the respective zeros of the gauge.

Primary bench-mark H, Governor's Island.—The bench-mark is the extreme NE. corner of the large stone having a ring-bolt in the top and forming part of the coping of the sea-wall in front of Castle William. A cross was cut in the stone. Established by Assistant Marindin in 1886.

Primary bench-mark I, Governor's Island.—Is situated on the south end of door-sill, entrance into Castle William. It is a cross cut in the sill on the left of main entrance.

Primary bench-mark C, Hall of Records, Brooklyn.—It is on the east side of Kings County Hall of Records, facing Boerum Place. The granite foundation of this building consists of two courses of stone; the lower course of granite projects beyond the upper one about 2 inches, thus forming a ledge which slopes from the inner edge; the mark is on the top of this ledge, about 5½ feet from the corner of the building. Established in May, 1887.

Primary bench-mark D, Brooklyn Navy Yard.—This bench-mark is situated on the south front of the United States machine shop No. 28 (in 1870) in the navy-yard, close to the gate on Flushing avenue. It is a square cavity of 1 inch side and of half an inch depth, cut in the stone sill of the double door at south end of building. It is about 1 foot from the front edge of the sill, and the bottom of the cavity is the mark. Established in May, 1887.

Primary bench-mark F.—At the gas company's warehouse, used for storage of coal, foot of Hudson avenue and west of the navy-yard. The bench-mark is on the north side of the stone building on the east face of the fourth buttress from the NE. corner and consists of a cross cut on the fourth course of stone above the foundation. Established in May, 1887.

Primary bench-mark E, Corlear's Hook, New York City.—This mark is situated on the SW. corner of Coe's bonded warehouse, corner of Water and East streets, Corlear's Hook. It consists of a cross cut in the granite door-jamb, first door from the SW. corner and about 5 feet from the ground. Established in May, 1887.

Tidal bench-mark, Corlear's Hook, N. Y.—Established by Assistant Marindin in October, 1886. The bench-mark is the edge of stone sill belonging to the door of Coe's warehouse nearest to Corlear street. The door-jambs are each monoliths, and where the foot of the western jamb meets the stone sill is the level of the bench. This mark is 12.180 feet above the zero of the gauge.

Tidal bench-mark, Hunter's Point, East River.—Established by Assistant Marindin in October, 1886. The bench-mark was taken on the curbing in the west side of Front street. It is at the extreme SE. end of the fence that surrounds the triangular space between the building, Long Island News Company's office, and the Annex pier. The mark is 11.196 feet above the zero of the gauge. It is also described as B. M. No. 8.

Primary bench-mark B, Hunter's Point.—This mark is established on the large brick building known as Miller's Long Island City Hotel, corner of Borden avenue and Front street. The entrance to building is at the SW. corner, there being a triangular space or vestibule before the door. The bench-mark is a cross cut in the NW. corner of this space, about 1 inch from the outer edge of the sill and about 4 inches from where the brick wall ends. The sill is of North River blue-stone. Established in May, 1887.

SECTION V.—*From Hunter's Point, Long Island, to New York City and Dobbs' Ferry, Hudson River.*

Temporary bench-mark, station No. 39, Hunter's Point.—Is a triangle cut on crossing stone, corner of Vernon avenue and Ninth street, Hunter's Point, Long Island.

B. M. No. 7, Ravenswood, Long Island.—The mark is on the lowest step of the entrance to A. Fischer's garden on Webster avenue, and is a small square cut on the flag-stone top. The mark is 16.894 feet above the zero of the tide-gauge.

B. M. No. 6, Astoria, Long Island.—This bench-mark is a triangle cut into the top of the curbstone on the corner of Fulton street and Perot avenue. It is about 2½ feet from the lamp-post and 7½ feet from the fire-plug.

B. M. No. 4, near Astoria Dock.—Is a triangle cut into the wooden stringer forming part of the sea-wall or bulkhead. An iron nail was driven into each corner of the triangle and the letters "U. S." were cut on one side.

B. M. No. 1 Pot Cove, Long Island.—The bench-mark is a triangle cut into the stringer above the tide-gauge of 1886. An iron nail was driven in each corner of the triangle. The 11-foot mark of the gauge is 3.3 feet below the B. M., or the latter is 4.359 meters above the zero of the gauge used in 1885 and 1886.

B. M. No. 2, *Pot Cove, Long Island.*—The bench is a small cross on the coping of the wall that divides the properties of Messrs. Morrison and Whittemore at Pot Cove. An iron fence comes to an end at the place selected for the bench.

B. M. No. 3, *between Pot Cove and Polhemus, Long Island.*—On the river road between Pot Cove and Polhemus is a triangle cut into the lowest stone of a flight of stairs leading to Barclay's place. Two iron gate-posts rest on this stone and the bench is half a foot from the most easterly one.

B. M. No. 4a, Polhemus Dock, Long Island.—A triangle cut into the top stone of the northeast corner of the Polhemus dock, which is at the intersection of River road and Wolcott avenue. The bench is 10.308 feet above the zero of the gauge of 1886.

B. M. No. 5, *New York City, foot of Eighty-fourth street.*—This bench is on the sea-wall in process of construction on the East River, foot of Eighty-fourth street. It is the extreme southeast end of the sea-wall, River View Park (at the Eighty-fourth street end of it), and is the upper surface at the corner marked by a square. It was the intention of the Park commissioners to put on top of the stone selected for the bench-mark a course of dressed granite coping, which may now be in place. Established by Assistant Marindin in 1886.

Tidal bench mark foot of Forty-second street, New York City, Hudson River.—Established in 1885 by Assistant Marindin. The bench-mark is a small cross made on the new brick pilaster that supports the iron arch leading to the gas company's wharf and in line with the end of the coal-shed. It is on the thirty-second brick, counting from the level of the dock up; the horizontal line on the brick is the datum line. The bench-mark established on the wall of the same building (gas company's) in connection with the gauge of 1885 is a cross on the brick wall having the letters "U. S. C. S." marked upon it; this mark is about 48 meters from the mark of 1886 and on the side of the wall facing the paved roadway from the entrance of the works to the pier.

Tidal bench-mark, Dobb's Ferry, Hudson River.—Established by Assistant Marindin in 1885. This work consists of a cross with the letters "U. S. C. S." cut in the brick wall of S. Taylor's lumber office, near the wharf. It is on the west side of the SE. corner of the two-story brick building, about 2 feet from the corner and 2½ above the surface of the ground. The horizontal cut of the cross is the point of reference.

Primary bench-mark V, Dobbs' Ferry.—Established by Subassistant McGrath in August, 1887. It is on the same brick building as above. The mark consists of a copper bolt leaded horizontally in middle of brick in the first course below B. M. of 1885; it is the sixth brick from extreme SE. corner of building. The center of the head of the bolt is the bench-mark.

SECTION VI.—*From Hunter's Point, Long Island, to Willet's Point, Long Island.*

All the bench-marks in this section were established in 1886, or refer to that year, and served for the hydrographic survey of the East River.

B. M. No. 9, *Borden Avenue Bridge.*—Is a triangle cut in the extreme southern end of the coping of the south abutment of the wagon bridge where Borden avenue crosses arm of Newtown Creek.

B. M. No. 10, *in Flushing*, on Lawrence street.—Is a small square cut into a sandstone sidewalk flag, near J. Milnor Peck's lumber-yard.

B. M. No. 11, *at College Point.*—Is a small (1½-inch) square cut into the NE. corner of the granite stone covering the catch-basin at the intersection of Nineteenth street and Fifth avenue. The middle of the square is the point of reference.

Tidal bench-mark, Station No. 68, *College Point.*—Is the horizontal line of a cross cut into a granite stone of the foundation wall of a house at the ferry-yard, foot of Third avenue, College Point. The mark is 15.749 feet above the zero of the gauge.

B. M. No. 12.—Is the middle of a square cut on the SW. corner of the top stone of the bridge culvert about 700 feet beyond the College Point Station of the Long Island Railroad, north division, in the direction towards Whitestone.

B. M. No. 105, *at Willet's Point.*—A square cut on the stringer of the long dock at Willet's Point, immediately over the Coast and Geodetic Survey gauge of 1886. The mark is 16.126 feet above the zero of the gauge. The United States engineers also have a bench-mark at this place;

it is a cross made in a stone of the retaining wall, on the left when coming from the dock into the post grounds. The zero of the engineers' gauge is 2.139 feet above the zero of the Coast and Geodetic Survey gauge, and the engineers' bench-mark is (above the zero of the engineers' gauge) 18.056 feet (October 9, 1886).

The records in the archives of the Survey generally contain additional detail information to the above, and the descriptions are accompanied by sketches of the locality; copies of these may be had on application to the Survey Office.

Supplementary note to preceding paper.

Taking advantage of the time available before the printing of the annual report, some further results may now be given the data for which were not accessible at the time when writing the report.

(1) *Additional information respecting the average sea-level at Sandy Hook.*—This level, upon which the heights of the spirit-levels (which are ultimately to cross the continent from ocean to ocean) depend, reads on the tide-gauge 8.561 feet, as given in Appendix No. 11, Coast and Geodetic Survey Report for 1882; it is the result of six years of observations. Since that time the tides have, with some unavoidable interruptions, continued to be observed, and we can now add to the former values for the reading of the half-tide level, as derived from the high and low waters, the following values, for which I am indebted to Mr. Alexander S. Christie, Chief of Tidal Division of this Office, who communicated them with all desirable detail, under date of October 17, 1888.

From the series January 1, 1882, to August 31, 1884, we obtain 8.719 feet ± 0.030 foot, and from the series December 1, 1886, to March 31, 1888, the half-tide level 8.634 feet ± 0.023 foot. The latter series is far superior in accuracy to the first; both are corrected for annual inequality, as was necessary, since the series do not group themselves by years. They have reference to the same bench-mark A as in 1881. Comparing these values with the six annual values for the years 1876–1881, given on page 519 (*ibid.*), we find them to be included within the extreme values of that set. The eight values roughly combined would give 8.590 ± 0.025 feet in the place of 8.561 ± 0.029 feet as found by me in June, 1882; the difference, 0.029 foot or 8.8 millimeters, is too small to be applied at present as a correction* to the heights of the line of levels of 1882 and of 1886–'87; moreover, the tidal observations are still going on and in course of time will yield a final value, which, however, may be supposed not to fall outside the limits covered by the present assigned probable error; hence no change will be made in the results of the above reports.

(2) *Comparison of the results of the spirit-leveling with the water levels observed in* 1886, *in connection with the hydrological survey of New York Harbor and approaches.*—The tides were observed by the party of Assistant H. L. Marindin in September and October, 1886. At four stations only do the observations cover as much as one lunation; these are Sandy Hook, Governor's Island, Willet's Point, and Dobbs' Ferry. At the other nineteen secondary and simultaneously occupied stations the comparative observations extend over a few days only. In the construction of the following table of comparisons the differential method was used, Mr. Marindin having collated the reading of the average sea-level at each place resulting from the *hourly* ordinates of the tides and the result of the *corresponding hourly* ordinates as observed at Sandy Hook, which was selected as the comparing station; this information, combined with the mark and staff reading of the average sea-level at each place resulting from the operation of spirit-leveling, indicated how much at each station the local level was found to be above or below the average Sandy Hook level. By the differential method the effect of the annual inequality in the average sea-level is eliminated. The magnitude of this inequality, as given by Mr. A. S. Christie, may be seen from the following table derived by him from forty-seven months between January 1, 1882, and April 1, 1888. A positive sign indicates elevation above, a negative sign depression below the average sea-level; the time refers to the middle of each month, and the amount is given in feet and decimals of a foot.

*If applied it would make the height of the tide-house bench-mark above the sea-level 11.415 feet or $3^{m}.4793 \pm 0^{m}.0076$, and all other heights depending on it would have to be reduced by the same amount ($8^{mm}.8$).

Annual inequality in the average sea-level at Sandy Hook.

Month.	Feet.	Month.	Feet.	Month.	Feet.	Month.	Feet.
January.	−0.40	April.	0.00	July.	+0.19	October.	+0.25
February.	−0.34	May.	+0.09	August.	+0.26	November.	−0.02
March.	−0.20	June.	+0.15	September.	+0.31	December.	−0.29

Accordingly, during the time the comparative observations were made the sea-level is supposed to have stood about 0.28 foot above the normal level, and this would of course be the same for all the stations. In strictness simultaneous comparisons of heights should have reference rather to identity of phase; thus the tide requires twenty-nine minutes* to travel over the 19 statute miles from Sandy Hook to Governor's Island; the inaccuracy arising from non-attention to this circumstance would be small and is practically eliminated from the results by beginning and ending the comparisons with the same phase of the tide, *i. e.*, taking full cycles. All comparisons are made with the Sandy Hook series, since this is the only one which extends over the whole of the time during which at any one place tidal observations were made. The tabular results were checked by a second reduction under the direction of Mr. Christie, who, for the sake of simplicity, used high and low waters only in the place of hourly ordinates, but reached nearly the same results.

As an example of the derivation of the tabular quantities I present the case for Port Monmouth, N. J.:

At Sandy Hook.—Eight-foot mark of tide-staff *above* the average sea level derived from six years of observations, 1.265 meters or 4.151 feet; hence reading of average sea level on staff, 3.849 feet. The mean hourly reading of this staff during September 22–25, 1886, when corresponding tidal observations were had at Port Monmouth, was 3.891, or 0.042 foot higher than the average sea-level.

At Port Monmouth.—Eight-foot mark of tide-staff *above* the average sea level at Sandy Hook as brought to Port Monmouth by means of spirit-leveling, 1.675 meters or 5.496 feet; hence reading of average sea-level of Sandy Hook, 2.504; and since the level during September 22–25 was 0.42 above this, the Port Monmouth reading corresponding to the above mean hourly reading at Sandy Hook is 2.546 feet, the actual or local reading of the ordinates was 2.348; hence apparently the average sea-level at Port Monmouth *below* that of Sandy Hook, 0.198 foot. This is indicated by a minus sign in the table.

Comparison of average tidal level of New York Harbor and approaches with the average tidal level of the ocean, as depending on special tidal observations made in 1886 and on spirit-levels made in 1886 and 1887, connecting these stations.

Number.	Name of tidal station.	Reference mark.	Height of mark above average sea-level at Sandy Hook, 1876–1881.		Observations.		Number of ordinates.	Staff-reading of average sea-level.	Corresponding staff-reading at Sandy Hook.	Difference from Sandy Hook average sea-level.	Local mean level above mean level of ocean.
					Commence.	Terminate.†					
			Meters.	*Feet.*				*Feet.*	*Feet.*	*Foot.*	*Foot.*
1	Sandy Hook, Horseshoe.	8-foot mark on staff.	1.265	4.151	.....	......	....	....	[3.849]	....	0.00
2	Port Monmouth.	8-foot mark on staff.	1.675	5.496	Sept. 22, 11⅓ h.	Sept. 25, 14⅙ h.	450	2.348	3.891	−0.198	−0.02
3	Conaskonk Point.	Tidal bench-mark, 17.027 feet above zero.	3.960	12.993	Sept. 22, 11 h.	Sept. 23, 12⅙ h.	152	3.815	3.821	−0.191	−0.01
4	South Amboy.	14.567 feet on staff.	1.151	3.776	Sept. 22, 0 h.	Sept. 25, 14 h.	149	10.622	3.850	−0.170	+0.01
5	Great Kills.	Tidal bench-mark, 13.879 feet above zero.	1.968	6.458	Sept. 22, 0 h.	Sept. 25, 14⅙ h.	518	7.262	3.850	−0.160	+0.02
6	Elizabethport.	Tidal bench-mark, 18.858 feet above zero.	3.759	12.331	Oct. 11, 16½ h.	Oct. 14, 12½ h.	137	6.977	4.349	−0.050	+0.13

*Appendix 13, Report for 1885, page 492. Tides at Governor's Island, by W. Ferrel.

†The hours count from midnight to midnight, 0 to 24 h.

Comparison of average tidal level of New York Harbor and approaches, etc.—Continued.

Number.	Name of tidal station.	Reference mark.	Height of mark above average sea level at Sandy Hook, 1876-1881.		Observations.		Number of ordinates.	Staff-reading of average sea-level.	Corresponding staff-reading at Sandy Hook.	Difference from Sandy Hook average sea-level.	Local mean level above mean level of ocean.
					Commence.	Terminate.*					
			Meters.	*Feet.*				*Feet.*	*Feet.*	*Foot.*	*Foot.*
7	Elm Park.	8-foot mark on staff.	1.057	3.468	Oct. 11, 16½ h.	Oct. 14, 12½ h.	137	4.929	4.349	−0.130	+0.05
8	Hackensack Bridge.	8-foot mark on staff.	1.490	4.887	Oct. 11, 16½ h.	Oct. 14, 12½ h.	137	3.536	4.349	−0.076	+0.10
9	Constable's Hook.	8-foot mark on staff.	1.082	3.552	Sept. 29, 18 h.	Oct. 1, 7 h.	75	4.897	4.586	−0.288	−0.11
10	Quarantine Dock.	10-foot mark on staff.	1.788	5.867	Sept. 22, 0 h.	Sept. 25, 14⅙ h.	518	3.936	3.850	−0.198	−0.02
11	Locust Grove, Bath.	15.2-foot mark on staff.	1.367	4.486	Sept. 22, 0 h.	Sept. 25, 14⅙ h.	518	10.656	3.850	−0.060	+0.12
12	Bath Beach, wharf.	0.0-foot mark on staff.	3.328	10.918	(No tidal observations made in 1886.)						
13	Bay Ridge.	8-foot mark on staff.	1.444	4.736	Sept. 29, 18 h.	Oct. 1, 7 h.	75	3.741	4.586	−0.261	−0.08
14	Governor's Island.	9.8-foot mark on staff.	1.642	5.386	Oct. 2, 8 h.	Oct. 30, 5 h.	670	4.401	4.050	−0.213	−0.04
15	Corlear's Hook.	8-foot mark on staff.	1.040	3.412	Oct. 4, 0 h.	Oct. 7, 8 h.	481	4.535	4.059	−0.263	−0.09
16	Hunter's Point.	8-foot mark on staff.	0.810	2.657	Oct. 4, 1½ h.	Oct. 7, 11½ h.	159	5 442	4.059	−0.111	+0.06
17	College Point.	Tidal bench-mark, 15.749 feet above zero.	2.890	9.482	Oct. 4, 0 h.	Oct. 7, 8 h.	165	6.374	4.059	−0.103	+0.07
18	Willet's Point.	Tidal bench-mark, 16.126 feet above zero.	3.036	9.960	Oct. 4, 20 h.	Oct. 30, 5 h.	610	6.129	4.067	−0.255	−0.08
19	Ravenswood.	Tidal bench-mark, 16.894 feet above zero.	3.003	9.852	Oct. 4, 1 h.	Oct. 7, 10½ h.	164	7.078	4.059	−0.174	0.00
20	Pot Cove.†	Tidal bench-mark, 14.39 feet above zero.	2.888	9.477	Oct. 4, 1½ h.	Oct. 7, 10½ h.	163	5.054	4.059	+0.021	+0.20
21	Polhemus.	Tidal bench-mark, 10.308 feet above zero.	2.046	6.711	Oct. 4, 19½ h.	Oct. 6, 9½ h.	77	3.531	3.851	−0.068	+0.11
22	Eighty-fourth street, New York.	Tidal bench-mark, 12.417 feet above zero.	2.267	7.437	Oct. 4, 1 h.	Oct. 7, 10½ h.	164	5.024	4.059	−0.166	+0.01
23	Forty-second street, New York.	8-foot mark on staff.	1.008	3.306	Sept. 29, 18 h.	Oct. 1, 7 h.	75	5.193	4.586	−0.237	−0.06
24	Dobbs' Ferry.	8-foot mark on staff.	1.371	4.499	Oct. 4, 20 h.	Oct. 30, 5 h.	610	3.718	4.067	−0.001	+0.18

SUPPLEMENTARY COMPARISONS.

4½	South Amboy.	....	....	....	Oct. 11, 15 h.	Oct. 14, 17 h.	147	11.028	4.253	−0.167
3½	Conaskonk Point.	....	....	....	Sept. 24, 13⅙ h.	Sept. 25, 2⅓ h.	79	3.958	4.121	−0.196
10½	Quarantine Dock.	....	....	...	Sept. 29, 18 h.	Oct. 1, 7 h.	75	4.609	4.586	−0.261
14½	Governor's Island.	....	....	....	Oct. 4, 2½ h.	Oct. 7, 8 h.	164	4.400	4.059	−0.223
14½	Governor's Island.	....	....	....	Oct. 11, 16 h.	Oct. 14, 12½ h.	138	4.746	4.349	−0.167
18½	Willet's Point.	....	....	....	Oct. 4, 19½ h.	Oct. 6, 9½ h.	77	6.142	3.851	−0.026

* The hours count from midnight to midnight, 0 to 24 h.

† Result unreliable, the staff being left dry at some low waters.

The figures in the last column but one apparently indicate a lower average level than that at Sandy Hook for all the interior stations, an inadmissible result, which can only be explained by some defect in the connection of the levels with the staff at Sandy Hook; in fact, Assistant Marindin thinks it not impossible that the wharf to which the staff was attached had changed its level, due to the raising action of ice during the severe winter intervening between the observations and the level connection. Be this as it may, the mean level of the lower bay as given by the six stations Nos. 2, 3, 4, 5, 10, 11, and by No. 18 must be identical with that of the ocean outside, hence the excess at Sandy Hook is 0.176 ± 0.014 foot, which amount, when added to the respective figures previously given, is contained in the last column of the table and shows the resulting differences of height in the mean or half-tide level at the several localities. The probable error of any of these figures is about ± 0.06 foot or ± three-quarters of an inch—an accuracy which speaks well, particularly for the short series of tidal observations. The rise of mean level at Dobbs' Ferry is accordingly 0.18 foot or 2.2 inches, with a probable uncertainty of about a quarter of an inch.

(3) *Propagation of the tide-wave up the bay and harbor.*—In connection with the above investigation of the mean level, and as a hydrodynamical subject of interest, I may be permitted to present here a brief inquiry into the velocity of the tidal wave, while traveling up from Sandy Hook and past the city to Dobbs' Ferry. This kind of wave, which has been called by Russell the solitary, the primary wave of the first order, or great wave of translation, travels along a channel, according to this authority, with a velocity of transmission nearly equal to that which a heavy body would acquire in freely falling through a space half the depth of the fluid. The velocity is therefore $v = \sqrt{g(p \pm h)}$, where g = acceleration of gravity (9.805 meters or 32.17 feet nearly, p = the depth of fluid supposed at rest, and h = the height of the crest of the wave above this plane of repose; the positive sign is to be used for the incoming flood tide, which is a positive wave, and the minus sign will have to be used for the outgoing or ebb tide, which is a negative wave. This formula is due to Lagrange, but is generally known as Russell's or Airy's,* and supposes to apply to waves moving in water of unlimited expanse. According to Hagen † the form $v = \sqrt{\frac{3}{2} gp}$ agrees better with his own experiments. Scott Russell points out that when a wave of translation enters a comparatively narrow channel, as a river, for instance, with a variable cross-section, the average depth should be substituted for the maximum depth along the channel.

As the depth of a channel decreases, the velocity of transmission decreases, but the height of the wave increases; should, farther on, the depth be again increasing, the velocity would likewise increase, but the height of the wave would decrease. The height of a wave in a channel of uniform depth, but contracting in width, will vary as the square root of the width. The friction, internal between the particles of water and external at bottom and sides (and on the surface), will finally consume the original energy of the wave.

Applying the formulæ to the case of the flood wave propagated from Sandy Hook to Governor's Island we have: Average depth at *low* water along the channel way, 7.35 fathoms, range of tide (trough to crest), 4.6 feet; hence $p + h = 48.7$ feet or 14.85 meters; hence $v = 12.07$ meters per second according to Russell and 14.78 meters according to Hagen. Distance or length of path, 19 statute miles or 30.57 kilometers; hence time required for transmission, 42.2 minutes (Russell) and 34.5 minutes (Hagen). The actual or observed time is 29 minutes, according to Ferrel's "Tides at Governor's Island" (Appendix 13, Coast and Geodetic Survey Report for 1885), but 32 minutes according to the Coast and Geodetic Survey "Tide-Tables for 1889" (pp. 216, 217). It may be remarked that it is not easy to get the exact time of transmission of such an immensely flat wave as the tidal wave. The accord between theory and observation is tolerably good, notwithstanding the circumstance of an interference tidal wave entering at Throg's Neck, which makes the average

* Report on Waves, by J. Scott Russell. Fourteenth meeting of the British Association for the Advancement of Science, 1844. London, 1845, pp. 311–390.

Sir G. B. Airy's work "On Tides and Waves" can be found in the Encyclopædia Metropolitana, Vol. V, p. 292. The above simple expression is but a rough approximation and supposes the motion of the individual particles forming the wave to move in circular orbits, and not as in Airy's theory in different elliptic orbits.

† See "Oceanographie," Vol. II, O. Krümmel, Stuttgart, 1887, p. 20, etc. With this author g signifies the *distance* fallen through under gravity in the first second.

rise and fall of the tide in the (so-called) East River intermediate between their values at either entrance to the harbor.

For a second application we take the line Governor's Island to Dobbs' Ferry, on the Hudson. Average depth at *low* water, on the average of the cross-section, 5.68 fathoms, range of tide 4.6 feet; hence effective depth 38.7 feet or 11.80 meters; hence $v = 10.75$ and 13.17 meters per second, according to Russell and Hagen, respectively. The distance is 24 statute miles or 38.62 kilometers; hence time of transmission, 59.8 minutes (Russell) and 48.9 minutes (Hagen), whereas the observed time is 72 minutes (Tide-Tables); here we have a deviation in the opposite direction from that in the first application, but I have doubts as to the reliability of the observed interval. The flow of the river is not supposed to have much influence on the time of ascent of the wave.

This purely dynamical subject, however, can not be pursued here any farther since it properly belongs to another division of the Survey, and has only been introduced here as remotely connected with the operation of spirit-leveling.

C. A. SCHOTT.

JANUARY 2, 1889.

APPENDIX No. 15.—1887.

REPORT ON THE RESULTS OF THE PHYSICAL SURVEYS OF NEW YORK HARBOR.

By HENRY MITCHELL, Assistant.

MARCH 24, 1888.

SIR: I submit the following as my annual report. It includes the data sent to the Board of Engineers, except as regards the observations made by Mr. Marindin's party in 1887. The report is in two parts, the first showing the relations of the Hudson to the Bar, and the second the same river's relation to the Hell Gate Entrance. It brings the outstanding work to a close, except that it does not state results from last summer's work (now being reduced), nor does it present the subject of "water contours" which Mr. Marindin will report upon.

Very respectfully, yours,

HENRY MITCHELL,
Assistant Coast and Geodetic Survey.

Mr. F. M. THORN,
Superintendent Coast and Geodetic Survey.

PART 1.—THE UNDER-RUN OF THE HUDSON RIVER.

ITS RELATION TO NEW YORK BAR.

The discovery of a *resultant* or *net* discharge through New York Harbor from Long Island Sound to the ocean, which formed the subject of my report of last year (and which was inserted as Appendix 13 in the Annual Report of the Coast and Geodetic Survey for 1886, then in press), was the result primarily of a somewhat theoretical study of combinations of serpentine curves. It was shown that for any harbor of two dissimilar approaches the alternate *slopes* induced in the harbor by the presence of two tides might be equal, *i. e.*, the same for the movement one way as for the movement the other way, but that the discharges induced by these slopes could not be equal because the slopes occur at different *stages*, and different stages imply different *sections* and *perimeters* of channel. The proposition was proven geometrically before we appealed to the observations for confirmation.* We mention this because there are so many influences of winds and river outflow to be canceled in the strictly inductive process that we should not feel sure of our result if not otherwise proven.

* First stated in "Science," issue of March 4, 1887, under title "Circulation of the sea through New York Harbor."

The numerical value of the "resultant," which we may state at three to four hundred millions of cubic feet in a half-tidal day, can only be reduced to the average for the year by having simultaneous tidal observations made at the two entrances to our scene. We have furnished coefficients with such hoped-for observations in view.

And now we are led back to a re-examination of one of our oldest themes, viz, the *under-run*, which presents, in the dry season, an antithesis to the "*resultant*" of our previous paper.

We are accustomed to apply the term *under-run* distinctively to the current that predominates along the bed of the channel carrying salt water to interior basins during the dry season, when the *head* of the river falls below that which is necessary to counterbalance the heavier waters of the sea.

The specific gravity of the sea beyond New York Bar is about 1.024; *i. e.*, the sea is about 2½ per cent. heavier than fresh water. If (for illustration) we suppose the basin of the Hudson connected with the sea by a continuous channel 100 feet deep, the surface of the river water would have to stand 2½ feet above the ocean to prevent the salt water from running in along the bottom; and the sea-water would creep into the basin as soon as the head fell below this.†

Our problem is much less simple than our illustration, because we have really no constancy of depth or slope for any length of time or space. Although the Hudson is an unusually deep and straight river, its direct communication with the sea is interrupted by the *Bar*, which is a submerged dam. The depth that can be carried over the best channel at the Bar is less than the channel depth along the course of the Hudson for 100 miles. Thirty-six feet can be carried from the Lower Quarantine to the middle of the Tappan Sea, 33 nautical miles, and 30 feet to Rondout, 85 nautical miles.

We may ignore for the present the Hell Gate Entrance, which is of ample depth, but narrow and crooked, and consider only the direct course from the Lower Bay of New York.*

The following table and diagram are compiled by Mr. E. E. Haskell and Mr. Homer P. Ritter from observations made in the parties of Assistants H. L. Marindin and Marcus Baker, with whom the first two were associated as experts. Diagram A (Illustration No 44) shows how the sea underlies the river water from actual observations as grouped by lunar hours upon Table No. 1.

* The first notice of the existence of this *under-run* appears in my observations in New York Narrows July 30, 1858, but it was not until 1862 that I connected the phenomenon definitely with the rise and fall of the fresh-water *head* of the Hudson. (See Annual Report of Coast Survey, 1859, for description and sketch of subcurrent apparatus, and Annual Report Coast Survey, 1863, for review of my letter to Professor Bache, Superintendent.) We began in 1860 to make regular observations of density in connection with current observations.

In the "Science" article above mentioned the decline of the fresh-water discharge in winter, when the tributaries are all ice-bound, was stated without proof. In casting about for a proper support to this statement I have come across a letter from Prof. Wolcott Gibbs (Appendix 63, Annual Report Coast Survey, 1856) on "An analysis of specimens of water from New York Harbor." These specimens were collected by myself in March, 1856. One of them taken from a hole in the ice off Fort Washington, about One hundred and fifty-second street, gave 1.0126; another from off Pier No. 1, near Castle Garden, gave 1.0183 as specific weights, about the same that we find at the close of summer in those neighborhoods. Drought and long-continued freezing produce like effects.

† See Part 2 of this paper.

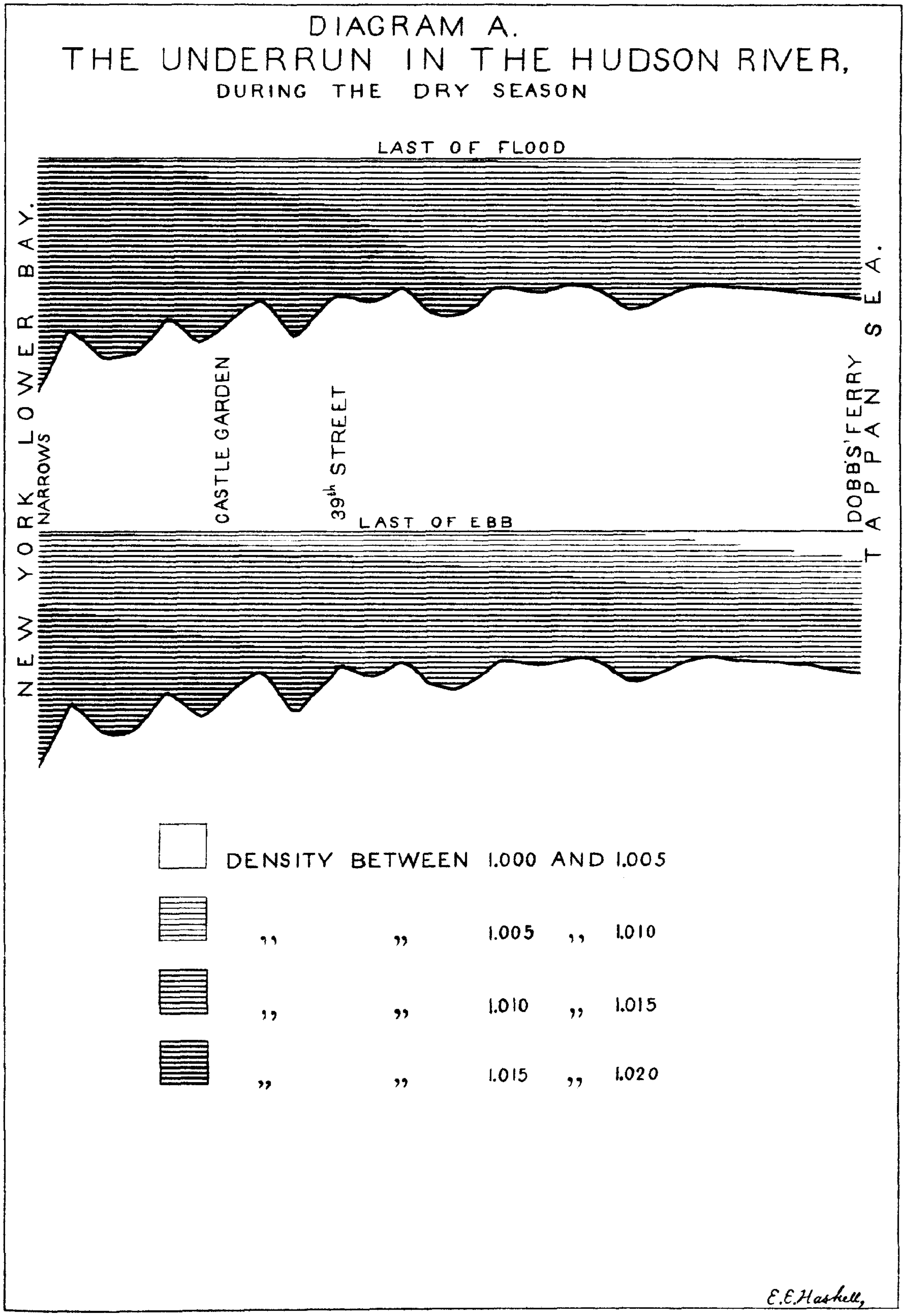


DIAGRAM A.
THE UNDERRUN IN THE HUDSON RIVER,
DURING THE DRY SEASON
LAST OF FLOOD
LAST OF EBB
NEW YORK LOWER BAY.
NARROWS
CASTLE GARDEN
39th STREET
DOBBS' FERRY
TAPPAN SEA.
DENSITY BETWEEN 1.000 AND 1.005
" " 1.005 " 1.010
" " 1.010 " 1.015
" " 1.015 " 1.020
E. E. Haskell,

TABLE NO. 1.—*Densities at different depths, from observations taken in the summer of* 1885.

[Compiled by Homer P. Ritter.]

Lunar hours.	Depth.	New York Harbor, the Narrows.	Hudson River.		East River, 19th street.
			39th street.	Dobbs' Ferry.	
		Density at 60° Fahr.	Density at 60° Fahr.	Density at 60° Fahr.	Density at 60° Fahr.
0	Surf.	1.0137	1.0121	1.0029	1.0187
	25 feet.	1.0176	1.0158	1.0118	1.0188
	45 feet.	1.0197	1.0165	1.0116	1.0185
I	Surf.	1.0137	1.0116	1.0030	1.0193
	25 feet.	1.0166	1.0157	1.0112	1.0193
	45 feet.	1.0186	1.0163	1.0112	1.0193
II	Surf.	1.0106	1.0090	1.0034	1.0198
	25 feet.	1.0154	1.0141	1.0104	1.0197
	45 feet.	1.0187	1.0155	1.0110	1.0197
III	Surf.	1.0089	1.0080	1.0029	1.0201
	25 feet.	1.0183	1.0143	1.0095	1.0190
	45 feet.	1.0212	1.0155	1.0110	1.0201
IV	Surf.	1.0098	1.0084	1.0025	1.0199
	25 feet.	1.0155	1.0122	1.0098	1.0198
	45 feet.	1.0184	1.0138	1.0101	1.0199
V	Surf.	1.0110	1.0078	1.0026	1.0190
	25 feet.	1.0174	1.0124	1.0096	1.0189
	45 feet.	1.0187	1.0127	1.0106	1.0194
VI	Surf.	1.0150	1.0089	1.0000	1.0180
	25 feet.	1.0180	1.0109	1.0098	1.0182
	45 feet.	1.0195	1.0102	1.0116	1.0183
VII	Surf.	1.0159	1.0094	1.0031	1.0178
	25 feet.	1.0184	1.0152	1.0090	1.0179
	45 feet.	1.0204	1.0158	1.0104	1.0180
VIII	Surf.	1.0165	1.0107	1.0030	1.0182
	25 feet.	1.0195	1.0158	1.0109	1.0178
	45 feet.	1.0207	1.0160	1.0122	1.0180
IX	Surf.	1.0168	1.0112	1.0039	1.0180
	25 feet.	1.0195	1.0158	1.0104	1.0184
	45 feet.	1.0208	1.0165	1.0111	1.0180
X	Surf.	1.0166	1.0115	1.0047	1.0179
	25 feet.	1.0195	1.0170	1.0115	1.0179
	45 feet.	1.0214	1.0170	1.0123	1.0180
XI	Surf.	1.0167	1.0120	1.0057	1.0178
	25 feet.	1.0195	1.0157	1.0122	1.0178
	45 feet.	1.0205	1.0163	1.0123	1.0177

As stated above, 30 feet is the channel depth of the Hudson; $2\frac{1}{2}$ per cent. of 30 feet gives 0.75 foot as the head necessary to counterbalance the sea, and the tidal observations of 1856, with the line of levels which connected their bench references, give West Point, 53 nautical miles from Lower Quarantine, as the station where mean level lay 0.75 foot above the sea in that dry season of the year.*

In our report made in May, 1873, it is stated that "during the past two seasons we have taken pains to measure densities, and have traced the sea-water along the channel bed as high up as Carthage, 70 miles from Sandy Hook; but the surface water was found essentially fresh at Teller's Point, 43 miles from Sandy Hook," at the head of the Tappan Sea.†

By the old series of tidal observations and levels, to which we have referred above, the head at Carthage (64 miles from Lower Quarantine) was, in September, 1856, 0.86 foot above the sea, which for a 30-foot continuous channel should have expelled the sea-water requiring only 0.75 foot *head.* The autumn of 1871 was evidently a season of lower stage than 1856. Our observations of September 20, 1871, at Carthage showed the densities to be 1.0000 at surface, 1.0015 at 30 feet, and 1.0015 at 48 feet, while just above, at Barnegat (69 miles from Lower Quarantine) the water was fresh from top to bottom.

In October, 1886, Mr. Haskell and myself sought again the limits of the *under-run*, and found it at Cold Spring (61 nautical miles from Lower Quarantine), only $1\frac{1}{2}$ miles above the station (West Point) at which we have placed the theoretical limit, based upon the tides of 1856, as we have just seen. There is a good deal of mere coincidence in the agreement of our figures for different seasons, but *good field-notes are very apt to fit well together.*

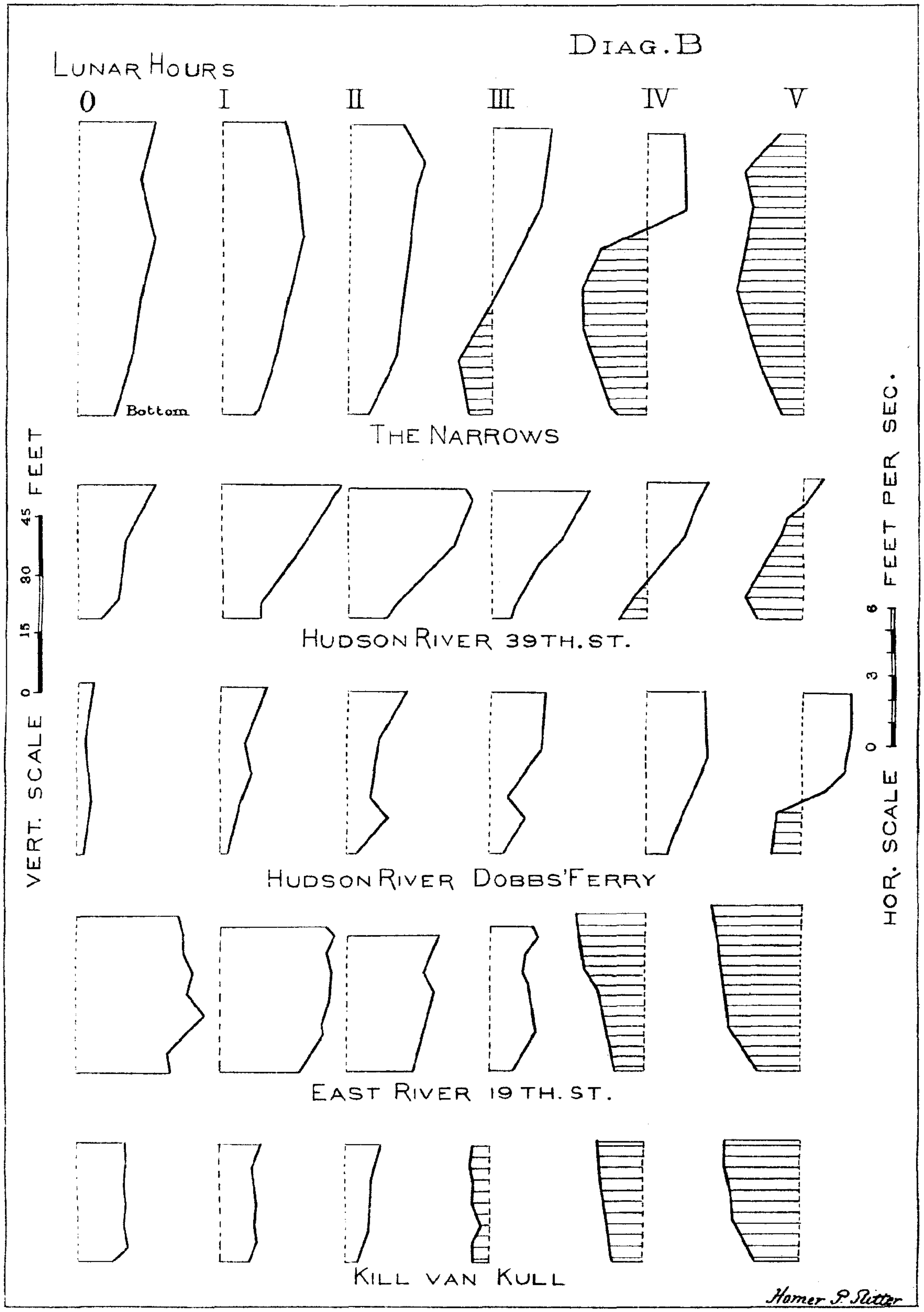
Mr. Haskell has suggested that "it is at once more logical and simple to compare *differences* of density with *differences* of surface elevation," and thus avoid reference to the unconscious sea as a base, and I agree with him, provided that we eliminate the tide. If from the tidal observations of Mr. H. L. Marindin's party in 1886, we take the mean level at the entrance to the Tappan Sea, we find it was 0.25 foot above New York Harbor, 21 nautical miles below. In order to balance so small a head as this, the difference of density need not have been more than five-thousandths, whereas we know that it is usually three times as much in the dry season, and hence the accumulation of sea-water which we have found again and again every dry season in the bottom of the Tappan Sea, and even to its surface occasionally. This basin may have received its name in the autumn when it had become a veritable *arm of the sea.*

Of course the *under-run* tends to raise the river, increasing the slope in one direction (seaward) and diminishing it in the other; it therefore quickens the surface outflow transiently. Even the profile of the tide must be changed by it. Because of the effect of tide upon slope, we should expect changes in the salt-water limits from day to day, the last distinct traces being found in pot-holes. The deep pass through the Highlands is, as we have seen, invaded by the sea. At a station half way between Dunderberg and Anthony's Nose, Mr. Marindin and myself found, in September, 1871, that the first 30 feet of water was fresh, while at the depth of 120 feet the specific gravity was 1.0025, or one-tenth part sea-water.

To refer again to our report of 1873 we call attention to the following statement: "The Bar at the entrance to New York Harbor does not lie in the dead angle between fresh and salt water; but at the depth of 22 feet, which is that of the Bar channel, there is still ample seaward scouring force all along the line." From our observations of 1885, Mr. Homer P. Ritter has compiled for us the velocities and densities of the water at different depths. See Table No. 2 and Diagram B (Illustrations Nos. 45 and 46), which follow:

*It is probable that the old line of levels can be trusted as far up as Poughkeepsie, but above that place there is doubt. We use for river slope the study of Mr. L. F. Pourtales made soon after the tides and levels were observed (1856–'57).

†This report of 1873 was appended to Annual Report of the Coast Survey for 1871 (which lingered long enough in press to receive this paper), and also appeared as a pamphlet issued by the New York Chamber of Commerce, entitled "New York Harbor, its condition, May, 1873."


DIAG. B
LUNAR HOURS
0
I
II
III
IV
V
Bottom
THE NARROWS
HUDSON RIVER 39TH. ST.
HUDSON RIVER DOBBS' FERRY
EAST RIVER 19 TH. ST.
KILL VAN KULL
VERT. SCALE 0 15 30 45 FEET
HOR. SCALE 0 3 6 FEET PER SEC.
Homer P. Ritter

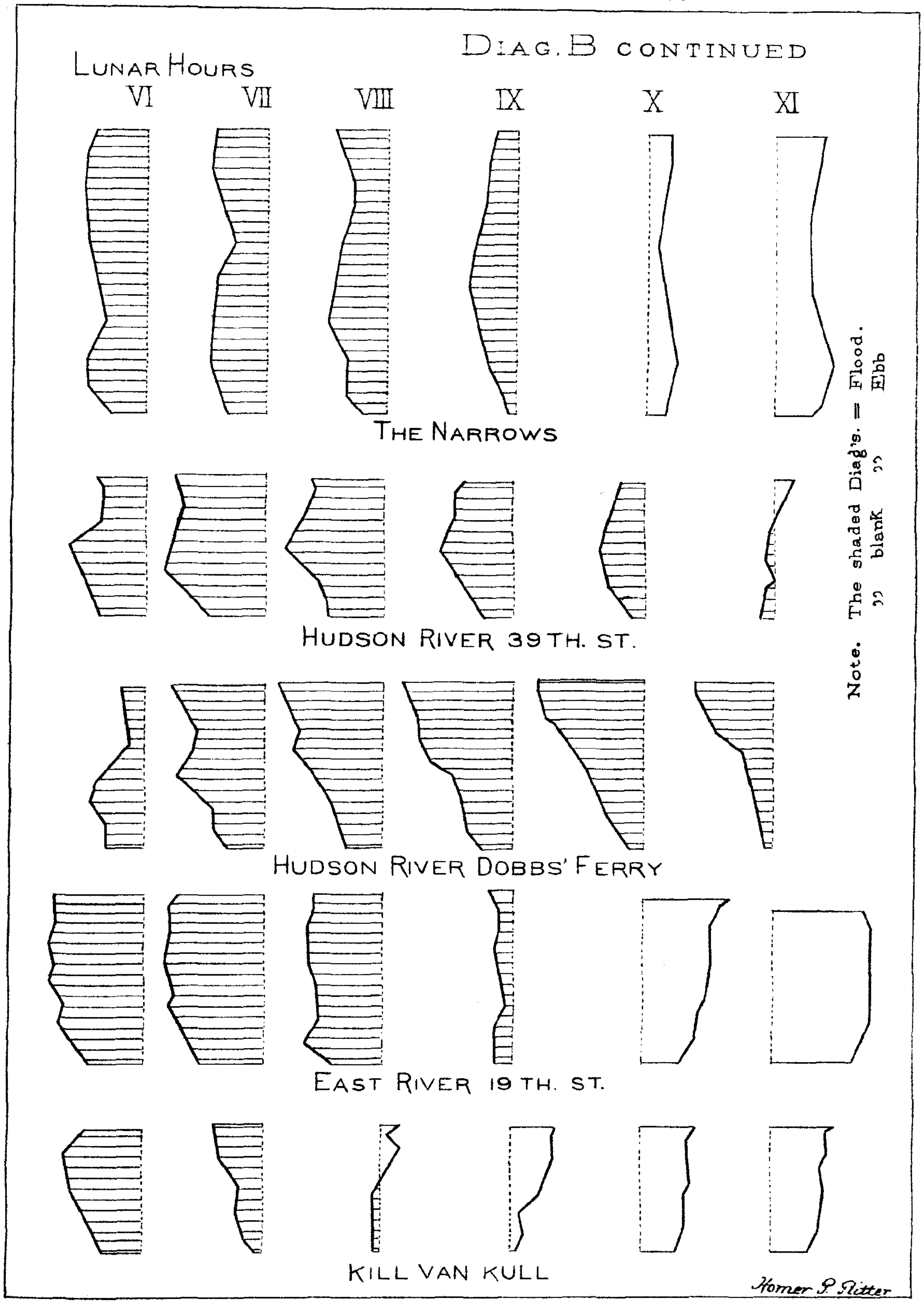

DIAG. B CONTINUED
LUNAR HOURS
VI
VII
VIII
IX
X
XI
THE NARROWS
HUDSON RIVER 39TH. ST.
HUDSON RIVER DOBBS' FERRY
EAST RIVER 19 TH. ST.
KILL VAN KULL
Note. The shaded Diag's. = Flood.
" blank " Ebb
Homer P. Ritter

Table No. 2.—*Currents at different depths, from observations of* 1885.

[Velocity in feet per second.]

Lunar hour.	Locality.	Depth of water.	Bottom.	5 feet from bottom.	10 feet from bottom.	15 feet from bottom.	20 feet from bottom.	25 feet from bottom.	30 feet from bottom.	35 feet from bottom.	40 feet from bottom.	50 feet from bottom.	60 feet from bottom.	70 feet from bottom.	Surface.	Remarks.
		Ft.														
0	New York Harbor:															
	The Narrows.	76	1.50	...	1.85	....	2.49	....	2.49	....	3.00	2.48	2.80	3.15	3.20	Current, ebb.
	Hudson River:															
	Thirty-ninth st.	43	0.91	1.66	1.75	2.00	2.00	2.16	2.33	....	....	....	....	....	3.09	Current SW., ebb.
	Dobbs' Ferry.	48	0.31	0.31	0.48	0.56	0.39	0.31	0.31	0.56	0.48	....	....	....	0.64	Current SSW., ebb.
	East River:															
	Nineteenth st.	40	3.95	3.74	4.55	5.21	4.66	4.88	4.39	4.34	....	....	....	....	4.14	Current S., ebb.
	Kill van Kull.	37	1.49	2.07	1.91	2.03	1.95	2.03	2.07	....	....	....	....	....	2.03	Current E. ½ N., ebb.
I	The Narrows.	76	1.00	....	1.50	...	2.28	....	2.60	....	2.90	3.35	3.35	2.55	2.75	Current, ebb.
	Thirty-ninth street.	43	1.58	1.66	2.16	2.75	3.50	3.59	3.59	....	....	....	....	....	4.84	Current SW., ebb.
	Dobbs' Ferry.	46	0.31	0.56	0.48	0.98	1.40	0.81	0.89	1.14	1.31	....	....	....	1.98	Current, ebb.
	19th street (E. R.).	37	3.32	3.90	4.24	4.21	4.60	4.59	4.45	4.78	....	....	....	....	4.38	Do.
	Kill van Kull.	36	1.20	1.49	1.41	1.53	1.45	1.45	....	....	....	....	....	....	1.74	Do.
II	The Narrows.	75	0.80	....	1.11	....	1.50	....	2.20	....	2.45	2.54	2.90	2.60	2.20	Current, ebb.
	Thirty-ninth street.	42	1.41	1.75	2.08	2.50	4.01	4.68	4.76	....	....	....	....	....	5.10	Current SW.
	Dobbs' Ferry.	45	0.31	1.40	1.65	0.98	1.31	1.23	1.40	2.15	2.48	...	....	....	[illegible].65	Current, ebb.
	19th street (E. R.).	37	2.71	3.14	3.44	3.61	3.63	3.23	3.48	3.77	....	....	....	....	2.64	Do.
	Kill van Kull.	35	0.57	0.86	0.99	0.99	1.11	1.20	....	....	....	....	....	....	1.53	Do.
III	The Narrows.	74	1.01	....	1.36	....	0.86	....	0.10	....	1.12	1.81	2.08	2.30	2.38	Surface current, ebb; bottom current, flood.
	Thirty-ninth street.	41	0.91	1.08	1.66	2.08	3.09	3.42	3.76	....	....	....	....	....	4.09	Current SW., ebb.
	Dobbs' Ferry.	45	0.56	1.06	1.48	0.64	0.89	1.06	2.06	1.90	2.15	....	....	....	2.23	Current, ebb.
	19th street (E. R.).	37	0.98	1.44	1.81	1.60	1.59	1.47	1.53	2.00	....	....	...	....	1.80	Do.
	Kill van Kull.	35	0.57	0.57	0.41	0.66	0.66	0.70	......	....	....	....	....	...	0.61	Current, flood.
IV	The Narrows.	73	1.20	....	2.05	....	2.60	...	2.77	....	2.28	0.40	1.55	1.55	1.55	Surface current, ebb; bottom current, flood.
	Thirty-ninth street.	43	1.08	0.57	0.57	0.99	1.66	1.91	2.25	....	....	...	....	....	2.50	Current, ebb, except 5 feet from bottom.
	Dobbs' Ferry.	45	0.81	1.56	1.40	1.98	2.06	2.57	2.40	2.32	2.23	....	....	....	2.40	Current, ebb.
	19th street (E. R.).	40	1.17	1.43	1.57	1.78	1.91	2.44	2.55	2.66	....	....	....	....	2.98	Current, flood.
	Kill van Kull.	35	1.30	1.45	1.50	1.61	1.75	1.80	......	....	....	....	...	....	1.90	Do
V	The Narrows.	73	1.00	...	1.62	....	2.08	....	2.65	....	2.45	2.20	2.45	1.30	1.00	Current, flood.
	Thirty-ninth street.	45	1.91	2.42	2.08	1.66	0.99	0.74	0.66	....	...	....	....	....	0.91	Current, ebb on surface; 10 feet below surface, flood.
	Dobbs' Ferry.	44	1.23	0.98	1.14	0.89	1.81	1.98	2.06	1.48	....	...	....	....	1.98	Flood on bottom, surface ebb.
	19th street (E. R.).	42	1.85	2.28	2.99	3.08	3.30	3.46	3.46	3.55	3.68	....	....	....	3.73	Current. flood.
	Kill van Kull.	36	1.78	2.36	2.70	2.82	3.03	3.11	3.16	....	....	....	....	...	3.07	Do.
VI	The Narrows.	74	1.35	...	2.47	....	2.13	....	1.89	....	2.24	2.56	2.65	2.40	2.20	Current, flood.
	Thirty-ninth street.	46	1.91	2.08	2.50	3.00	3.25	1.91	1.75	1.91	....	....	....	....	2.25	Do.
	Dobbs' Ferry.	43	1.56	1.65	2.31	2.06	1.23	0.64	0.81	0.81	0.98	...	....	....	1.14	Do.
	19th street (E. R.).	43	2.42	2.96	3.51	3.41	3.83	3.76	3.96	3.75	3.80	....	...	....	3.88	Do.
	Kill van Kull.	36	1.66	2.24	2.61	3.07	3.15	3.24	2.66	....	....	....	....	....	2.45	Do.
VII	The Narrows.	75	1.70	....	2.18	....	2.41	....	2.20	....	1.72	1.70	1.22	2.30	2.20	Current, flood.
	Thirty-ninth street.	..	2.33	3.17	3.59	4.17	3.92	3.67	3.51	3.59	...	....	....	....	3.67	Do.
	Dobbs' Ferry.	45	1.[illegible]	2.15	2.15	3.07	3.65	3.07	2.90	3.32	3.65	....	...	....	3.90	Do.
	19th street (E. R.).	44	2.72	3.47	3.63	3.97	3.77	4.08	4.09	3.99	3.92	...	....	....	3.67	Do.
	Kill van Kull.	37	0.28	0.86	1.20	1.03	1.16	1.78	1.95	....	....	....	....	...	2.11	Do.

TABLE NO. 2.—*Currents at different depths, from observations of* 1885—Continued.

[Velocity in feet per second.]

Lunar hour.	Locality.	Depth of water.	Bottom.	5 feet from bottom.	10 feet from bottom.	15 feet from bottom.	20 feet from bottom.	25 feet from bottom.	30 feet from bottom.	35 feet from bottom.	40 feet from bottom.	50 feet from bottom.	60 feet from bottom.	70 feet from bottom.	Surface.	Remarks.
		Ft.														
VIII	The Narrows.	74	1.00	...	1.65	....	2.40	....	2.20	....	1.99	1.45	1.45	1.95	2.10	Current, flood.
	Thirty-ninth street.	45	2.26	2.42	3.00	3.67	4.26	3.50	3.17	3.09	...	....	....	....	3.17	Do.
	Dobbs' Ferry.	47	1.56	1.81	2.15	2.48	2.90	3.82	3.57	3.99	4.24	...	....	....	4.41	Do.
	19th street (E. R.).	44	2.20	3.27	2.85	2.75	2.78	3.16	3.19	3.22	2.93	....	....	....	2.99	Do.
	Kill van Kull.	39	0.24	0.24	0.24	0.24	....	0.78	0.24	....	....	....	....	....	0.82	Surface current, ebb; bottom current nearly on a stand.
IX	The Narrows.	73	0.32	....	0.85	....	1.30	....	1.70	....	1.70	1.36	1.13	0.93	0.88	Current, flood.
	Thirty-ninth street.	44	1.24	1.58	2.00	2.50	3.09	2.84	2.50	2.58	....	....	....	....	2.33	Do.
	Dobbs' Ferry.	50	1.40	1.98	2.06	2.15	2.65	3.74	4.07	4.15	4.49	....	....	....	4.61	Do.
	19th street (E. R.).	45	0.71	0.72	0.77	0.38	0.48	0.58	0.74	0.56	0.60	....	....	...	1.09	Do.
	Kill van Kull.	38	0.28	0.49	0.41	1.24	1.53	1.78	1.70	....	...	....	....	....	1.74	Current, ebb.
X	The Narrows.	73	0.85	...	1.20	....	1.12	....	0.70	....	0.38	0.41	0.68	0.81	0.81	Current, ebb.
	Thirty-ninth street.	43	0.57	0.91	1.16	1.41	1.83	2.00	1.49	1.24	....	....	...	....	1.08	Current, flood.
	Dobbs' Ferry.	50	0.39	1.06	1.65	1.98	2.32	2.90	3.74	4.15	4.49	...	....	....	4.61	Do.
	19th street (E. R.).	43	1.57	2.24	2.32	2.62	2.67	2.96	2.92	2.89	3.22	...	....	....	3.60	Current, ebb.
	Kill van Kull.	38	1.32	1.66	1.82	1.82	2.07	2.03	1.95	....	....	....	....	....	2.32	Do.
XI	The Narrows.	73	1.50	....	2.30	....	2.18	....	1.71	....	1.68	1.50	1.70	2.05	2.10	Current, ebb.
	Thirty-ninth street.	43	0.66	0.41	0.00	0.32	0.32	0.00	0.49	....	....	....	...	....	0.74	Current, ebb, on surface; below 10 feet nearly stationary.
	Dobbs' Ferry.	48	0.39	0.39	0.64	0.89	1.15	1.31	2.40	2.90	3.32	....	....	....	3.40	Current, flood.
	19th street (E. R.).	42	2.89	3.61	4.17	4.27	4.31	4.23	4.26	4.26	3.80	....	....	....	3.70	Current, ebb.
	Kill van Kull.	37	1.61	1.99	2.11	2.20	2.11	2.45	2.32	....	....	....	....	....	2.61	Do.

TABLE NO. 3.—*Currents on the outer slope of New York Bar*, 1885.

Hours after transit.	Velocity in feet per second.	Direction (true).	Number of observations.	Remarks.
0	1.83	Ebb.	6	In this table the observations, made simultaneously at three stations, are combined, viz: *Eagre*, anchored 4.8 nautical miles S. 88° 56′ E. (true) of Romer Beacon. *Daisy*, 4.7 nautical miles S. 71° 25′ E. (true) of Romer Beacon. *Endeavor*, 5.1 nautical miles S. 54° 55′ E. of Romer Beacon. These stations were occupied August 11, 12, and 13, 1885, by Lieutenants Hanus and Hawley, U. S. N.
I	1.28	Ebb.	11	
II	0.62	Ebb.	11	
....	0.02	Flood.	11	
III	0.29	Flood.	11	
IV	1.13	Flood.	9	
V	1.31	142°	8	
VI	1.31	Flood.	8	
VII	0.84	Flood.	9	
VIII	0.40	Flood.	8	
....	0.04	Ebb.	8	
IX	0.82	Ebb.	8	
X	1.59	Ebb.	9	
XI	1.83	Ebb.	8	

We have re-opened this question of the "dead angle," or, as we should now prefer to say, the *neutral plane*, because of its critical relation to the resultant scour at the Bar. Reviewing the observations of the past years we have drawn up a table (No. 4) in which the point in each vertical is given at which inflow and outflow balance. No attempt is made to reconcile discordances.

TABLE NO. 4.—*Depth of neutral plane below surface.*

Locality.	Date.	Number of hours of observation.	Depth of neutral plane.	Date.	Number of hours of observation.	Depth of neutral plane.
			Feet.			*Feet.*
Between east and west banks.	1859	24	24	......	....	......
Narrows.	1858	12	41	1885	48	31
Robbins' Reef.	1859	18	30	......	....	....
Between Bedloe's and Governor's Islands.	1858	24	36	......	....	....
Off Castle Garden.	1859	24	32	......	....	....
Thirty-ninth street (Hudson River).	1858	12	26	1885	60	19

At the station between Bedloe's and Governor's Islands, September 1, 1858, there was found more *under-run* near the bottom than outflow at surface; *i. e.*, more flood along the bottom than ebb at surface.

In our report of 1873 we ventured to say that the neutral point lay below the crest of the bar. The more careful observations and computations given in the foregoing table indicate 33 feet for the Narrows and 20 feet for the Hudson River at Thirty-ninth street.

We had written the above clause before it occurred to us to look in our report of 1858–'59 (unpublished) to see what our earliest impressions had been. This report, after stating relations of densities inducing *under-run*, says: " * * * different stations occupied at various dates do not agree in giving the same position for the neutral line between the two strata. The transition space, as given upon Diagram C, would seem to lie from 30 to 36 feet below the surface."* (Diagram C was velocities at different depths.) On the outer slope of the Bar we usually found that the *resultant* movement on the bottom took a westerly direction, *i. e.*, toward the harbor; but we judged that such might be the case because of the shelter from the *ebb* that the Bar itself afforded.

Of course no great accuracy is claimed for these figures, and our object in quoting from earlier reports is to indicate that we have always reached about the same result as to the plane at which the limit of scour would be reached at New York Bar during the dry season; and we have no adequate reason for believing that the *under-run* determines the position or height of this Bar.

As the ebb current flowing towards the Narrows from the East River is about as dense as that found 80 feet below the surface in the Narrows (see Table 2), we may conclude that the "*resultant from the Sound" has practically no limit of scour.* It was this "resultant from the Sound" that was our theme last year.†

The deeper portions of the Hudson River Channel preserve considerable uniformity of width, indicating that in broad portions of the river—the Tappan Sea and Haverstraw Bay, for instances—the deposits have not been uniformly distributed. If the Tappan Sea were as broad at 30 feet depth as at the surface, there might be five times the *under run* that now occurs. As compared with Haverstraw, it betrays more earth filling, as if the *under run* had added its contributions to those offered by the river.

The rate at which the sea-water travels along the bottom of the channel depends upon the discrepancy of river-head and upon the depth—in very dry seasons and in very great depths the influx must be most rapid. On September 1, 1858, we found at 68 feet depth, in the channel

* Manuscript report "On the Currents of New York Bay and Harbor, by Henry Mitchell. 1858–1859. (Revised December, 1862.)"

† See "Science" of March 4, 1887, also a report of May 6, 1887, on "The Circulation of the Sea through New York Harbor," which was inserted as Appendix No. 13 in Annual Report Coast and Geodetic Survey for 1886, which still remained in press.

between Bedloe's and Governor's Island, a rate of 21 nautical miles per day; while on August 20, 1885, Dobbs' Ferry at depth of 45 feet gave but 6 nautical miles per day. It would seem that the drainage of New York City must be storing up in August and September at the bottom of the Hudson. Some simple tests for sulphides which we employed when the *under-run* was first discovered indicated that the mixture of sea and river water was recent. No "spoiled" water in the pot-holes of the great central channel was found. Happily for the communities along the Lower Hudson, the floods and freshets occur often enough to purge the great trench above New York City of sea-water and sewer-water, in spite of the long inland journeys which these are prone to take in late summer and autumn—and perhaps winter.

LIMIT OF THE TIDE, AS AFFECTING THE SCOUR OF THE CHANNELS IN NEW YORK HARBOR.

The Hudson is occupied by portions of two tides at the same time. When, for instance, it is high water at Sandy Hook, it is low water near Hyde Park, 4 or 5 miles above Poughkeepsie; beyond which the previous tide prevails. In order to find how much of this wedge-shaped tidal volume between the harbor and Hyde Park may be credited to the flood current in the harbor channels, we have taken the gaugings of Forty-first street and compared the volume entering the river with the accumulation above, after deducting the fresh-water discharge of the river for six hours. We have not data enough to fix accurately the extreme limits of tide-water useful to the harbor, but we shall state our approximations. In 1867 we made the limit Verplanck's Point (head of Haverstraw Bay); but from the new gaugings of Mr. Marindin's party in 1885, Mr. Haskell's computations give Newburgh. He, however, finds that nine-tenths of the useful volume falls below Iona Island in the Highlands, and two-thirds below the head of the Tappan Sea. Of course this limit moves down the river (if measured by the volume of flood current) in the freshet seasons; but we do not know to what extent the simplest "backing up" may be useful in the subsequent "flushing." There are many degrees of uncertainty in this question of the limits of tide-water; but they are mostly beyond practical values. If we include Haverstraw Bay among the tidal reservoirs of New York Harbor, we have not only all the great basins of the river to the extent of five-sixths of its foreign tide-water, but we have gone three tidal hours from the Bar, and four hours, counting interval between the *strengths* of the ebb current.

So much of the foregoing discussion is speculative that we feel constrained to recapitulate our firmest conclusions, so far as they may relate to improvements by dredging on encroachments upon tide-water.

RECAPITULATION.

First. The sea-water under-runs the Hudson whenever the fresh-water discharge declines after a dry season or when tributary streams are ice-bound; but this does not neutralize the "*resultant*" from Long Island Sound at present limits of channel depth on the Bar.

Second. The tidal system, so far as materially affecting the scour through the harbor of New York and at the Bar, includes the Tappan Sea.

Third. There are reasons to believe that sewage from the cities on New York Harbor may at some seasons, more especially in September and March, be stored up for awhile in the river basins above.

PART 2.—COURSES OF THE HUDSON TIDES THROUGH NEW YORK HARBOR.

When no freshets prevail in the Hudson its waters do not flow into Long Island Sound, but directly into the ocean by way of the Narrows, because the surface of the East River during much the larger part of the ebb period is inclined in the same direction as the Hudson, viz, towards the Narrows. In short, *the Hudson has two outlets for its commerce, but only one for its waters.*

We offer the following table of slopes to bear out this testimony, and we add detailed accounts of the tidal conditions for each hour to illustrate it:

TABLE NO. 5.—*Slopes of the Hudson and East Rivers.*

Hours after transit.	Slope, feet per mile.		Remarks.
	Hudson.	East River.	
0	−0.09	−0.26	The minus sign indicates that the surface slopes toward New York Harbor.
I	−0.07	−0.24	The hours are counted from one superior (or inferior) transit to the next inferior (or superior) transit of the moon.
II	−0.06	−0.15	The slopes are averaged in a distance of 20 nautical miles in the Hudson and 14 nautical miles in the East River.
III	−0.02	−0.02	These distances are measured from parallels passing through Governor's Island Tidal Station.
IV	+0.02	+0.12	
V	+0.06	+0.20	
VI	+0.07	+0.28	
VII	+0.05	+0.27	
VIII	+0.03	+0.14	
IX	+0.00	−0.02	
X	−0.04	−0.14	
XI	−0.08	−0.22	
0			

0 *Hours.*—At the hour of the moon's transit there is a general concurrence of tidal phenomena in New York Harbor. The Hudson, Kill van Kull, and East Rivers present surfaces inclined towards the Upper Bay, and each of these avenues is near its maximum slope for the *ebb*. In each of these avenues the currents at all depths take the direction of the surface slope. The ebb current is near its maximum strength in the East River and Kill van Kull, at the Narrows and over the Bar. In the Hudson the maximum velocity of ebb is yet two hours off, although the surface of Haverstraw Bay lies fully 3 feet above the Upper Bay, and the slope is 0.10 foot to the mile. (See Diagram C, Illustrations Nos. 47, 48, and 49.)

The East River stream is continuous from the Sound, through New York Harbor, to the sea, *and runs quite down to the bottom.*

I.—One hour after the transit of the moon the maximum slope is in the Tappan Sea, where it reaches 1.8 feet in 15 miles or 0.12 foot per mile. Ebb current prevails not only in the Lower Hudson, but in the *East River and Kills.* All slopes are towards the Sandy Hook entrance, except in the Upper Hudson near Poughkeepsie.*

II.—Two hours after the moon's transit it is low water in the ocean and high water near Poughkeepsie in the Upper Hudson. New York Harbor has a flat surface about at low-water level, but the Hudson has still a seaward slope of 0.05 foot per mile abreast of the city and 0.12 foot per mile in the great basin above. The currents of the Lower Hudson, the East River, and the Kill van Kull are all flowing *down* towards the harbor and through it to the Lower Bay and the ocean. There is some doubt of the generality of our diagram so far as the relations of Sandy Hook and the Narrows are concerned for this hour.

Even in the low-river season the ebb in the track of the Hudson through New York Harbor is found at 0, I, and II hours after the transit, running *over* 40 *feet deep. Under-run*, even in the Narrows at 80 feet, is rare for these hours, although, as it happened, on the occasion of our first discovery of the under-run in 1858, we had already at first hour a steady in-run at the Narrows at the depth of 92 feet below the surface.

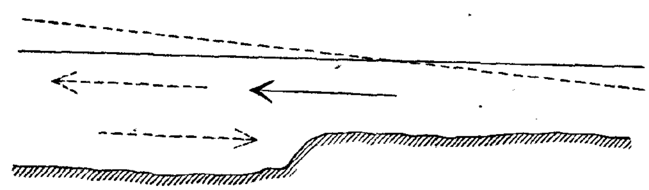
* By *Upper Hudson* we shall distinguish that portion which lies above Poughkeepsie.

III.—Three hours after the moon's transit the East River slope vanishes and the ebb current continues to pour into the harbor only by reason of its *vis viva.* The slope of the Hudson is undergoing reversion. Although there is a very steep seaward slope through the great basin (Haverstraw Bay and Tappan Sea), the level surface at Thirty-ninth street is about to be tilted in the up-river direction. Of course the river waters are flowing into the harbor and the movement is from surface to bottom. In Kill van Kull the current turns from ebb to flood, and in the Narrows the discharge is still seaward, although the current has turned near the bottom.

The slope above Thirty-ninth street in the Hudson is 0.03 foot per mile seaward, while the tide has begun to rise at Governor's Island, and the Hudson to Thirty-ninth street is a level surface, with low water at the latter place.

IV.—Four hours after the moon's transit the Lower Hudson presents a concave surface, the greatest depression being somewhere near the foot of Tappan Sea. The seaward slope in this "sea" is 0.05 foot to the mile, while the reverse slope at Castle Garden is 0.05. Still the surface-water has not yet turned from ebb, but below the flood is setting up along the bottom. The ebb at the foot of the seaward slope at Dobbs' Ferry runs all the way to the bottom. The discharge is eastward through East River, westward into Kill van Kull, and northward through the Narrows; *i. e.*, flood through all the gateways except the Hudson.

It must be borne in mind that the great mass of water continues its acquired motion after the slope has reversed, but in portions of the channel sheltered from acquired motion the slope acts promptly and the current reverses very soon after the slope reverses. (See sketch.)



In this sketch we have supposed one slope of river surface (ebb) to be represented by a full line and the reverse slope (flood) represented by a dotted line. The reversion has just taken place, and the great mass of water in *continuity* retains still the movement impressed upon it, in a direction opposed to the present slope; but in a depression of the bottom the water obeys the new impulse. One may conceive of a case where sea-water would work up along the bed of a river simply by advancing on the deep-running flood and hiding under the dead angles of the bottom during ebb. It has been observed in some of our bays that articles rolling along the bottom sometimes go up the channel.

In our diagram C we may conceive of the curve of the fourth lunar hour as the arc of a pendulum, the down-hill portion *inducing* the motion and the up-hill portion *reducing* the motion of the great mass, while outlying and underlying bodies of water move under the strictly local action of gravity.

V.—At the fifth hour after the moon's transit the Lower Hudson presents still a concave surface, the greatest depression being at the foot of Haverstraw Bay, where it is low water. There is also a depression at Throg's Neck (western end of Long Island Sound). The discharge is now northward through the Narrows and into the Hudson, westward through the Kills, and eastward through the East River, but there is still at this hour sometimes a surface ebb in the Lower Hudson all the way to the harbor.

VI.—Six hours after the transit of the moon we find a rising tide and a flood current everywhere in New York Harbor. The tide is three-quarters full in the Upper Bay,* but it is low water in the Highlands of the Hudson, and it is low water at Throg's Neck or its neighborhood. The current flowing northward into the Hudson, eastward towards the Sound, or westward through Kill van Kull, is strong from surface to bottom.

* Governor's Island to the Narrows. The simultaneous tidal observations of October 11 to 14 of 1886 are used in this history of the tide's progress.

VII.—Seven hours after the moon's transit the tide is rising in all parts of New York Harbor, and the flood current is at its strength in the East River and in the Hudson, and has scarcely declined at the Narrows. Kill van Kull has fallen off considerably. It is about high water in the ocean beyond the Bar and low water between Newburgh and Poughkeepsie on the Hudson. From Diagram B one may observe that at Dobb's Ferry (at the entrance to the generally shallow Tappan Sea) and at Kill van Kull (entrance to the shallow Newark Bay) there is a great decline of velocity with the depth. It is at or near this hour that the Lower Hudson lies at greatest slope.

VIII.—Eight hours after the transit of the moon it is high water in the Narrows, but the current still runs strong flood from surface to bottom. The Hudson has high water at its mouth, low water just beyond Poughkeepsie, and high water of previous tide above Albany, if completed. There has been little reduction of the flood current in the Narrows or in the Hudson River. It is still strong in the East River, but in Kill van Kull it has essentially ceased, and the surface current has reversed, although the flood continues near the bottom. The Upper and Lower Bays lie at the same level.

IX.—Nine hours after the moon's transit it is high water in the Hudson near Yonkers, but below this the tide is falling all along the direct course to the sea, while the East River is essentially flat, *i. e.*, at surface level, throughout, at what we have called in our last year's report its "*upper restoration.*" The flood current prevails everywhere except in Kill van Kull; it is, however, slacking up at the Bar and through the East River. *The Tappan Sea appears to receive its maximum volume on this hour.*

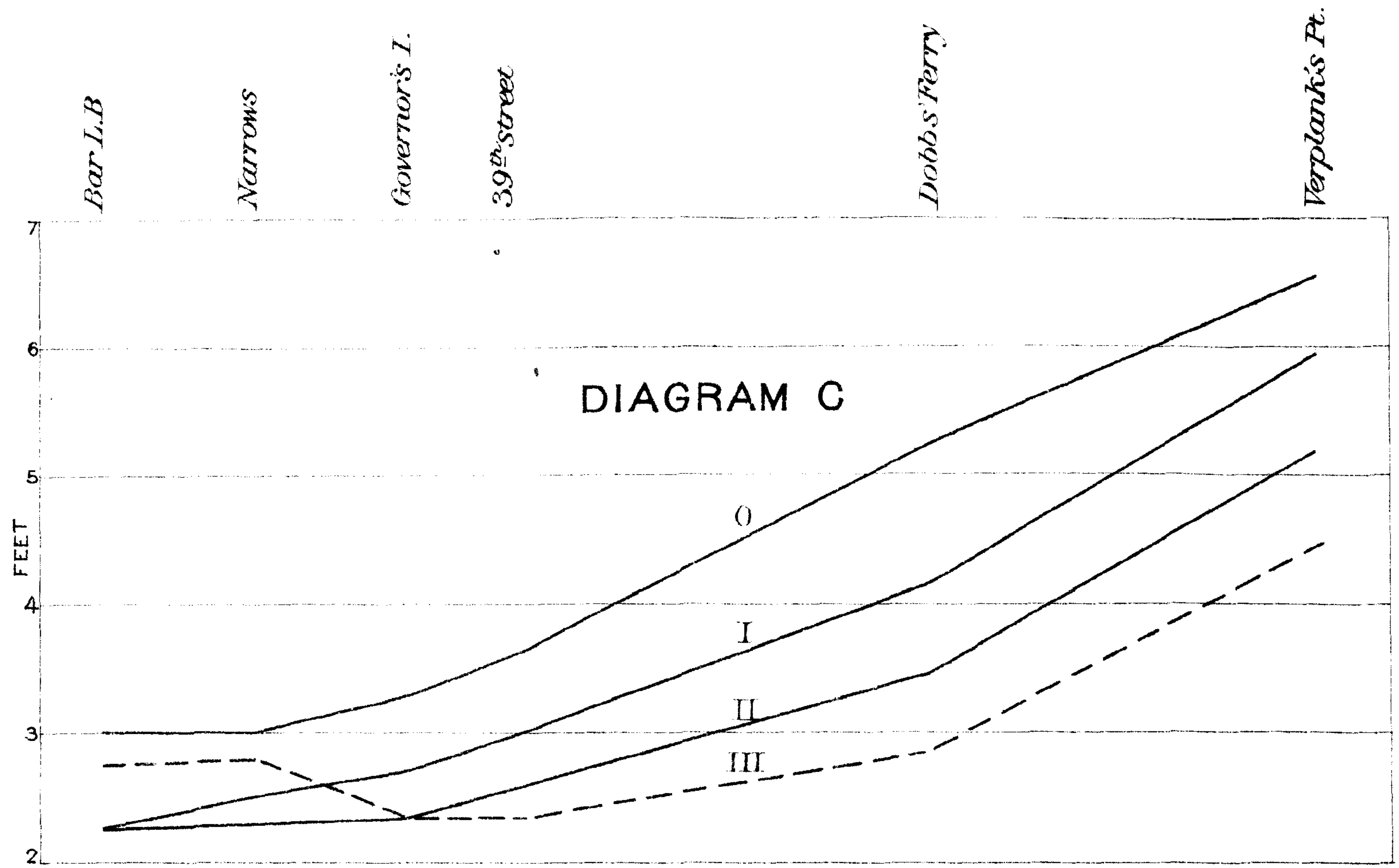
X.—Ten hours after the moon's transit it is high water in the Tappan Sea and in Hell Gate, and the tidal current has reversed in the Narrows and in the East River, *i. e.*, it has turned from running north and east to the opposite courses, but the great basins of the Hudson are still receiving great flood volumes, and there is still flood current above Thirty ninth street.

XI.—Eleven hours after the southing of the moon it is high water at the head of Haverstraw Bay, or not far above that, and at the western end of Long Island Sound.

At this hour we are presented with a remarkable, but not unfamiliar, instance of *slack water* (at Thirty-ninth street, Hudson River), near time of *greatest surface slope.* One has but to revert to the illustration of the pendulum to see why this must occur at some point (or even at numerous points successively) in a deep and long tidal avenue. The East River current moves down its slope under the immediate action of gravity; not so the Hudson.

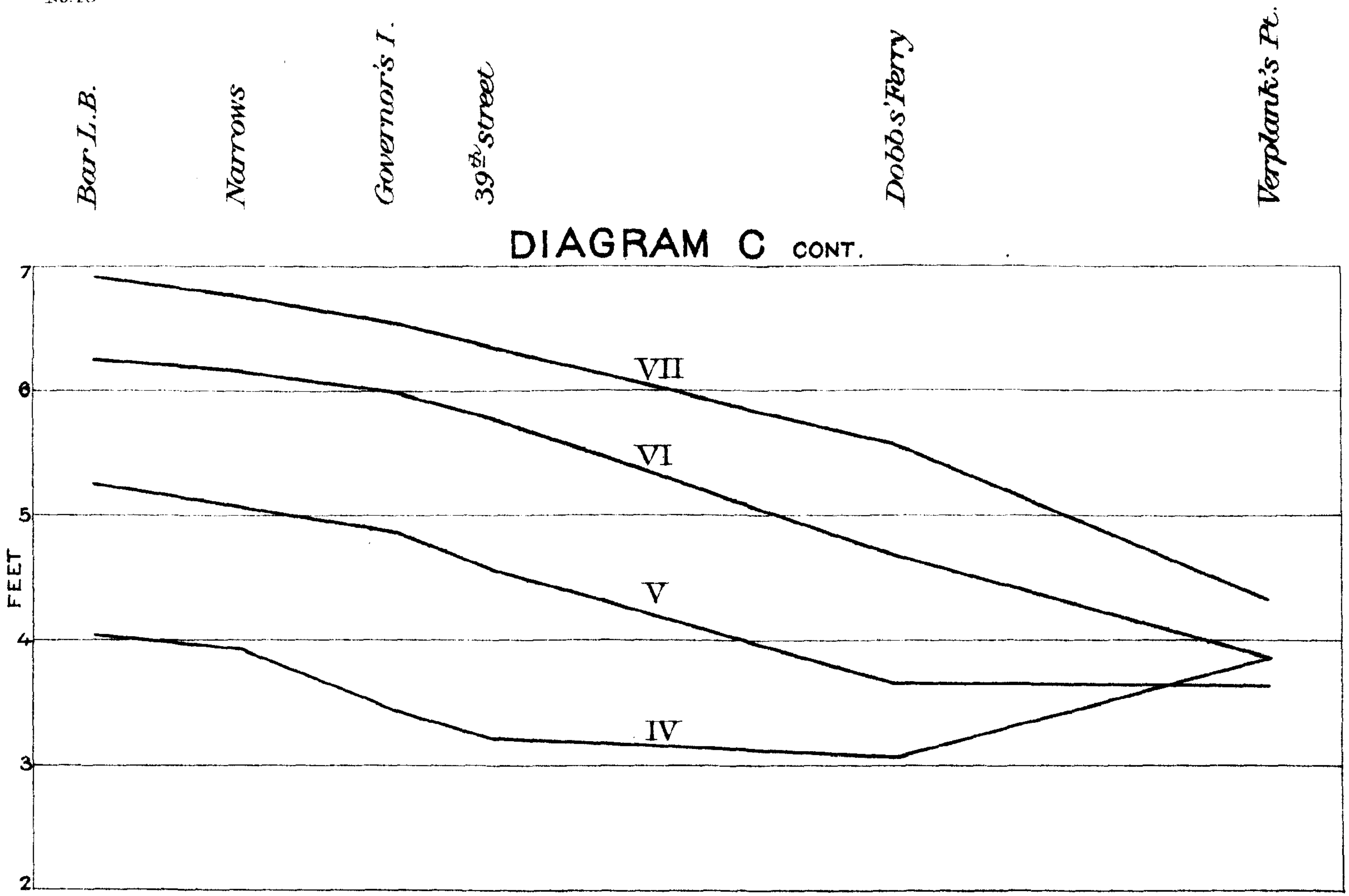
Appended are three sketches indicating the actual slopes of the Hudson for each hour after the transit of the moon. In these sketches the zero of the Governor's Island gauge of 1886 is the datum.

HENRY MITCHELL,
Coast and Geodetic Survey.



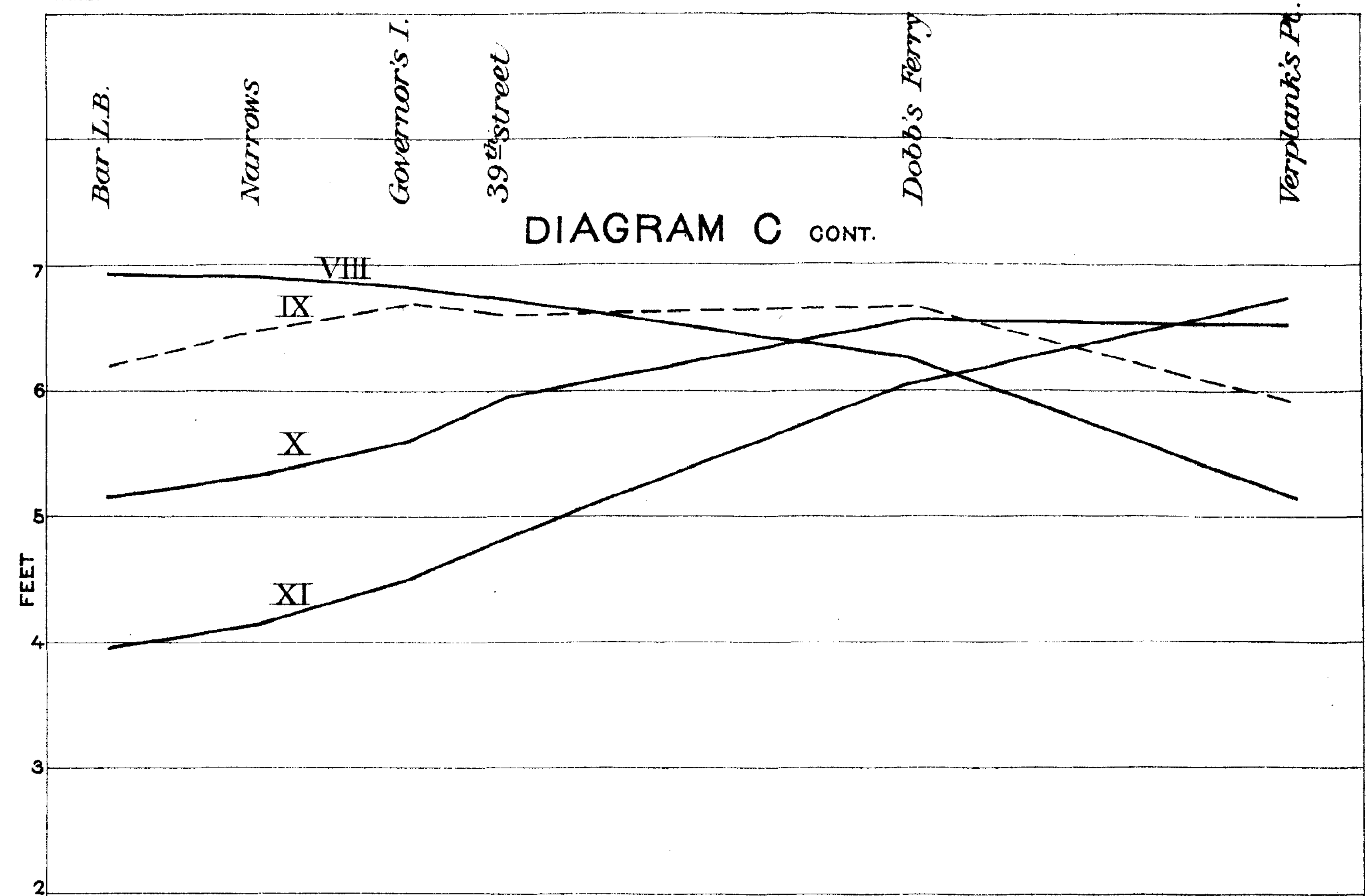
Tides in the track of the Hudson
(Synchronous)

DIAGRAM C CONT.



Tides in the track of the Hudson
(Synchronous)

DIAGRAM C CONT.



Tides in the track of the Hudson (Synchronous)

APPENDIX No. 16.—1887.

A BIBLIOGRAPHY OF GEODESY.

By J. HOWARD GORE, B. S., Ph. D.

INTRODUCTION.

Although the restricted popular demand for a work peculiarly designed for the uses of the student and scientist rarely induces its author or compiler to forego its preparation, it is nevertheless likely to be a matter of serious consideration in connection with the question of publication by private enterprise. It is especially the case that, beyond the gratification of his own scientific tastes and the undemonstrative approbation of the worthy few who appreciate the value of appliances which lessen the labor of learning, the compiler of so complete and exhaustive a Bibliography of Geodesy as that of Professor Gore can have had little to inspire his zeal and sustain his prolonged labor in an undertaking which, at the outset, involved the thorough exploration, in person, of thirty-four of the principal libraries of America and Europe, the exploration of the minor libraries by proxy, and, in addition, a searching inquiry by correspondence with all the geodesists or mathematicians of both continents. That Professor Gore has not lacked, during the preparation of his work, such inspiration as was derivable from the approbation of the competent, is attested by the courteous action of Colonel Herschel, R. E., in placing at the Professor's service his own manuscript contribution to Pendulum Bibliography, as well as by the generous overtures from various institutions, among them being the International Geodetic Association at Berlin, offering to undertake the publication of his book—a most gratifying recognition of his fitness for the work and of its anticipated value.

The propriety of the reason, assigned in his preface, for declining to place the publication of his book in foreign hands, will hardly be disputed by any save those who are indifferent to the just fame of American scientists and to the continued honorable identification of the U. S. Coast and Geodetic Survey with the best work, and the successful promotion of the highest interests, of Geodesy.

My own conviction of the propriety of Professor Gore's attitude was so clear that I could not, without a conscious disregard of duty, have declined the proffer of his manuscript to this Survey, for preservation and publication among the scientific Appendices to its Annual Report, and so assuring, without cost for preparation or compilation, appropriate association of the recognized American Bureau of Geodesy with a complete Bibliography of Geodesy, American in inception and authorship and the first work of its kind.

F. M. THORN,
Superintendent.

COAST AND GEODETIC SURVEY,
Washington, May 23, 1889.

PREFACE.

The reason for the preparation of this work was the need of it felt by the compiler. He began in 1885 a History of Geodesy, but before proceeding far it was found very difficult at any time to be sure that the literature regarding the operations of a given period had been exhausted. It was at once deemed best to collect titles as well as the works themselves. The excellent library facilities in the various technical departments in Washington emphasized the feasibility of such an undertaking. The number of titles collected for this purpose only, so far exceeded the special lists as given in the various bibliographies of mathematics that many persons suggested an extension of the original plan, so as to make the compilation useful to others. In response to this proposition the various libraries in Washington were carefully searched, and during two trips to Europe nearly every library facility there has been exhausted. In order to procure titles of such recent works of living authors as might escape notice, owing to delay in obtaining a place in the library catalogues, a circular letter was sent to every mathematician whose address could be obtained. Each circular had appended to it the titles of all of the known works of the recipient, with a request that omissions be supplied. This alone was the labor of several months, but was fully repaid in the gratifying assurances from many that nothing could be added, as well as in the few additional titles which tend towards making this work complete.

Special effort has been made to examine carefully catalogues of libraries, however small, bibliographies of the exact sciences, biographies of mathematicians, and trade lists of antiquarian books, in addition to such well-known sources as the "Royal Society Catalogue of Scientific Papers," Reuss, "Repertorium," etc.

A most opportune assistance was furnished by Col. John Herschel, R. E., who, through the courtesy of the Royal Society, and with the consent of the India Office, sent a manuscript supplement to his contribution to pendulum bibliography, which was published in "Operations of the Great Trigonometrical Survey of India," Vol. v. From this veritable treasure seventy-two new titles were found, each in the body of this work followed by (H). Most cordial thanks are due Colonel Herschel for his aid, as well as the confidence displayed in unreservedly placing such valuable material in the hands of another.

During the progress of the compiling, various overtures were made by institutions desiring to become the source from which the completed work should emanate, but it was deemed only proper that it should be published in the country which witnessed its inception and fostered its growth. Therefore it is with pardonable pride that the compiler sees the results of his labors issuing from an institution of his own country, which throughout the world is the recognized advance guard in geodetic science.

In this connection thanks should be tendered Mr. F. M. Thorn, Superintendent, and Mr. B. A. Colonna, Assistant in Charge of Office and Topography, of the U. S. Coast and Geodetic Survey, for their energetic interest in this undertaking.

The title "Bibliography" may appear as high sounding or inappropriate to a work in which all the refinements of bibliographic science are not observed. The entire collation is not always given, since a *large* proportion of the books have appeared in but one edition. The only well-defined purpose has been to give as much of the title as will enable one desiring the book to obtain it from any library possessing it, with the minimum effort to himself and the librarian. This object was also in view in preparing the abbreviations for the serial publications, which, it is hoped, may be amplified without looking for their equivalents in their alphabetical place.

It is a pleasure to acknowledge obligations to Mr. C. C. Darwin, librarian of the U. S. Geological Survey, for suggestions in preparing these abbreviations.

The scope of the work will easily make itself evident to the user. The intention was to include only such works as treated directly of the figure of the earth, or described operations which could be used in determining that figure. The only digression from this plan will be seen in the case of the pendulum, where the theoretical side is also included. This was done because of the belief that the pendulum will soon become a more important geodetic instrument, when it may be necessary to reconsider some of its theoretical features. A few treatises on surveying, bearing the word "geodesy" or its equivalent in the title, have been inserted with a remark indicating the character of the contents. As a rule, remarks are used simply to correct erroneous impressions which the title alone might make.

The plan adopted is to use only *one* alphabet, in which will be found authors, abbreviations, and subjects. Full names of the authors have been given as far as possible, but in any subsequent repetition only the initials of their Christian names are given. The title will be found repeated under the name of each co-writer or each person named in the title. A dash (—) in a title refers to the *first* name given, as the one who wrote the review, or about whom the article was written. This method gives, so far as entry is concerned, equal prominence to all persons named.

Under the authors, their works are arranged chronologically; in the case of serials, according to the date as given to the entire volume. This will be found advantageous when it is desired to find the full title from the abbreviated form as given under a subject. It is also believed that the insertion of an abbreviated title in the subject classification will be found helpful, as it will enable one to see at a glance if an author whose name appears under the desired subject has written upon the special theme sought for, without turning to the author catalogue.

After each book title, and after the full title of each serial publication, there appears in parentheses the name of the owner of the work from which the title as given was taken. Of course it does not intimate that the work in question can be found *only* there. When a book was once found it was not again looked for. As a rule, those accredited to European libraries could not, at the time of trial, be found in any library in America.

It is impossible to mention here the names of all who have assisted in this work. But special thanks are due Mr. Nicholson, of the Bodleian, Oxford; Mr. Fortescue, of the British Museum; Professors Helmert and Foerster, of Berlin; Captain von Kalmár, of Vienna; Colonel Hennequin, of Brussels; the faithful assistants in the libraries of America and Europe who searched for dusty books so seldom called for that they became lost for the time, and to those who in the University Library at Cambridge and the Royal Library of Munich used their holiday hours in looking for books which they alone possessed.

J. HOWARD GORE.

COLUMBIAN UNIVERSITY, *May*, 1889.

BIBLIOGRAPHY OF GEODESY.

A. A. A. S. Proc., *for* Proceedings of the American Association for the Advancement of Science.
8°, Salem. (Washington, Geological Survey.)

A. (G.). Sur les mesures récentes d'arcs du méridien effectuées dans la partie nord-est de l'Europe.
Bibl. Univ. Genève, XXIII, 1853, 275–278.
An account of Struve's Russian arc.

Abbadie (Antoine d'). Résumé géodésique des positions déterminées en Éthiopie.
4°, Leipzig, 1859, pp. viii, 28. (Washington, Coast Survey.)

——— Géodésie d'une partie de la haute Éthiopie, revue et rédigée par **R[odolphe] Radau**.
4°, Paris, 1860–'63, pp. 456. (British Museum.)
Originally published in three parts.

——— Sur les variations dans l'intensité de la gravité terrestre.
Acad. d. Sci. Paris, Comp. Rend., LII, 1861, 911–912.

——— Description d'un instrument pour la pratique de la géodésie expéditive.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 1195–1199.

——— Directions de la pesanteur.
Acad. d. Sci. Paris, Comp. Rend., LXI, 1865, 838.

——— Géodésie d'Éthiopie, ou triangulation d'une partie de la haute Éthiopie, exécutée selon des méthodes nouvelles par A. d'Abbadie, vérifiée et rédigée par **R. Radau**.
4°, Paris, 1873, pp. xxxii, 502, 11 maps. (Gore.)
Revd. by JORDAN (W.). Vierteljahrs. d. astr. Ges., X, 1875, 39–50.

——— Études sur la verticale.
Paris, Ass. Sci. de France, Bull., XIII, 1874, 162–164.

———: **Perrier (F.)**. Sur la nouvelle triangulation de l'île de Corse, présenté par —.
Acad. d. Sci. Paris, Comp. Rend., LXXVIII, 1874, 1569–1572.

——— Note accompagnant la présentation des premiers résultats des observations sur les mouvements microscopiques des pendules librement suspendus, faites par **de Rossi**.
Acad. d. Sci. Paris, Comp. Rend., LXXX, 1875, 1236.

———: **Gilbert (P.)**. Compte rendu de la géodésie d'Éthiopie par —.
Revue des questions scientifiques, Brux., L, 1877, 318–319.

Abbadie (A. d')—continued. Sur les variations de la verticale. Acad. d. Sci. Paris, Comp. Rend., LXXXIX, 1879, 1016–1017.
The Observatory, II, 1879, 52.

Abbe (Cleveland). A historical note on the method of least squares.
Am. Journ. of Sci., I, 1871, 411–415.

Abbe (D. Ernst). Ueber die Gesetzmässigkeit in der Vertheilung der Fehler bei Beobachtungsreihen.
4°, Jena, 1863, pp. 20.

Abendroth (William). Darstellung und Kritik der ältesten Gradmessungen in Programm des Gymnasiums zum heiligen Kreuz in Dresden womit zu dem Valedictions-Actus am 26. März ergebenst einladend das Lehren-Collegium.
8°, Dresden, 1866, pp. 47. (Gore.)

Abraham Ben Chija (*or* **Chaja**). De forma terræ. De planetis et sphæris. De computo astrologico-sphæra mundi, describens figuram terræ, dispositionumque orbium cœlestium et motus stellarum.*
Sebastian Münstrer (editor), Basel, 1546.
Poggendorff, I, Col. 5.

Acad. de Belgique, Bull., *for* Bulletin de l'Académie royale des sciences, des lettres et des beaux arts de Belgique.
8°, Bruxelles, 1832+. (Washington, Congress.)

Acad. de Belgique, Mém. couron., *for* Mémoires couronnés et mémoires des savants étrangers de l'Académie royale des sciences, des lettres et des beaux arts de Belgique.
8°, Bruxelles, 1858+. (Washington, Congress.)

Acad. Cien. Madrid, Mem., *for* Memorias de la real Academia de ciencias exactas, físicas y naturales.
4°, Madrid, 1850–'64 (6 v.). (Washington, Congress.)

Acad. du Gard, aperçu d. trav., *for* Notice aperçu analytique des travaux les plus remarquables de l'Académie royale du Gard.
8°, Nîmes, 1807+. (Washington, Congress.)

Acad. d. Inscr., Mém., *for* Mémoires de l'Académie des inscriptions.

Acad. d. l'Inst. Paris, Mém. Sav., *for* Mémoires présentés par divers savans (sciences mathématiques et physiques) à l'Académie royale des sciences de l'Institut de France.
4°, Paris, 1827+. (Washington, Observatory.)

Acad. Lugd.-Bat., Ann., *for* Annales Academiæ Lugduno-Batavia.
4°, Leyden, 1815–'37 (22 v.). (Washington, Congress.)

Acad. Moguntinæ, Acta, *for* Acta Academiæ electoralis Moguntinæ scientiarum utilium.
4°, Erfurt, 1751–'95 (14 v.). (Washington, Congress.)

Acad. d. Sci. Berlin, Hist., *for* Histoire de l'Académie royale des sciences et des belles lettres, avec les mémoires tirés des registres de cette académie.
4°, Berlin, 1745–'69 (25 v.). (Washington, Observatory.)

Acad. d. Sci. Berlin, Mém., *for* Mémoires de l'Académie royale des sciences et des belles lettres, Berlin.
4°, Berlin, 1786–1807. (Washington, Observatory.)

Acad. d. Sci. Caen, Mém., *for* Mémoires de l'Académie impériale des siences, arts et belles lettres.
4°, Caen, 1811+. (Washington, Congress.)

Acad. d. Sci. Metz, Mém., *for* Mémoires de l'Académie royale nationale (impériale), des sciences.
8°, Metz, 1828. (Washington, Congress.)

Acad. d. Sci. Paris, Comp. Rend., *for* Comptes rendus hebdomadaires des séances de l'Académie des sciences.
4°, Paris, 1835+. (Washington, Observatory.)

Acad. d. Sci. Paris, Mém., *for* Histoire de l'Académie royale des sciences avec les mémoires de mathématique et de physique, tirés des registres de cette académie.
1699–1789. (Washington, Observatory.)

Acad. Sci. phil. Med. Hassiacæ, Acta, *for* Acta philosophico-medica societatis Academiæ scientiarum principalis (Hassiacæ).
4°, Francofurti, 1771. (Washington, Congress.)

Acad. d. Sci. Toulouse, Mém., *for* Mémoires de l'Académie royale (impériale) des sciences, inscriptions et belles-lettres.
8°, Toulouse, 1782–'90, 1827–'41, 1844. (Washington, Congress.)

Acad. de St.-Pétersbourg, Acta, *for* Nova acta Academiæ scientiarum imperialis Petropolitana.
4°, St. Pétersbourg, 1783–1802 (15 v.). (Washington, Observatory.)

Acad. de St.-Pétersbourg, Bull., *for* Bulletin scientifique de l'Académie impériale des sciences de St.-Pétersbourg.
4°, St.-Pétersbourg, 1836–'42. (Washington, Observatory.)

Acad. de St.-Pétersbourg, Com., *for* Commentarii Academiæ scientiarum imperialis Petropolitana.
4°, St.-Pétersbourg, 1726–1802. (Washington, Observatory.)

Acad. de St.-Pétersbourg, Bull. phys.-math., *for* Bulletin de la classe physico-mathématique de l'Académie impériale des sciences.
4°, St.-Pétersbourg, 1842+. (Washington, Observatory.)

Acad. de St.-Pétersbourg, Mél. phys. chim., *for* Mélanges physiques et chimiques tirés du Bulletin physico-mathématique de l'Académie impériale des sciences de St.-Pétersbourg.
8°, St.-Pétersbourg, 1849+. (Washington, Observatory.)

Acad. de St.-Pétersbourg, Mém. math. phys., *for* Mémoires de l'Académie impériale des sciences de St.-Pétersbourg. Sciences mathématiques, physiques et naturelles.
4°, St.-Pétersbourg, 1830+. (Washington, Observatory.)

Acad. de St.-Pétersbourg, Mém. sav. étrang., *for* Mémoires présentés à l'Académie impériale des sciences de St.-Pétersbourg par divers savans.
4°, St.-Pétersbourg, 1830–'59 (9 v.). (Washington, Observatory.)
On the back, **Mémoires des savants étrangers.**

Accad. Sci. Bologna, Com., *for* Commentarii scientiarum et artium institutum bononiense atque academia.
4°, Bologna, 1731, 1748–'91. (Washington, Congress.)

Accad. Sci. Bologna, Rendi., *for* Rendiconto delle sessioni della Accademia delle scienze dell' Istituto di Bologna.
12°, Bologna, 1833, 1837–'42, 1846+. (Washington, Congress.)

Accad. Lincei, Atti, *for* Atti della reale Accademia dei lincei.
4°, Roma, 1870+. (Washington, Congress.)

Accad. nuovi lincei, Atti, *for* Atti della Accademia pontificia de' nuovi lincei.
4°, Roma, 1847+. (Washington, Congress.)

Accad. Sci. Napoli, Atti, *for* Atti della reale Accademia delle scienze e belle lettere.
4°, Napoli, 1819–'51 (6 vols.).
Atti della Società reale; Accademia della scienze fisiche e matematiche.
Napoli, 1863+. (Washington, Congress.)

Accad. Sci. Torino, Atti, *for* Atti della reale Accademia delle scienze di Torino.
8°, Torino, 1866+. (Washington, Congress.)

Accad. Sci. Torino, Mem., *for* Memorie della reale Accademia della scienze di Torino.
4°, Torino, 1815+. (Washington, Congress.)

Achard. Bemerkungen über die von Bertier angestellten Versuche, aus welchen es folgert, dass das Gewicht der Körper zunimmt, je mehr man sie vom Mittelpunkt der Erde entfernt.
Ges. Naturf. Freunde, Beschäftigung, II, 1876, 1.

Adams (John): Ulloa (Antonio de). A voyage to South America, translated by —.
London, 1760, 1772, 1806, 1807.
Title in full under ULLOA (A. DE).

Adan (E.-H.-J.). Cours de géodésie.
4°, Bruxelles, 1864, pp. 131. (Brussels, Royal.)
Lithographed.

——— Essai sur les limites à poser à la mesure de précision des observations immédiates.
Acad. de Belgique, Bull., XXII, 1866, 480–502.
Rapport de M. LIAGRE sur la même, 454–455.

——— Loi générale de la probabilité des erreurs étendue à tous les genres d'observations immédiates.
Acad. de Belgique, Bull., XXIII, 1867, 148–187.

——— Rapport sur les travaux exécutés en Belgique en 1875. (Geodetic.)
Int. Geod. Cong., Gen.-Ber., 1875, 155–157.

Adan (E.-H.-J.)—Continued.

——— Grandeur et forme de la terre, déterminées par les mesures d'arcs.
12°, Bruxelles, 1876. Pp. 62, 1 chart. (Gore.) Published by Dépôt de la Guerre.

——— Grandeur et forme de la terre. Oscillations du pendule.
12°, Bruxelles, 1876, pp. 47, 1 chart. (Gore.) Published by Dépôt de la Guerre.

——— Notice sur l'Association internationale de géodésie.
18°, Ixelles, 1876, pp. 51. (Gore.)

——— Notices sur les travaux géodésiques du Dépôt de la Guerre de Belgique.
12°, Gand, 1876, pp. 66, 1 chart.
Separate from Revue belge d'art, de science et de technologie militaire, I, 1876.

——— Rapport sur les travaux géodésiques du Dépôt de la Guerre en 1876. (Belgique.)
Int. Geod. Cong., Gen.-Ber., 1876, 73–83.

——— Rapport sur les travaux géodésiques en Belgique en 1877.
Int. Geod. Cong., Gen.-Ber., 1877, 262–269.

——— Déviation de la verticale. (Extrait, Acad. de Belgique, Mém. couron., XXIX.)
8°, Ixelles, 1876, pp. 12.

——— Comparaison entre les coordonnées réelles et les coordonnées théoriques d'un lieu de la terre. Déviation ellipsoïdale. (Extrait, Acad. de Belgique, Mém. couron., XXIX.)
8°, Bruxelles, 1878, pp. 16.

——— Attractions locales. Corrections des éléments de l'ellipsoïde osculateur. (Extrait, Acad. de Belgique, Mém. couron., XXIX.)
8°, Bruxelles, 1878, pp. 31.

——— Mémoire sur l'ellipsoïde unique. (Extrait, Acad. de Belgique, Mém. couron., XXIX.)
8°, Bruxelles, 1878, pp. 10, 1 plate.

——— Association géodésique internationale. Conférence de Hambourg, 1878.
Soc. belge de géogr., Bull., 1, 1878, 529–533.

——— Rapport sur les travaux géodésiques en Belgique pendant l'année 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 76–81.

——— Dépôt de la Guerre. Triangulation de Belgique. Supplément au Livre III. Observations astronomiques. Partie théorique.
4°, Ixelles-Bruxelles, 1878, pp. iv, 193, 11 plates. (Gore.)

——— Association géodésique internationale. Conférence de Genève, 1879.
Soc. belge de géogr., Bull. 3, 1879, 658–665.

——— Rapport sur les travaux géodésiques en Belgique pendant l'année 1878.
Int. Geod. Cong., Gen.-Ber., 1879, 78–83.

——— Attractions locales. Corrections des éléments de l'ellipsoïde osculateur.
Acad. de Belgique, Mém. couron., XXIX, 1880, 3–29.

——— Note sur la figure de la terre.
Int. Ceod. Cong., Gen.-Ber., 1880, 7–8.

Adan (E.-H.-J.)—Continued.

——— Rapport de la conférence générale de l'Association géodésique internationale tenue à Munich du 13 au 17 septembre 1880.
8°, Bruxelles, 1880, pp. 19.
Separate, Soc. belge de géogr., IV, 1880.

——— Rapport sur les travaux géodésiques en Belgique pendant l'année 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 6–7.

——— [Sur le premier volume des observations et calculs de la triangulation belge.]
Acad. de Belgique, Bull., L, 1880, 75–76.

——— Sur la compensation d'une chaine de triangles géodésiques.
Acad. de Belgique, Bull., L, 1880, 260–265.

——— Triangulation du royaume de Belgique. Publiée avec l'autorisation de M. le Ministre de la guerre par l'Institut cartographique militaire. Observations et calculs de la triangulation de premier ordre.
Tome premier. 4°, Ixelles-Bruxelles, 1880, pp. cvi, 378, 10 plates. (Gore.)

——— Triangulation du royaume de Belgique. Publiée avec l'autorisation de M. le Ministre de la guerre par l'Institut cartographique militaire. Calculs des coordonnées géographiques et construction de la carte.
Tome troisième. 4°, Ixelles-Bruxelles, 1881, pp. lvii, 125, 4 charts. (Gore.)

——— [Sur la jonction géodésique exécutée entre l'Espagne et l'Algérie en 1879.]
Acad. de Belgique, Bull., 1, 1881, 8–18.

——— Sur la triangulation du royaume (Belgique).
Acad. de Belgique, Bull., 1, 1881, 209–213.

———: **Houzeau** (J.-C.). Sur la triangulation du royaume d'une troisième base géodésique; par —.
Acad. de Belgique, Bull., 1, 1881, 867–872.

Adcock (R. J.). Force of gravity at any latitude.
Analyst, IV, 1877, 20.

Adēlos. The geodesy of Britain; or the ordnance survey of England, Scotland, and Ireland: Its history and progress, scales and changes; the principal purposes which it ought to subserve; the mode in which it may subserve them; and the determination which the legislature should come to in reference to its final completion. In a letter to a Scottish laird and imperial M. P.
8°, London, 1859, pp. 76. (Southampton, Ordnance Survey.)

ADJUSTMENT OF FIGURE. *See* **FIGURE ADJUSTMENT.**

Adrain (Robert). Investigation of the figure of the earth, and of the gravity in different latitudes.
Am. Phil. Soc., Trans., 1, 1818, 119–135.
Ellipticity 1 : 319.

——— Research concerning the mean diameter of the earth.
Am. Phil. Soc., Trans., 1, 1818, 353–366.

Aguilar (Antonio). [Les travaux géographiques dépendant de la Junta general de estadística.]
Astron. Nachr., LV, 1864, 337–340.

Ainslie (John). Treatise on land surveying. A new and enlarged edition, embracing railway, military, marine, and geodetical surveying. By **Wm. Galbraith.**
8°, Edinburgh, 1849, pp. viii, 534, 20. (Washington, Congress.)

Airy (George Biddell): Young (T.). Estimate of the effect of terms involving the square of the disturbing force on the figure of the earth. In a letter to —.
Quart. Jour. Sci., XXI, 1826, 346–347.

——— Mathematical tracts on physical astronomy, the figure of the earth, precession and nutation and the calculus of variations.
8°, Cambridge, 1826, pp. viii, 180.
2d ed., 1831.
Figure of the earth, 61–123.

——— On the figure of the earth.
Roy. Soc. London, Phil. Trans., CXVI, 1826, 548–575.
Revd. in Bull. Sci. Math. (Férussac), VII, 1827, 385–386, e=1: 287.8.

——— [On the figure of the earth.]
Brit. A. A. S., Rep., I–II, 1832, 165–169; 178–180.

——— Abriss einer Geschichte der Astronomie im Lauf des 19. Jahrhunderts (1800–1832). Aus dem Englischen von C. L. Littrow.
8°, Wien, 1835.
Shape of the earth, 76–83.

——— On the flexure of a uniform bar supported by a number of equal pressures applied at equi-distant points, and on the positions proper for the applications of the pressures, in order to prevent any sensible alteration of the length of the bar by small flexure.
Roy. Astron. Soc., Month. Not., VI, 1843–'45 143–146; XV, 1846, 157–163.

——— [Essay on the figure of the earth.]
In *Encyclopedia of Astronomy*, 4°, London, 1848, 165–240, 3 plates.

——— On the figure of the earth.
Encyclopedia Metropolitana. Part 35. London, 1849, 165–240, 3 plates.*

——— On a problem of geodesy.
Phil. Mag., XXXVI, 1850, 96–99.

——— Account of pendulum experiments undertaken in the Harton Colliery, for the purpose of determining the mean density of the earth.
Roy. Soc. London, Phil. Trans., CXLVI, 1856, 297–355; Roy. Astron. Soc., Month. Not., XV, 1854–'55, 46; 125–126; Ann. d. Phys. (Poggendorff), XCVIII, 1856, 599–605; Ann. d. Chim., XLIII, 1855, 381–383; Roy. Inst., Proc., II, 1854–'58, 17–22; Am. Journ. of Sci., XX, 1856, 359–604; Bibl. Univ. Genève, XXXV, 1857, 15–29.
Revd. in Roy. Astron. Soc., Month. Not., XVIII, 1858, 222. D=6.623, and 6.566.

——— On the computation of the effect of the attraction of mountain-masses, as disturbing the apparent astronomical latitude of stations in geodetic surveys.
Roy. Soc. London., Phil. Trans., CXLV, 1855, 101–104; Roy. Astron. Soc., Month. Not., XVI, 1855–'56, 42–43.

———: **Schubert (T. F. de).** *Essai d'une détermination de la véritable figure de la terre.* Revd. by,
Roy. Astron. Soc., Month. Not., XIX, 1859, 104–170.

Airy (G. B.)—Continued.

——— Account of the construction of the new national standard of length, and of its principal copies.
Roy. Soc. London, Phil. Trans., CXLVII, 1857, 621–702.
Revd. in Roy. Astron. Soc., Mem. XIX, 1850, 250–263.

———: **Gumpach (J. von).** A letter on the figure of the earth to —
London, 1862.
Title in full under GUMPACH (J. VON).

——— [Measures of the earth and of the heavens.]
Roy. Astron. Soc., Month. Not., XXIII, 1863, 70–72.

———: **Maclear (T.).** Verification and extension of La Caille's Arc of Meridian. Edited by ———.
London, 1866.
Title in full under MACLEAR (T.).

———: **Folie (F.).** Sur le calcul de la densité de la terre d'après les observations d'———.
Acad. de Belgique, Bull., XXXIII, 1872, 389–407.

——— On the algebraical and numerical theory of errors of observations and the combinations of observations.
12°, London, 1861, XVI, 103. (Gore.)
2d edition, revised. London, 1875.

——— Investigations applying to the Indian geodesy.
India, Trig. Survey, II, 1879, app. I, 3–10.

Albrecht (Theodor). Formeln und Hilfstafeln für geographische Ortsbestimmungen, nebst kurzer Anleitung zur Ausführung derselben.
4°, Leipzig, 1873.
2d ed., Leipzig, 1879, pp. VI, 240. (Brussels, Dépôt de la Guerre.)

———, **und Peters (C. A. F.).** [Bericht über die geodätischen Arbeiten in Preussen im Jahre 1874.]
Int. Geod. Cong., Gen.-Ber., 1874, 63–66.

——— Bericht über die Arbeiten des geodätischen Instituts. 1878, 1881–'82.
Title in full under BAEYER (J. J.).

——— Ueber die Umkehrung der Bessel'schen Methode der sphäroidischen Uebertragung.
Astron. Nachr., XCVI, 1880, 209–218.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XII, 1880, 851, by B[RUNS].

——— Bestimmungen der Länge der Secundenpendels in Leipzig, Dresden und dem Abrahamsschachte bei Freiberg in den Jahren 1869–'71.*
4°, Berlin, 1885.
Separatabdruck aus der iii. Abtheilung: Die astronomischen Arbeiten für die europäische Gradmessung im Königreiche Sachsen.

Alembert (Jean Le Rond d'). Recherches sur la précession des équinoxes.*
4°, Paris, 1749.
Flattening of the earth is deduced from the precession of the equinoxes in Chapter IX.
HOUZEAU, II, 1149.

——— Opuscules mathématiques, ou mémoires sur différens sujets de géométrie, de mécanique, d'optique, d'astronomie, etc.
8 vols., 8°, Paris, 1761–'68.
Figure de la terre, VI, 47–259.

Alexander (C. A.): Merino (Miguel). Figure of the earth. Translated by —.
Smithsonian Institution, Rep. 1863, 306–330.

Alexander (J.). Concerning a place in New York for measuring a degree of latitude.
Roy. Soc. London, Phil. Trans., XLI, 1740, I, 383.
Suggests that the Hudson River be used in winter when frozen over from New York to Albany.

ALGIERS.
PERRIER (F.). Description géométrique de l'Algérie. Paris 1871, 1874.
—— Rapport sur les travaux géodésiques en . . . Algérie. Int. Geod. Cong., Gen.-Ber., 1874, 25; 1877, 283-286; 1880, 9-11; 1886, 128-129; 1887, V, 1-6.
—— Jonction géodésique de l'Algérie avec l'Espagne.
Acad. d. Sci. Paris, Comp. rend., LXXXIX, 1879, 885-889; Observatory, III, 1880, 326-327; Int. Geod. Cong., Gen.-Ber., 1880, 47-53; Acad. d. Sci. Paris, Comp. Rend., CIV, 1887, 1817-1821.
REITZ (F. H.). Ueber die trigonometrische Verbindung von Spanien und Algerien.
Hamburg, 1883.
YVON-VILLARCEAU (A.-J.-F.). Rapports sur les travaux géodésiques exécutés en Algerie.
Acad. d. Sci. Paris, Comp. Rend., LXXXIV, 1877, 1002-1014.
ANON. Geodetic operations in Algeria.
Van Nostrand's Mag., IX, 1873, 22-23.
—— Jonction de la géodésie de l'Europe à la géodésie de l'Algérie.
Soc. géogr., Bull., XVIII, 1879, 470.

Allé (Moriz). Zur Theorie des Gauss'schen Krümmungsmaasses.
K. Ak. Wiss. Wien, math.-phys. Cl., Sitz.-Ber., LXXIV, II, 1876, 9-38.

Allégret (Alexandre). Mémoire sur la flexion des lignes géodésiques tracées sur une même surface quelconque.
Acad. d. Sci. Paris, Comp. Rend., LXVI, 1868, 342-344; Les Mondes (Paris), XVII, 1868, 271; 423.
Revd. in Jahrb. üb. d. Fortschr. d. Math., I, 1868, 389, by BRUNS.

Allg. Bauzeit (Förster), *for* Allgemeine Bauzeitung für Architecten, Ingenieure, etc. (Förster).
Fol., Wien, 1836+. (Washington, Patent Office.)

Allg. geog. Eph., *for* Allgemeine geographische Ephemeriden (Zach).
8°, Weimar, 1798-1816 (1800-'16). (Washington, Observatory.)

Allg. Zeit., *for* Allgemeine Zeitung.
Fol., Augsburg. (Washington, Congress.)

Allison (William B.), *Chairman.* Testimony before the joint commission to consider the present organization of the Signal Service, Geological Survey, Coast and Geodetic Survey, and the Hydrographic Office of the Navy Department, with a view to secure greater efficiency and economy of administration of the public service in said bureaus, authorized by the sundry civil act, approved July 7, 1884, and continued by the sundry civil act, approved March 3, 1885. Misc. Doc., No. 82, 49th Cong., 1st session.
8°, Washington, 1886, pp. xxxvii, 1104. (Gore.)

Allman (George Johnston): McCullagh. On the attraction of ellipsoids, with a new demonstration of Clairaut's theorem, being an account of the late Professor **McCullagh's** lectures on those subjects, compiled by —.
Roy. Irish Acad., Trans., XXII, 1855, 379-395.

Alsted (Johannes Heinrich). Elementale mathematicum, continentur arithmetica, geometria, geodæsia, astronomia, geographia, musica, optica.*
Francofurti, 1611.
Poggendorff, I, col. 34.

Amante (Fedele). Nouveau calcul de l'arc du méridien entre Montjouy et Formentera.
8°, Naples, 1843, pp. 28. (Paris, Observatory.)
—— Memoria sulle formole da usari ne' calcoli geodetici per la riduzione degli angoli all' orizzonte della stazione.
Acad. sci. Napoli, Atti, I, 1843, 157-178.
—— Elementi di geodesia. Parte prima. Trigonometrica e geografia matematica.
8°, Napoli, 1847.
Communicated by Prof. E. FERGOLA.
—— Considerazioni sulle formole adoperate comunemente dai geografi per calcolare le posizione geografichi dei vertici dei triangoli geodetici.
4°, Napoli, 1852, pp. 25. (Berlin, Geodetic Institute.)*

Am. Acad. Sci., Mem., *for* Memoirs of the American Academy of Arts and Sciences.
4°, Boston, 1783+. (Washington, Observatory.)

Am. Jour. Ed., *for* American Journal of Education.
8°, Hartford, 1856+. (Washington, Congress.)

Am. Jour. Sci., *for* The American Journal of Science, sometimes known as Silliman's Journal.
8°, New Haven, 1818+. (Washington, Patent Office.)

Ammann. [Nachricht von seiner Vermessung in Augsburgischen.]
Astron. Jahrb., 1800, 113-119.

Ammon (Franz). Lehrbuch der mathematischen und physischen Erdbeschreibung für die bayrischen Gymnasien.
8°, Augsburg, 1829.
Zweite verbesserte Auflage. 8°, Augsburg, 1837, pp. xii, 128, 156. (British Museum.)
Von der Gestalt der Erde, 28-39.

Ampère (André-Marie). Théorie de la terre.
Revue des Deux Mondes, III, 1833, 96-107.
From a dynamic point of view.

Am. Phil. Soc., Proc., *for* Proceedings of the American Philosophical Society (held at Philadelphia, for promoting useful knowledge).
8°, Philadelphia, 1838+. (Washington, Observatory.)

Am. Phil. Soc., Trans., *for* Transactions of the American Philosophical Society, held at Philadelphia, for promoting useful knowledge.
4°, Philadelphia, 1769+. (Washington, Observatory.)

Analect. Mag., *for* Analectic Magazine.
8°, Philadelphia, 1813-'20 (16 vols.). (Washington, Congress.)

Andersson (Johan Oscar). Geodetisk mätningskunskap.
8°, Stockholm, 1876, pp. ii, 236. (British Museum.)

Andrae (Carl Christopher Georg). Om beregningen af brede, langde, og azimuth paa sphæroiden.
K. Svenska Vetensk. Ak., Öfvers., 1858, 230–269; Astron. Nachr., L, 1859, 161–168.

——— Om rækkeudviklingen af de formler, som tjene til bestemmelsen af geodætiske positioner paa den sphæroidiske jordoverflade.
K. Svensk. Vetensk. Ak., Öfvers., 1859, 27–69; Astron. Nachr., LIII, 1860, 369–380.

——— Theorien for Udjevningen af et geodætisk triangelnet.*
Kjøbenhavn, 1864.

——— Die dänischen Hauptdreiecke, welche Kopenhagen mit den schwedischen und preussischen Dreiecken verbinden.
Int. Geod. Cong., Gen.-Ber., 1865, 4–9.

——— Bericht über die in Dänemark ausgeführten [geodetic] Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1868, 11–15.

——— Bericht über die in Dänemark ausgeführten Arbeiten [for 1869].
Int. Geod. Cong., Gen.-Ber., 1869, 5–9.

——— Ueber den mittleren Fehler wiederholter Messungen.
Astron. Nachr., LXXIV, 1869, 283–284.

——— Theorien for Udmaalingen af Vinkler ved Repetitionsmethoden.*
Kjøbenhavn, 1872.

——— Den danske Gradmaaling. Første Bind, indeholdende Hovedtrianglerne paa Sjælland og deres Forbindelser med svenske og preussiske Triangelrækker. Udgivet af C. G. Andrae.
4°, Kjøbenhavn, 1867, pp. xxviii, 579, 4 plates. (Gore.)

——— Den danske Gradmaaling. Andet Bind, indeholdende Meridianbuens Hovedtriangler fra Elben til Samsö og deres Forbindelse med Maalingerne paa Sjælland. Udgivet af C. G. Andrae.
4°, Køjbenhavn, 1872, pp. xiv, 490, 3 plates.
Revd. by HELMERT. Astron. Ges., Vierteljahrs., XII, 1877, 184–209.

——— ——— *Tredie Bind, indeholdende de Tilbagestaaende* Dele af Triangelnettet og dettes Nedlægning paa Sphæroiden. Udgivet af C. G. Andrae.
4°, Kjøbenhavn, 1878, pp. xiv, 422.
Revd. by HELMERT. Astron. Ges., Vierteljahrs., XIII, 1878, 57–80.

——— Ueber die Bestimmung des wahrscheinlichen Fehlers durch die gegebenen Differenzen von *m* gleich genauen Beobachtungen eines Unbekannten.
Astron. Nachr., LXXIX, 1872, 257–272.

——— Bericht über die in Dänemark ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1872, 3.

——— Bericht über die geodätischen Arbeiten in Dänemark pro 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 167–169.

——— Ueber die Ausgleichung eines Dreiecksnetzes.
Int. Geod. Cong., Gen.-Ber., 1877, 244–252.

——— Bericht über die geodätischen Arbeiten in Dänemark für das Jahr 1877.
Int. Geod. Cong., Gen.-Ber., 1877, 269–272.

Andrae (Carl Christopher Georg).—Continued.

——— Bericht über die ausgeführten [geodetic] Arbeiten in Dänemark für das Jahr 1879.
Int. Geod. Cong., Gen.-Ber., 1879, 84–87.

——— Problémes de haute géodésie. Extraits de l'ouvrage danois: "Den danske Gradmaaling."
Formation et calcul des triangles géodésiques.
4°, Copenhague, 1881, pp. 52.

Calcul des latitudes, des longitudes et des azimuths sur le sphéroïde.
4°, Copenhague, 1882, pp. 55.

Détermination du sphéroïde terrestre par la combinaison des mesures géodésiques avec les observations astronomiques.
4°, Copenhague, 1883, pp. 56, 1 plate. (Southampton, Ordnance Survey.)

——— Den danske Gradmaaling. Fjerde Bind. Indeholdene de astronomiske Jagttagelser og Bestemmelsen af Sphæroiden.
4°, Kjøbenhavn, 1884, pp. xii, 432, 1 plate. (Gore.)

André. Théorie de la surface actuelle de la terre.
Journ. d. Mines, XXI, 1807, 431–440.
Chiefly geology and mineralogy.

Andres (Theodor). Ueber die Bestimmung jener drei Gleichungen, welche dienen, aus gemachten Ablesungen am Limbus eines Winkelinstrumentes die Excentricität desselben zu berechnen.
Arch. d. Math. (Grunert), XXXIII, 1859, 95–104.

——— Die Zahlenformel für den mittleren Krümmungshalbmesser des Erdsphäroids.
Arch. d. Math. (Grunert), XXXV, 1860, 72– 0.

——— Berechnung der geodätischen Coordinaten und der geographischen Positionen der Dreieckspunkte, gestützt auf die Bessel'schen sphäroidischen Umwandlungsformeln.
Arch. d. Math. (Grunert), LXIII, 1871, 364–378.
Revd. in Jahrb. üb. d. Fortschr. d. Math., III, 1871, 547–548, by B[RUNS].

Andrews, jun. (Horace). Marking geodetic stations.
Science, I, 1883, 458.

——— Methods of marking trigonometrical stations and of recovering them if lost.
Final Results N. Y. State Survey, 1887, 122–126.

Andronowitz. Von der Gestalt und Grösse des Erdkörpers.
8°, Belgrade, 1886, pp. 34.
In Servian language. Title given in Zeits. f. Vermes., XVI, 1887, 497.

Anger (Carl Theodor). Ueber eine Aufgabe der Geodäsie.
Astron. Nachr., IX, 1831, 359–364.

ANGLES, REDUCTION OF, AT STATION.

AMANTE (F.) . . . *La riduzione degli angoli all' orizzonte della stazione.*
Accad. Sci. Napoli, Atti, I, 1843, 157–178.

FAVARO (A.). Procedimento grafico per la riduzione degli angoli al centro di stazione.
L' Ingegneria, Torino, V, 1879, 1–8.

FOLQUE (F.). Taboas para o calculo da reducção ao centro.
Lisboa, 1853.

FRANKE (J. H.). Winkel-Centrirung.
Zeits. f. Vermes., V, 1876, 41–42.

ANGLES, REDUCTION OF, AT STATION—Continued.

KERSCHBAUM (G.). Ueber Winkel-Centrirung.
Zeits. f. Vermes., v, 1876, 115–119.

MAYER (J. R.). A mode of determining graphically the correction for the reduction to centre of station.
Journ. Frank. Inst., LXXI, 1866, 98–99.

PERNY (M.-J.). Méthodes pour réduire les angles observés au centre d'une station.
Angers, 1808.

PUCCI (E.). Réduction . . . des angles géodésiques d'une surface de niveau à une autre.
Astron. Nachr., XCIX, 1881, 161–168.

SCHOTT (C. A.). Adjustment of horizontal angles.
U. S. C. and G. Survey 1854, 70–95.

SCHREIBER (O.). Ueber die Anordnung von Horizontalwinkel-Beobachtungen auf der Station.
Zeits. f. Vermes., VII, 1878, 209–240.

SONDERHOF (A.). Die geodätischen Correctionen der auf dem Sphäroid beobachteten Horizontalwinkel.
Arch. d. Math. (Grunert), LI, 1870, 20–41.

VOGLER (C. A.). Ueber Stationsbeobachtungen in symmetrischer Anordnung.
Zeits. f. Vermes., XIV, 1885, 49–59.

WEINGARTEN (J.). Ueber eine geodätische Aufgabe.
Astron. Nachr., LXXIII, 1868, 65–76.

——— Ueber die Reduction der Winkel eines sphäroidischen Dreiecks.
Astron. Nachr., LXXV, 1869, 91–96.

WERNER (W.). Ueber die Beziehung der bei der Stations-Ausgleichung gewählten Nullrichtung.
4°, Berlin, 1880.

WINCKLER (A.). Ueber einige trigonometrischen Messungen vorkommende Aufgaben.
Zeits. f. Math. (Schlömilch), II, 1857, 334–338.

ZACH (F. VON). Ueber Reduction geneigter Winkel auf den Horizont.
Mon. Corr. (Zach), XIX, 1809, 317–330.

Analyst (The).
4°, Des Moines, 1874–'84. (Washington, Congress.)

Ann. d. Chimie, *for* Annales de chimie, 1789–1816. Annales de chimie et de physique.
8°, Paris, 1817+. (Washington, Observatory.)

Ann. d. Erdkunde (Berghaus), *for* Annalen der Erd-, Völker- und Staatenkunde (Berghaus.)
8°, Berlin, 1830–'35 (12 v.). (Washington, Patent Office.)

Ann. Hydrog., *for* Annales hydrographiques.
8°, Paris, 1849+. (Washington, Congress.)

Ann. d. Math. (Gergonne), *for* Annales de mathématiques pures et appliquées. (Gergonne.)
8°, Nismes, 1810–'31. (Washington, Observatory.)

Ann. Math., *for* Annals of Mathematics.
4°, Charlottesville, 1884+. (Washington, Congress.)

Ann. of Phil. (Phillips), *for* Annals of Philosophy (Phillips).
8°, London, 1821–'26 (12 v.). (Washington Patent Office.)

Ann. of Phil. (Thomson), *for* Annals of Philosophy (Thomson).
8°, London, 1813–'20 (16 v.). (Washington, Patent Office.)

Ann. d. Phys. (Gilbert), *for* Annalen der Physik (Gilbert), 1799–1808. Annalen der Physik und der physikalischen Chemie (Gilbert).
8°, Halle, 1819–'24. (Washington, Observatory.)

Ann. d. Phys. (Poggendorff), *for* Annalen der Physik und Chemie (Poggendorff).
8°, Berlin, 1824–'77. (Washington, Observatory.)

Ann. d. Phys. (Wiedemann), *for* Annalen der Physik und Chemie (Wiedemann).
8°, Leipzig, 1877+. (Washington, Observatory.)

Ann. Sci. Mat. e Fis. (Tortolini), *for* Annali di scienze matematiche e fisiche (Tortolini).
8°, Roma, 1850–'57. (Oxford, Bodleian.)

Annali di matematica pura ed applicata (Tortolini).
8°, Roma, 1858–'65. (Oxford, Bodleian.)

Annali di matematica pura ed applicata (Brioschi).
8°, Milano, 1867+. (Oxford, Bodleian.)

Ann. d. Sci. Nat., *for* Annales des sciences naturelles.
8°, Paris, 1842+. (Oxford, Bodleian.)

Anville (Jean-Baptiste Bourguignon d'). Proposition d'une mesure de la terre, dont il résulte une diminution considérable dans sa circonférence sur les parallèles.
12°, Paris, 1735, pp. xxix, 147. (British Museum.)

——— Mesure conjecturale de la terre.*
Faris, 1736.
Poggendorff, I, 51.

——— Réponse au mémoire envoyé à l'Académie par M. Simonin contre la mesure conjecturale de l'équateur en conséquence de l'étendue de la mer du sud.
8°, Paris, 1738, pp. 48.
In the Bibliothèque nationale, Paris, the only library in which a copy of this work could be found, this brochure with the printed page 2½ by 4¾ inches is bound in vol. 302 of a series entitled: Recueil de mémoires, dissertations, lettres, pour servir de supplément aux Mém. Acad. d. Sci. Paris.

——— Traité des mesures itinéraires anciennes et modernes.
16°, Paris, 1769, pp. vi, 195. (Gore.)
Of value in discussing the unit used in the Egyptian degree determinations.

———: **Ideler (C. L.).** Ueber die von—in die alte Geographie eingeführten Stadien.
K. Ak. d. Wiss., phil. Cl., 1826, 1–18.

Aoust (Louis). Sur une forme de l'équation de la ligne géodésique ellipsoïdale, et de ses usages pour trouver les propriétés communes aux lignes ellipsoïdales et à des courbes planes correspondantes.
Acad. d. Sci. Paris, Comp. Rend., L, 1860, 484–489.

Appelgren (Sim. William). De figura telluris ope pendulorum determinanda.
8°, Aboæ, 1810, pp. 10. (British Museum.)

Arago (Dominique-François-Jean). Extrait du Rapport sur le voyage de découvertes, exécuté dans les années 1822, 1823, 1824 et 1825 sous le commandement de M. **Duperrey.**
Ann. d. Sci. Nat., VI, 1825, 206–221.

——— Sur les opérations géodésiques exécutées en Italie par les ingénieurs-géographes français.
Conn. d. Temps, 1827, 385–391.

Arago (**Dominique-François-Jean**)—Continued.
——— Sur les observations du pendule faites pendant le premier voyage du capitaine Parry.
Conn. d. Temps, 1827, 392–394.

——— Rapport fait à l'Académie des sciences sur le voyage [de la Coquille] de découvertes exécuté dans les années 1822–'25 sous le commandement de M. Duperry.
Conn. d. Temps, 1828, 240–272.

——— et **Biot** (**J.-B.**). Sur un mémoire de M. **Puissant** lu à l'Académie dans sa dernière séance et inséré au compte rendu.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 450–453.
Concerning the distance between the parallels of Montjouy and Formentera.

———: **Puissant** (**L.**). Dernières remarques sur une nouvelle détermination de l'arc de méridien compris entre Montjouy et Formentera, en reponse à —.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 483–486.

———: **Faye** (**H.-A.-E.-A.**). Sur la détermination géodésique des latitudes, avec une réponse à la critique de M. —.
Acad. d. Sci. Paris, Comp. Rend., XXXVI, 1853, 267–276.

Arbues-Moreira (**Carlos Ernesto de**). *See* **Moreira** (**Carlos Ernesto de Arbues**).

Arch. d. Math. (**Grunert**) *for* Archiv der Mathematik und Physik (Grunert).
8°, Greifswald, 1841–'77; Leipzig, 1878+. (Washington, Observatory.)

Arch. Math. og Naturwid., *for* Archiv for Mathematik og Naturwidenskab (Lie).
8°, Christiania, 1876+. (Washington, Congress.)

Arch. Néerl., *for* Archives néerlandaises des sciences exactes et naturelles.
8°, La Haye, 1866+. (Washington, Congress.)

Arch. Russ. (**Erman**), *for* Archiv für wissenschaftliche Kunde von Russland (Erman).
8°, Berlin, 1841–'67 (25 v.). (Washington, Congress.)

Arch. u. Ing.-Verein Hannover, Zeits., *for* Zeitschrift des Architekten-und Ingenieur-Verein für das Königreich Hannover.
Fol., Hannover, 1855+. (Washington, Patent Office.)

Arch. v. Wisk., *for* Nieuw Archief voor Wiskunde.
8°, Amsterdam, 1875+. (Washington, Congress.)

Arcy (**Patrick d'**). Mémoire sur les degrès d'ellipticité des sphéroïdes, par rapport à l'intensité de l'attraction.
Acad. d. Sci. Paris, Mém., 1758, 318–320.

Arena (**Filippo**). Diss. geogr. de dimensione et figura telluris.*
Panormi, 1757.
Poggendorff, I, 59.

Argelander (**Friedrich Wilhelm August**). Ueber die Anwendung der Methode der kleinsten Quadrate auf einen besondern Fall.
Astron. Nachr., XXI, 1843, 163–168.
Regarding the formation of normal equations when the observations are on sums of unknown values.

Argelander (**Friedrich Wilhelm August**)—Continued.
——— [Ueber die neue Längengradmessung auf dem 52. Parallel quer durch Europa.]
Niederrhein. Gesell., Sitz.-Ber., I, 1864, 49–53.

Arrest (**Heinrich d'**). Schreiben [über die Berechnung der Gewichte].
Astron. Nachr., XLVII, 1859, 17–20.

Asiatic researches.
4°, Calcutta, 1788–1839 (20 v.). (Washington, Congress.)

Asiat. Soc. Bengal, Journ., *for* Journal of the Asiatic Society of Bengal.
8°, Calcutta, 1832–'64. (Washington, Congress.)

Asselin (**F.**). Problèmes de géométrie élémentaire, avec leurs solutions raisonnées, suivis de quelques notions d'arpentage et de géodésie.
8°, Amiens et Paris, 1865, pp. vii, 232.
Simple surveying.

Assoc. Franç. Av. Sci., Comp. Rend., *for* Compte rendu de la session de l'Association française pour l'avancement des sciences.
1872+. (Washington, Observatory.)

Assoc. Sci. de France, Bull., *for* Bulletin hebdomadaire de l'Association scientifique de France.
8°, Paris, 1871+. (Washington, Observatory.)

Aster (**F. L.**): **Bugge** (**T.**). Beschreibung der dänischen Ausmessungsmethode. Edited by —.
Dresden, 1787.
Title in full under BUGGE (T.).

Åstrand (**J. J.**). Indberetning til det academiske Collegium ved det kongelige Frederiks Universitet, om astronomiske og geodetiske Observationer, anstillede paa en Reise i sondre Bergenhuu's og Stavangers Amter i Sommeren 1861.
Mag. f. Naturvid., XII, 1863, 1–11; XIII, 1864, 193–224.

——— Om astronomiske og geodetiske Observationer, anstillede paa en Reise i sondre Bergenhuu's og Stavangers Amter i Sommeren 1861.
8°, Christiania, 1863, pp. 78. (Paris, Observatory.)

——— Indberetning om astronomiske og geodetiske Observationer, anstillede paa en Reise i sondre Bergenhuu's Amt i Sommeren 1863.
8°, Christiania, 1864, pp. 32. (Gore.)

——— Geodætisk Bestemmelse af Bergens Observatoriums geografiske Beliggenhed.
8°, Christiania, 1874, pp. 22. (Paris, Observatory.)

Astron. Ges., Vierteljahrs., *for* Vierteljahrsschrift der astronomischen Gesellschaft.
8°, Leipzig, 1866+. (Washington, Observatory.)

Astron. Jahrb., *for* Astronomisches Jahrbuch.
8°, Berlin, 1776–'80 (Bode), 1781–1829.
Berliner astronomisches Jahrbuch (Encke), 1830–'43; 1844+. (Washington, Observatory.)

Astron. Nachr., *for* Astronomische Nachrichten.
4°, Altona, 1823+. (Washington, Observatory.)

Attanasio-Gatto (**Niccolo**). Nuovo apparato misuratore di basi geodetiche.
8°, n. d., pp. 7, 1 plate. (Gore.)

ATTRACTION, LOCAL.
ADAN (E.-H.-J.). Attractions locales.
Bruxelles, 1878; 1880.

ATTRACTION, LOCAL—Continued.

AIRY (G. B.). On the computation of the effect of the attraction of mountain masses.
Roy. Soc. London, Phil. Trans., CXLV, 1855, 101-104.

BAEYER (J. J.). Von einer Abweichung der Lothlinie in Königsberg.
Astron. Nachr., LVII, 1862, 347-352.

BAUERNFEIND (C. M.). . . . Lothablenkung.
K. bay. Ak. d. Wiss., math.-phys. Cl., Abhandl., XI, 1873, II, 1-40.

BENAZÉ (O.-D. DE). Recherche de la déviation . . . par suite de l'attraction qu'exercent sur lui la chaîne des Andes et . . .
Revue Marit., XXXIV, 1872, 388-402.

BOUGUER (P.). Sur la direction qu'affectent les fils à plomb.
Acad. d. Sci. Paris, Mém., 1754, 250-268.

CELORIA (M. E. G.). Sopra una deviazione sensibile dee filo a piombo esistente fra Milano e Genova.
Ist. Lomb., Rend., XVII, 1884, v, 1-44.

CLARKE (A. R.). Note on Pratt's paper on the effect of local attraction on the English arc.
Roy. Soc. London, Proc., IX, 1858, 496-497; Phil. Trans., CXLVIII, 1858, 787-789.

CRAWFORD (J. L.). On the deviations of the plumb line in the Island of Mauritius.
Dun Echt Obsy., Publications, III, 1885, 499-506.

FRESCOLM (S. W.). Deflection of the plumb-line at the Sayre Observatory.
Eng. Soc. Lehigh Univ., Journ., III, 1888, 82-86.

GALBRAITH (W.). . . . the effects of a supposed attraction at Calton Hill.
Edinb. Phil. Journ., XXX, 1841, 326-346.

GERMAIN. Observation de la déviation de la verticale sur les côtes sud de France.
Acad. d. Sci. Paris, Comp. Rend., CII, 1886, 1100-1103.

GOULD (B. A.). Remarques sur les attractions locales.
Acad. d. Sci. Paris, Comp. Rend., LXIX, 1869, 814-815.

GREENE (F. V.). Local deflection of the plumb-line near the 49th parallel.
Washington, 1876.

HELMERT (F. R.). Zur Berechnung der Loth-Ablenkung durch den Mond.
Astron. Nachr., XCI, 1877, 235-238.

——— Lothabweichungen.
Berlin, 1886.

——— Rapport sur les déviations de la verticale.
Int. Geod. Cong., Verhandl., 1887, I, 1-54.

HERSCHEL (J.). On the local deviation of the plumb-line from the vertical as affecting the accuracy of a trigonometrical survey.
Indian Eng. (Medley), I, 1864, 315-323.

HIRSCH (A.). Sur une déviation remarquable du fil à plomb, découverte à Moscou.
Soc. Sci. Nat. Neuchâtel, Bull., VI, 1861-'63, 319-325.

JAMES (H.). On the deflection of the plumb-line at Arthur's Seat.
Roy. Soc. London, Phil. Trans., CXLVI, 1856, 591-606.

KELLER (F.). Ricerche sull' attrazione delle montagne.
Roma, 1872.

MASKELYNE (N.). An account of observations made on Shehallien for finding its attraction.
Roy. Soc. London, Phil. Trans., LXV, 1775, 500-542; 495-499.

MOROZOWICZ (O. VON). Ueber Bremiker's Theorie der Lothablenkung.
Astron. Nachr., XC, 1877, 353-356.

NAGEL (A.). Lothungen und Lothungsapparate.
Civ.-Ing., XXIV, 1878, 621-664.

PECHMANN (E.). Die Abweichung der Lothlinie . . . und ihre Berechnung als Erforderniss einer Gradmessung.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Denkschr., XXII, 1864, I, 41-88; Sitz.-Ber., XLVII, 1863, II, 432-437.

ATTRACTION, LOCAL—Continued.

PETERS (C. A. F.). Von den kleinen Ablenkungen der Lothlinie, welche durch die Anziehungen der Sonne . . . hervorgebracht werden.
Astron. Nachr., XXII, 1844, 32-42.

PRATT (J. H.). On the attraction of the Himalaya Mountains . . . upon the plumb-line in India.
Roy. Soc. London, Phil. Trans., CXLV, 1855, 53-100; Proc., IX, 1858, 493-496; 701-702; Phil. Trans., 1859, 745-748.

——— On the effect of local attraction upon the plumb-line at stations on the English arc.
Roy. Soc. London, Phil. Trans., CXLVI, 1856, 31-52.

——— On the influence of the ocean on the plumb-line in India.
Roy. Soc. London, Proc., IX, 1858, 597-599.

——— Memorandum showing the effect of local attraction upon the operations of the trigonometrical survey of India.
Asiatic Soc., Journ., XXXI, 1862, 146-150.

——— On the effect of local attraction on geodetic operations.
Roy. Soc. London, Proc., 1864, 253-276.

——— On the degree of uncertainty which local attraction occasions in the mean figure of the earth.
Roy. Soc. London, Proc., XIII, 1863, 18-19; 253-276; Asiatic Soc. Journ., XXXIV, 1865, II, 34-42.

PRESTON (E. D.). Deflection of the plumb-line in the Hawaiian Islands.
Am. Journ. Sci., CXXXVI, 1888, 305-317.

SADEBECK (B. A. M.). Ueber den Einfluss der Lothablenkungen auf Winkelmessungen.
Astron. Nachr., XC, 1877, 113-118; XCI, 1877, 145-152.

SANTINI (G.). Relazione intorno alle attrazioni locali resultanti nei Mosca.
Ist. Veneto d. Sci., Mem., XII, 1864, 77-79.

SCHOTT (C. A.). Local deflections of the zenith in the vicinity of Washington.
U. S. C. and G. Survey, Rep., 1869, 113-115.

——— Comparison of local deflections of the plumb-line.
U. S. C. and G. Survey, Rep., 1879, 110-123.

SCHUBERT (T. F. de). Sur l'influence des attractions locales dans les opérations géodésiques.
Astron. Nachr., LII, 1860, 321-362.

SCHWEIZER (K. G.). Untersuchungen über die in der Nähe von Moscau stattfindenden Localattractionen.
Soc. Nat. Moscou, Bull., XXXVII, 1864, I, 96-171.

SHORTREDE (R.). . . . the disturbing attraction of the Himalayas.
Roy. Astron. Soc., Mem., XVII, 1849, 93-106.

STEBNITZKI (J.). Ueber die Ablenkung der Lothlinie durch die Anziehung der kaukasischen Berge.
Acad. de St.-Pétersbourg, Bull., XV, 1871, 232-245; Mél. Math., IV, 1871, 633-651.

STERNECK (R. von). Ueber . . . die Störung der Richtung der Lothlinie im Gebirge.
Wien, 1879.

STRUVE (O.) On a remarkable local deviation in the direction of gravity, lately observed in Russia.
Roy. Astron. Soc., Month. Not., XXIII, 1863, 185-188.

——— Note on a deviation of the plumb-line.
Roy. Astron. Soc., Month. Not., XXXVII, 1876-'77, 362.

WINTERBERG (C.). Ueber die Abweichungen des Lothes.
Astron. Nachr., XCI, 1877, 97-108; Civ.-Ing., XXVIII, 1882, 473-479; Arch. d. Math. (Grunert), LXV, 1880, 113-160.

WITTSTEIN (T.). Ueber die Ablenkung der Lothlinie in grössen Höhen.
Astron. Nachr., LXXIV, 1869, 251-254.

ZACH (F. X. von). L'attraction des montagnes et ses effets sur le fil à plomb.
Avignon, 1814.

ANON. Some plumb-line deflections in the Hawaiian Islands.
Science, 1888, 35.

ATTRACTION, SPHEROIDAL.

LEGENDRE (A.-M.). Mémoire sur l'attraction des ellipsoïdes homogènes.
Inst. de France, Mém. Cl. Math. Phys., 1810, II, 15–183; 1812, II, 1–5 (Hist.).

MACCULLAGH (J.). On a difficulty in the theory of the attraction of spheroids.
Roy. Irish Acad., Trans., XVII, 1837, 237–240; Proc., III, 1845–'47, 367–369; Trans., XXII, 1855, 379–395; L., E., D. Phil. Mag., III, 1833, 282–285.

POISSON (S.-D.). Mémoire sur l'attraction d'un ellipsoïde homogène.
Acad. d. Sci. Paris, Mém., XIII, 1835, 497–545; Conn. d. Temps, 1837, 93–102; Acad. d. Sci. Paris, Comp. Rend., VII, 1838, 3–5.

PRATT (J. H.). A treatise on attractions . . .
Cambridge, 1860–'71.

RODRIGUES. Mémoire sur l'attraction des sphéroïdes.
École Polytech., Corr., III, 1814–'16, 361–385.

STOKES (G. G.). On attractions.
Camb.-Dub. Math. Journ., IV, 1849, 194–219.

TODHUNTER (I.). A history of the mathematical theories of attraction . . .
London, 1873.

YOUNG (T.). Calculation of the direct attraction of a spheroid.
Journ. Nat. Phil. (Nicholson), XX, 1808, 114–117.

YVON-VILLARCEAU (A.-J.-F.).

ZÜGE (E. H.). Ueber die Anziehung eines homogenen Ellipsoids.
8°, Halle, 1875.

Aubuisson (C. d'): Laussedat (A.). Sur la méthode employée par — en 1810 pour la mesure des bases géodésiques.
Acad. d. Sci. Paris, Comp. Rend., XCI, 1880, 922–923; Ann. d. Mines, IX, 1881.

Augustin. [Ueber die Triangulirung im Wiener Parallel.]
Mon. Corr. (Zach), XXVII, 1813, 379–382, 571–575.

Ausland, *for* Das Ausland.
4°, Stuttgart, 1829+.

AUSTRIA.

BINNENTHAL. Instruction für die bey der k. k. österreich. Landes-Vermessung angestellten Officiere.
Wien, 1810.

—— Instruction für die im Calculs-Büreau der k. k. österreichischen Landes Vermessung angestellten Officiere.
Wien, 1810.

—— Trigonometrische Vermessung in der österreichischen Monarchie.
Mon. Corr. (Zach), XXV, 1812, 37–57, 121–139, 232–249.

GANAHL. Bericht über die geodätischen Arbeiten in Oesterreich Ungarn.
Int. Geod. Cong., Gen.-Ber., 1871, 33–38; 1872, 16–17; 1873, 7–10; 1874, 67–71; 1875, 181–189; 1876, 106–113; 1877, 208–209, 294–298.

—— Die astronomisch-geodätischen Arbeiten des k. k. militär-geographischen Institutes.
4 vols., Wien, 1871–'76.

HARTL (H.). Bericht über die Leistung des . . . geographischen Institutes.
Int. Geod. Cong., Verhandl., 1884–'86, 154–177.

—— Materialien zur Geschichte der astronomisch-trigonometrischen Vermessung der österreichisch-ungarischen Monarchie.
K. k. militär-geogr. Inst., Mittheil., VII, 1887, 117–228.

HELDENFELD (A. M.). Neues astronomisch-trigonometrisches Netz über die ganze österreichische Monarchie.
Mon. Corr. (Zach), XV, 1807, 461–467; XVIII, 1808, 17–33.

AUSTRIA—Continued.

KALMÁR (A.). Bericht über die für Zwecke der europäischen Gradmessung in Oesterreich ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1879, 98–101; 1880, 23–29; 1881–'82, 91–111; 1883, 261–269; 1884–'86, 154–177; 1887, VII, 1–18.

KREIL (K.). Observations géodésiques faites en Autriche.
Acad. de Belgique, Bull., XIV, 1847, I, 286–291; XVI, 1849, I, 329–333.

LITTROW (K. L. VON). Bericht über die österreichisch-russische Verbindungs-Triangulation.
K. k. Ak. d. Wiss. naturwiss. Cl., Sitz.-Ber., IX, 1852, 912–915; Denkschr., V, 1853, 111–128.

OPPOLZER (T. VON). Rapport sur les travaux géodésiques en Autriche.
Int. Geod. Cong., Gen.-Ber., 1874, 58–62; 1878, 91–96; 1879, 97–98; 1880, 23; 1881–'82, 89–90; 1883, 261; 1884–'86, 151–153.

SEDLACZEK (E.). Mittheilungen des k. k. militär-geographischen Institutes.
Wien, 1881.

WANKA VON LENZENHEIM (J.).
Mittheilungen des k. k. militär-geogr. Institutes. III, Wien, 1883.

ZACH (F. X. VON). Oesterreich'sche Gradmessung.
Mon. Corr. (Zach), XXIII, 1811, 151–168.

Austria. Mittheilungen des kaiserl. königl. militär-geographischen Institutes. Herausgegeben auf Befehl des k. k. Reichs-Kriegs-Ministeriums.
8°, 7 vols., Wien, 1881–'87. Im Selbstverlage.

Auzout (Adrien). Mesures prises sur les originaux et comparées avec le pied du Chastelet de Paris.
Divers ouvrages de math. et phys. par messieurs de l'Acad. Roy. des Sci. Paris, 1693, 368–370.

Avila (A.-J. d'). Rapport sur l'état actuel des travaux géodésiques en Portugal.
Int. Geod. Cong., Verhandl., 1884–'86, 183–186.

—— Rapport sur les travaux géodésiques accomplis en Portugal en 1887.
Int. Geod. Cong., Verhandl., 1887, IX, 1–3.

Avout (Baron d'). Mémoire sur la figure de la terre.
8°, Paris, 1852, pp. 66, 1 plate.
This name is sometimes written D'AVOUST.

B. Ueber die Längen-Gradmessung zwischen dem Tour de Cordorian und Fiume, im Parallel des 45sten Grades von **Brousseaud, Nicollet, Plana, Carlini.**
Hertha, IX, 1827, 277–288; XI, 1828, 448–456.

B. (B.). The Coast Survey. Reply to the official defense of its cost, abuses, and power.
8°, n. d., pp. 36. (Gore.)
A letter addressed to the editor of the New York Times in answer to "Public Documents."

Babinet (Jacques): Guyot (J.). Le pendule n'est pas perpendiculaire à la surface des eaux tranquilles; par —.
Acad. d. Sci. Paris, Comp. Rend., XXXII, 1851, 705; Cosmos, II, 1853, 447.

—— Note sur le rayon moyen de la terre.
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 121–124.

—— Sur la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 732–735.

—— Appareil pour la mesure statique de la pesanteur.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 244–248.

Babinet (**Jacques**): **Guyot** (**J.**)—Continued.
Note sur le calcul de l'expérience de Cavendish, relative à la masse et à la densité moyenne de la terre.
Cosmos, XXIV, 1864, 543–545.

Bacaloglo (**E.**). [Ueber den sphärischen Excess.]
Arch. d. Math. (Grunert), XXXIX, 1862, 237–241; Mondes, III, 1863, 94–96.

——— Quelques observations relatives à la direction de la verticale à différentes hauteurs au-dessus du sol.
Arch. d. Math. (Grunert), XLII, 1864, 271–275.

Bache (**Alexander Dallas**). A description of a base apparatus, planned by him and executed by Mr. Wm. Würdeman, mechanician of the Coast Survey.
Am. Phil. Soc., Proc., IV, 1847, 368–370.

——— Survey of the coast of the United States.
Sidereal Messenger, I, 1848, 98–99.

——— United States Coast Survey.
Sidereal Messenger, II, 1848, 55–56.

——— Comparison of the results obtained in geodesy by the application of the theory of least squares.
A. A. A. S., Proc., 1849, 102–105.

——— On the progress of the survey of the coast of the United States.
A. A. A. S., Proc., 1849, 162–178.

——— Report of Prof. Alexander D. Bache, superintendent of the United States Coast Survey, showing the progress of work for the year ending Oct., 1850.
Am. Jour. Sci., XII, 1851, 158–164.
A short review of the work of that year.

——— Comparison of the reduction of horizontal angles by the methods of "dependent directions" and of "dependent angular quantities" by the method of least squares.
U. S. C. and G. Survey, Rep., 1854, 63–70.

——— Notes on the measurement of the base for the primary triangulation of the eastern section of the coast of the United States, on Epping Plains, Maine.
A. A. A. S., Proc., 1857, 160–166; Am. Jour. Sci., XXV, 1857, 58–62.

——— Epping Base, Maine.
U. S. C. and G. Survey, Rep., 1857, 302–305.
Note on the preparation of site, measurement of line, and progress, as compared with other measurements of the Coast Survey.

——— Notes on the measurement of a base for the primary triangulation of the eastern section of the United States, on Epping Plains, Maine. (Abstract from a paper read before the American Association for the Advancement of Science.)
Canadian Journ., III, 1858, 74–75.

Bachoven von Echt. Die kürzeste auf dem Erdsphäroid nebst die Hauptaufgaben der Geodäsie in neuer Darstellung.
8°, Coesfeld, 1865, pp. i, 137. (British Museum.)

Backeljau (**F.**). Éléments pratiques d'arpentage, géodésie, nivellement.
8°, Gand, 1884, pp. 198, 6 plates. (Brussels, Royal.)

Baeyer (**Johann Jacob**) *und* **Bessel** (**F. W.**). Gradmessung in Ostpreussen.
Berlin, 1838.
Title in full under BESSEL (F. W.).

Baeyer (**Johann Jacob**)—Continued.
——— Die Küstenvermessung und ihre Verbindung mit der Berliner Grundlinie. Ausgeführt von der trigonometrischen Abtheilung des Generalstabes.
Berlin, 1849, pp. xx, 587, 1 map, 2 pl. (Gore.)

——— Ueber die Anfertigung einiger Copien von der Bessel'schen Toise.
Astron. Nachr., XXXVIII, 1854, 273–288.

——— Die Verbindungen der preussischen und russischen Dreiecksketten bei Thorn und Tarnowitz. Ausgeführt von der trigonometrischen Abtheilung des Generalstabes.
4°, Berlin, 1857, pp. xvi, 442, 4 plates. (Gore.)

——— Ueber die Beziehungen der Strahlenbrechung in der Atmosphäre zu der Witterung und über den Zusammenhang einer Landesvermessung mit der Meteorologie.
Arch. f. Landeskunde, V, 1858, 1–40.

——— Die Triangulation von Thüringen. Ausgeführt in den Jahren 1851 bis 1855 von der trigonometrischen Abtheilung des königl. preussischen Generalstabes.
4°, Berlin, 1859, pp. VI, 183, 6 plates, 1 chart. (Berlin, Landesaufnahme.)

——— Ueber Strahlenbrechung in der Atmosphäre.
Acad. d. St.-Pétersbourg, Mém., III, 1860, 1–82; Astron. Nachr., XLI, 1855, 305–336.

——— Ueber die Grösse und Figur der Erde. Eine Denkschrift zur Begründung einer mitteleuropäischen Gradmessung, nebst einer Uebersichtskarte von **J. J. Baeyer.**
8°, Berlin, *Reimer*, 1861, pp. vi, 111. (Gore.)
Revd. by BERTRAND (J.). Journ. d. Sav., 1874, 697–719.

——— Das Messen auf der sphäroidischen Erdoberfläche. Als Erläuterung meines Entwurfes zu einer mitteleuropäischen Gradmessung.
4°, Berlin, 1862, pp. viii, 125, 3 plates. (Gore.)
A correction in Astron. Nachr., LX, 1863, 129–136.

——— [Von einer Abweichung der Lothlinie in Königsberg.]
Astron. Nachr., LVII, 1862, 347–352.

——— Zur Entstehungsgeschichte der europäischen Gradmessung. Entwurf zu einer mitteleuropäischen Gradmessung.
4°, Berlin, 1862, pp. 13. (Gore.)

——— Ueber einige Verbesserungen in meiner Schrift: "Das Messen auf der sphäroidischen Erdoberfläche. Berlin, 1862."
Astron. Nachr., LX, 1863, 129–136.

——— Ueber die Auflösung grosser sphäroidischen Dreiecke.
Astron. Nachr., LXI, 1863, 225–240.

——— Notizen über einige Erscheinungen, welche der Aufmerksamkeit der Herren Bevollmächtigten zur gelegentlichen weitern Beobachtung empfohlen worden.
Int. Geod. Cong., Gen.-Ber., 1863, 35–38.
Regarding the best time to use the heliotrope and the twist of a wooden theodolite support. Reprinted in part in Rep. f. phys. Tech. (Carl), I, 1866, 167–170.

——— Ueber die sphärische Berechnung sphäroidischer Dreiecke.
Int. Geod. Cong., Gen.-Ber., 1864, 49–62.

Baeyer (Johann Jacob)—Continued.

——— Bericht über den Stand der Organisation des Centralbüreaus, und über die im Jahre 1856 ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1865, 29.

——— Die königl. preussische Landestriangulation. Hauptdreiecke. Erster Theil. Hauptdreiecke in der Provinz Preussen, an der Weichsel und östlich davon. Berlin, 1866.
Astron. Nachr., LXVIII, 1865, 81–88.
Notice of the above by —.

——— Bericht über die Thätigkeit des Centralbüreaus im Jahre 1866.
Int. Geod. Cong., Gen.-Ber., 1866, 26–27.

——— Die Veränderungen, welche Massstäbe von Eisen und von Zink in Bezug auf ihre Länge und auf ihren Ausdehnungs-Coefficienten mit der Zeit erleiden.
Int. Geod. Cong., Gen.-Ber., 1866, 34–41.

——— Ueber den gegenwärtigen Stand der Gradmessung.*
Geogr. Jahrb. (Behm), 1866, 338 +.
Containing a résumé of the various determinations of the dimensions of the earth.

——— Bericht über die Organisation des Central-Büreaus und die seit 1864 ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1867, 16–22.

——— Die königlich preussische Landestriangulation.
Astron. Nachr., LXIX, 1867, 1–4.

——— [Ueber die Veränderungen, welche Maassstäbe von Eisen und von Zink in Bezug auf ihre Länge und auf ihren Ausdehnungs-Coefficienten mit der Zeit erleiden.]
K. Ak. d. Wiss., Berlin, Monatsber., 1867, 1–13; 1872, 560–562.

——— Bericht über die Fortschritte der Gradmessungs-Arbeiten in Spitzbergen und Chile.*
Geogr. Jahrb. (Behm). II, 1868.

———: **Hansen (P. A.)**. Gegenbericht an die permanente Commission der europäischen Gradmessung. Auf Veranlassung des Berichts des General —.
Gotha, 1868.
Title in full under HANSEN (P. A.).

——— Entwurf zur Anfertigung einer Karte von den östlichen Provinzen des preuss. Staates nach dem heutigen Standpunkt der Wissenschaft und Technik.
8°, Berlin, 1868, pp. x, 77.
This first appeared in part in Arch. f. Landeskunde, II, 1856.

——— Ueber die Berechnung sphäroidischer Dreiecke und den Lauf des geodätischen Linie.
Astron. Nachr., LXXI, 1868, 289–314.

———, **Bruhns (C.), Sadebeck (B. A. M.), Bremiker, Börsch, Wittstein.** Bericht über die Thätigkeit des geodätischen Instituts und des internationalen Centralbüreaus.
Int. Geod. Cong., Gen.-Ber., 1869, 23–58.

———, **Sadebeck, Bremiker, Wittstein, Voit, Peters (C. F. W.)**. Bericht über die von dem geodätischen Institut und dem internationalen Centralbüreau ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1870, 30–58.

Baeyer (Johann Jacob)—Continued.

——— Bericht über die Fortschritte der Gradmessungen.
Geogr. Jahrb. (Behm), III, 1870, 152–172.

——— Wissenschaftliche Begründung der Rechnungsmethoden des Central-Büreaus der europäischen Gradmessung. (Als Manuscript gedruckt.)
I. Methode der kleinsten Quadrate, Anwendung derselben auf die Geodäsie. 4°, Berlin, n. d., pp. 73.
II. Allgemeine Auflösung der sphäroidischen Dreiecke. Reduction der Winkel eines sphäroidischen Dreiecks auf die eines ebenen oder sphärischen von gleichen Seiten (von Weingarten). Nebst Beispielen von Baeyer und Sadebeck und einer Tabelle der Gaussischen Krümmungsmaasse von Sadebeck. 4°, Berlin, 1870, pp. iv, 76.
III. Ausgleichung eines geometrischen Nivellements. (Berlin, Geodetic Institute.)

——— Ausgleichung eines Dreiecksnetzes nach der Bessel'schen Methode und Aufklärung einiger gegen dieselbe erhobenen Bedenken.
4°, Berlin, 1871, pp. 17. (Berlin, Royal.)

——— Bericht über die Thätigkeit des geodätischen Institutes und des internationalen Centralbüreaus seit der zweiten allgemeinen Conferenz.
Int. Geod. Cong., Gen.-Ber., 1871, 11–24.

——— Ueber die Vertheilung der Fehler nach Winkelgleichung und nach Seitengleichungen.
4°, Berlin, 1871, pp. 3.

———, **Sadebeck (B. A. M.)** *und* **Bremiker.** Bericht des Centralbüreaus der europäischen Gradmessung (1872).
Int. Geod. Cong., Gen.-Ber., 1872, 22–53.

——— Bericht über die neuesten Fortschritte der europäischen Gradmessungen und die im Jahre 1871 in Wien stattgehabte Conferenz.
Geogr. Jahrb. (Behm), IV, 1872, 1–16.

——— Massvergleichungen. 1. Heft. Die in den Jahren 1866 und 1867 ausgeführten Vergleichungen mit der Copie No. 10 der Bessel'schen Toise, derselben, die früher bereits in Pulkowa und Southampton mit russischen und englischen Maassen verglichen worden war.
4°, Berlin, 1872, pp. viii, 49. (Berlin, Geodetic Institute.)
Herausgegeben von dem Centralbüreau der europäischen Gradmessung.

———, **Morozowicz (von), Sadebeck (B. A. M.), Bremiker.** Bericht des geodätischen Institutes resp. des Centralbüreaus der europäischen Gradmessung (1873).
Int. Geod. Cong., Gen.-Ber., 1873, 14–29.

——— Ueber die Thätigkeit des geodätischen Instituts resp. des Centralbüreaus der europäischen Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1874, 15–23.

——— Rapport du Bureau central et de l'Institut géodésique de Berlin sur les travaux exécutés pendant l'été de 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 7–10, 45–48.

———, **Bruhns, Oppolzer, Peters (C. A. F.)**. Gutachten der Pendel-Commission.
Int. Geod. Cong., Gen.-Ber., 1875, 78–79, 90–101.

Baeyer (Johann Jacob)—Continued.

——— Bericht des Centralbüreaus resp. geodätischen Institutes über die im Sommer 1875 ausgeführten Arbeiten.

Int. Geod. Cong., Gen.-Ber., 1875, 205–212.

——— Maassvergleichungen. 2. Heft. Beobachtungen auf den Steinheil'schen Fühlspiegel-Comparator.

4°, Berlin, 1876, pp. xii, 96, 1 plate. Publication des königl. preuss. geodätischen Institutes. (Berlin, Geodetic Institute.)

——— Rapport du Bureau central et de l'Institut géodésique sur les travaux accomplis en 1876.

Int. Geod. Cong., Gen.-Ber., 1876, 8–13; 36–43.

——— Bericht über die geodätischen Arbeiten in Baden für das Jahr 1876.

Int. Geod. Cong., Gen.-Ber., 1876, 71.

——— Bericht des Centralbüreaus resp. des geodätischen Instituts für das Jahr 1877.

Int. Geod. Cong., Gen.-Ber., 1877, 12–18; 92–98.

——— Ueber die Bessel'sche Methode. Zerlegung eines Dreiecksnetzes nach Gruppen. Verbindung der Gruppen unter einander.

Int. Geod. Cong., Gen.-Ber., 1877, 203–207.

——— Bericht über die geodätischen Arbeiten in Baden für das Jahr 1877.

Int. Geod. Cong., Gen.-Ber., 1877, 259.

——— Bericht des Central-Büreaus [for 1878].

Int. Geod. Cong., Gen.-Ber., 1878, 10–14.

——— Bericht an die permanente Commission über die Gründung eines Observatoriums zur Erforschung der terrestrischen Refraction.

Int. Geod. Cong., Gen. Ber., 1878, 23–26.

———, **Sadebeck, Albrecht, Fischer.** Bericht über die Arbeiten des preussischen geodätischen Institutes für das Jahr 1878.

Int. Geod. Cong., Gen.-Ber., 1878, 99–104.

——— Bericht über die geodätischen Arbeiten in Baden für das Jahr 1879.

Int. Geod. Cong., Gen.-Ber., 1879, 73.

———, **Sadebeck (B. A. M.), Fischer.** Bericht über die Arbeiten des preussischen geodätischen Institutes für das Jahr 1879.

Int. Geod. Cong., Gen.-Ber., 1879, 102–109.

——— Vergleichung einiger Hauptdreiecksketten der königlichen Landestriangulation mit der Bessel'schen Methode. Als Manuscript gedruckt.

4°, Berlin, 1879, pp. 12. (Brussels, Cartographic Institute.)

——— Verhandlungen des wissenschaftlichen Beiraths des königlichen geodätischen Instituts zu Berlin, 1878–'85.

8 vols., 4°, Berlin, 1879–'85.

——— Bericht über die geodätischen Arbeiten in Baden für das Jahr 1880.

Int. Geod. Cong., Gen.-Ber., 1880, 3.

——— Bericht des Centralbüreaus resp. des geodätischen Instituts (für das Jahr 1880).

Int. Geod. Cong., Gen.-Ber., 1880, 15–19.

———, **Sadebeck, Fischer.** Bericht über die Arbeiten des preussischen geodätischen Instituts für das Jahr 1880.

Int. Geod. Cong., Gen.-Ber., 1880, 29–35.

Baeyer (Johann Jacob)—Continued.

——— Antwort auf einen Brief von Förster.

Int. Geod. Cong., Gen.-Ber., 1880, 50–53.

Regarding the lengths of the standard toises.

——— (*Präsident.*) Voten der Mitglieder des wissenschaftlichen Beirathes des königlichen geodätischen Instituts über die Frage: Ob die von der königlichen Landestriangulation im Jahre 1870 publicirten Dreiecks-Messungen und Berechnungen (Haupt-Dreiecke, 1. Theil) als preussische Gradmessungs-Arbeiten angesehen werden können? und Bemerkungen des Präsidenten des geodätischen Instituts.

4°, Berlin, 1880, pp. 16. (Berlin, Geodetic Institute.)

———, **Sadebeck, Börsch, Albrecht, Fischer.** Bericht über die Arbeiten des preussischen geodätischen Instituts für die Jahre 1881 und 1882.

Int. Geod. Cong., Gen-Ber., 1881–'82, 113–123.

——— Bericht des Centralbüreaus resp. des geodätischen Instituts (für das Jahr 1883).

Int. Geod. Cong., Gen.-Ber., 1883, 20–24; 134–137.

———, **Fischer, Löw.** Bericht über die geodätischen Arbeiten in Preussen für das Jahr 1883.

Int. Geod. Cong., Gen.-Ber., 1883, 270–277.

———: **Helmert (F. R.).** Uebersicht der Arbeiten des königl. geodätischen Instituts unter —.

Berlin, 1886.

Revd. in Zeits. f. Vermes., XV, 1886, 497–506.

Title in full under HELMERT (F. R.).

Baille (J.) *et* **Cornu (A.).** Détermination de l'attraction et la densité de la terre.

Acad. d. Sci. Paris, Comp. Rend., LXXVI, 1873, 954–958.

——— *et* ——— Sur la mesure de la densité de la terre.

Acad. d. Sci. Paris, Comp. Rend., LXXXVI, 1878, 699–702; Ann. d. Phys. (Poggendorff), II, 1878, 453–455.

——— *et* ——— Analyse de l'influence perturbatrice des termes proportionnels au carré des écarts du levier de la balance de torsion.

Acad. d. Sci. Paris, Comp. Rend., LXXXVI, 1878, 1001.

Bailly (Jean-Sylvain). Histoire de l'astronomie ancienne et moderne de J.-S. Bailly. Dans laquelle on a conservé littéralement le texte historique de l'auteur, en supprimant les détails scientifiques, les calculs abstraits, les notes hypothétiques, peu utiles à beaucoup de lecteurs, et aux élèves auxquels ce livre est spécialement destiné.

12°, Paris, 1805, pp. xlviii, 371; 495. (Gore.)

Mesure de la terre et des voyages entrepris en France pour les progrès de l'astronomie, II, 255–275.

——— Histoire de l'astronomie moderne depuis la fondation de l'ecole d'Alexandrie jusqu'à l'époque de MDCCXXX. Par M. Bailly.

Nouvelle édition, 3 vols., 4°, Paris, 1785.

De la mesure de la terre par les anciens, et de leurs mesures itinéraires, I, 143–168; de la mesure de la terre, II, 337–376.

———: **Vorion.** Histoire de l'astronomie, depuis 1781 jusqu'en 1811 pour servir de suite à l'histoire de l'astronomie de —.

4°, Paris, 1810, pp. ix, 383.

Baily (Francis): **Cagnoli (A.)**. Method of ascertaining the figure of the earth. Translated by —.
From: Mem. Soc. Italiana, VI, 1792, 227–235. Phil. Mag. (Tilloch), LIII, 1819, 350–360; 406–416.

—— Short accounts of two invariable pendulums, the one of iron and the other of copper.
Roy. Astron. Soc., Month. Not., I, 1827–'30, 78–80.

—— On the discordancies in the results of the methods for determining the length of the simple pendulum.
Phil. Mag. (Taylor), V, 1829, 97–104.

—— On the correction of a pendulum for the reduction to a vacuum; together with remarks on some anomalies observed in pendulum experiments.
Roy. Soc. London, Phil. Trans., 1832, 399–492.

—— Report on Captain Foster's pendulum experiments.
Roy. Astron. Soc., Month. Not., III, 1833–'36, 1–3.

—— Report on the new standard scale of the society.
Roy. Astron. Soc., Month. Not., III, 1833–'36, 179–183.

—— A report on the experiments made by the late Captain Henry Foster, R. N., with the pendulums taken out by him in his scientific voyage, in the years 1828–'31, with a view to determine the figure of the earth.
Roy. Astron. Soc., Mem., VII, 1834, pp. VI, 1–378.

—— Report on the new standard scale of this society. A short history of the standard measures of this country.
Roy. Astron. Soc., Mem., IX, 1836, 35–184.

—— An account of some experiments on two new invariable pendulums.
Roy. Astron. Soc., Month. Not., IV, 1836–'39, 141–143; V, 1839–'43, 63–64.

—— On the repetition of the Cavendish experiments for determining the mean density of the earth.
Roy. Astron. Soc., Month. Not., IV, 1836–'39, 96–97.

—— An account of some experiments made in London, and at two stations on the river Euphrates, with the two pendulums belonging to this society, and with one of Kater's invariable pendulums.
Roy. Astron. Soc., Mem., XII, 1842, 61–81.

—— An account of some experiments made in London, and at the Cape of Good Hope, with one of Kater's invariable pendulums.
Roy. Astron. Soc., Mem., XII, 1842, 83–101; Month. Not., V, 1839–'43, 63–64.

—— An account of some experiments with the torsion-rod for determining the mean density of the earth.
Roy. Astron. Soc., Month. Not., V, 1839–'43, 188–206; Mem., XIV, 1843, 1–5; Ann. de Chim., V, 1842, 338–353; Bibl. Univ. Genève, XLIII, 177–181; L., E., D. Phil. Mag., XXI, 1842, 111–121; Ann. d. Phys. (Poggendorff), LVII, 1842, 453–467.

—— [Determination of the density of the earth.]
Roy. Astron. Soc., Month. Not., VI, 1843–'45, 107–101.

——: **Cornu (A.)**. Correction probable du résultat de —.
Acad. d. Sci. Paris, Comp. Rend., LXXXVI, 1878, 699.

Bailey (W.). Cape of Good Hope. Report on the trigonometrical survey of a portion of the colony and British Kaffraria. Presented to both houses of parliament by command of His Excellency the Governor.
Fol., Cape Town, 1863, pp. 70, lxxi, ccxxi.

Bakhuyzen (H. G. van de Sande). *See* **Sande-Bakhuyzen (H. G. van de)**.

Bald (William). An account of a trigonometrical survey of Mayo, one of the maritime counties of Ireland.
Roy. Irish Acad., Trans., XIV, 1825, 39–50.

Bangma (Obbe Sikkes). Verhandeling over de regtlijnige en klootsche driehoeksmeting.
8°, Amsterdam, 1808, pp. vi, 126, 1 plate. (British Museum.)

—— Verhandeling over de klootsche driehoeken, waarin onderzocht en aangetoond wordt, in hoe verre men, door drie bekende termen eens klootschen driehoeks, over het stomp of scherp zijn der onbekende termen oordeelen kan.
8°, Amsterdam, 1817, pp. 35.

Barfuss (Friedrich Wilhelm). Handbuch der höheren und niederen Messkunde, oder gründliche Unterweisung in der gewöhnlichen Feldmesskunst, sowie zu grösseren geodätischen Aufnahmen, zu geographischen Triangulirungen, barometrischen Höhenmessungen, zu Nivellements und zur Instrumentenlehre. Nach dem neuesten Standpunkte der Wissenschaft bearbeitet.
8°, Weimar, 1842, pp. xxvi, 467, 14 folio plates. (Gore.)

Bariola (P.) Calcolo supplementare affine di aggiungere un' altra condizione al calcolo già eseguito per la parte meridionale della rete di primo ordine di Sicilia sulla zona meridiana di Capo Passero a Patte.
Int. Geod. Cong., Gen.-Ber., 1870, 11–25.

Barnard (Frederick Augustus Porter) *and* **Tresca (H.)**. Comparison of metres. Iron metre forwarded to France by the Government of the United States.
U. S. C. and G. Survey, Rep., 1867, 134–137.

—— The metric system of weights and measures.
8°, New York, 1872, pp. 194. (Berlin, Geodetic Institute.)
Geodetic operations, 94–103.

Barocio (Francisco). Heronis mechanici liber de machinis bellicis necnon liber de geodæsia.
8°, Venetiis, 1572, pp. [iv], 74.

Barra (François-Xavier). Essai sur une nouvelle méthode géodésique pour faire sur le papier les projets de canaux.
Journ. Génie Civ., IX, 1830, 266–294.

Barraquer (Joaquin M.) y Cabello (Francisco). Memoria sobre la compensacion general de los errores de la red geodésica de España por —. Publicada, de órden del Gobierno de la República, por el Instituto geográfico y estadístico.
8°, Madrid, 1874, pp. 58, 2 charts.

—— Informe sobre la compensacion, por trozos, de los errores angulares de la red geodesica de España.*
Madrid, 1878.

Barraquer (J.-M.) *et* **Perrier (F.)**. Jonction géodésique de l'Algérie avec l'Espagne.
Int. Geod. Cong., Gen.-Ber., 1880, 47-53.

——— Discurso sobre la significacion geodésica de los observaciones con el péndulo de inversion.*
Madrid, 1881.

——— *et* **Ibañez (C.)** Rapport sur les travaux géodésiques (Espagne).
Int. Geod. Cong., Gen.-Ber., 1881-'82, 134-141.

——— Noticia de los primeros experimentos hechos en España con el péndulo de inversion.*
Madrid, 1882.

Barraquer y Rovira (Joaquin). Estudios experimentales en que se funda la equacion del metro de platino definido por trazos de la comision permanente de pesas y medidas.
Spain, Mem. del Inst. Geogr. y Estadístico, IV, 1883, 1-96.

——— Rapport sur la mesure de la pesanteur.
Int. Geod. Cong., Gen.-Ber., 1883, 286-289.

Barrozzi (Capitaneanu). [Rapport sur les travaux géodésiques en Roumanie pendant l'année 1874.]
Int. Geod. Cong., Gen.-Ber., 1874, 74-75.

——— Rapport sur les travaux géodésiques en Roumanie en 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 212-213.

——— Rapports présentés à la commission internationale de la mesure des degrés, sur les travaux du dépôt général de la guerre de Roumanie en 1882.
4°, Berlin, 1883.
Int. Geod. Cong., Gen.-Ber., 1881-'82, 123-125.

Barrow (John): **Maclear (T.)**. Observations made for the verification of the amplitude made of de Lacaille's arc of the meridian. Communicated by —.
Roy. Soc. London, Proc., IV, 1839, 192-193; Roy. Astron. Soc., Month. Not., V, 1839-'43, 45-50.

Bartlett (W. H. C.). Elements of natural philosophy. IV. Spherical astronomy. Fifth edition.
8°, New York, n. d., pp. vii, 465.
Shape and dimensions of the earth, 310-313.

BASE APPARATUS.

ATTANASIO-GATTO (N.). Nuovo apparato misuratore di basi geodetiche. N. d.

BACHE (A. D.). Description of a base apparatus.
Am. Phil. Soc., Proc., IV, 1847, 368-370.

BOUTELLE (C. O.). Primary base apparatus.
U. S. C. and G. Survey, Rep., 1855, 264-267.

BREEN (H.). Base-line apparatus.
Van Nostrand's Mag., XXVII, 1882, 89-98.

BRUHNS (C.). Mittheilung . . . über die Construction eines Basisapparates.
K. sächs. Ges. d. Wiss., math.-phys. Cl., 1872, 352-369.

EVEREST (G.). On the compensating measuring apparatus of the trigonometrical survey of India.
Asiatic Researches, XVIII, 1833, ii, 189-214.

FAYE (H.-A.-E.-H.). Nouvel appareil pour mesurer les bases géodésiques.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 372-380.

GELPKE (O.). Beschreibung eines neuen Basismessapparates.
Civil-Ing., XVIII, 1872, 465-479.

HANER. Basisapparat.
Eisenbahn, XIV, 1882, 19.

BASE APPARATUS—Continued.

HILGARD (J. E.). Description of base apparatus for measuring subsidiary lines.
U. S. C. and G. Survey, Rep., 1857, 395-398; 1862, 248-255.

——— An account of a perfected form of the contact-slide base apparatus.
U. S. C. and G. Survey, Rep., 1880, 341-344.

HUNT (E. B.). Description of base-measuring apparatus as used in the Coast Survey.
U. S. C. and G. Survey, Rep., 1854, 103-108; 1873, 132-136.

IBAÑEZ (C.). Experiencias hechas con el apparato de medir del bases.
Madrid, 1859.

KERSCHBAUM (G.). Basis-Apparat mit Eis-Temperatur.
Zeits. f. Vermes., XIV, 1885, 251.

KOPPE (C.). Der Basisapparat des General Ibañez.
Nordhausen, 1881.

LAUSSEDAT (A.). Expériences faites avec l'appareil à mesurer les bases . . .
Paris, 1860.

PORRO (I.). Nouvel appareil destiné à la mesure des bases trigonométriques.
Acad. d. Sci. Paris, Comp. Rend., XXIX, 1849, 666; XXX, 1850, 550; XXXI, 1850, 232-247; Revista Cien. Fis. Madrid, I, 1850, 192-202, 317-321; III, 1853, 336-345.

REISSIG (C. VON). Der Apparat zur Messung einer Basis.
St. Petersburg, 1823.

REITZ (F. H.). Apparat zum Messen von Grundlinien.
Zeits. f. Vermes., X, 1881, 233-237.

REPSOLD (A.). Beschreibung eines Basis-Mess-Apparates.
Hamburg, 1869.

SCHOTT (C. A.). Description and construction of a new compensation base apparatus.
U. S. C. and G. Survey, Rep., 1882, 107-138.

SCHUMACHER (H. C.). Skrivelse . . . over det Apparat han har anvendt til Malingen af Standlinien ved Brak i Aaret.
Altona, 1821.

SECCHI (A.). Descrizione degli istrumenti adoperati nella misura della base romana sulla via Appia.
Corr. Sci., IV, 1856, 171-188.

TISSOT (A.). Notice sur l'appareil . . . pour la mesure des bases.
Paris, n. d.

WESTPHAL (A.). Der Basisapparat des General Ibañez und sein Verhältniss zum älteren spanischen Apparat.
Zeits. f. Instrumentenkunde, I, 1881, 173-183.

——— Basisapparate und Basismessungen.
Zeits. f. Instrumentenkunde, V, 1885, 257-274, 333-345, 373-385, 420-432; VIII, 1888, 189-236, 337-346.

WIEGAND (A.). Der geodätische Messapparat.
Halle, 1848.

ANON. Subsidiary base apparatus.
U. S. C. and G. Survey, Rep., 1856, 308-310.

BASE MEASURING.

BACHE (A. D.). Notes on the measurement of the Epping base.
A. A. A. S., Proc., 1857, 160-166; U. S. C. and G. Survey, Rep., 1857, 302-305; Canadian Journ., III, 1858, 74-75.

BASEVI (J. P.). Practical errors of the measurement of the Cape Comorin base.
India, Trig. Survey, I, 1870, 52-60.

BOUQUET DE LA GRYE. Note sur l'usage du cercle méridien de Brunner et sur son emploi dans la mesure des bases.
Ann. Hydrog., XVI, 1859, 151-160.

BREMIKER (C.). Das rheinische Dreiecksnetz. Die Bonner Basis.
Berlin, 1876.

BRUHNS (C.). Die Grossenhainer Grundlinie.
Berlin, 1882.

BASE MEASUIRNG—Continued.

DAVIDSON (G.). Report of the measurement of the Yolo base.
U. S. C. and G. Survey, Rep., 1882, 139–149; 1883, 273–288.

DUFOUR (G.-H.). Notice sur la mesure de la base d'Arberg en Suisse.
Bibl. Univ. Genève, LVII, 1834, 372–385.

ECKHARDT (C. L. P.). Messung einer Basis mit Platinastäben.
Cor. Astron. (Zach), XXIII, 1811, 507–509.

—— Mémoire sur la mesure de la base de Darmstadt exécutée en 1808.
Bibl. Univ. Genève, XI, 1819, 3–16, 81–100.

G. Die rheinbayerische Grundlinie.
Zeits. f. Vermes., XVI, 1887, 234–236.

GALLE (J. G.). Bericht über [die Neumessung der schlesischen Grundlinie].
Breslau, 1880.

GILBERT (G. K.). On the Kanab base line.
Phil. Soc. Wash., Bull., III, 1878–'80, 34–36.

HAUPT (C.). Ein Mittel zur Steigerung der Genauigkeit von Basismessungen.
Zeits. f. Instrumentenkunde, II, 1882, 241–252.

HENNESSEY (J. B. N.). Base lines.
India, Trig. Survey, I, 1870, I, 1–23; I, 1870, II, 1–48; I, 1870, III, 1–26; I, 1870, IV, 1–28; I, 1870, V, 1–32; I, 1870, VI, 1–31; I, 1870, VII, 1–30; I, 1870, VIII, 1–32; I, 1870, IX, 1–48.

HILGARD (J. E.). Account of a base-line measurement.
A. A. A. S., Proc., 1875, 90–98; Phil. Soc. Wash., Bull., II, 1875–'80, 50–51.

HOLFELD (J.). Neue Theorie von der Wahl der Standlinien.
Lemberg, 1793.

HOUZEAU (J.-C.). Sur . . . la mesure d'une troisième base géodésique.
Acad. de Belgique, Bull., I, 1881, 867–872.

IBAÑEZ (C.). Noticia de los resultados obtenidos en la medicion de la base central de España.
Cien. Fis., Madrid, XIII, 1863, 513–519; Astron. Nachr., LXI, 1864, 339–346.

—— Base centrale de la triangulation géodésique d'Espagne.
Madrid, 1865.

JÄDERIN (E.). Geodätische Längenmessungen mit Stahlbändern und Metalldrähten.
K. Svenska Veten. Handl., Bihang, IX, 1885, XV, 1–57.

JORDAN (W.). Ueber die Berechnung des mittleren Fehlers einer Basismessung.
Astron. Nachr., LXXX, 1873, 189–190; LXXXI, 1873, 51–56.

—— Die Basismessung der preussischen Landesaufnahme bei Göttingen.
Zeits. f. Vermes., IX, 1880, 377–403.

—— Basis-Messung der preussischen Landesaufnahme bei Meppen.
Zeits. f. Vermes., XII, 1883, 577–584.

KERSCHBAUM (G.). Die nord-amerikanische Basismessung von Chicago.
Zeits. f. Vermes., XIII, 1884, 533–547.

KOPPE (C.). Die Basismessung der Aarberger Basis.
Nordhausen, 1881.

KRAMER (J. H.). Ueber den Gebrauch einer Normal-Linie bei geodätischen Arbeiten.
Hamm, 1822.

LAUSSEDAT (A.). Sur la méthode employée par d'Aubuisson en 1810, pour la mesure des bases géodésiques.
Acad. d. Sci. Paris, Comp. Rend., XCI, 1880, 922–923.

MAYER (C.). Basis Palatina.
Mannheim, 1763.

MEYER (A.). Sur la base géodésique dans les environs de Bonn.
Acad. de Belgique, Bull., XIV, 1847, II, 14–19.

MOSSMAN (S.). Primary base on Hounslow Heath.
Geogr. Mag., V, 1878, 282–286.

BASE MEASURING—Continued.

NAGEL (A.). Die Messung der Basis für die Triangulirung des Erzgebirgischen Kohlenbasins.
Dresden, 1861.

—— Basis-Messung auf der Plattform des Polytechnikums zu Dresden.
Civ.-Ing., XXVI, 1880, 293–423.

—— Die Grossenhainer Basis.
Civ.-Ing., XXVIII, 1883, 1–36; 535–546.

NERENBURGER (A.-W.). Sur la base géodésique dans les environs de Bruxelles.
Acad. de Belgique, Bull., XVII, 1850, II, 135.

OSTERWALD (P. VON). Bericht über die vorgenommene Messung einer Grundlinie von München bis Dachau.
K. bayer. Ak. d. Wiss., 1764, II, 363–386.

PERRIER (F.). Verzeichniss der alten und neuen Grundlinien.
Int. Geod. Cong., Gen.-Ber., 1877, 39–57.

—— Rapport sur les mesures des bases géodésiques.
Int. Geod. Cong., Gen.-Ber., 1880, VII, 1–8; 1883, III, 1–9; 1887, IV, 1–6.

PETERS (C. A. F.). Bericht über die neue Berechnung der Braack Basis.
Danske Gradmaaling, I, 1872, 391–420.

PFEIL (L. VON). Messung auf der kurzen Basis.
Arch. d. Math. (Grunert), XLVII, 1867, 49–73.

PUCCI (E.). Sulla teoria delle basi geodetiche.
Giorn. Math. Univ. Italiana, XIX, 1881, 151–156.

REGGIO (F.). De mensione basis habita anno 1788 ab astronomis Mediolanensibus.
Eff. Astron., Milano, 1794, 3–20.

RICCARDI (P.). Construzione di basi geodetiche stabili.
Accad. Sci. Bologna, Mem., VI, 1885, 678–682.

RICCI (G.). Rapporto alla misura di una base nella pianura di Catania.
Torino, 1867.

ROGERS (F.). An account of the measurement of two base lines in Florida.
Journ. Frank. Inst., LX, 1855, 361–372, Polytech. Journ. (Dingler), CXLV, 1857, 180–185.

ROY (W.). An account of the measurement of a base on Hounslow Heath.
Roy. Soc. London, Phil. Trans., LXXV, 1785, 385–480; Paris, 1787.

SCHIAVONI (F.). Sulla misura della base geodetica eseguita in Puglia.
Napoli, 1861.

—— Principii fondamentali intorno alla misura di una base geodetica, esposti dal —.
Napoli, 1862.

—— Relazione sulla base misurata ne' piani di Catania.
Int. Geod. Cong., Gen.-Ber., 1865, 58–67; Napoli, 1867.

SCHLEBACH. Ueber Genauigkeit und Branchbarkeit des Messrades bei gewöhnlichen Längenmessungen.
Zeits. f. Vermes., VI, 1877, 241–249.

SCHOTT (C. A.). Epping base line.
U. S. C. and G. Survey, Rep., 1864, 120–144; 1866, 141.

—— Length of the Kent Island base.
U. S. C. and G. Survey, Rep., 1866, 140.

—— Results for the length of the primary base line in Yolo County, Cal.
U. S. C. and G. Survey, Rep., 1883, 273–288.

—— Peach-Tree Ridge base, near Atlanta, Ga.
U. S. C. and G. Survey, Rep., 1873, 123–136.

SCHREIBER (O.). Die Resultate der Basismessung bei Göttingen.
Zeits. f. Vermes., XI, 1882, 1–17.

SCHWERD (F. M.). Die kleine Speyer Basis.
Speyer, 1822.

SECCHI (A.) Misura della base trigonometrica eseguita sulla via Appia.
Roma, 1858.

BASE MEASURING—Continued.

—— Une nouvelle mesure de la base de Boscovich.
Acad. d. Sci. Paris, Comp. Rend., 1860, 377–378.

SIMONS. Triangulation du royaume de Belgique.
Bruxelles, n. d.

STAMKART (F. J.). Over de Basismeting in de Haarlemmermeer in den zomer van het jaar 1868.
K. Ak. van Wetens., Mededeelingen, XI, 1869, III, 267–294.

TOPPING (M.). Measurement of a base line upon the sea beach, near Porto Novo, on the coast of Coromandel.
Roy. Soc. London, Phil. Trans., 1792, 99–114.

VITA (G.). Relazione sul procedimento del calcolo della base geodetica misurata presso la foce del crati.
Int. Geod. Cong., Gen.-Ber., 1872, 6–15.

VORLÄNDER (J. J.). Ueber die Genauigkeit der Längen-Messungen . . .
Zeits. f. Math. (Schlömilch), I, 1856, 142–159; Zeits. f. Vermes., I, 1872, 154–162.

WALKER (J. T.). Cape Comorin base line.
India, Trig. Survey, I, 1870, x, 35.

YOLAND (*Capt.*). Account of the measurement of the Lough Foyle Base.
4°, London, 1847, pp. XIX, 154, 117, 14 plates.

ZACH (F. X. VON). Sur la mesure des petites bases.
Corr. Astron. (Zach), VII, 1822, 201–218; 501–508.

—— Sur les grandes bases astronomiques.
Corr. Astron. (Zach), IX, 1823, 217–239, 321–328, 417–431.

ZACHARIAE (G.). Ueber die Bestimmung des mittleren Fehlers einer . . . doppelt gemessenen Grundlinie.
Astron. Nachr., LXXXI, 1873, 225–228.

ANON. Results of the primary triangulation of the coast of New England from the northeastern boundary to the vicinity of New York.
U. S. C. and G. Survey, Rep., 1865, 187–203; 1866, 141.
Comparison of the measured and computed lengths of the base-lines in the chain.

—— Full explanation of the different successive operations connected with the measurement of a subsidiary base-line.
U. S. C. and G. Survey, Rep., 1868, 133–139.

—— The Los Angeles base line.
Mining and Scientific Press, LVIII, 1889, 228.

Basevi (James Palladio). On the pendulum operations about to be undertaken by the great trigonometrical survey of India; with a sketch of the theory of their application to the determination of the earth's figure, and an account of some of the principal observations hitherto made.
Ind. Eng. (Medley), IV, 1867, 97–108, 199–208; Asiat. Soc. Journ., XXXIV, 1865, 251–272.

—— Preliminary abstract of mean results with pendulums. Nos. 4 and 1821.
Roy. Soc. London, Proc., XIX, 1871, 105.

—— Report on the practical error of the measurement of the Cape Comorin base.
India, Trig. Survey, I, 1870, x, 52–60.

—— *and* **Heavside (W. J.).** Details of the pendulum operations by —, and of their reduction.
India, Trig. Survey, V, 1879, pp. lxii, 299.

Bassot (L.) *et* **Perrier (P.).** Étude comparative des observations de jour et de nuit.
Acad. d. Sci. Paris, Comp. Rend., LXXXIV, 1877, 1312–1315.

—— Étalonnage des règles géodésiques du service géographique de la France.
Int. Geod. Cong., Gen.-Ber., 1887, V *b*, 1–4.

—— La méridienne de Laghouat.
Acad. d. Sci. Paris, Comp. Rend., CVI, 1888, 818–820.

Bauernfeind (Carl Maximilian von). Die Bedeutung moderner Gradmessung. Vortrag in der öffentlichen Sitzung der k. bayerischen Akad. der Wissenschaften am 25. Juli 1866. Zur Vorfeier des Geburts- und Namenfestes S. Majestät des Königs, gehalten von —.
4°, München, 1866, pp. 41. (Gore.)

—— Die terrestrische Strahlenbrechung auf Grund einer neuen Aufstellung über die physikalische Constitution der Atmosphäre.
Astron. Nachr., LXVII, 1866, 33–88.

—— Ueber die Behufs der Landesvermessung ausgeführte Triangulation von Bayern und deren Beziehung zur mitteleuropäischen Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1867, 22–33.

——, **Steinheil** *und* **Seidel.** Bericht der königlichen Commission für die europäische Gradmessung über die im Jahre 1868 von ihr vorgenommenen Arbeiten.
Int. Geod.-Cong., Gen.-Ber., 1868, 4–9.

—— Ueber ein neues Spiegelprisma mit constanten Ablenkungswinkeln.
K. bay. Ak. d. Wiss., Sitz.-Ber., I, 1868, 495–497.

—— Bericht über die im Jahre 1869 in Bayern ausgeführten geodätischen Arbeiten für die europäische Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1869, 70–73.

—— Elemente der Vermessungskunde.
8°, Stuttgart, 3d ed., 1869, pp. xxii, 878.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869–'70, 833, by BRUNS.
4th ed., 1873, 2 vols., pp. xvi, 460; VI, 533. (Gore.)
5th ed., 1876–'77.
6th ed., 1879, pp. xvi, 557; XII, 633.
Adds to the title: "Ein Lehrbuch der technischen Geometrie." Revd. in Zeits. f. Vermes., IX, 1880, 299–304, by HELMERT.

—— Nachträgliche Bemerkungen über die zu geodätischen Zwecken dienenden Spiegelprismen.
K. bay. Ak. d. Wiss., Sitz.-Ber., I, 1869, 159–161.

—— Bericht über die im Jahre 1870 in Bayern ausgeführten geodätischen Arbeiten für die europäische Gradmessung für das Jahr 1870.
Int. Geod. Cong., Gen.-Ber., 1870, 3–5.

——: **Franke (J. H.).** Die Dreiecksnetze vierter Ordnung. Mit einem Vorwort von —.
München, 1871.
Title in full under FRANKE (J. H.).

—— Ueber einen Apparat zur mechanischen Lösung der nach Pothenot und Hansen benannten geodätischen Aufgabe.
K. bay. Ak. d. Wiss., math.-phys. Cl., Abhandl., XI, 1871, 83–99.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IV, 1872, 578–579.

—— Ueber eine mechanische Lösung der sogenannten Pothenot'schen Aufgabe.
K. bay. Ak. d. Wiss., Sitz.-Ber., I, 1871, 124–128.

—— [Ueber ein neues graphisches und mechanisches Verfahren zur Lösung der sogenannten Hansen'schen Aufgabe.]
K. bay. Ak. d. Wiss., Sitz.-Ber., I, 1871, 157–161.

Bauernfeind (Carl Maximilian von)—Continued.

——— Bericht der königl. bayerischen Commission für die europäischen Gradmessung über die von ihr im Jahre 1872 vorgenommenen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1872, 76–78.

——— Die dritte allgemeine Conferenz und der gegenwärtige Stand der europäischen Gradmessung.
Allg. Zeit., 1872, 3–4, 18–20, 34–35, 82–83.

——— Bericht über die von der königl. bayerischen Kommission für die europäische Gradmessung im Jahre 1873 ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1873, 1–3.

——— *und* **Orff (von).** Die bayerische Landesvermessung in ihrer wissenschaftlichen Grundlage.
München, 1873.
Title in full under ORFF (VON).

——— Geodätische Bestimmung der Erdkrümmung und Lothablenkung.
K. bay. Ak. d. Wiss., math.-phys. Cl., Abhandl. x, 1873, II, 1–40.

——— Bericht über die geodätischen Arbeiten in Bayern pro 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 153–155.

——— Bericht über die geodätischen Arbeiten in Bayern für das Jahr 1876.
Int. Geod. Cong., Gen.-Ber., 1876, 71–73.

——— Bericht über die geodätischen Arbeiten in Bayern für das Jahr 1877.
Int. Geod. Cong., Gen.-Ber., 1877, 259–261.

——— Bericht über die geodätischen Arbeiten in Bayern für das Jahr 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 75–76.

——— Bericht über die geodätischen Arbeiten in Bayern für das Jahr 1879.
Int. Geod. Cong., Gen.-Ber., 1879, 73–77.

——— Bericht über die geodätischen Arbeiten in Bayern für das Jahr 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 3–5.

——— Die sechste Generalversammlung der europäischen Gradmessung in München.
Zeits. f. Vermes., IX, 1880, 457–474; Allg. Zeit., 1880, 4594–4595, 4611–4612, 4642–4643.

——— Ergebnisse aus Beobachtungen der terrestrischen Refraction.
K. bay. Ak. d. Wiss., math.-phys. Cl., Abhandl., XIII, 1880, 181–310; XV, 1883, I, 1–102; XVI, 1888, I, 519–567, 5 plates.

——— Ueber Refractionsbeobachtungen.
Int. Geod. Cong., Gen.-Ber., 1880, 1–6.

——— Die Gradmessungs-Conferenz im Haag.
Allg. Zeit., 1882, 4179–4180.

——— Neue Untersuchungen über terrestrische Refraction.
Int. Geod. Cong., Gen.-Ber., 1883, 1–5.

——— Bericht über die geodätischen Arbeiten in Bayern für das Jahr 1883.
Int. Geod. Cong., Gen.-Ber., 1883, 223–227.

——— Deutsches Vermessungswesen.
Allg. Zeit., 1884, 1074–1076, 1250–1252.

Bauernfeind (Carl Maximilian von)—Continued.

——— Die siebente General-Conferenz der europäischen Gradmessung zu Rom im October 1883.
Zeits. f. Vermes., XIII, 1884, 133–140.

——— Die allgemeine Konferenz der europäischen Gradmessung zu Rom im Oktober 1883.
Ausland, I, 1884, 61–69, 81–91.
8°, München, 1884, pp. 59.

——— [Bericht über die geodätischen Arbeiten in Bayern in den Jahren 1884–'86.]
Int. Geod. Cong., Verhandl., 1884–'86, 115–121.

Baulina (Jean). Rapport sur l'avancement des travaux de la commission géodésique italienne pendant les années 1881–'82.
Int. Geod. Cong., Gen.-Ber., 1881–'82, 85–88.

Baumann (Ad.). Fehlergrenzen der aichpflichtigen Gegenstände und sonstige Zahlenangaben in den Aichungsvorschriften.*
Berlin, 1887, *Julius Springer.*
Revd. in Zeits. f. Vermes., XVI, 1887, 604–606, by J.

Baur (C. W.). Zwei Theilungsaufgaben zu geodätischer Anwendung.
Arch. d. Math. (Grunert), XXVII, 1856, 85–93.

——— Die Ausgleichung der Richtungen in einem Dreiecksnetz mit unvollständigen Central-Systemen.
4°, Stuttgart, 1857, pp. 38, 1 plate.
Einladungsschrift d. k. polytechnischen Schule in Stuttgart.

——— [Vorschlag einer neuen mitteleuropäischen Gradmessung.]
Württemberg, Jahresheft, XX, 1864, 37–47.

———, **Schoder** *und* **Zech.** Schreiben der königlich württembergischen Bevollmächtigten an den Präsidenten des Centralbüreau. [Concerning the geodetic work in Würtemberg during 1866.]
Int. Geod. Cong., Gen.-Ber., 1866, 49–51.

———, **Schoder** *und* **Zech.** Bericht über den Stand der Arbeiten für die europäische Gradmessung in Württemberg.
Int. Geod. Cong., Gen.-Ber., 1868, 54–56.

———, **Schoder** *und* **Zech.** Bericht der württembergischen Commission. [Regarding the geodetic operations during 1869.]
Int. Geod. Cong., Gen.-Ber., 1869, 66–69.

———, **Schoder** *und* **Zech.** Bericht der württembergischen Commissäre für die europäische Gradmessung über die im Jahre 1870 ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1870, 70–72.

———, **Schoder** *und* **Zech.** Bericht der württembergischen Commissäre für die europäische Gradmessung über die im Jahre 1873 ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1873, 32–33.

——— Verschiebung eines trigonometrischen Netzes.
Zeits. f. Vermes., X, 1881, 402–408.

BAVARIA.

BAUERNFEIND (C. M.). Ueber die ausgeführte Triangulation von Bayern.
Int. Geod. Cong., Gen.-Ber., 1867, 22–33; 1868, 4–9; 1869, 70–73; 1870, 3–5; 1872, 76–78; 1873, 1–3; 1875, 153–155; 1876, 71–73; 1877, 259–261; 1878, 75–76; 1879, 73–77; 1880, 3–5; 1883, 223–227; 1884–'86, 115–121.

BAVARIA—Continued.

Beigel (G. W. S.). Die trigonometrische Vermessung in Bayern.
Mon. Corr. (Zach), VIII, 1803, 353-366, 377-401, 510-528.

Orff (C. von). Die bayerische Landesvermessung in ihrer wissenschaftlichen Grundlage.
München, 1873.

Schiegg (U.). Ueber die Vermessung von Bayern, nebst Bemerkungen von Zach.
Mon. Corr. (Zach), VIII, 1803, 354-355; X, 1804, 253-267, 278-288.

—— Die bayerische Landesvermessung in ihrer wissenschaftlichen Grundlage. Herausgegeben von dem topographischen Bureau des k. Generalstabes.
München, 1873.

Beardsley. The reputed figure and motions of the earth.
The English Mechanic, London, XI, 1870, 134+.

Beaumont (Élie de). Rapport sur les travaux géodésiques relatifs à la nouvelle détermination de la méridienne de France, fait au nom d'une commission formée des membres des sections de géométrie, d'astronomie, de géographie et navigation et des membres composant le bureau.
Acad. d. Sci. Paris, Comp. Rend., LXXVIII, 1874, 723-736.

Beautemps-Beaupré. Exposé des travaux relatifs à la reconnaissance hydrographique des côtes occidentales de France.
Paris, 1829.
Contains; Daussey, Précis des opérations géodésiques, 69-124.

——— : **Bégat (P.).** Exposé des opérations géodésiques sous la direction de —.
Paris, 1839.

Beccaria (Joannes Baptista [Giaccomo Battista]). Gradus Taurinensis.
Augustæ Taurinorum, 1774, pp. x, 195, 3 plates.

——— Lettere d' un italiano ad un Parigino intorno alle riflessioni del Signor Cassini de Thury sul grado Torinense.*
Firenze, 1777.
Poggendorff, I, 123.

——— : **Zach (F. X. von).** Le degré du méridien mesuré en Piémont par —.
Accad. Sci. Torino, Mem., 1811-'12, 81-116; Mon. Corr. (Zach), XXVII, 1813, 272-281.

Beek-Calkoen (Jan Frederik van). Ueber die Messung eines Breitengrades durch Willebrord Snellius, verbessert von Peter van Muschenbroek.
Allg. geogr. Ephem., I, 1798, 625-639.
The name is sometimes written Beeck.

——— Ueber die Bestimmung des Erd-Ellipsoids.
Mon. Corr. (Zach), XII, 1805, 256-266.

Bégat (Pierre). Traité élémentaire de géographie mathématique, physique et politique, pour l'intelligence de la mappe-monde.
8°, Paris, 1834, pp. xxxv, 112. (Munich, Royal.)
La mesure de la terre, VIII-X.

——— Exposé des opérations géodésiques relatives aux travaux hydrographiques exécutées sur les côtes septentrionales de France par les ingénieurs hydrographes de la marine, sous la direction de M. Beautemps-Beaupré.
4°, Paris, 1839, pp. [ii,] 56, 1 plate. (Washington, Coast Survey.)

Bégat (Pierre)—Continued. Traité de géodésie à l'usage des marins, ou méthodes et formules trigonométriques relatives au levé et à la construction des cartes hydrographiques.
8°, Paris, 1839, pp. 288, 3 plates. (Washington, Coast Survey.)

——— Exposé des opérations géodésiques relatives aux travaux hydrographiques, exécutées sur les côtes méridionales de la France, sous la direction de feu M. Monnier.
4°, Paris, 1844, pp. 50, [5], 2 plates. (Washington, Coast Survey.)

Beigel (Georg Wilhelm Siegmund). Ueber die trigonometrische Vermessung in Bayern.
Mon. Corr. (Zach), VII, 1803, 353-366, 377-401, 510-528.

——— Ueber den französischen Mètre als materielles Mass betrachtet.
Mon. Corr. (Zach), VIII, 1803, 101-115.

——— : **Camerer (J. W. von).** Ueber den französischen Mètre. Reply by —.
Mon. Corr. (Zach), IX, 1804, 223-230.
Title in full under Camerer (J. W. von.).

Belatti. Intorno ad un modo di simplificare in alcuni casi l' applicazione del metodo dei minimi quadrati al calcolo delle constanti empiriche.*
Ist. Veneto, Atti, I.

BELGIUM.

Adan (E.-H.-J.). Rapport sur les travaux géodésiques.
Int. Geod. Cong., Gen.-Ber., 1875, 155-167; 1876, 78-83; 1877, 262-269; 1878, 76-81; 1879, 78-83; 1880, 6-7.

——— Notices sur les travaux géodésiques du dépôt de la guerre.
Gand, 1876.

——— Triangulation du royaume de Belgique.
Ixelles, 1878; 1880; 1881.

——— Le premier volume de la triangulation belge.
Acad. de Belgique, L, 1880, 75-76; I, 1881, 209-213.

——— Base géodésique mesurée en juillet 1850 aux environs de Bruxelles sur le plateau de Linthout par les officiers d'état-major attachés au dépôt de la guerre. Triangulation qui relie cette longueur à l'Observatoire royal de Bruxelles.
Bruxelles, 1851.

Delporte (A.). Notice sur les travaux nécessaires pour compléter le réseau géodésique belge.
Bruxelles, 1884.

Folie. Sur les travaux nécessaires pour compléter le réseau géodésique belge.
Acad. de Belgique, Bull., VI, 1883, 422-423.

Hennequin (E.). Rapport sur les travaux géodésiques de l'institut cartographique militaire de Belgique.
Int. Geod. Cong., Gen.-Ber., 1881-'82, 144-148; 1883, 227-229; 1884-'86, 121-122.

——— Triangulation du royaume de Belgique.
Bruxelles, 1885.

Houzeau (J.-C.). Sur . . . la mesure d'une troisième base géodésique.
Acad. de Belgique, Bull., I, 1881, 867-872.

Le Marie. Rapport sur les opérations géodésiques exécutées en Belgique.
Int. Geod. Cong., Gen.-Ber., 1872, 2-3.

Liagre (J.-B.-J.). Rapport présenté à la commission de l'Association géodésique internationale.
Acad. de Belgique, Bull., XLI, 1876, 397-407.

Meyer (A.). Sur la triangulation du royaume.
Acad. de Belgique, Bull., XIV, 1847; II, 320-321.

BELGIUM—Continued.

NERENBURGER (A.-W.). Sur les triangulations qui ont été faites, en Belgique, antérieurement à 1830.
Acad. de Belgique, Bull., XXIII, 1856, II, 430–479; I, 1857, 281–344.

SIMONS. Triangulation du royaume de Belgique.
Bruxelles, 1867.

—— Rapport sur les travaux géodésiques exécutés en Belgique.
Int. Geod. Cong., Gen.-Ber., 1869, 4–5; 1870, 6.

Beltrami (Eugenio). Sulla teoria delle linee geodetiche.
Ist. Lomb. Sci., Rendi., I, 1868, 708–718.

——: **Maggi (G. A.).** Intorno ad alcune formole relative al calcolo degli errori d' osservazione. Presentata dal —.
Ist. Lomb. Sci., Rendi., XV, 1882, 351–358.

Benazé (O. Duhil de). Recherche de la déviation que subit le pendule au Port de Callao (Pérou) par suite de l'attraction qu'exercent sur lui la chaîne des Andes et tout le continent de l'Amérique Sud. (H.)
Revue Marit., XXXIV, 1872, 388–402.

Bender (C.). Trigonometrische Aufnahme des Herzogthums Berg.
Astron. Jahrb. (Bode), 1808, 262–263.

—— Bestimmung der Schwingungsdauer materieller Pendel.
Ann. d. Phys. (Poggendorff), CL, 1873, 295–303.

Benoit (Philippe-Martin-Narcisse). Cours complet de topographie et de géodésie à l'usage de l'école d'application du corps royal d'état-major.
8°, Paris, 1822, pp. xii, 195, 6 plates; Paris, 1825, pp. xii, 196, 6 plates.

—— Résultats des comparaisons de la toise du Pérou au mètre international, exécutés au Bureau international des poids et mesures par M. Benoit, présentés par M. C. Wolf.
Acad. d. Sci. Paris, Comp. Rend., CVI, 1888, 977–982.

Benzenberg (Johann Friedrich). Ueber die trigonometrische Aufnahme des Herzogthums Berg.
Astron. Jahrb. (Bode), IV, 1808, 130–134.

Berg (F. J. van den). Over de onderlinge afwijkingen van de geodetische lijn en van tre dersydsche vlakke normale doorsneden tuschen twee nabjgelegen punten van een gebogen oppervlak.
K. Ak. Weten. Amsterdam, Versl., X, 1876, 1–45.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VIII, 1876, 728–729, by G. [VAN GEER].

—— Sur les écarts de la ligne géodésique et des sections planes normales entre deux points rapprochés d'une surface courbe.
Arch. Néerl., XII, 1877, 353–398.
A translation of the above.

Bergstrand (P. E.). Mesure des droits géodésiques au moyen de bandes d'acier et de fils métalliques.*
Stockholm, 1885.

Bernardi [Bernard] (Edward). De mensuris et ponderibus antiquis, libri tres. Editio altera, prior et duplo locupletior.
Oxoniæ, 1688, pp. xiv, 261, 86.

Bernardinis (G. de). Sullo scostamento della linea geodetica dalle sezioni normali di una superficie.
Accad. Sci., Torino, Rend., XIX, 1883–'84.

Bernardinis (G. de)—Continued.

——: **Dorna (A.).** Relazione su "Sullo scostamento della linea geodetica . . ." di —.
Accad. Sci. Torino, Atti, XIX, 1886, 94–98.

Bertier (R.-P.). [Lettre relatant une expérience démontrant que la pesanteur augmente à mesure qu'on s'élève dans l'atmosphère.*
Journ. d. Phys. (Rozier), II, 1773, 251.

——: **Lesage.** Réflexion sur une nouvelle expérience du —, que prouverait que la pesanteur augmente à mesure qu'on s'éloigne de la terre.
Journ. d. Phys. (Rozier), II, 1773, 378.

Bertrand (Joseph François). Méthode des moindres carrés. Mémoires sur la combinaison des observations. Par Ch.-Fr. Gauss. Traduits en français et publiés avec l'autorisation de l'auteur.
8°, Paris, 1855, pp. 167.
It contains translations of pp. 208–220 of *Theoria motus*, 1809; pp. 20–26, Disquisitio de . . . 1811 and the whole of the memoirs of 1816, 1822, 1823, 1826, and 1827. MERRIMAN, 199.

—— Figure de la terre.
Journ. Sav., 1874, 697–719.
A review of J. BAEYER. Ueber die Grösse und Figure der Erde. LISTING. Ueber unsere jetzige Kenntniss der Gestalt und Grösse der Erde.

—— Sur ce qu'on nomme le poids et la précision d'une observation.
Acad. d. Sci. Paris, Comp. Rend., CV, 1887, 1099–1102.

—— Sur la loi des erreurs d'observation.
Acad. d. Sci. Paris, Comp. Rend., CV, 1887, 1147–1148.

—— Sur la loi de probabilité des erreurs d'observation.
Acad. d. Sci. Paris, Comp. Rend., CVI, 1888, 153–156.

Bessel (Friedrich Wilhelm). Trigonometrische Bestimmung einiger Punkte in Königsberg und Prüfung einiger Winkel der Textor'schen Vermessung von Preussen.
Zeits. f. Astron. (Lindenau), IV, 1817, 286–296.

—— [Ueber Berechnung geodätischer Vermessungen.]
Astron. Nachr., I, 1823, 33–35.

—— [Berechnung eines Dreiecks, dessen Seiten geodätische Linien sind.]
Astron. Nachr., I, 1823, 85–90.

—— Ueber die Berechnung der geographischen Längen und Breiten aus geodätischen Vermessungen.
Astron. Nachr., IV, 1826, 241–254.
Note by ORIANI, 461–466; Quart. Journ. Sci., XXI, 1826, 138–153.

—— Untersuchungen über die Länge des einfachen Sekunden-Pendels.
K. Ak. d. Wiss., math.-phys. Cl., Abhandl., 1826, 1–256; Ann. d. Phys. (Poggendorff), XII, 1828, 337–351.
Also separately printed, 4°, Berlin, 1828, pp. 254. This paper was read in 1828. Its appearance in the Abhandl. for 1826, then on the point of publication, was due to its importance. HERSCHEL.
Revd. in Bull. Sci. Math. (Ferussac), XII, 1829, 236–239, by L. (Fr.).

Bessel (**Friedrich Wilhelm**)—Continued.

——— Ueber die Unrichtigkeit der bisher bei Pendelversuchen angewandten Reductionen auf den luftleeren Raum.

Astron. Nachr., VI, 1827, 149–150.

——— [Ueber einen Aufsatz von Ivory im "Phil. Mag." betreffend beider Methoden zur Berechnung der geodätischen Vermessungen.]

Astron. Nachr., V, 1827, 177–180.

——— Ueber die von Herrn F. R. Hassler, zur Vermessung der Küste der Vereinigten Staaten ergriffenen Maassregeln.

Astron. Nachr., VI, 1828, 349–356.

Translated by RENWICK (J.). Am. Journ. Sci., XVI, 1829, 225–234; Phil. Mag. (Tilloch), VI, 1829, 401–409.

———: **Sabine** (**E.**). Account of —'s pendulum experiments.

Quart. Journ. Sci., V, 1829, 1–27.

——— Versuche über die Kraft mit welcher die Erde Körper von verschiedener Beschaffenheit anzieht.

K. Ak. d. Wiss., Abhandl., 1830, 41–103.

This paper describes experiments at Königsberg in 1828. It was presented and read in 1832 and was allowed to appear in the volume of 1830 on account of its exceptional interest. It was also separately printed, 4°, Berlin, 1832, pp. 1–60.

——— Ueber den Einfluss eines widerstehenden Mittels auf die Bewegung eines Pendels.

Astron. Nachr., IX, 1831, 221–236.

——— Nachricht von der Vereinigung der beiden russischen, sich über acht Grade der Breite ausdehnende Gradmessungen.

Astron. Nachr., X, 1833, 325–328.

——— Betrachtung über die Methode der Vervielfältigung der Beobachtungen.

Astron. Nachr., XI, 1834, 269–290.

——— Bestimmung der Länge des einfachen Secundenpendels für Berlin.

K. Ak. d. Wiss., math.-phys. Cl., 1835, 161–262.

——— Ueber den Einfluss der Unregelmässigkeiten der Figur der Erde, auf geodätische Arbeiten und ihre Vergleichung mit den astronomischen Bestimmungen.

Astron. Nachr., XIV, 1837, 269–312.

——— Bestimmung der Axen des elliptischen Rotationssphäroids, welches den vorhandenen Messungen von Meridianbögen der Erde am meisten entspricht.

Astron. Nachr., XIV, 1837, 333–346; Bibl. Univ., Genève, X, 1837, 170–172; Ann. d. Phys. (Poggendorff), XLII, 1837, 622–624; Sci. Mem. (Taylor), II, 1841, 387–400.

——— Neue Berechnung der Beobachtungen der Polhöhen, auf welchen die zweite in Indien ausgeführte Gradmessung beruhet.

Astron. Nachr., XIV, 1837, 349–368.

——— Ueber die Polhöhen, welche der englischen Gradmessung zum Grunde liegen.

Astron. Nachr., XIV, 1837, 381–390.

——— *und* **Baeyer** (**J. J.**). Gradmessung in Ostpreussen und ihre Verbindung mit preussischen und russischen Dreiecksketten, ausgeführt von **Bessel** (**F. W.**) und **Baeyer** (**J. J.**).

4°, Berlin, 1838, pp. xiv, 452, 7 plates. (Gore.)

Extracts from this work are found in Abhandlungen von BESSEL, Leipzig, 1875, III, 82–138.

Bessel (**Friedrich Wilhelm**)—Continued.

——— Untersuchungen über die Wahrscheinlichkeit der Beobachtungsfehler.

Astron. Nachr., XV, 1838, 369–404.

——— Darstellung der Untersuchungen und Massregeln, welche in den Jahren 1835 bis 1838 durch die Einheit des preussischen Längenmasses veranlasst worden sind. Bekannt gemacht durch das Ministerium der Finanzen und des Handels.

4°, Berlin, 1839, pp. iv, 148, 7 plates. (British Museum.)

——— Ein Hülfsmittel zur Erleichterung der Anwendung der Methode der kleinsten Quadrate.

Astron. Nachr., XVII, 1840, 225–230.

Abhandlungen von BESSEL (Leipzig), 1875, II, 398–401.

——— Neue Formel von Jacobi, für einen Fall der Anwendung der Methode der kleinsten Quadrate.

Astron. Nachr., XVII, 1840, 305–308.

Abhandlungen von BESSEL, Leipzig, 1875, II, 401–402. Formulæ for solving normal equation and determining at the same time the weights. MERRIMAN, 184.

——— Ueber einen Fehler in der Rechnung der französischen Gradmessung und seinen Einfluss auf die Bestimmung der Figur der Erde.

Astron. Nachr., XIX, 1841, 97–116.

Abhandlungen von BESSEL, Leipzig, 1875, III, 55–62.

——— Ueber die Gestalt der Erde.

Ann. d. Phys. (Poggendorff), LV, 1842, 529–530.

——— [Ueber die Figur der Erde.]

Mémoires du dépôt topographique [de Russie], IX, 1844, 908.

It was in this article that Bessel first discussed the figure of the earth, using eight arcs (in his later discussion he had ten). This was communicated in a letter to General Tenner in 1844, three years before the publication of his renowned article in Astron. Nachr., XIV, 1837, 333–346.—STRUVE (F.-G.-W.). Arc du méridien, etc., I, 1860, XIX (note).

——— Ueber die aus der Schwere hervorgehenden Veränderungen, die der Kreis eines Instrumentes in der lothrechten Lage seiner Ebene erfährt.

Astron. Nachr., XXV, 1847, 1–42.

——— Populäre Vorlesungen über wissenschaftliche Gegenstände. Herausgegeben von H. C. Schumacher.

Hamburg, 1848.

Ueber das, was uns die Astronomie von der Gestalt und dem Inneren der Erde lehrt, 34–68.

——— Construction eines symmetrisch geformten Pendels mit reciproken Axen.

Astron. Nachr., XXX, 1849, 1–6.

———: **Busch** (**A. L.**). Verzeichniss der Werke von —.

Königsberg, 1849.

Title in full under BUSCH (A. L.).

———: **Casaroti** (**F.**). Sulla regola seguita da . . . per osservare gli angoli orizzontali.

Accad. dei Lincei, Atti, II, 1875, 9–14.

Title in full under CASORATI (F.).

——— Abhandlungen, herausgegeben von Engelmann. Geodäsie, III.

4°, Leipzig, 1875–'76.

Herausgegeben von RUDOLF ENGELMANN.

Bessel (Friedrich Wilhelm)—Continued.

——— Briefwechsel zwischen Gauss und Bessel. Herausgegeben auf Veranlassung der königlichen preussischen Akademie der Wissenschaften.
8°, Leipzig, 1880, pp. xxvi, 579. (Washington, Observatory.)
Geodetic references in Pt. 1, pp. 405, 428, 446, 459, 487, 570; in Pt. 2, pp. 374, 390, 396, 464, 480, 484, 513, 564.

———: J. Die Erddimensionen von —.
Zeits. f. Vermes., XIV, 1885, 22–28.

Beucke (K.). Die geodätischen Linien und die als "geodätischen Ellipsen und Hyperbeln" betrachteten Krümmungskurven auf dem dreiachsigen Ellipsoid.
8°, Halle, 1885, pp. 29. (Gore.)

Bevis: Liesganig (J.). A letter to—, containing a short account of the measurement of three degrees of latitude under the meridian of Vienna.
Roy. Soc. London, Phil. Trans., LVIII, 1768, 15–17.

Bianco (O. Zanotti). Sopra una vecchia e poco nota misura del semidiametro terrestre.
Accad. Sci. Torino, Atti, XIX, 1886, 791–795.
Refers to a method of EDWARD WRIGHT in "Certain errors in navigation detected." London, 1610.

Bibl. Brit. Genève, *for* Bibliothèque britannique.
8°, Genève, 1796–1835. (Washington, Congress.)

BIBLIOGRAPHY.

BÖRSCH (O.). Literatur der praktischen und theoretischen Gradmessungs-Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1883, VIII, 1–32.
(Berlin, 1889.)

GERKE (R.). Uebersicht der Literatur für Vermessungswesen.
Zeits. f. Vermes., X, 1881, 1–44; XI, 1882, 185–232; XII, 1883, 369–404; XIII, 1884, 437–478; XIV, 1885, 321–351; XV, 1886, 401–428, 433–457, XVI, 1887, 473–502, 514–519.

GORE (J. H.). A bibliography of geodesy.
U. S. C. and G. Survey, Rep., 1887, App., 16.

HELMERT (F. R.). Uebersicht der Literatur für Vermessungswesen.
Zeits. f. Vermes., V, 1876, (1)–(64); VI, 1877, (1)–(88).

HERSCHEL (J.). A bibliographical list of works relating to pendulum operations.
India, Trig. Survey, V, 1879, V, 103–126.

HOUZEAU (J.-C.). Catalogue des ouvrages d'astronomie . . . qui se trouvent dans les bibliothèques de la Belgique.
Bruxelles, 1878.

——— *et* LANCASTER (A.). Bibliographie générale de l'astronomie. Tome second.
Bruxelles, 1882.

JORDAN (W.). Uebersicht der Literatur für Vermessungswesen.
Zeits. f. Vermes., VII, 1878, (1)–(66); VIII, 1879, (117)–(150).

MURHARD (F. W. A.) Literatur der mathematischen Wissenschaft.
Leipzig, 1797–'98.

NAGEL (A.). Drei classische Werke der letzten Jahrzehnte.
Civ.-Ing., XXIII, 1877, 257–290.

PETZOLD (M.). Uebersicht der Literatur für Vermessungswesen.
Zeits. f. Vermes., XVII, 1888, 404–416, 425–429, 465–479, 497–510, 527–543.

POPPE (J. H. M. VON). Geschichte der Mathematik.
Tübingen, 1828.

REUSS (J. D.). Repertorium commentationum v.
Gottingæ, 1804.

ROGG (I.). Handbuch der mathematischen Literatur.
Göttingen, 1830.

BIBLIOGRAPHY—Continued.

SADEBECK (B. A. M.). Literatur der praktischen und theoretischen Gradmessungs-Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1880, 1–108.

SEDLACZEK (E.) Katalog der Bücherwerke des k. k. militär-geographischen Institutes.
Wien, 1884–'88.

SOHNCKE (L. A.). Bibliotheca mathematica.
Leipzig, 1854.

WEIDLER (J. F.). Bibliographia astronomica.
Wittembergæ, 1755.

ANON. Zusammenstellung der Literatur der Gradmessungs-Arbeiten. Herausgegeben von dem Centralbüreau der europäischen Gradmessung.
4°, Berlin, 1876, pp. [i], 32.

Bibl. Rep., *for* Biblical Repertory and Princeton Review.
Princeton, 1829–'71; New York, 1818+. (Washington, Congress.)

Bibl. Univ. Genève, *for* Bibliothèque universelle de Genève.
8°, Genève, 1836–'45. (Washington, Congress.)

Bidone (Giorgio). Note sur la longueur du pendule simple, et sur l'intensité de la gravité terrestre.
Ann. d. Math. (Gergonne), XVIII, 1827–'28, 341–352.

Biedermann (Rudolph), *editor*. Handbuch enthaltend Aufsätze über die exacten Wissenschaften und ihre Anwendungen. Internationale Ausstellung wissenschaftlicher Apparate in South Kensington Museum.
8°, 1876, pp. xx, 402. (British Museum.)
Geometrische und Messinstrumente, 38–68.

Bignon (*l'Abbé*). Différence de la longueur du pendule à Paraïbe et à Paris.
Acad. d. Sci. Paris, Mém., 1700, 175–178.

Binnenthal (*General* **von**). Instruction für die bey der k. k. österreichischen Landes-Vermessung angestellten Herrn Officiere.
4°, Wien, 1810, pp. iii, 5 plates. (Berlin, Royal.)

——— Instruction für die im Calculs-Büreau der k. k. österreichischen Landes-Vermessung angestellten Herrn Officiere.
4°, Wien, 1810, pp. 58, 2 plates. (Berlin, Royal.)

——— Trigonometrische Vermessung in der österreichischen Monarchie.
Mon. Corr. (Zach), XXV, 1812, 37–57, 121–139, 232–249.
The first article is: Relation über die im Jahre 1810 bey Eörs in Ungarn in Raaber Comitat gemessene Basis und ihre Verbindung mit der Basis nächst Wienerisch-Neustadt in Oesterreich.

Biot (Jean-Baptiste) *et* **Biot (E.).** Mémoire sur la mesure des azimuts géodésiques.
Conn. d. Temps, 1830, 70–82.
Title in full under BIOT (J.-B.).

——— Expériences sur la mesure du pendule à secondes, sur différens points de l'arc du méridien compris entre Dunkerque et l'île de Formentera.
Soc. Philom., Bull., I, 1807, 261–262.

——— Rapport fait à l'Institut sur la longueur du pendule à secondes observée aux deux extrémités de la méridienne et sur l'aplatissement de la terre qui en résulte.
Bibl. Britan., XLII, 1809, 20–26; Giornale d. Fis. (Brugnatelli), II, 1809, 498–500.

Biot (Jean-Baptiste)—Continued.

——— Recherches sur les réfractions extraordinaires qui s'observent très près de l'horizon.
Inst. de France, Mém. Cl. Sci. Math. Phys. 1809, 1–266.

——— Notice sur les opérations entreprises pour déterminer la figure de la terre.
4°, [Paris, 1815?], pp. 28. (British Museum.)

——— Lettre aux rédacteurs sur le rapport du mètre au pied anglais.
Ann. d. chim., VII, 1817, 13–16.

——— Notices sur les voyages entrepris pour mesurer la courbure de la terre et la variation de la pesanteur terrestre sur l'arc du méridien compris entre les îles Pythiouses et les îles Shetland.
Acad. d. Sci. Paris, Mém., III, 1818 (Hist), 73–172; Quart. Jour. Sci., v, 1818, 340–351; Phil. Mag. (Tillock), LII, 1818, 119–131; LIII, 1819, 292–300; Blackwood's Mag., iii, 1818, 463–470; Analectic Mag., xiii, 1819, 26–41.

——— Notice sur la continuation des travaux entrepris pour déterminer la figure de la terre, et sur les résultats des observations du pendule en 1817 aux îles Shetland.
Bibl. Univ. Genève, x, 1819, 225–238.

——— Sur la longueur du pendule à secondes, observée à Unst, la plus boréale des îles Shetland.
Soc. Philom., Bull., 1819, 21–23; Edinb. Phil. Journ. (Brewster), I, 1819, 77–79.

——— *et* **Arago**. Recueil d'observations géodésiques astronomiques et physiques exécutées par ordre du bureau des longitudes de France, en Espagne, en Angleterre et en Écosse, pour déterminer la variation de la pesanteur et des degrés terrestres sur le prolongement du méridien de Paris, faisant suite au troisième volume de la base du système métrique.
8°, Paris, 1821, pp. xxx, 588, 2 plates. (Washington, Observatory.)
Revd. by DELAMBRE (J.-B.-J.). Hist. de l'Acad. Roy. d. Sci., 85–90 (partie math.)

——— Sur la longueur absolue du pendule à secondes, mesurée en Angleterre et en Écosse par le procédé de Borda, avec des remarques sur le degré d'exactitude que ce procédé comporte.
Soc. Philom. Bull., VI, 1821, 70–78; Ann. d. Phys. (Gilbert), LXIX, 1821, 337–352.

———: **Galbraith (W.)**. Remarks on the experiments of the pendulum made by —.
Phil. Mag. (Tilloch), LXIV, 1824, 161–170.

——— An account of experiments, etc. Exposé d'expériences pour déterminer la figure de la terre par les vibrations du pendule à diverses latitudes, avec des recherches sur divers autres objets des sciences, par Édouard Sabine.
Journ. d. Sav., 1825, 643–651; 1826, 3–18; 1827, 208–217; 1829, 205–222.
A review of SABINE's work.

———: **Saigey**. Comparaison des observations du pendule à divers latitudes, par —.
Bull. Sci. Math. (Saigey), VII, 1827, 31–43, 171–184; Hertha, XIII, 1829, 287–290.

Biot (Jean-Baptiste)—Continued.

——— Mémoire sur la figure de la terre.
Acad. d. Sci. Paris, Mém., VIII, 1829, 1–56; Bull. Sci. Math. (Ferussac), XIV, 1830, 183–186.

——— *et* **Biot (E.)**. Mémoire sur la mesure des azimuts dans les opérations géodésiques, et en particulier sur l'azimut oriental de la chaîne de triangles qui s'étend de Bordeaux à Fiume, en Istrie.
Conn. d. Temps, 1830, 70–82.

——— Sur un mémoire de M. Puissant.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 450–453.
Full title under ARAGO.

———: **Puissant (L.)**. Dernières remarques sur une nouvelle détermination de l'arc de méridien compris entre Montjouy et Formentera, en réponse à —.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 483–486.

——— Mémoire sur la latitude de l'extrémité de l'arc du méridien de France et Espagne.
Acad. d. Sci. Paris, Comp. Rend., XVI, 1843, 1019–1032; Acad. d. Sci. Paris, Mém., XIX, 1845, pp. 359–399.

——— Note [sur les opérations géodésiques, etc., dans les provinces caucasiennes].
Acad. d. Sci. Paris, Comp. Rend., XXX, 1850, 539–540.

———: **Struve (F.-G.-W.)**. Note sur l'ouvrage relatif à l'arc du méridien de 25° 20′ entre la Mer Glaciale et le Danube, publié par l'Académie des sciences de Saint-Pétersbourg. Note par —.
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 513–514.

——— Nouvelles études sur les réfractions atmosphériques.
4°, Paris, 1855, pp. viii, 124, 4. (Berlin, Geodetic Institute.)

——— Remarques relatives à la communication de M. Struve [sur la mesure de l'arc du méridien de 25° 20′ entre la Mer Glaciale et le Danube].
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 514–517, 605–610.

——— Mélanges scientifiques et littéraires.
8°, Paris, 1858, 3 vols. Voyages géodésiques, I, 16–122. (Southampton, Ordnance Survey).

———: **Faye (H.-A.-E.-A.)**. Rapport concernant la constante de la pesanteur à Paris et les corrections de —.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1463–1466.

Birnbaum (Johann Heinrich Ludwig). Disquisitio de penduli simplicis oscillationibus in arcus circuli æque in vacuo ac fluido resistente.
4°, Marburg, 1828, pp. 24, 1 plate. (Berlin, Royal.)

——— Grundzüge der astronomischen Geographie. Vorlesungen für Gebildete.
8°, Leipzig, 1862, pp. vi, 294. (British Museum.)
Gestalt der Erder, 38–69.

Bischof (Gustav). Die Gestalt der Erde und der Meeresfläche und die Erosion des Meeresbodens.
8°, Bonn, 1867, pp. 38. (Gore.)

Biver (P.-E.). Sur une nouvelle méthode de conduire et de calculer les triangulations géodésiques.
Acad. de Belgique, Bull., XXIII, 1856, 99-148.

Björck (Elias Daniel). Theoremata magnitudini telluris, computandæ inservitura.
8°, Gryphiswaldiæ, 1794, pp. 16. (Gore.)

Blackstone (Dodge Pierce). The attraction and the figure of equilibrium of a rotating fluid mass and the interior density and temperature of the earth. Stray leaves from the report of the Academy of Sciences, Arts, and Letters of the State of Wisconsin, 1885.
8°, Madison, 1885, pp. 58. (Gore.)

Blackwood, *for* Blackwood's Edinburgh Magazine.
8°, Edinburgh, 1817+. (Washington, Congress.)

Blaesing (David). De linea meridiana.*
Lipsiæ, 1716.

B[lair] (H. W.). The Lake Survey.
Science, I, 1883, 174.

——— Marking geodetic stations.
Science, I, 1883, 394-395.

Blair (John). History of the rise and progress of geography.
12°, London, 1784, pp. 186. (British Museum.)
Gives a good account of the early attempts at degree measurements.

Blakewell (F. C.): R. New theory of the figure of the earth. An answer to —.
Civil Eng. and Arch. Journ., XXIV, 1861, 278.

——— New theory of the figure of the earth.
Civil Eng. and Arch. Journ., XXIV, 1861, 232-235, 313-314, 345-346.

——— Considerations respecting the figure of the earth in relation to the action of centrifugal force, and to the attempts to determine the ellipticity of the globe by pendulum experiments.*
London, 1862.
Revd. in Civil Eng. and Arch. Journ., XXV, 1862, 123. Commercial Catalogue.

Blaramberg (von). Memoirs of the army topographic department of Russia.
4°, XIX-XXVIII, St. Petersburg, 1857-'67.

——— Die Vermessung des Parallelbogens von 52° nördl. Breite durch ganz Europa und die Betheiligung Russlands an derselben.
Petermann, Mittheil., 1861, 209-212.

Blass (Friedrich). Einiges aus der Geschichte der Astronomie im Alterthum.
8°, Kiel, 1883, pp. 16. (Oxford, Bodleian.)
Earth measurements, 14-16.

Blau (Friedericus). Commentatio de ambitu terræ, ab Erastothene et Psidonio diversis definito. Contained in: Ad sollemne discipulis omnium ordinum gymnasii Nordhausani die V. et VI. April. MDCCCXXX. Subeundum et aliquot adolescentium publice abituorum declamationes die VII, ejus d. M. Audiendas invitat Dr. Carolus Augustus Schirlitz.
12°, Nordhausæ, 3-13, n. d. (Gore.)

Bliss (P. C.). Mason and Dixon's line.
Historical Mag., V, 1861, 199-202.

Blosseville (de). Note sur les observations du capitaine Sabine dans son dernier voyage.
Corr. Astron. (Zach.), XIII, 1825, 422-427.

Boaz (James). Proposal for a new method of determining a fixed unit of measure, by deducing the same from the curvative of the earth.
Phil. Mag. (Tilloch), LXI, 1823, 266-269.

Bode (Johann Elert). Anleitung zur physischen, mathematischen und astronomischen Kenntniss der Erdkugel.
12°, Berlin, 1786, pp. 366.
2d ed., Berlin, 1803.
3d ed., Berlin, 1820, pp. xxiv, 527, 7 plates. (Gore.)
Dritter Abschnitt: Nähere Untersuchung über die eigentliche Gestalt der Erde, 143-161. Vierter Abschnitt: Von der Grösse der Erde, 161-203.

Böckh (August). Metrologische Untersuchungen über Gewichte, Münzfüsse und Masse des Alterthums.
8°, Berlin, 1838, pp. xxviii, 482. (Washington, Congress.)

Boehmus (Andreas). Desideria circa rerum mensuras.
Acad. Sci. Phil. Med. Hassiacæ, Acta, 1771, 5-10.

Boeklen (O.). Ueber die geodätischen Linien auf dem Ellipsoid.
Arch. d. Math. (Grunert), XXXV, 1860, 101-103.

——— Zur Theorie der geodätischen Linien.
Arch. d. Math. (Gurnert), XXXIX, 1862, 189-198.

——— Ueber die Winkelsumme in Dreiecken, gebildet aus Linien des Systems (a) oder aus geodätischen Linien.
Arch. d. Math. (Grunert), XLIII, 1865, 18-25.

——— Ueber geodätische Linien.
Zeits. f. Math. (Schlömilch), XXVI, 1881, 264-269.

——— Ueber das physiche Pendel.
Zeits. f. Math. (Schlömilch), XXVIII, 1883, 304-309.

Börsch (A.). Ueber den Einfluss der Wahl verschiedner Nullrichtungen auf die Ausgleichung von Richtungsbeobachtungen.
Astron. Nachr., XLCVII, 1880, 181-186.

——— Die Bestimmungen der Ausdehnungscoefficienten von Eisen und Zink vermittelst des Bessel'schen Basisapparats.
Astron. Nachr., XCIX, 1881, 177-190.

———: **Gauss (C. F.).** Abhandlungen zur Methode der kleinsten Quadrate.
Berlin, 1887.
Title in full under GAUSS (C. F.).

——— Das märkisch-thüringische Dreiecksnetz. Veröffentlichung des königl. preussischen geodätischen Instituts.
4°, Berlin, 1889, VIII, 144, 1 map. (Gore.)
Revd. in Zeits. f. Vermes., XVIII, 1889, 155-159.

Börsch (O.). Ueber die Genauigkeit der Winkel- und Linien-Messungen.
Zeits. f. Math. (Schlömilch), VIII, 1863, 321-341.

——— Bestimmung der Genauigkeit von Winkel- und Linien-Messungen aus Beobachtungen abgeleitet.*
8°, Marburg, 1863.

——— *und* **Kaupert.** Bericht über den Stand der geodätisch-astronomischen Arbeiten im Kurfürstenthum Hessen zum Zwecke der mitteleuropäischen Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1864, 12-13; 1865, 45-56.

Börsch (O.)—Continued.

——— ——— Auszug aus dem Berichte über die im Jahre 1866 ausgeführten geodätischen Arbeiten für die mitteleuropäische Gradmessung im vormaligen Kurfürstenthum Hessen.
Int. Geod. Cong., Gen.-Ber., 1866, 30–33.

——— Ueber den mittleren Fehler der Resultate aus trigonometrischen Messungen.
Arch. d. Math. (Grunert), XLVI, 1866, 40–44.

——— Anleitung zur Berechnung der rechtwinkeligen sphärischen Coordinaten der Dreieckspunkte sowie der Dreiecksseiten und ihrer Richtungen aus den gegebenen geographischer Breiten und Längen der Dreieckspunkte. Mit besonderer Berücksichtigung der trigonometrischen Landesaufnahme des vormaligen Kurfürstenthums Hessen als Grundlage für Gemarks-, Forst- und dergleichen Vermessungen.
8°, Cassel, 1868, pp. 48.
2d ed., Cassel, 1885. (British Museum.)

——— Ueber die Ausgleichung einer um ein Polygon gelegten geodätischen Dreieckskette.
Astron. Nachr., LXXI, 1868, 265–268, 379–380.

——— Tafeln für geodätische Berechnungen zwischen den geographischen Breiten von 35° bis 71°, nach Bessel's Elementen des Erdsphäroides.
4°, Cassel, 1869, pp. 28. (Brussels, Dépôt de la Guerre.)

——— Bericht über die Thätigkeit des geodätischen Instituts, 1869, 1881–'82.
Title in full under BAEYER (J. J.).

——— Ueber die Genauigkeit der Längen-Messungen mit Kette und Latten.
Zeits. f. Vermes., II, 1873, 185–199.

——— Literatur der praktischen und theoretischen Gradmessungs-Arbeiten. Zweite Mittheilung, enthaltend die Publicationen aus den Jahren 1881, 1882 und 1883.
Int. Geod. Cong., Gen.-Ber., 1883, 1–32, Appendix 8.

——— Geodätische Literatur. Auf Wunsch der Permanenten Commission im Centralbureau zusammengestellt von —.
8°, Berlin, 1889, pp. VII, 226.

BOHEMIA.

FLIGELY. Bericht über die in Böhmen ausgeführten geodätischen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1863, 15–16; 1864, 24–26; 1865, 17–19; 1866, 53–55; 1868, 57–59; 1869, 80–83; 1870, 27–29.

Bohn (C.). Ueber einen Temperatureinfluss bei geodätischen Längenmessungen.
Zeits. f. Vermes., XI, 1882, 514–523.

——— Die Landesmessung. Ein Lehr- und Handbuch.
8°, Berlin, 1886, pp. xvi, 761. (Berlin, Royal.)

Bohnenberger (Johann Gottlieb Friedrich von). Anleitung zu geographische Ortsbestimmung.
8°, Göttingen, 1795.
2d ed. Bearbeitet von G. A. Jahn, Göttingen, 1852, pp. xii, 346, 5 pl.

——— Trigonometrische Vermessung von Schwaben.
Mon. Corr. (Zach), V, 1802, 216–226; VI, 1802, 23–27.

——— Astronomie.
8°, Tübingen, 1811, pp. 448. (Washington, Observatory.)
Von der Gestalt und Grösse der Erde, 187–218; Von der Gestalt der Erde und der Planeten, von dem Gesetz der Veränderung der Lage ihrer Umeredungsaxen, 626–697.

Bohnenberger (Johann Gottlieb Friedrich von)—Continued.

——— Barometrische und trigonometrische gemessene Höhen in Schwaben.
Tübinger Blätter, I, 1815, 326–336.

——— Eine Aufgabe der praktischen Geometrie.
Zeits. f. Astron. (Lindeneau), 1817, 121–126.

——— Ueber die Bestimmung der Länge des einfachen Secundenpendels.
Württemb. Abhandl., I, 1826, 1–34.

——— Die Berechnung der trigonometrischen Vermessung mit Rücksicht auf die sphäroidische Gestalt der Erde. Deutsche Bearbeitung von Hammer.
8°, Stuttgart, 1885, pp. vi, 65. (Berlin, Royal.)

Bohnenberger (Joan. Theophil. Frider.). De computandis dimensionibus trigonometricis in superficie terræ sphæroidica institutis commentatur et vitas illorum quibus summi in philosophia honores, A. 1823–'24 tributi sunt.
8°, Tubingæ, 1826, pp. 63. (Washington, Congress.)

Bolotof (Alexei Pawlowitsch). Vollständiger Cursus der höheren und niederen Geodäsie. (Russian.)
St. Petersburg, 1837; St. Petersburg, 1845, pp. xiii, 580; St. Petersburg, 1849, pp. xi, 300, 4 tables, 16 plates. (British Museum.)

Boncompagni (Pietro). Sulle variazioni orarie e mensili di gravità.
Nuovi annali delle scienze naturali, V, 1841, 297–302; VII, 1842, 165–167.
Appendice by GHERARDI, 302–305.

Bond (George M.). Standards of length and their subdivisions.
Jour. Frank. Inst., CXVII, 1884, 281–295.
Marked to be concluded, but no more was published.

Bond (George P.). On the use of equivalent factors in the method of least squares.
Am. Acad., Mem., VI, 1857, 179–212.

Bonne (Rigobert). Principes sur les mesures en longueur et en capacité, sur les poids et les monnoies; dépendans du mouvement des astres principaux et de la grandeur de la terre. Ouvrage propre à réformer ou à rectifier les poids et les mesures de la France et des autres états.
8°, Paris, 1790, pp. XV, 87, 1 plate. (Washington, Coast Survey.)

——— De la détermination des longitudes terrestres par le moyen des signaux de feu.
Dépôt de la Guerre, Mém., III, 1826, 25–60.
A historic sketch of the attempts. The first was in 1739.

——— Notice sur la mesure de l'arc de longitude compris entre Munich et Brest, exécutée dans le cours de cette année 1825, faisant suite au mémoire sur le même objet, inséré, page 25, de ce recueil. *See* **Bonne**. De la détermination, etc.
Dépôt de la Guerre, Mém., III, 1826, 395–406.

——— Opérations géodésiques (France).
Dépôt de la Guerre, Mém., I, 1829, 25–78.

Bonnet (Pierre-Ossian). Sur quelques propriétés des lignes géodésiques.
Acad. d. Sci. Paris, Comp. Rend., XL, 1855, 1311–1313.

——— Sur les lignes géodésiques.
Acad. d. Sci. Paris, Comp. Rend., XLI, 1855, 32–35.

Bonnet (Pierre-Ossian)—Continued.

——— Note sur la courbure géodésique.
Acad. d. Sci. Paris, Comp. Rend., XLII, 1856, 1137–1139.

——— Mémoire sur la figure de la terre considérée comme peu différente d'une sphère.
Ann. Sci. Mat. e Fis. (Tortolini), II, 1859, 46–59, 113–131, 180–184.

——— Démonstration du théorème de Gauss relatif aux petits triangles géodésiques situés sur une surface courbe quelconque.
Acad. d. Sci. Paris, Comp. Rend., LVIII, 1864, 183–188.

——— Démonstration nouvelle de deux théorèmes de M. Bertrand (Périphérie et contenu d'un cercle géodésique).
Acad. d. Sci. Paris, Comp. Rend., XCVII, 1883, 1360–1362.

Bonsdorff (Johann Gabriel). De figura telluris ope pendulorum determinanda.
8°, Aboæ, 1815, pp. 10. (British Museum.)

Borda (Jean-Charles de), Lagrange, Laplace, Monge *et* **Condorcet.** Rapport fait à l'Académie des sciences sur le choix d'une unité de mesures.
Acad. d. Sci. Paris, Mém., 1791, 7–16 (Hist.).
Suggesting the use of the ten-millionth part of the earth's quadrant as the unit.

——— : **Biot (J.-B.).** Sur la longueur du pendule par le procédé de —.
Soc. Philom., Bull., VI, 1821, 70–77; Ann. d. Phys. (Gilbert), LXIX, 1821, 337–352.

——— : **Rünker (C. L. C.).** Observations for determining the absolute length of the pendulum vibrating seconds at Paramatta, according to the method of —.
Roy. Astron. Soc., Mem., III, 1827, 277–298; Month. Not., I, 1827–'30, 75–76.

——— : **Faye (H.-A.-E.-A.).** Rapport sur un mémoire de M. Peirce concernant les anciennes déterminations de la pesanteur par —.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1463–1466.

Borden (Simeon) *and* **Paine (R. T.).** Account of a trigonometrical survey of Massachusetts.
Am. Acad., Mem., I, 1833, 338–344.

——— Comparisons of the dimensions of the earth, obtained from measurements made in the survey of the State of Massachusetts, with accredited mean determinations.
Am. Phil. Soc., Proc., III, 1843, 130–132.

——— Tables of bearings, distances, latitudes, longitudes, etc., ascertained by the astronomical and trigonometrical survey of Massachusetts. Published agreeably to a resolve of the general court by John G. Palfrey, secretary of the Commonwealth.
Boston, 1846, pp. —. (Washington, Congress.)

——— Account of a trigonometrical survey of Massachusetts, by Simeon Borden, esq., with a comparison of its results with those obtained from astronomical observations by Robert Treat Paine, esq., communicated by Mr. Borden. Read 16th April, 1841.
Amer. Phil. Soc., Trans. IX, 1846, 33–93.

Borden (Simeon)—Continued.

DAUSSY (P.). Sur le levé trigonométrique de l'état de Massachusetts.
Soc. Géogr., Bull., XVI, 1841, 324–331.

GORE (J. H.). Borden's survey of Massachusetts.
Railroad and Eng. Jour., LXI, 1887, 152–153; Zeits. f. Vermes., XVII, 1888, 203–207.

ANON. Borden's Survey.
North Am. Rev., LXI, 1845; 455–468.

Bordoni (Antonio Maria). Trattato di geodesia elementare.
Milano, 1825, pp. viii, 456, 17 plates. (Gore.)
2d ed., Pavia, 1843.
3d ed., Milano, 1859.
Revd. in Bull. Sci. Math. (Ferussac), II, 1824, 30–31; III, 1825–'26.

Borenius (Henrik Gustaf). Calcul comparatif de différentes observations du pendule constant.
Acad. de St.-Pétersbourg, Bull. Sci., IX, 1842, 73–75.

——— Ueber die Berechnung der mit dem unveränderlichen Pendel zur Bestimmung der Abplattung der Erde angestellten Beobachtungen.
Acad. de St.-Pétersbourg, Cl. Phys.-Math. Bull., I, 1843, 1–29.

——— De gravitate ope penduli ex dato situ geographico determinanda. (H.)
Helsingfors, 1845.

Borletti. Precisione della misura d' un angolo fatta col teodolite e col cleps.*
Il Politecnico, XXXIV, 310+.

Bosscha (J.) *et* **Stamkart (F. J.).** Résumé des travaux géodésiques exécutés dans les Pays-Bas en 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 20–22.

Boscovich (Ruggiero Giuseppe). Dissertatio de telluris figura, habita in Seminario Romano. Nunc primum aucta, et illustrata ab ipsomet auctore.
4°, Romæ, 1739.

Memorie sopra la fisica e istoria naturale, II, 1744, 159–218.

——— De veterum argumentis pro telluris sphaericitate, dissertatio habita in Seminario Romano.*
4°, Romæ, 1739.
Lalande, 409.
Not found in La lande's own copy of Boscovich's opera now in Bibliothéque royale, Brussels. It may be a part of Dissertatio de telluris, etc., though there is no such sub-title.

——— De inæqualitate gravitatis in diversis terræ locis, dissertatio habita in Seminario Romano.*
4°, Romæ, 1741.
Lalande, 415.

——— *et* **Marie (C.).** De expeditione ad dimetiendos duos meridiani gradus.
Romæ, 1755. Translation, Paris, 1770.
Title in full under MARIE (C.).

——— ——— : **dela Condamine (C. M.).** Letter to Dr. Malty regarding the measure of—.
Roy. Soc. London, Phil. Trans., XLIV, II, 1756, 623–624.

——— De inequalitate gravitatis per superficiem telluris, et figura ipsius telluris ex æquilibrio.
Phil. Recent. (Stay), II, 1760, 359–380.

Boscovich (**Ruggiero Giuseppe**)—Continued.

——— De deviationibus pendulorum ex asperitate superficiei terrestris, et methodo definiendi massam terræ.
Phil. Recent. (Stay), II, 1760, 380–385.

——— De veterum conatibus pro magnitudine terræ determinanda.
Phil. Recent. (Stay), II, 1760, 385–390.

——— De primis recentiorum conatibus pro determinanda magnitudine telluris.
Phil. Recent. (Stay), II, 1760, 390–393.

——— De figura et magnitudine terræ ex plurium gradum comparatione.
Phil. Recent. (Stay), II, 1760, 400–406.

——— De recentissimis graduum dimensionibus et figura ac magnitudine terræ inde derivanda.
Phil. Recent. (Stay), II, 1760, 406–426.

——— Opera pertinenta ad opticam et astronomicam. 5 vols, (H.)
4°, Bassani, 1785.
De determinatione longitudinis pendulis oscillantis ad singula secunda temporis medii. v. 179–270.

———: **Ricchebach** (**G.**). Esame imparziale della triangolazione del —.
Roma, 1846.
Title in full under RICCHEBACH (G.).

Bosscha (**J.**). Relation des expériences qui ont servi à la construction de deux mètres étalons en platine iridié, comparés directement avec le mètre des archives.
École Polytech., Ann., I, 1885, 65–144; II, 1886, 1–122.

Boswell (**G. J.**). Remarks on a paper of Mr. — on invariable pendulums.
Jour. Nat. Phil. (Nicholson), XV, 1806, 84–86.

Boucheporn (**de**). [Note sur la variation de la pesanteur.]
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 1005–1007.
Regarding the height of the column of mercury in a closed barometer. *See* BABINET, "Sur la prétendue."

Bouchotte (**Émile**). Étude sur la valeur du stade de la coudée et de quelques autres mesures anciennes.
Acad. de Metz, Mém., XLI, 1859–'60, 415–448.

Boué (**Ami**). Ueber die geometrische Regelmässigkeit des Erdballes im Allgemeinen, insbesondere über diejenige seiner Wasserrinnen und die Abtheilung dieser in symmetrische Gruppen.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., XXIII, 1850, 255–269.

Bouguer (**Pierre**). Comparaison des deux loix que la terre et les autres planètes doivent observer dans la figure que la pesanteur leur fait prendre.
Acad. d. Sci. Paris, Mém., 1734, 21–54.

——— Sur la longueur du pendule (dans l'isle de Saint-Dominigue).
Acad. d. Sci. Paris, Mém., 1735, 522–528.

——— De la manière de déterminer la figure de la terre par la mesure des degrés de latitude et de longitude.
Acad. d. Sci. Paris, Mém., 1736, 443–468.

Bouguer (**Pierre**)—Continued.

——— Relation abrégée du voyage fait au Pérou par messieurs de l'Académie royale des sciences pour mesurer les degrés du méridien aux environs de l'équateur, et en conclure la figure de la terre.
Acad. d. Sci. Paris, Mém., 1744, 249–297.
Continued in the same for 1846, 569–606.

——— Expériences faites à Quito et dans divers autres endroits de la zone torride, sur la dilatation et la contraction que souffrent les métaux par le chaud et par le froid.
Acad. d. Sci. Paris, Hist., 1745, 230–260.

——— La figure de la terre déterminée par les observations de MM. Bouguer et de la Condamine de l'Académie royale des sciences, envoyés par ordre du roi au Pérou pour observer aux environs de l'équateur.
4°, Paris, 1749, pp. [xxii], cx, 394, 7 plates. (Gore.)

——— Sur les observations de la parallax de la lune qu'on pourroit faire en même temps en plusieurs endroits, avec la méthode d'évaluer les changemens que cause à ces parallaxes la figure de la terre.
Acad. d. Sci. Paris, Mém., 1751, 64–86.

——— Justifications des Mémoires de l'Académie royale des sciences de 1744, et du livre de la figure de la terre, déterminées par les observations faites au Pérou, sur plusieurs faits qui concernent les opérations des académiciens.
4°, Paris, 1752, pp. viii, 54. (British Museum.)
2d ed., Acad. d. Sci. Paris, Mém., 1809.

——— Lettre à monsieur * * * dans laquelle on discute sur divers points d'astronomie pratique et où l'on fait quelques remarques sur le supplément au journal de M. de la Condamine.
Paris, 1754, pp. 51. (British Museum.)

——— *et* **Camus** (**C.-E.-L.**), **Cassini de Thury** *et* **Pingré.** Opérations faites par ordre de l'Académie pour mesurer l'intervalle entre Ville Juive et Juvisy, en conclure la distance de la tour de Montthéri au clocher de Brie-Comte-Robert, et distinguer entre les différentes déterminations que nous avons du degré du méridien aux environs de Paris, celle qui doit être préservée.
Acad. d. Sci. Paris, Mém., 1754, 172–186.

———: **de la Condamine** (**C.-M.**). Réponsé à la lettre de — sur le supplément de M. de la Condamine.
Paris, 1754.
Title in full under DE LA CONDAMINE (C.-M.).

——— Sur la direction qu'affectent les fils à plomb.
Acad. d. Sci. Paris, Mém., 1754, 250–268.

———: **de la Condamine** (**C.-M.**). Supplément au Journal historique pour servir de réponse aux mémoirs de B[ougueur].
Paris, 1754.
Title in full under DE LA CONDAMINE (C.-M.). *See* BOUGUEUR (P.). Lettre sur "le supplément." Paris, 1754.

———, **Camus, Cassini de Thury** *et* **Pingré.** Observations faites par ordre de l'Académie royale des sciences pour la vérification du degré du méridien compris entre Paris et Amiens.
8°, Paris, 1757, pp. 28. (British Museum.)

Bouguer (Pierre)—Continued

——: **David (J.-P.)**. Dissertation sur la figure de la terre . . . la cause de réfractions que M. — assignoit à ce phénomène.

La Haye, 1771.

Title in full under DAVID (J.-P.).

——: **Grenus (T.)**. Resultate einer Vergleichung der Werke von —.

Mon. Corr. (Zach), XVI, 1807, 238–256.

Boulenger. Traité de la sphère du monde. Diuisé en quatre liures, ausquels est adrousté le cinquiesme de l'usage d'icelle.

2^e éd., 8°, Paris, 1628, pp. 30, 245.

De la mesure du globe terrestre, 179–183.

Bouquet de la Grye. Note sur l'usage du cercle méridien de Brunner et sur son emploi dans la mesure des bases.

Ann. Hydrog., XVI, 1859, 151–160.

Bourguignon-d'Anville (Jean-Baptiste). *See* **Anville (Jean-Baptiste-Bourguignon d')**.

Bourns (Charles). Principles and practice of land engineering, trigonometrical, subterraneous and marine surveying, with an appendix.

8°, London, 1843, pp. 366, 7 plates.

3d ed., 8°, London, 1846, pp. 356, 9 plates. (Oxford, Bodleian.)

Boutelle (Charles Otis). Primary base apparatus.

U. S. C. and G. Survey, Rep., 1855, 264–267.

—— Description of tripod and scaffold as used by him at primary triangulation stations.

U. S. C. and G. Survey, Rep., 1855, 361–363.

—— Geodetic night signals. Different kind of lights, experiments, comparison of day and night observations, expense, etc.

U. S. C. and G. Survey, Rep., 1880, 96–109.

—— On the construction of observing tripods and scaffolds.

U. S. C. and G. Survey, Rep., 1882, 199–208, App. 10.

—— *and* **Schott (C. A.)**. Connection at Lake Ontario of the primary triangulation of the Coast and Geodetic Survey with that of the Lake Survey.

U. S. C. and G. Survey, Rep., 1884, 387–390, App. 9.

—— On geodetic reconnaissance.

U. S. C. and G. Survey, Rep., 1885, 469–481, App. 10.

—— On a geodetic survey of the United States.

Science, VII, 1886, 460–461; Van Nostrand's Mag., XXXV, 1886, 38–40.

Bowditch (Nathaniel). On the calculation of the oblateness of the earth by means of the observed length of a pendulum in different latitudes, according to the method given by La Place in the second volume of his "Mécanique céleste," with remarks on other parts of the same work, relating to the figure of the earth.

Am. Acad., Mem., IV, 1818, 30–49.

——: **La Place (P.-S. de)**. Mécanique céleste. Translated by —.

Boston, 1829–'39.

Title in full under LA PLACE (P.-S. de).

Bradley (James). An account of some observations made in London, by Mr. G. Graham, and at Black River, in Jamaica, by C. Campbell, concerning the going of a clock, in order to determine the difference between the lengths of isochronal pendulums in those places.

Roy. Soc. London, Phil. Trans., XXXVIII, 1735, 302–314.

The ellipticity of the earth is also deduced from these observations.

—— Experiments to determine the length of the pendulum vibrating seconds at Greenwhich. (H.) 1743–'49.

[Brande (W. T.).] A brief investigation of the properties of the geodetic curve.

Quart. Jour. Sci., XXI, 1826, 136–137.

A criticism of Bessel's method of computing the curve of shortest distance on a spheroid, founded on the theorem of Taylor.

—— A simple rectification of the geodetic curve.

Quart. Jour. Sci., XXI, 1826, 153–155.

—— A table of coefficients, subservient to geodetical calculations.

Quart. Journ. Sci., XXI, 1826, 337–345.

Brandes (Heinrich Wilhelm). Vorlesungen über die Astronomie, zur Belehrung derjenigen, denen es an mathematischen Vorkenntnissen fehlt, von H. W. Brandes.

8°, Leipzig, 1827, pp. i, viii, 255, 10 plates. (Washington Obsevratory.)

Gestalt der Erde, 24–35.

II. Leipzig, 1827, VIII, 273, 11 plates.

Branfill (B. R.) *and* **Hennessey (J. B. N.)**. Budhon meridian series.

India, Trig. Survey, VII, 1882, i–xvi, 1–74, 1 plate.

—— —— Gurwani meridional series. (Long. 82° 20′.)

India, Trig. Survey, VIII, 1882, i–viii, 1–45.

—— —— Gora meridional series.

India, Trig. Survey, VIII, 1882, i–ix, 1–70.

—— —— Chendwar meridional series.

India, Trig. Survey, VIII, i–viii, 1–56.

Braschmann (Nic.). Note sur le mouvement de pendule simple. (H.)

Acad. de St.-Pétersbourg., Bull., X, 1852, 81–86.

Brassinne (E.). Proposition sur une question de mécanique relative à la figure de la terre.

Acad. d. Sci. Paris, Comp. Rend., XCVII, 1883, 637–639, 1137–1139.

Braunmühl (A. von). Ueber geodätische Linien auf Rotationsflächen und jene Einhüllenden derselben, welche von allen durch einen Punkt gehenden kürzesten Linien gebildet werden.

8°, München, 1878, pp. 52, 1 plate. (Munich, Royal.)

—— Ueber Enveloppen geodätischer Linien.

Math. Ann. (Clebsch), XIV, 1879, 557–566.

—— Geodätische Linien und ihre Enveloppen auf dreiaxigen Flächen zweiten Grades.

Math. Ann. (Clebsch), XX, 1882, 557–586.

—— Ueber die reducirte Länge eines geodätischen Bogens und die Bildung jener Flächen deren Normalen eine gegebene Fläche berühren.

K. bay. Ak. d. Wiss., math.-phys. Cl., XIV, III, 1882, 93–110.

Braunmühl (A. von)—Continued.

——— Ueber geodätische Linien auf den dreiaxigen Flächen zweiten Grades, welche sich durch elliptische Functionen darstellen lassen.*
Math. Ann. (Clebsch), XXVI, 1885.

Bredichin (Th.). Expériences faites avec le pendule à réversion.
Obs. de Moscou, Ann., VIII, 1882, 31–56.

Breen (H.). Base-line apparatus.
Van Nostrand, Mag., XXVII, 1882, 89–98.

Bremiker (Carl). Ueber Gradmessungen.
Astron. Nachr., XLIII, 1856, 209–224.
A continuation promised but not given.

——— Studien über höhere Geodäsie.
8°, Berlin, 1869, pp. 81. *Weidmann.* (Gore.)
Revd. in Jahrb. d. Fortschr. d. Math. II, 1869–'70, 836–838, by B[RUNS].
An effort to find a spheroid on which the sum of the squares of the deflections of the plumb-lines shall be a minimum, these deflections being what is known as station errors, or the differences between observed and computed astronomic positions.

——— Bericht über die Thätigkeit des geodätischen Instituts, 1869–'70, 1872–'73.
Title in full under BAEYER (J. J.).

——— Bericht über die geodätischen Arbeiten in Baden pro 1873.
Int. Geod. Cong., Gen.-Ber., 1873, 1.

——— *und* (**Peters C. A. F.**). [Bericht über die geodätischen Arbeiten in Preussen im Jahre 1874.]
Int. Geod. Cong., Gen.-Ber., 1874, 63–66.

——— Ueber Winkelmessung und Ausgleichung. Vergleichung zwischen drei Methoden: (1) Winkelmessung zwischen allen Combinationen der Zielpunkte, (2) Winkelmessung nur mit der Horizontprobe auf 360°, (3) Richtungsbeobachtungen mit mehr als zwei Zielpunkten in einem Satze.
Astron. Nachr., LXXXIX, 1877, 65–78.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 779–780, by B[runs].

——— *und* **Fischer (A.)**. Das rheinische Dreiecksnetz. Publication des geodätischen Instituts.
4°, I. Die Bonner Basis, Berlin, 1876, pp. [4], 75, 1 plate.
Revd. in Astron. Ges., Vierteljahrs., XII, 1877, 146–166.
II. Die Richtungs-Beobachtung, Berlin, 1878, pp. xii, 164, 6 plates.
III. Die Netzausgleichung, Berlin, 1882, pp. vii, 205. (Gore.)

Bremond (de). [Transactions philosophiques de la Société royale de Londres.] Translated with notes, 1731–'36; (H.)
4°, Paris, 1739–'41.
There is a note to Bradley's account of the Jamaica experiments containing an exhaustive review of pendulum history up to date.

Brettner (H. A.). Mathematische Geographie. Ein Leitfaden beim Unterrichte dieser Wissenschaft in höhern Lehranstalten. Vierte verbesserte und vermehrte Auflage.
8°, Breslau, 1856, VIII, 1001. (British Museum.)
Die Gestalt der Erde, 5–11.
Leipzig, 1868; 7. ed., Breslau, 1872.

Brewer (Johann Paul). Anfangsgründe der mathematischen Geographie für mittlere und obere Klassen der Gymnasien, sowie für alle, welche ohne mathematische Vorkenntnisse sich einen deutlichen Begriff von dem Weltsysteme zu verschaffen wünschen.
8°, Düsseldorf, 1828, pp. 154, 4 plates. (Berlin, Royal.)
Von der Gestalt der Erde, 16–36.

Brewster (David). On the effects produced in astronomical and trigonometrical observations, etc., by the descent of the fluid which lubricates the cornea.
Quart. Journ. Sci., II, 1816, 127–131.

Breymann (C.). Sammlung geodätischer Aufgaben.*
Wien, 1868.
Revd. in Jahrb. üb. d. Fortschr. d. Math., I, 1868, 384.

Brill (A.). Zur Theorie der geodätischen Linie und der geodätischen Dreiecks.
K. bay. Ak. d. Wiss., math.-phys. Cl., Abhandl., XIV, 1883, ii, 109–140; Sitz.-Ber., XIII, 1883, 51.

Brinkley (John). Elements of astronomy.
2d ed., 8°, Dublin, 1819, pp. xxiii, 328. (Washington, Observatory.)
Measurements of degrees of latitude, pp. 244–258.

Brioschi (Carlo). Della variazione del moto dei pendoli dipendente da quella della temperatura. (H.)
Eff. Astron., Milano, 1812, 114–123.

Brioschi (Francesco). Sulla integrazione della equazione geodetiche.
Ann. Sci. Mat. e Fis. (Tortolini), IV, 1853, 133–135.

Brisbane (Thomas): **Kater (A.)**. Account of experiments made with a pendulum at New South Wales by —.
Roy. Soc. London, Phil. Trans., CXIII, 1823, 308–325.

———: **Dulong (T.)**. Expériences faites avec un pendule par —.
Bull. Sci. Math. (Saigey), II, 1824, 123–124.

Brisson (Mathurin-Jacques). Essai sur l'uniformité des mesures, tant linéaires que de capacité et de poids; et sur une nouvelle manière de construire les toises destinées à servir d'étalon.
Acad. d. Sci. Paris, Mém., 1788, 722–727.

Brit. A. A. S., Rep., *for* British Association for the Advancement of Science. Reports of the meetings, including its proceedings, recommendations, and transactions.
8°. (Washington, Observatory.)

Brito Limpo (Francisco Antonio de). Memoria sobre a determinação do comprimento do pendulo.
4°, Lisboa, 1865, pp. 13. (Vienna, War Office.)

——— Taboas para o calculo das refracções terrestres, e resolução analytica de uno problema de topographia.
8°, Lisboa, 1865, pp. 24, 1 plate. (Berlin, Geodetic Institute.)

——— Sobre as refracções terrestres.*
Soc. Atheno do Porto, Rev. I, 1885.

Brix (Adolph Ferdinand Wencelaus). Bericht über die im Jahre 1863 angestellten Vergleichungen zweier dem k. Handelsministerium angehörigen Metermaasse mit dem Urmeter der kaiserl. Archiv zu Paris.
4°, Berlin, 1864. pp. 22. (Berlin, Geodetic Institute.)

Broch (Ole Jacob). Accélération de la pesanteur sous différentes latitudes et à différentes altitudes.
Int. Bureau Weights and Measures, Travaux et Mém., I, 1881, 1–15.

Brönnimann (F.) Auffindung eines groben Winkelfehlers in einem Polygonzug.
Zeits. f. Vermes., XVII, 1888, 524–526.

Broun (John Allan). *Notice of an instrument intended for the measurement of small variations of gravity.*
Roy. Soc. Edinb., Proc., IV, 1862, 411–412.

——— On an apparatus for the statical measure of gravity.
L., E., D. Phil. Mag., XXVI, 1863, 158–160.

Brousseaud *et* Niccollet. Mémoire sur la mesure d'un arc du parallèle moyen entre le pôle et l'équateur.
Conn. d. Temps, 1829, 252–296.
Separately, 8°, Paris, 1826, pp. 46, 1 plate.
Revd. in Journ. d. Sav., 1827, 574.

———: (**B.**). Ueber die Längen-Gradmessung im Parallel des 45. Grades.
Hertha, IX, 1827, 277–288; xi, 448–456.
Title in full under B.

——— Mesure d'un arc du parallèle moyen entre le pôle et l'équateur.
4°, Limoges, 1839, pp. 194, 7 plates. (British Museum.)

Bruhns (Carl Christian). Gradmessung.
Allgemeine Encyklopädie der Wissenschaften und Künste von Ersch und Grüber, Section 1, 18–37.

——— Bericht über die geodätischen und astronomischen Arbeiten im Königreich Sachsen.
Int. Geod. Cong., Gen.-Ber., 1865, 35–37.

——— Bericht über die geodätisch-astronomischen Arbeiten im Königreich Sachsen.
Int. Geod. Cong., Gen.-Ber., 1866, 45–46.

——— Bericht der permanenten Commission für Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1867, 12–15.

——— *und* **Weisbach (J.).** Ueber die geodätischen Arbeiten im Königreich Sachsen, 1868.
Int. Geod. Cong., Gen.-Ber., 1868, 49–53.

——— Bericht über die Thätigkeit des geodätischen Instituts, 1869.
Title in full under BAEYER (J. J.).

——— Bestimmung der Länge des Secundenpendels in Bonn, Leyden und Mannheim.
4°, Leipzig, 1871.
In Publication des königl. preussischen geodätischen Instituts. Astronomisch-geodätische Arbeiten, 1870, 107–162, 2 plates; Int. Geod. Cong., Gen.-Ber., 1870, 43–46, 60–63.

——— Zusammenstellung der ausgeführten astronomischen Bestimmungen, welche zur europäischen Gradmessung gehören.
K. k. geogr. Ges., Mittheil., XV, 1872, 410–415; Int. Geod. Cong., Gen.-Ber., 1871, 127–132.

——— Mittheilung über die Ermittelung der Coordinaten der Pleissenburg und verschiedener Thürme in Bezug auf die Leipziger Sternwarte, und über die Construction eines Basisapparates.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Ber., 1872, 352–369.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IV, 1872, 586–587, by WTN. [WITTSTEIN].

Bruhns (Carl Christian)—Continued.

——— *und* **Nagel (A.).** Bericht über die im Jahre 1872 im Königreich Sachsen ausgeführten Gradmessungs-Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1872, 53–57.

——— *und* ——— Bericht über die im Jahre 1873 im Königreich Sachsen ausgeführten Gradmessungsarbeiten.
Int. Geod. Cong., Gen.-Ber., 1874, 29–32.

——— Bericht über die neuesten Fortschritte der europäischen Gradmessung.
Geogr. Jahrb. (Behm), V, 1874, 144–168; VI, 1876, 284–310; VII, 1878, 243–279; VIII, 1880, 275–303.

——— *und* **Nagel (C. A.).** Bericht über die im Königreich Sachsen ausgeführten Gradmessungsarbeiten (1875).
Int. Geod. Cong., Gen.-Ber., 1875, 215–216.

——— Gutachten der Pendel-Commission.
Int. Geod. Cong., Gen.-Ber., 1875, 78–89.

——— *und* **Nagel (A.).** Bericht über die geodätischen Arbeiten in Sachsen pro 1876.
Int. Geod. Cong., Gen.-Ber., 1876, 122–123.

——— Ueber die Bestimmung der Grösse und Figur unserer Erde durch Gradmessungen.
Kalendar und statistisches Jahrbuch für das Königreich Sachsen auf das Jahr 1876, 8°, Dresden, 1876, 52–69.

——— *und* **Nagel (A.).** Bericht über die geodätischen Arbeiten in Sachsen für das Jahr 1877.
Int. Geod. Cong., Gen.-Ber., 1877, 304–305.

——— Die fünfte allgemeine Conferenz der Bevollmächtigten der europäischen Gradmessung.
Leopoldina, XIII, 1877, 184–185.

——— *und* **Nagel (A.).** Bericht über die geodätischen Arbeiten in Sachsen für das Jahr 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 106–110.

——— ——— *Bericht über die geodätischen Arbeiten* in Sachsen für das Jahr 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 36–37.

——— ——— Die Grossenhainer Grundlinie. Astronomisch-geodätische Arbeiten für die europäische Gradmessung im Königreich Sachsen. 1. Abtheilung.
4°, Berlin, 1882, pp. vii, 172, 5 plates.
Revd. in Zeits. f. Vermess., XII, 1883, 596–604, by HELMERT.

——— *und* **Paschen (P.).** Grossherzoglich mecklenburgische Landesvermessung.
Schwerin, 1882.
Title in full under PASCHEN (P.).

Bruno (Fr. Faà de). *See* **Faà De Bruno (Fr.).**

Bruns (Heinrich). Die Figur der Erde. Ein Beitrag zur europäischen Gradmessung. Publication des königl. preussischen geodätischen Institutes.
4°, Berlin, 1878, pp. 49. *Stanciewicz.* (Gore.)
Revd. in Jahrb. üb. d. Fortschr. d. Math., x, 1878, 765–767, by B[RUNS].

——— Ueber die Umkehrung der Bessel'schen Methode der sphäroidischen Uebertragung.
Astron. Nachr., XCVII, 1880, 73–74.

——— Bemerkung über die geodätische Linie.
Zeits. f. Vermes., x, 1881, 298–301.

Bruns (Heinrich)—Continued.

——: **Helmert (F. R.)**. Die mathematische und physische Theorie der höheren Geodäsie. Second part. Revd. by —.
Astron. Ges., Vierteljahrs., XX, 1885, 182–193.
Title in full under HELMERT (F. R.).

—— Ueber eine Aufgabe der Ausgleichungsrechnung.*
Leipzig, 1886.

Bürja (Abel) [*sometimes* Burja]. Erleichteter Unterricht in der höheren Messkunst, oder deutliche Anweisung zur Geometrie der krummen Linien.
8°, Berlin, 1788, I, pp. xxxiii, 382; II, pp. 388. (Berlin, Royal.)

—— Sur la longueur du pendule à secondes à Berlin.
Acad. d. Sci. Berlin, Mém., 1799–1800, 3–17.

Bugge (Thomas). Beskrivelse over den Opmaalings Maade, som er brugt ved de danske geographiske Karter; med tiløret trigonometrisk Karte over Siæland, og de der hendrønde Triangler, begegnede Longituder og Latituder, samt astronomiske Observationer.
4°, Kjøbenhavn, 1779, pp. xvi, 132, 1 chart. (British Museum.)

—— Beschreibung der Ausmessungs-Methode, welche bei den dänischen Karten angewendet worden.
4°, Dresden, 1787, pp. 177, 2 maps. (British Museum.)
Translated from the Danish by J. F. Marcus, and edited by F. L. Aster.

Bull. Sci. Math. (Férussac), *for* Bulletin universel des sciences et de l'industrie. Publié sous la direction du baron de Férussac et divisé en huit sections principales. Section I. Bulletin des sciences mathématiques, physiques et chimiques. (Saigey.)
8°, Paris. (Washington, Congress.)

Bunt (Thomas G.). On pendulum experiments.
L., E., D. Phil. Mag., I, 1851, 552–554; II, 1851, 37–41; IV, 1852, 272–275.

Burckhardt (Johann Karl). Remarques sur la mesure d'un arc du méridien, exécutée en Angleterre par Mr. Mudge.
Bibl. Brit. Genève, XXVIII, 1805, 284–287.

—— Examen des différentes manières d'orienter une chaîne des triangles.
Inst. d France, 1809, 535–545.

Bur. d. Long., Annuaire, *for* Annuaire du Bureau des longitudes.
18°, Paris, 1796 +. (Washington, Observatory.)

Burns (Arthur). Geodæsia improved; or, a new and correct method of surveying made exceedingly easy.
8°, Chester, 1771, pp. x, 355. (Oxford, Bodleian.)
Simple surveying.

Burrow (Reuben): **Dalby (J.)**. Account of measurement of a degree of longitude in Bengal.
London, 1796.
Title in full under DALBY (J.).

Busch (August Ludwig). Verzeichniss sämmtlicher Werke, Abhandlungen, Aufsätze und Bemerkungen von Friedr. Wilh. Bessel. Zusammengetragen, chronologisch geordnet und mit einem gedrängten Sachregister versehen von —.
4°, Königsberg, 1849, pp. 34.

Buttmann (Walther). Die niedere Geodäsie, ein Stiefkind im preussischen Staats-Organismus. Ein offenes Wort an alle Freunde des Vermessungswesens.
8°, Berlin, 1875, pp. 24. (British Museum.)

Buzengeiger (Karl Heribert Ignatius). Berechnung der Länge und Breite eines Orts aus gegebenen Perpendikel und Abstand vom Meridian eines gegebenen Orts.
Mon. Corr. (Zach), XXV, 1812, 478–483.

C. Geodetic observations by night.
Journ. Frank. IV, 18277, nst., CI27.
Conclusion of Perrier that azimuthal observations by night possess a degree of precision at least equal, if not superior, to that of observations by day.

—— The longest geodetic arc.
Journ. Frank. Inst., CX, 1880, 61.

—— Compensation of geodetic triangles.
Journ. Frank. Inst., CXII, 1881, 314.
Translation of a part of Adan's article in Acad. de Belgique, Bull., L, 1880, 260–265.

C. (H. T.). On fluidity, and an hypothesis concerning the structure of the earth.
Quart. Journ. Sci., IX, 1820, 52–61.
The hypothesis is that the interior of the earth is composed of condedsed fluids upholding lighter solids.

Cabello (Francisco) *y* **Barraquer (J. M.)**. Memoria sobre los errores de la red geodescia de España.
Madrid, 1874.
Title in full under BARRAQUER (J. M.).

—— ——. Estudios en que se funda la ecuacion del metro.
Madrid, 1881.
Title in full under BARRAQUER (J. M.).

Cagnoli (Antonio). Nuovo e securo mezzo per riconoscere la figura della terra.
Soc. Italiana, Mem., VI, 1792, 227–235.
Ascribed to ANDREA CAGNOLI by POGGENDORFF, I, 359.

—— Memoir on a new and certain method of ascertaining the figure of the earth by means of occultation of the fixed stars, with notes and an appendix by Francis Baily.
Phil. Mag. (Tilloch), LIII, 1819, 350–360, 406–416.
Translated from Memorie di matematica e di fisica della Società italiana, Tom. VI, 1792.

Caille (Nicholas-Louis de la). *See* **Lacaille (Nicholas-Louis de)**.

Calcutta Rev., *for* Indian Review and Journal of Science and the Arts.
8°, Calcutta, 1837–'38 (3 v.). (Washington, Congress.)

Calkoen (J. F. van Beek). *See* **Beek-Calkoen (J. F. van)**.

Callandreau (O.) Sur une méthode générale de transformation des intégrales dépendant de racines carrées. Application à un problème fondamental de géodésie.
Acad. d. Sci. Paris, Comp. Rend., LXXXV, 1877, 664–666, 1062–1065.
Revd. in Jabrb. üb. d. Fortschr. d. Math., IX, 1877, 780–781, by B[RUNS].

—— Sur la théorie de la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., C, 1885, 1204–1206.

Callandreau (O.)—Continued.

——— Mémoire sur la théorie de la figure de planètes.
Obs. de Paris, Ann., XIX, 1886.

——— Remarques sur la théorie de la figure de la terre.
Bull. Astron., 1888, 1–8.

Camb. Math. Jour. (Thomson), *for* Cambridge and Dublin Mathematical Journal (Thomson), 1846–'54. (Washington, Congress.)

Camb. Phil. Soc., Proc., *for* Proceedings of the Cambridge Philosophical Society.
8°, Cambridge, 1865+. (Washington, Observatory.)

Camerer (Johann Wilhelm von). Noch etwas über den französischer Mètre.
Mon. Corr. (Zach), IX, 1804, 220–223.
Reply by BEIGEL, 223–230.

——— Ueber die Veränderungsrechnung bey eben Dreyecken.
Astron. Jahrb. (Bode), 1805, 139–148.

Camp: Oltmanns (J.). Die trigonometrisch-topographische Vermessung Ostfrieslands durch —.
Leer, 1815.
Title in full under OLTMANNS (J.).

Campbell (C.): Bradley (J.). Account of some pendulum observations by—in Jamaica.
Roy. Soc. London, Phil. Trans., XXXVIII, 1735, 302–314.
Title in full under BRADLEY (J.).

Camus (C.-E.-L.) *et* **Picard (J.).** Degré du méridien entre Paris et Amiens.
Paris, 1740.
German translation, Zurich, 1742.
Title in full under PICARD (J.).

——— *et* **Bouguer (P.).** Opérations pour mesurer l'intervalle entre Ville Juive et Juvisy.
Acad. d. Sci. Paris, Mém., 1754, 172–186; Hist., 103–107.
Title in full under BOUGUER (P.).

Canadian Jour., *for* Canadian Journal of Industry, Science, and Art.
8°, Toronto, 1856–'68. (Washington, Patent Office.)

Cantor (Moritz). Die römischen Agrimensoren und ihre Stellung in der Geschichte der Feldmesskunst. Eine historisch-mathematische Untersuchung.
8°, Leipzig, 1875, pp. 237, 6 plates. (British Museum.)

CAPE OF GOOD HOPE.

EVEREST (G.). On the triangulation of the Cape of Good Hope.
Roy. Astron. Soc., Mem., I, 1822–'25, 255–270.

KATER (H.). Contributions to astronomy and geodesy from the Cape of Good Hope.
London, 1851.

LACAILLE (N.-L. DE). Journal historique du voyage fait au cap de Bonne-Espérance.
Paris, 1776.

MACLEAR (T.). Observations made at the Cape of Good Hope for the verification of the amplitude of Lacaille's arc of the meridian.
Roy. Soc. Lond., Proc., IV, 1839, 192–193; Roy. Astron. Soc., Month. Not., V, 1839–'43, 45–50.

——— On the position of Lacaille's stations at the Cape of Good Hope.
Roy. Astron. Soc., Mem., XI, 1840, 91–137.

CAPE OF GOOD HOPE—Continued.

——— Report on the remeasurement of Lacaille's arc.
Roy. Astron. Soc., Month. Not., VII, 1845–'47, 57–58; Astron. Nachr., XXIV, 1846, 359–364; Roy. Astron. Soc., Mem., XX, 1851, 7–29; Month. Not., XVIII, 1858, 107–108, 313–316; XIX, 1859, 137.

——— Verification and extension of Lacaille's arc of the meridian at the Cape of Good Hope.
London, 1866.

Carlini (Francesco) *e* **Plana (G. A. A.).** Relazione delle operazioni astronomiche per la misura di un parallelo terrestre.
Accad. Sci. Torino, Mem., XXVIII, 1824.

Carlini (Francesco). Osservazioni della lunghezza del pendolo simplice fatte all' altezza di mille tese sul livello del mare.
Eff. Astron., Milano, 1824, 28–40.
Revd. in Bull. Sci. Math. (Saigey), III, 1825, 278–301.

———: **Sabine (E.).** An account of —'s pendulum experiments on Mont Cenis.
Quart. Journ. Sci., II, 1827, 153–159.

———: **B.** Ueber die Längen-Gradmessung im Parallel des 45. Grades.
Hertha, IX, 1827, 277–288; XI, 1828, 448–456.
Title in full under B.

——— Esposizione delle osservazioni di signali a polvere movamente accesi sul monte Baldo e sul monte Cimone nell' anno 1825.
Eff. Astron., Milano, 1828, 33–36; 1829, 25–38.

——— Esposizione delle operazioni eseguite per assicurare coll' erezione di due piramidi di granito i termini della base trigonometrica in Lombardia.
Eff. Astron., Milano, 1837, 67–90.

——— Sur la détermination de la densité moyenne de la terre déduite de l'observation du pendule faite à l'hospice du Mont-Cenis en septembre 1821. Note de Charles-Ignace Giulio.
Accad. Sci. Torino, Mem., II, 1840, 379–385.

——— Dell' ampiezza dell' arco di meridiano che attraversando la pianura di Lompardia è terminato dai paralleli di Zurigo e di Genova, premessa una notizia gradi del meridiano di Roma e di Torino.
Eff. Astron., Milano, 1843, 3–68.

Carney. Mémoire sur les poids et les mesures. (H.)
8°, Montpellier, 1792, pp. 138.

Carpenter (Frank de Yeux). Geographical surveying.
Van Nostrand's Mag., XIV, 1876, 513–521; XIX, 1878, 52–71, 163–183.

——— Geographical surveying, its uses, methods, and results.
18°, New York, 1878, pp. 176. (Gore.)

Carret (Jules). Déplacement de l'axe polaire.
Soc. Géogr., Bull., XII, 1876, 473–491.

Carusso (C.-D.). Notice sur les cartes topographiques de l'état-major général d'Autriche-Hongrie.
8°, Genève, 1887, pp. 131. (Washington, Coast Survey.)

Casa (Vittorio de la). Opusculo analitico di geodesia sublime.
8°, Vienna, 1824, pp. viii, 40, 1 plate.

Casati (Paolo). Terra machinis mota ejusque gravitas et dimensio.*
Romæ, 1655-'68.
POGGENDORFF, I, 386.

Casorati (Felice). Intorno ad alcuni punti della teoria dei minimi quadrati.*
4°, Roma, 1858.

—— Sulla regola seguita da Bessel e dal sig. generale Baeyer, durante la misura del grado nella Prussia orientale, per osservare gli angoli orizzontali senza correggere continuamente la linea di collimazione e l' asse di rotazione del cannocchiale del teodolite.
Accad. Lincei, Atti, II, 1875, 9-14.

Cassini (Giovanni Domenico). De la méridienne de l'Observatoire royale de Paris, prolongée jusqu'aux Pyrénées.
Acad. d. Sci. Paris, Mém., 1701, 171-184; Hist., 96-97.

—— Voyages au Cap Verd en Afrique et aux îles de l'Amérique par MM. Varin, des Hayes et de Glos; avec une instruction pour ces sortes de voyages [1682]. (H.)
Acad. d. Sci. Paris, Mém., v, 1736, 150-178.
It contains the first clear recognition of the importance of pendulum observations.

Cassini (Jacques). Réflexions sur la mesure de la terre, rapportée par Snellius, dans son livre intitulé: Eratosthenes Batavus.
Acad. d. Sci. Paris, Mém., 1702, 60-66; Hist., 82-83.

—— Observations de la longueur des pendules à la Martinique.
Acad. d. Sci. Paris, Mém., I, 1708, 16.

—— De la figure de la terre.
Acad. d. Sci. Paris, Mém., 1713, 187-199; Hist., 62-66.

—— De la grandeur de la terre et de sa figure.
Acad. d. Sci. Paris, Mém., 1718, 245-256; Hist., 64-66.

—— Traité de la grandeur et de la figure de la terre.
4°, Paris, 1720, pp. 306, 5 plates, 4 maps. (British Museum.)
Referred to in Acad. d. Sci. Paris, Hist., 66-77.

—— Traité de la grandeur et de la figure de la terre.
8°, Amsterdam, 1723, pp. v, 376, 5 maps, 5 plates. (British Museum.)

—— De la méridienne de l'observatoire.
Acad. d. Sci. Paris, Mém., 1732, 452-470.

—— Réponse aux remarques qui ont été dans le journal historique de la république des lettres sur le traité: "De la grandeur et de la figure de la terre."
Acad. d. Sci. Paris, Mém., 1732, 497-513.
Corrections to "De la grandeur . . . ", 512-513.

—— De la carte de la France, et de la perpendiculaire à la méridienne de Paris.
Acad. d. Sci. Paris, Mém., 1733, 389-405; Hist., 79-81.

——: **Clairaut (A.-C.).** Détermination de la perpendiculaire à la méridienne par —.
Acad. d. Sci. Paris, Mém., 1733, 406-416; 1739, 83-96.

Cassini (Jacques)—Continued.

—— De la perpendiculaire à la méridienne de Paris prolongée vers l'orient.
Acad. d. Sci. Paris, Mém., 1734, 434-452; Hist., 74-77.

—— Méthode de déterminer si la terre est sphérique ou non, et le rapport de ses degrés entr'eux, tant sur les méridiens que sur l'équateur et ses parallèles.
Acad. d. Sci. Paris, Mém., 1735, 71-86.

——: **Clairaut (A.-C.).** Sur la nouvelle méthode de — pour connaître la figure de la terre.
Acad. d. Sci. Paris, Mém., 1735, 117-122.

—— Seconde méthode de déterminer si la terre est sphérique ou non, indépendamment des observations astronomiques.
Acad. d. Sci. Paris, Mém., 1735, 255-261.

—— Des opérations géométriques que l'on emploie pour déterminer les distances sur la terre et des précautions qu'il faut prendre pour les faire le plus exactement qu'il est possible.
Acad. d. Sci. Paris, Mém., 1736, 64-86; Hist., 80-84.

—— Réponse à la dissertation de M. Celsius, professeur royal d'astronomie à Upsal, sur les observations que l'on a faites en France pour déterminer la figure de la terre.
8°, Paris, 1738, pp. 16. (Paris, National.)

—— Mathematische und genaue Abhandlung von der Figur und Grösse der Erde, wobey die bewundernswürdige Verlängerung der Mittagslinie des königlichen Observatorium zu Paris durch ganz Frankreich von einem Ende desselben bis zum andern insbesondere deutlich beschrieben und vorgestellet wird von —. Ihres vielfältigen Nutzen wegen, so in Ausübung der Geometrie, Trigonometrie, Astronomie und Geographie daraus zu erlangen stehet, aus dem französischen Original in die teutsche Sprache treulich übersetzet, zum Druck befördert und mit einer Vorrede statt einer Einleitung zu mehren Verständniss des ganzen Wercks begleitet von Johann Albrecht Klimmen.
8°, Zürich, 1741, pp. xl, 416, 7 plates. (Berlin, Observatory.)

—— Moyens de construire un pendule qui ne puisse s'allonger par la chaleur ni de se raccourcir par le froid.
Acad. d. Sci. Paris, Mém., 1741, 363-371.

Cassini (Jacques-Dominique). De la jonction des observatoires de Paris et de Greenwich, et précis des travaux géographiques exécutés en France qui y ont donné lieu.
Acad. d. Sci. Paris, Mém., 1788, 706-717.

—— Exposé des opérations faites en France en 1787 pour la jonction des observatoires de Paris et de Greenwich; par MM. Cassini, Méchain et Le Gendre. Description et usage d'un nouvel instrument propre à donner la mesure des angles, à la précision d'une seconde.
Fol., Paris, [1791], pp. xv, 94, 5 plates. (British Museum.)

—— Mémoire sur les expériences faites par Borda sur la longueur du pendule.*
Paris, 1792.
POGGENDORFF, I, 393.

Cassini de Thury (**César-François**). De la perpendiculaire à la méridienne de Paris, décrite à la distance de 60,000 toises de l'observatoire vers le midi.
Acad. d. Sci. Paris, Mém., 1735, 403–413.

——— Sur la perpendiculaire à la méridienne de l'observatoire à la distance de 60,000 toises vers le nord.
Acad. d. Sci. Paris, Mém., 1736, 339-341; Hist., 103–104.

——— Sur les opérations géométriques faites en France dans les années 1737–'38.
Acad. d. Sci. Paris, Mém., 1739, 119–134.

——— La méridienne de l'Observatoire royal de Paris prolongée vers le nord.
Acad. d. Sci. Paris, Mém., 1740, 276-292; Hist., 69–75.

——— La méridienne de l'Observatoire royal de Paris, vérifiée dans toute l'étendue du royaume par des nouvelles observations: pour en déduire la vraye grandeur des degrés de la terre, taut en longitude qu'en latitude, et pour y assujettir toutes les opérations géométriques faites par ordre du roi, pour lever une carte générale de la France. Avec des observations d'histoire naturelle, faites dans les provinces traversées par là.
Acad. d. Sci. Paris, Mém., 1742, 42–51. (Hist.)
8°, Paris, 1744, pp. 292, ccxxxv.
This work contains the observations extending over several years made by CASSINI, MARALDI, and LA CAILLE, having in view the two-fold purpose of making a skeleton for a map of France and determining the lengths of degrees of latitude. The same stations were occupied in 1796 and 1797 by DELAMBRE.

——— Sur la jonction de la méridienne de Paris avec celle que Snellius a tracée dans Hollande; avec des réflexions sur la carte de la Flandre.
Acad. d. Sci. Paris, Mém., 1748, 123–132; Hist., 109–115.

——— *et* **Bouguer** (**P.**). Opérations pour mesurer l'intervalle entre Ville Juive et Juvisy.
Acad. d. Sci. Paris, Mém., 1754, 172–186; Paris, 1757.
Title in full under BOUGUER (P.).

——— Mémoire sur la prolongation de la perpendiculaire de Paris jusqu'à Vienne en Autriche.
Acad. d. Sci. Paris, Mém., 1763, 299–317; Hist., 80–93.

——— Comparaison de la latitude des principales villes du royaume, déterminée par les observations astronomiques de MM. de l'Académie, avec celle qui résulte des triangles.
Acad. d. Sci. Paris, Mém., 1764, 490–491; Hist., 157–158.

——— Relation de deux voyages faits en Allemagne par ordre du roi. Par rapport à la figure de la terre, pour déterminer la grandeur des degrés de longitude. Par rapport à la géographie, pour poser les fondemens d'une carte générale et particulière de l'Allemagne. Par rapport à l'astronomie, pour connoître la position des principales villes où les astronomes allemands ont fait leurs observations, et établir une correspondance entre les observatoires d'Allemagne et celui de Paris.
4°, Paris, 1763, pp. xxii, 186.
2e ed., Paris, 1775. (British Museum.)

Cassini de Thury (**César-François**)—Continued.

——— Relation d'un voyage en Allemagne, qui comprend les opérations relatives à la figure de la terre et à la géographie particulière du Palatinat, du duché de Wurtemberg, du cercle de Souabe, de la Bavière et de l'Autriche, fait par ordre du roi; suivie de la description des conquêtes de Louis XV, depuis 1745 jusqu'en 1748.
4°, Paris, 1775, pp. xxviii, 194, 11 plates. (Washington, Congress.)

——— Description géométrique de la terre.
Paris, 1775.*
POGGENDORFF, I, 392.

———: **Beccaria** (**G. B.**). Lettere al— sul grado torinense.
Firenze, 1777.
Title in full under BECCARIA (G. B.).

——— Description géométrique de la France.
4°, Paris, 1783, pp. ii, 207, 1 map. (Southampton, Ordnance Survey.)

Castro (**A. G. Ferreira de**). *See* **Ferreira de Castro** (**A. G.**).

Cauchy (**Augustin-Louis**). Sur la plus grande erreur à craindre dans un résultat moyen, et sur le système de facteurs qui rend cette plus grande erreur un minimum.
Acad. d. Sci. Paris, Comp. Rend., XXXVII, 1853, 326–334.

Cavendish (**Henry**). Experiments to determine the density of the earth.
Roy. Soc. London, Phil. Trans., LXXXVIII, 1798, 469-526; Ann. d. Phys. (Gilbert), II, 1799, 1–62.
Density = 5.48. Revd. in Bibl. Brit., Genève, XI, 1799. 233-241.

——— Expériences pour déterminer la densité de la terre, par Henry Cavendish; traduit de l'anglais (Phil. Trans., LXXXVIII, 1798), par N.-M. Chompré.
École Polytech., Journ., X, 1815, 263–320.

———; **Baily** (**F.**). On the repetition of —'s experiments.
Roy. Astron. Soc., Month. Not., IV, 1839, 96–97.

———: **Babinet** (**J.**). Note sur le calcul de — relative à la densité de la terre.
Cosmos, XXIV, 1864, 543–545.

Cayley (**Arthur**). On the attraction of an ellipsoid. Part I. On Legendre's solution of the problem of the attraction of an ellipsoid on an external point.
Camb. Math. Journ. (Thomson), IV, 1849, 50–57.

——— On the attraction of an ellipsoid (Jacobi's method).
Camb. Math. Journ. (Thomson), V, 1850, 217–226.

——— Note on the attraction of ellipsoids.
Roy. Astron. Soc., Month. Not., XXIX, 1869, 254–257.

——— On the geodesic lines on an oblate spheroid.
L., E., D. Phil. Mag., XL, 1870, 328–340.

——— On geodesic lines, in particular those of a quadric surface.
Math. Soc., Proc., IV, 1871–'73, 191–211, 368–380.

——— On the geodesic lines on an ellipsoid.
Astron. Soc., Month. Not., XXXII, 1872, 31–53, 55–56.

Cayley (Arthur)—Continued.

—— On the geodesic lines on an ellipsoid (Jacobi's method). A review of —.
Astron. Ges., Vierteljahrs., IX, 1874, 47–51.

Cazin (A.). Intensité de la pesanteur à l'île St.-Paul. (H.)
Acad. d. Sci. Paris, Comp. Rend., LXXXIII, 1876, 1248–1250.

Cellérier (Ch.). Note sur la mesure de la pesanteur par le pendule.
Soc. Phys. Genève, Mém., XVIII, 1866, ii, 197–218.

—— Note sur le mouvement simultané d'un pendule et de ses supports.
Int. Geod. Cong., Gen.-Ber., 1877, 163–170.

—— *et* **Plantamour (E.).** L'état actuel des travaux entrepris dans les différents pays pour la détermination de la pesanteur à l'aide du pendule à réversion.
Int. Geod. Cong., Gen.-Ber., 1880, App. 2, 1–8.

Celoria (M. E. G.). Sopra una deviazione sensibile del filo a piombo esistente fra Milano e Genova.
8°, pp. 14.
From Ist. Lombardo, Rend., XVII, 1884, v.

Celsius (Anders). Bref om jordens figur.*
Upsala, 1736.
Poggendorff, I, 410.

—— De observationibus pro figura telluris determinanda in Gallia habitis disquisito.
4°, Upsala, [1738], pp. 20. (British Museum.)

——: **Maupertuis (P.-L.-M. de).** La figure de la terre déterminée par les observations de Maupertuis et —.
Paris, 1738; 1739.
English trans., London, 1738; German, Zürich 1741; Latin, Lipsiæ, 1742.
Title in full under MAUPERTIUS (P.-L.-M. DE).

——: **Cassini (J.).** Réponse à la dissertation de — sur les observations faites pour déterminer la figure de la terre.
Paris, 1738.
Title in full under CASSINI (J.).

——: **Eames (J.).** An account of a dissertation containing remarks upon the observations made in France to ascertain the figure of the earth by —.
Roy. Soc. London, Phil. Trans., XLI, 1740, I, 371–382.

—— Anmerkung von dem Nutzen, der Erde rechte Gestalt und Grösse zu wissen.
K. Vetens. Ak. Handl. üb. Holzbecher u. Kästner, III, 1741, 298–304.

—— Tractatus de de Maupertuis de figura telluris à dubiis Zellerianis vindicatur.*
4°, Upsala, 1743.
LA LANDE, 420.

Celsius (Nicolaus). Geodesia brevibus thesibus et problematibus explicata, quam consensu ampliss. facult. in Regia Academia Upsalensi placido eruditorum examini submittunt præses Nicolaus Celsius.
24° [1696], pp. ix, 130.
Nothing but problems in plane trigonometry are discussed.

Challis (James). Theory of the correction to be applied to a ball pendulum for the reduction to a vacuum.
L., E., D. Phil. Mag., I, 1832, 40–45; III, 1833, 185–187.

—— On the motion of a small sphere vibrating in a resisting medium.
L., E., D. Phil. Mag., XVII, 1840, 462–467; XVIII, 1841, 131–133.

Chanoine. Les travaux géodésiques de la Société impériale géographique de Russie, en Asie.
Soc. Géogr., Bull., XIV, 1877, 624–638.

Chasles (Michel). Sur l'attraction des ellipsoïdes.
Acad. de l'Inst. Paris, Mém. Sav., IX, 1846, 629–715; École Polytech., Journ., XV, 1833, 224–265; Acad. de Belgique, Bull., IV, 1837, 388–389; Corresp. Math. (Quetelet), IX, 1837, 475–479.

—— Solution synthétique du problème de l'attraction des ellipsoïdes.
Acad. d. Sci. Paris, Comp. Rend., V, 1837, 842; VI, 1838, 902–915.

—— Sur les lignes géodésiques et les lignes de courbure des surfaces du second degré.
Journ. Math. (Liouville), XI, 1846, 5–15.

—— Propriétés des lignes géodésiques et des lignes de courbure de ces surfaces.
Journ. Math. (Liouville), XI, 1846, 105–119.

—— Nouvelles démonstrations des deux équations relatives aux tangentes communes à deux surfaces du second degré homofocales; et propriétés des lignes géodésiques et des lignes de courbure de ces surfaces.
Acad. d. Sci. Paris, Comp. Rend., XXII, 1846, 313–318.

——: **Liouville (J.).** Note au sujet d'un mémoire de M. — sur les lignes géodésiques des surfaces.
Journ. Math. (Liouville), XII, 1847, 255.

Chasles (S.). Cours d'astronomie et de géodésie.*
4°, Paris, 1847.

Chauvenet (William). Method of least squares. Appendix to manual of spherical and practical astronomy, II, 469–566.
8°, Philadelphia, n. d. *Lippincott & Co.* (Gore.)

Cheseaux (J.-Ph.-Loys de). Sur la grandeur et la figure de la terre. (H.)
Lausanne, 1754.

Chisholm (H. W.). An account of comparison between two Russian pendulums and Repsold's scale, and between Repsold's scale and the standard subdivided imperial yard.
Rep. Warden of the Standards, London, 1873–'74, 26, 39–43.

—— On the science of weighing and measuring, and on the standards of weight and measure.
Nature, VIII, 1873, 268–270.

—— On the science of weighing and measuring, and standards of measure and weight.
8°, London, 1877, pp. xiv, 192. (British Museum.)

Chodzko (J.). Coup d'œil sur les traxaux trigonométriques du Caucase 1847–'63.*
Tiflis, 1864.

Chompré (Nicholas-Maurice): Cavendish (H.). Expériences pour déterminer la densité de la terre. Translated by —.
École Polytech., Journ., x, 1815, 263–320.
Title in full under CAVENDISH (H.).

Christoffel (E. B.). Ueber die Bestimmung der Gestalt einer krummen Oberfläche durch locale Messungen auf derselben.
Journ. d. Math. (Crelle), LXIV, 1865, 193–209.

——— Allgemeine Theorie der geodätischen Dreiecke.
K. Ak. d. Wiss., math.-phys. Cl., Abhandl., 1868, 119–176.

Ciscar (Gabriel de). Darstellung der im Laufe einer Welt-Umsegelung von den spanischen Corvetten "Descubierta" und "Atrevida" in Europa, America, Asia, dem stilien Ocean und in Neu-Holland gemachten Pendel-Beobachtungen.
Mon. Corr. (Zach), XXV, 1812, 467–477.

Civil Eng. and Arch. Jour., *for* Civil Engineer and Architect's Journal.
4°, London, 1837–'68. (Washington, Congress.)

Civ.-Ing., *for* Civil-Ingenieur.
4°, Freiberg, Leipzig, 1848+. (Washington, Patent Office.)

Clairaut (Alexis-Claude) [Clairault by Poggendorff]. Détermination géométrique de la perpendiculaire à la méridienne tracée par M. Cassini; avec plusieurs méthodes d'en tirer la grandeur et la figure de la terre.
Acad. d. Sci. Paris, Mém., 1733, 406–416; 1739, 83–96.

——— Sur la nouvelle méthode de Cassini pour connaître la figure de la terre.
Acad. d. Sci. Paris, Mém., 1735, 117–122.

——— Sur la mesure de la terre par plusieurs arcs de méridien pris à différentes latitudes.
Acad. d. Sci. Paris, Mém., 1736, 111–120.

——— Investigationes aliquot, ex quibus probetur terræ figuram secundum leges attractionis in ratione inversa quadrate distantiarum maxime ad ellipsu accedere debere.
Roy. Soc. London, Phil. Trans., XL, 1738, 19–25.
e = 1 : 230.280.

——— Des centres d'oscillations dans des milieux résistants.
Acad. d. Sci. Paris, Mém., 1738, 159–168.

———: **Maupertuis (P.-L.-M. de).** La figure de la terre, déterminée par les observations de Maupertuis et —.
Paris, 1738.
English translation, London, 1738, 1739.
German translation, Zürich, 1741.
Latin translation, Lipsiæ, 1742.
Title in full under MAUPERTUIS (P.-L.-M. DE).

——— An inquiry concerning the figure of such planets as revolve about an axis, supposing the density continually to vary from the centre to the surface.
Roy. Soc. London, Phil. Trans., XL, 1738, 277–306.
Translated by JOHN COLSON, from "La théorie de la figure de la terre." Paris, 1743.

——— *et* **Picard (J.).** Degré du méridien entre Paris et Amiens.
Paris, 1740.
German translation, Zürich, 1742. Title in full under PICARD (J.).

Clairaut (Alexis-Claude)—Continued.

——— La théorie de la figure de la terre, tirée des principes de l'hydrostatique.
12°, Paris, 1743, pp. xl, 305; Paris, 1808.
A portion of this work, translated by JOHN COLSON, appeared in Roy. Soc. London, Phil. Trans., 1738, 277–306.

——— Du système du monde dans les principes de la gravitation universelle.
Acad. d. Sci. Paris, Mém., 1745, 329–364; Hist., 58–62.

——— A translation and explanation of some articles of the book entitled: Théorie de la figure de la terre, by Mons. Clairaut.
Roy. Soc. London, Phil. Trans., XLVIII, 1753, i, 73–85.

——— Une nouvelle théorie de la figure de la terre.*
Jour. Sav., 1759. Pièces qui ont remporté le prix.
4°, Toulouse, 1758.

———: **Stokes (G. G.).** On attraction and on —'s theorem.
Camb. Math. Journ. (Thomson), IV, 1849, 194–219.

———: **Haughton (S.).** On —'s theorem.
Camb. Math. Journ. (Thomson), VI, 1851, 182–185.

———: **Pratt (J. H.).** On Professor Stokes' proof of —'s theorum.
L., E., D. Phil. Mag., XXXIV, 1867, 25–26.

———. **Helmert (F. R.).** Das Theorem von —.
Zeits. f. Vermes., VII, 1878, 121–145.

Claramontius (Scipione). Opuscula varia mathematica; in quibus tractatus I et III, de phasibus lunæ et horizonte sensibili, de diametro terræ. [Also:] Ex inspectione imaginis subjecti per reflexionem ex aqua quiescente in vase investigare quanta sit diameter terræ.
8°, Bononiæ, 1650, pp. viii, 328. (Oxford, Bodleian.)

Clark (Jacob M.). The English mile: its relation to the size of the earth and to ancient metrics.
Van Nostrand's Mag., XXVIII, 1883, 383–386.

Clark (Samuel): Love (J.). Geodæsia. Corrected and improved by —.
London, 1868.
Title in full under LOVE (J.).

Clarke (Alexander Ross). On the measurement of azimuths on a spheroid.
Roy. Astron. Soc., Month. Not., XI, 1851, 147; Mem., XX, 1851, 131–136.

——— On the figure, dimensions and mean specific gravity of the earth, as derived from the ordnance trigonometrical survey of Great Britain and Ireland.
Roy. Soc. London, Phil. Trans., 1856, 607–626.

——— [Some details respecting the trigonometrical survey of the British Isles.]
Roy. Astron. Soc., Month. Not., XVIII, 1858, 113–114.

——— Note on Archdeacon Pratt's paper on the effect of local attraction on the English arc. Communicated by Lieut.-Col. James.
Roy. Soc. London, Proc., IX, 1858, 496–497; Roy. Soc. London, Phil. Trans., CXLVIII, 1858, 787–789.
Stating that a revision of distances as given in recent volumes of the ordnance survey will change some of the conclusions of the above article.

Clarke (Alexander Ross)—Continued.

——— Note on the figure of the earth.
Roy. Astron. Soc., Month. Not., XIX, 1859, 36–38.

——— On the figure of the earth.
Roy. Astron. Soc., Month. Not., XIX, 1859, 263–264; Mem., XXIX, 1861, 25–44.

——— On Archdeacon Pratt's figure of the earth.
L., E., D. Phil. Mag., XXXI, 1866, 193–196.
The figures of the earth deduced by Archdeacon Pratt are, although they happen to be near the truth, arbitrary results, founded on an incorrect calculation, and can not be taken to supersede the results derived from the method of least squares, in which the deflections at every station, without partiality, are fully taken into account and their most probable values exhibited.

———: **Pratt (J. H.)**. Reply to – on the determination of the figure of the earth from geodetic data.
L., E., D. Phil. Mag., XXXII, 1866, 17–22.

——— Comparisons of the standards of length of England, France, Belgium, Prussia, Russia, India, Australia, made at the Ordnance Survey office, Southampton, by —, under the direction of Colonel Sir Henry James. Published by order of the secretary of state for war.
4°, London, 1866, pp. viii, 287, 5 plates; Roy. Soc. London, Phil. Trans., 1866, 161–180.

——— On the figure of the earth.
L., E., D. Phil. Mag., XXXII, 1866, 236–237.
Insists that Pratt's application of local attraction is hypothetical and arbitrary.

——— On the course of geodetic lines on the earth's surface.
L., E., D. Phil. Mag., XXXIX, 1870, 352–363.

——— Results of the comparisons of the standards of length of England, Austria, Spain, United States, Cape of Good Hope, and of a second Russian standard made at the Ordnance Survey office, Southampton.
Roy. Soc. London, Phil. Trans., 1873, 445–469; Proc., XXI, 1873, 407–408.
With a preface and notes on the Greek and Egyptian measures of length by HENRY JAMES.

——— Figure of the earth.
Encycl. Britannica, 9th ed., London, VII, 1877, 597–608.

——— On the potential of an ellipsoid at an external point.
L., E., D. Phil. Mag., IV, 1877, 458–461.

——— On the figure of the earth.
L., E., D. Phil. Mag., VI, 1878, 81–93; The Observatory, II, 1879, 312–314.
In which the three axes of the spheroidal earth and two eccentricities are deduced.
Revd. in Jahrb. üb. d. Fortschr. d. Math., x, 1878, 767–768.

[———] Geodesy.
Encycl. Britannica, London, x, 1879, 163–172.

——— Account of the remeasurement of the length of Kater's pendulum at the Ordnance Survey office, Southampton.
India, Trig. Survey, v, 1879, i, 1–9.

——— Geodesy.
8°, Oxford, 1880, pp. xi, 356. (Gore.)
Revd., Nature, XXI, 1880, 605–609; by HERSCHEL (J.). Quart. Journ. Sci., II, 1880, 405.

Clarke (Alexander Ross)—Continued.

———: **Frederici (R. M.)**. Die Gestalt und Grösse der Erde. Translated by —, with notes.
Nature, XVIII, 1818, 556–558, 577–580, 602–604.

———: **Stone (E. J.)**. Reduction of latitude and logarithm of the earth's radius with —'s value of the earth's compression.
Roy. Astron. Soc., Month. Not., XLIII, 1882–'83, 102–110.

Clausen (Thomas). De reductione temporis, quo oscillationes quotcunque penduli, ab amplitudinibus magnis incipientes, absolvuntur, ad tempus, quo totidem oscillationes amplitudinis infinite parvae perficiuntur.
Astron. Nachr., v, 1827, 91–94.

——— De resistentia aeris, quomodo in motibus lentis a celeritate pendet.
Astron. Nachr., v, 1827, 93–96.

——— Ueber die Bestimmung der Abplattung des Erdsphäroids.
Astron. Nachr., XXI, 1844, 333–336.

——— Ueber den Einfluss der Umdrehung un.. der Gestalt der Erde auf die scheinbaren Bewegungen an der Oberfläche derselben.
Acad. de St.-Pétersbourg, Cl. Phys.-Math., Bull., x, 1852, 17–31.

Clay (Joseph). Observations on the figure of the earth.
Am. Phil. Soc., Trans., v, 1802, 312–319.

Çlemens (F. A.). Ueber die Methode der kleinsten Quadrate.*
4°, Tilsit, 1848.

Clotten (M.). Ueber konstante Messungsfehler in Polygonzügen.
Zeits. f. Vermes., XII, 1883, 641–646.

Clyrton (W. E.) *and* **Perry (J.)**. Determination of the acceleration of gravity at Tokio, Japan.
L., E., D. Phil. Mag., IX, 1880, 292–301.

COAST SURVEY. *See* **UNITED STATES COAST AND GEODETIC SURVEY.**

Cöster (A.) *und* **Gerland (E.)**. Beschreibung der Sammlung astronomischer, geodätischer und physikalischer Apparate im königlichen Museum zu Cassel. Festgabe für die 51. Versammlung deutscher Naturforscher und Aerzte, im Auftrage des Herrn Ministers der geistlichen Unterrichts- und Medizinal-Angelegenheiten verfasst von —.
4°, Cassel, 1878, pp. 48, 5 pl. (Berlin, Geodetic Institute.)

Colby (Thomas) *and* **Mudge (W.)**. An account of the trigonometrical survey, 1800–1809.
London, 1811.
Title in full under MUDGE (W.).

———: **Gregory (O.)**. Dissertations and letters regarding the survey of England by —.
London, 1815.
Title in full under GREGORY (O.).

Cole (W. H.). Comparisons of the lengths of 10-feet standards A and B, and determinations of the difference of their expansions.
India, Trig. Survey, I, 1870, ii, 3–7.

Cole (W. H.)—Continued.

——— Comparisons between the 10-feet standards B, S, and A.
India, Trig. Survey, I, 1870, iii, 8–12.

——— On the periodic errors of graduated circles.
India, Trig. Survey, II, 1879, iv, 95–108.

——— On certain modifications of Colonel Everest's system of observing introduced to meet the specialities of particular instruments.
India, Trig. Survey, II, 1879, v, 109–117.

——— An alternative method of obtaining the formulæ in Chapters VIII and XV employed in the reduction of triangulation. Additional formulæ and demonstrations.
India, Trig. Survey, II, 1879, vii, 127–149.
See WALKER (J. T.). India, Trig. Survey, II, 1879, 101–110, 185–207.

——— The theoretical errors of the triangulation of the northwest quadrilateral.
India, Trig. Survey, II, 1879, xi, 255–282.

——— *and* **Hennessey** (**J. B. N.**). Rahun meridional series.
India, Trig. Survey, IV, 1876, vi, 106–108, 3 plates.

——— Great arc meridional series.
India, Trig. Survey, IV, 1876, pp. xi, 78, 104, 3 plates.

——— *and* **Hennessey** (**J. B. N.**). Gurhagarh meridional series.
India, Trig. Survey, IV, 1876, x, 115, 61, 1 plate.

——— Note on the simultaneous reduction. On the degree of numerical accuracy arrived at in the calculations.
India, Trig. Survey, VI, 1880, 161–164.

——— *and* **Hennessey** (**J. B. N.**). Great arc meridional series. Section 18° to 24°.
India, Trig. Survey, VI, 1880, pp. iii, 124, 2 plates.

———, **Herschel** (**J.**) *and* **Hennessey** (**J. B. N.**). East coast series.
India, Trig. Survey, VI, 1880, pp. xxxix, 161, 3 plates.

——— *and* **Hennessey** (**J. B. N.**). Jabalpur meridional series.
India, Trig. Survey, VI, 1880, pp. vii, 101, 2 plates.

——— ——— Bilaspur meridional series.
India, Trig. Survey, VI, 1880, pp. xviii, 128, 3 plates.

——— ——— Bider longitudinal series.
India, Trig. Survey, VI, 1880, pp. xiv, iii, 1 plate.

——— ——— Calcutta longitudinal series.
India, Trig. Survey, VI, 1880, pp. xiii, 226, 3 plates.

——— ——— The simultaneous reduction of the triangulation embraced by the southeast quadrilateral.
India, Trig. Survey, VI, 1880, pp. 164, 124, 2 plates.

——— The details of the meridional series, or series J of the northeast quadrilateral.
India, Trig. Survey, VII, 1882, pp. i, 111.

Cole (W. H.)—Continued.

——— *and* **Hennessey** (**J. B. N.**). Eastern frontier series.
India, Trig. Survey, VIII, 1882, pp. x, 108, 3 plates.

——— ——— Brahmaputra meridional series.
India, Trig. Survey, VIII, 1882, pp. xiv, 96, 2 plates.

——— ——— East Calcutta longitudinal series.
India, Trig. Survey, VIII, 1882, pp. xii, 79, 1 plate.

——— *and* **Haig** (**C. T.**). General description of the Jodpore series of the northwest quadrilateral.
India, Trig. Survey, IV, A, 1886.

Collignon (**Ed.**). Problème de géodésie.
Assoc. Française, 1879, 129–137.

Colpa. Een voorbild van constante fouten.*
Tijdschrift voor Kadaster en Landmeetkunde, II, 1886, 91.
Title from Zeits. f. Vermes., XVII, 1888, 506.

Colson (**John**): **Clairaut** (**A. C.**). An inquiry concerning the figure of such planets as revolve about an axis. Translated by —.
Roy. Soc. London, Phil. Trans., XL, 1738, 277–306.
This is taken from La théorie de la figure de la terre, beginning with p. xxiv.

Colvin (**Verplanck**). Reports on the progress of the Adirondack survey, 1872 to 1883.
8°, Albany, 4 vols. (Gore.)

Comstock (**C. B.**). Annual report of the United States Lake Survey (for 1871).
U. S. Eng. Rep., 1871, 982–1026, 1 map.

——— Annual report of Major C. B. Comstock, Corps of Engineers, for the fiscal year ending June 30, 1872. (Operations of the Lake Survey.)
U. S. Eng. Rep., 1872, 1031, 1108.

——— Annual report of Major C. B. Comstock, Corps of Engineers, for the fiscal year ending June 30, 1873. (Operations of the Lake Survey.)
U. S. Eng. Rep., 1873, 1169–1202.

——— Annual report of Major C. B. Comstock, Corps of Engineers, for the fiscal year ending June 30, 1874. (Operations of the Lake Survey.)
U. S. Eng. Rep., 1874, 402–476, 3 maps.

——— Survey of the northern and northwestern lakes. Annual report of Major C. B. Comstock, Corps of Engineers, for the fiscal year ending June 30, 1875.
U. S. Eng. Rep., 1875, II, 852–918, 3 charts.

——— Notes on European surveys.
U. S. Eng. Rep., App. HH., 1876, 8°, 107, 8 maps, Washington, 1876.
This is a compilation from the reports of the geodetic and topographic surveys of Great Britain, Germany, Austria, Italy, Spain, Switzerland, Sweden and Norway, Belgium, and Russia.
Revd. in Zeits. f. Vermes., XII, 1883, 156–164, by KERSCHBAUM.

——— Survey of the northern and northwestern lakes and the Mississippi River. Annual report of Major C. B. Comstock, Corps of Engineers, for the fiscal year ending June 30, 1877.
U. S. Eng. Rep., 1877, 1105–1206, 3 charts, 4 plates.

Comstock (**C. B.**)—Continued.

——— Survey of the northern and northwestern lakes and the Mississippi River. Annual report of Major C. B. Comstock, Corps of Engineers, for the fiscal year ending June 30, 1878.
U. S. Eng. Rep., 1878, 1355–1419.

——— Survey of the northern and northwestern lakes and the Mississippi River. Annual report of Major C. B. Comstock, Corps of Engineers, for the fiscal year ending June 30, 1879.
U. S. Eng. Rep., 1879, 1891–1972, 5 plates, 2 maps.

——— Survey of the northern and northwestern lakes. Report of Major C. B. Comstock, Corps of Engineers, Bvt. Brig. Gen. U. S. A., officer in charge of the work, for the fiscal year ending June 30, 1880.
U. S. Eng. Rep., 1880, 2365–2458, 2 charts, 4 plates.

——— Survey of the northern and northwestern lakes. Annual report of Major C. B. Comstock, Corps of Engineers, U. S. A., officer in charge of the work, for the fiscal year ending June 30, 1881.
U. S. Eng. Rep., 1881, III, 2781–2803, 3 charts.

——— Report upon the triangulation of the United States Lake Survey. By Lieut. Col. C. B. Comstock, Corps of Engineers, aided by the assistants on the survey.
4°, Washington, 1882, pp. xx, 922, 30 pl. Forming No. 24, of the U. S. Eng. Professional Papers.
Errata to pp. xv and 923–925 published in 1885. (Gore.)

——— Survey of the northern and northwestern lakes. Annual report of Lieutenant-Colonel C. B. Comstock, Corps of Engineers, Bvt. Brig. Ben. U. S. A., officer in charge of the work, for the fiscal year ending June 30, 1882.
U. S. Eng. Rep., 1882, 2785–2820, 4 plates.

——— Ratio of the metre to the yard.
Nat. Acad. Sci., Mem., III, 1886, 101–102.

Condamine (**Charles-Marie de la**). Description d'un instrument qui peut servir à déterminer, sur la surface de la terre, tous les points d'un cercle parallèle à l'équateur.
Acad. d. Sci. Paris, Mém., 1733, 294–301.

——— De la mesure du pendule à St. Dominigue.
Acad. d. Sci. Paris, Mém., 1735, 529–544.

——— Relation abrégée d'un voyage fait dans l'intérieur de l'Amérique méridionale depuis la côte de la mer du sud jusqu'aux côtes du Brésil et de la Gucaire, en descendant la rivière des Amazones.
8°, Paris, 1745, pp. xvi, 216. (Oxford, Bodleian.)
Bound with Lettre à Madame * * *

——— Extrait des opérations trigonométriques et des observations astronomiques faites pour la mesure des degrés du méridien aux environs de l'équateur.
Acad. d. Sci. Paris, Mém., 1746, 618–668.

——— Lettre à Madame * * * sur l'émeute populaire excitée en la ville de Cuença au Pérou, 29 août 1739, contre les académiciens des sciences envoyés pour la mesure de la terre. (Anon.)
8°, Paris, 1746, pp. 108. (Oxford, Bodleian.)

Condamine (**Charles-Marie de la**)—Continued.

——— Bekort verbaal v. een rezze gedaan in't binnenlands gedeelte v. Z. America.*
U. h. Fr., Amsterdam, 1746.

——— Nouveau projet d'une mesure invariable propre à servir de mesure commune à toutes les nations.
Acad. d. Sci. Paris, Mém., 1747, 489–514; (Hist.), 82–88.
Proposes to take the length of the equinoctial pendulums as a half toise.

——— Mesure des trois premiers degrés du méridien dans l'hémisphère austral tirée des observations de MM. de l'Académie royale des sciences, envoyés par le roi sous l'équateur.
4°, Paris, 1751, pp. viii, [10], 266, x. (Paris, National.)

——— Supplément au journal historique du voyage à l'équateur, et au livre de la mesure des trois premiers degrés du méridien, pour servir de réponse aux objections de M. B[ouguer].
4°, Part 1, Paris, 1752, pp. viii, 52; Part 2, Paris, 1754, [iv], 236. (Paris, National.)

——— Réponse à la lettre de M. Bouguer sur divers points d'astronomie pratique, et sur le supplément de M. de la Condamine.
4°, Paris, 1754, pp. 11. (British Museum.)

———: **Bouguer** (**P.**). Lettre sur "Le supplément au journal" de M. —.
Paris, 1754.
Title in full under Bouguer (P.).

——— Extract of a letter of Mons. la Condamine to Dr. Matty, part of which regards the measures of Lacaille, Marie, and Boscovitch.
Roy. Soc. London, Phil. Trans., XLIX, 1756, ii, 623–624.

———: **David** (**J.-P.**). Réplique à la lettre de M. — sur la figure de la terre.
La Haye, 1769.
Title in full under David (J.-P.).

———: **David** (**J.-P.**). Dissertation sur la figure de la terre, augmentée d'une lettre de M. —.
La Haye, 1771.
Title in full under David (J.-P.).

——— Remarques sur la toise étalon du Châtelet, et sur les diverses toises employées aux mesures des degrés terrestres et à celle du pendule à secondes.
Acad. d. Sci. Paris, Mém., 1772, II, 482–501; Hist., 8–13.

C., D. L. [**de la Condamine**]. Lettre de — sur le sort des astronomes qui ont eu part aux dernières mesures de la terre depuis 1735.
Journ. d. Sav., 1774.
La Lande, 537.

———: **Grenus** (**T.**). Resultate einer Vergleichung der Werke von —.
Mon. Corr. (Zach), XVI, 1807, 238–256.

Conder (**Claude Reignier**). The trigonometrical survey of Palestine.
Roy. Soc. Edinb., Proc., x, 1879–80, 379–397.

Condorcet *et* **Borda** (**J.-C.**). Rapport sur le choix d'une unité de mesures.
Acad. d. Sci. Paris, Mém., 1791, 7–16. (Hist.)
Title in full under Borda (J.-C.).

Conn. Acad. Sci., Mem., *for* Memoirs of the Connecticut Academy of Arts and Sciences.
8°, New Haven, 1810–'16 (4 v.). (Washington, Congress.)

Conn. Acad. Sci., Trans., *for* Transactions of the Connecticut Academy of Arts and Sciences.
8°, New Haven, 1866 +. (Washington, Congress.)

Conn. d. Temps, *for* Connaissances des temps.
12°, Paris, 1703 +. (Washington, Observatory.)

Conrads (P. A.).Grösse, Gestalt und Dicke der Erde.*
Köln, 1879.

Conraten (Johan). Geodaisia, das ist: von bewahrter Feldmessung eyn gründlicher Bericht: wie nämlich beyde aller Felder Grösse zu messen und abzurechnen: auch allerley erforderte Plätze von andern Feldern in gewissen Messe auss und abzutheilen oder auch an dieselbige anzumessen seie.
8°, Strassburg, 1580, pp. vi, 86. (Berlin, Royal.)

Cooke (John). A description of a new standard for weights and measures.
Am. Phil. Soc., Trans., III, 1793, 328–330.

Coraboeuf (Jean-Baptiste). Sur les opérations géodésiques des Pyrénées et la comparaison du niveau des deux mers.
Acad. d. l'Inst. Paris, Mém. Sav., III, 1832, 45–131.
The above includes: "Exposé des opérations qui ont été faites en 1825 aux deux extrémités de la base de Perpignan," 105–110.

——— Exposé des opérations qui ont été faites en 1825 aux deux extrémités de la base de Perpignan.
Conn. d. Temps, 1832, 74–78.

——— Rapport sur les opérations géodésiques faites en Sardaigne pour la construction d'une carte de cette île.
Soc. Géogr., Bull., XII, 1839, 43–50.

——— Rapport sur une relation des opérations géodésiques qui ont été exécutées dans les provinces septentrionales du royaume de Naples.
Soc. Géogr., Bull., XII, 1839, 50–68.

——— Notice sur les opérations géodésiques que les ingénieurs géographes français exécutèrent à Rome en 1809 et 1810.
Soc. Géogr., Bull., V, 1853, 353–374; VI, 1853, 5–72.

Cornu (Alfred) *et* **Baille (J.)**. Détermination nouvelle de la constante de l'attraction et de la densité moyenne de la terre.
Acad. d. Sci. Paris, Comp. Rend., LXXVI, 1873, 954–958; Chemical News, XXVII, 1873, 211.

——— Triangulation destinée à raccorder les résultats de la méridienne de Cassini (1740) avec ceux de la méridienne de Delambre (1792) pour contrôler la distance de l'observatoire à la tour de Montthèry.
Obs. de Paris, Ann. (Mém.), XIII, 1874, 303–308.

——— *et* **Baille (J.)**. Sur la mesure de la densité moyenne de la terre.
Acad. d. Sci. Paris, Comp. Rend., LXXXVI, 1878, 699–702; Ann. d. Phys. (Poggendorff), II, 1878, 453–455.
Density = 5.56.

——— ——— Analyse de l'influence perturbatrice des termes proportionnels au carré des écarts du levier de la balance de torsion.
Acad. d. Sci. Paris, Comp. Rend., LXXXVI, 1878, 1001.

Cornu (Alfred) *et* **Baille (J.)**—Continued.

——— Rapport sur le prix Gay relatif au pendule à réversion.
Acad. d. Sci. Paris, Comp. Rend., CI, 1885, 1391–1396.

Cornu (M.). Captain Perrier's geodetic operations in Algeria.
Nature, VII, 1873, 450–451.
A short account of the connection of France with Algeria through Spain.

Corr. Astron. (Zach), *for* Correspondance astronomique, géographique, hydrographique et statistique du Baron de Zach.
8°, Gênes, 1818–'26 (15 vols.). (Washington, Observatory.)

Corr. Math. (Quetelet), *for* Correspondance mathématique et physique (Quetelet.).
8°, Gand, Bruxelles, 1825–'39. (Brussels, Royal.)

Corr. Sci. Roma, *for* Corrispondenza scientifica di Roma l' avanzamento delle scienze (Scarpellini.).
4°, Roma, 1848–'69 (12 vols.).

Costard (George). History of astronomy, with application to geography, history, and chronology, exemplified by the globes, with engravings.
4°, London, 1767, pp. 307. (Oxford, Bodleian.)

Cotton (H. C.). On the trigonometrical survey of Van Diemen's Land.
Van Diemen's Land, Roy. Soc., Papers, III, 1855–'59, i, 92–108.

——— Notes on the trigonometrical survey of Tasmania.
Professional Papers on Indian Engineering, I, 1863–'64, 86–100.

Couplet le fils. Différence de la longueur du pendule à Lisbonne et à Paris.
Acad. d. Sci. Paris, Mém., 1700, 174–175; Hist., 116–120.

Cousin (Jacques Antoine Joseph). De figura terræ commentatio.
Acad. Mogunt., Acta, II, 1777, 209–216.

Couto (Mattheus Valente do). Memoria sobre os principios, em que se deve fundar qualquer methodo de calcular a longitude geografica de uno logar; tendo attenção a' figura de terra.
Acad. d. Sci. Lisboa, Mem., II, 1848, 301–316.

Covarrubias (Francisco Diaz). Coleccion de tablas geodésicas para las latitudes de la república.
Soc. Mex. Geogr., Bol., X, 1865, 125–143.

——— Tratado de topografía y de geodesia con los primeros elementos de astronomía práctica.
2 vols., 8°, Geodesia y Astronomía, II, México, 1869, pp. 564, 2 pl. (Washington, Observatory.)

——— Recherches relatives à l'influence de la chaleur solaire sur la figure de la terre.
8°, Paris, 1881, pp. iv, 56. (Paris, Observatory.)

Cram (Thomas Jefferson). On the length of a degree of the terrestrial meridian; oblateness and axes of the earth; comparative oblateness of the planets; reduction of latitude; radius of the earth; and length of a degree of parallel of latitude; with appropriate tables.
Am. Journ. Sci., XXXI, 1837, 222–235.

Cramer (W.). Beiträge zur Geschichte der Vorstellung von der Gestalt der Erde.*
Barr in Elsass, 1877.
Title from Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 773.

Crawford (James Ludovic, Earl of). On the deviations of the plumb-line evinced in the Island of Mauritius.
Dun Echt Obsy. Publications, III, 1885, 499–506.

Christiani (Girolamo Francesco). Delle misure d' ogni genere antiche e moderne, con note letterarie e fisico-matematiche, a giovamento di qualunque architetto.
4°, Brescia, 1760, pp. xxiv, 208, 2 plates. (Gore.)

Crofton (Morgan W.). On the proof of the law of errors of observations.
Roy. Soc. London, Phil. Trans., CLX, 1870, 179–188; Proc., XVII, 1869, 406–407.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869–'70, 115, by C[AYLEY].

Croizet (Vincent). Géodésie générale et méthodique des géodésies, considérée sous le rapport de la mesure et de la division des terres, et suivie des tables des logarithmes des nombres et des sinus, tangentes, etc., avec sept décimales.
4°, Paris et Péronne, 1840, pp. xx, 488, 21 plates.
Preceded by "Coup-d'œil rapide sur l'histoire des mathématiques pures."

Crosthwaite (John). An account and description of three pendulums invented and constructed by the author.
Roy. Irish Acad., Trans., II, 1788, 7–12.

Crotti. Compensazione degli errori nei rilievi geodetici.*
Il Politecnico, XXXIV, 1886, 587.
Title from Zeits. f. Vermes., XVII, 1888, 506.

Croyère (de la). *See* **Isle de la Croyère (Josephus Nicol de l').**

Cruls (Louis). Les travaux de la mesure d'un arc de méridien au Brésil, sous la direction de E. Liais.
8°, Rio de Janeiro, 1876, pp. 6.

Čubr (Em.). Von den Erdmessungen.*
Zeitschr. zur Pflege der Math. u. Phys., redigirt von F. J. Studnicka, Prag, III, 1874, 228–261; IV, 1875.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VI, 1874, 724–725, by W[EYR].

Cunningham (Allan). The India survey.
Nature, XXVII, 1882, 97–98.
A review of the general report on the operations of the survey of India during 1880–'81.

Cutts (Richard D.). Memoranda relating to the field work of a secondary triangulation. Description of station signals, methods of observations, correction for phase, eccentricity, spherical excess, measurement of subsidiary base-lines, etc.
U. S. and G. Survey, Rep., 1868, 109–139; 1882, 151–197.

——— Field work of the triangulation. (Reprinted, with additions, from U. S. Coast Survey Report for 1868).
4°, Washington, Gov't Printing Office, 1877, pp. 45.

Czemak (P.) *und* Hiecke (R.). Pendelversuche.*
Wien, 1885.

Czerny. Die Wirkungen der Winde auf die Gestaltung der Erde.
Petermann's Mittheil., XXII, 1876, Ergänzungshefte, 48.

Czuber (Emanuel). Bemerkungen über die mathematische Behandlung von Beobachtungsergebnissen.
Tech. Blätter, VIII, 1876, 131–139.

——— Genauigkeit der geodätischen Punktbestimmung durch zwei und mehrere Grade.
Tech. Blätter, X, 1878, 1–24.

——— Geometrische Wahrscheinlichkeiten und Mittelwerte.
8°, Leipzig, 1884, pp. v, 244, *Teubner*.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XVI, 1884, 178–180, by Ls. [LAZARUS].

D. On the general principles of geodesy, and on the several methods by which may be constructed a map of any country.
Gleanings in Science, Calcutta, II, 1830, 1–9.

D. (A. B. C.). A concise method of determining the figure of a gravitating body revolving round another.
Journ. Nat. Phil. (Nicholson), XX, 1808, 208–214.

Daddi (G. B.). Corso di geodesia. Sciola d' applicazione d' artiglieria e genio.
8°, Torino, 1876, pp. 372, 23 plates.
Unione typografica.

——— Della combinazione degli errori nel metodo dei minimi quadrate.*
Torino, 1879.

Dalby (Isaac). Remarks on Major-General Roy's account of the trigonometrical operations.
Roy. Soc. London, Phil. Trans., LXXX, 1790, 593–614.

Dalby (I.) *and* Mudge (W.). Account of the trigonometrical survey carried on in 1791.
Roy. Soc. London, 1795, 414–591.

Dalby (Isaac). A short account of the late R. Burrow's measurement of a degree of longitude and another of latitude near the tropic in Bengal in the year 1790 and 1791, by Isaak Dalby.
4°, London, 1796, pp. 21. (Southampton, Ordnance Survey.)
a : b :: 229½ : 230½.

Dalby (I.) *and* Mudge (W.). An account of the operations carried on for accomplishing a trigonometrical survey of England and Wales.
London, 1799.
Title in full under MUDGE (W.).

Dalby (Isaac): Tiarks (J. L.). On —'s method of finding the difference of longitude between two points of a geodetical line on a spheroid.
Phil. Mag. (Taylor), IV, 1828, 364–370.

Dalrymple-Hay (Harley H.). Trigonometrical surveying.
Inst. Civil Eng., Proc., LXXX, 1885, 283–318.

Dangos. Observations sur les réfractions terrestres.
Savans Étr., Mém., I, 1806, 463–468; Ann. d. Phys. (Gilbert), XLVII, 1814, 442–446.

Danvers (F. C.). The surveys of India. II. The trigonometrical survey (with a sketch map).
Quart. Journ. Sci., VII, 1870, 448–458.

Darboux (G.). Sur une série de lignes analogues aux lignes géodésiques.
École Norm., Ann., VII, 1870, 175–180.

Darlington (William). Mason and Dixon's line.
Historical Mag., II, 1858, 37–42.

Darquier de Pellepoix (Augustin). Observations astronomiques faites à Toulouse. Deuxième partie. (H.)

Length of second's pendulum at Toulouse, pp. 219–240.

Darwin (G. H.). Note on the ellipticity of the earth's strata.

Mess. of Math., VI, 1877, 109–110.

——— On the bodily tides of viscous and semi-elastic spheroids, and on the ocean tides upon a yielding nucleus.

Roy. Soc. London, Phil. Trans., 1879, i, 1–35.

——— On the precession of a viscous spheroid and on the remote history of the earth.

Roy. Soc. London, Phil. Trans., 1879, ii, 447–538, 1 plate.

Revd. in Nature, XIX, 1879, 292–293.

——— Problems connected with the tides of a viscous spheroid.

Roy. Soc. London, Phil. Trans., 1879, ii, 539–593.

——— The analytical expression which gives the history of a fluid planet of small viscosity attended by a single satellite.

Roy. Soc. London, Proc., L, 1880, 255–278.

——— On an instrument for detecting and measuring small changes in the direction of the force of gravity.

8°, 32 pp.

From: Brit. A. A. S., Rep., 1881–'82.

——— On the figure of equilibrium of a planet of heterogeneous density.

Roy. Soc. London, Proc., XXXVI, 1883–'84, 158–166.

The converse of LAPLACE's method for determining the figure of the earth; that is, assuming a given figure to find the law of compressibility.

Daussy (P.). Précis des opérations géodésiques qu'ont servi de base aux cartes et plans des trois premières parties du Pilote français.

4°, Paris, 1829.

Exposé des travaux relatifs à la reconnoissance hydrographique des côtes occidentales de France par BEAUTEMPS-BEAUPRÉ, 69–124.

——— Sur le levé trigonométrique de l'état de Massachusetts.

Soc. Géogr., Bull., XVI 1841, 324–331.

Regarding BORDEN's survey.

David (Aloys). Trigonometrische Vermessung zur Verbindung der Prager Sternwarte mit dem Lorenzberge und zur Bestimmung der Breite des Ortes auf dem Hradschin, wo Tycho beobachtet hat.

K. böhm. Ges., Abhandl., II, 1805, iii, 1–45.

——— Geographische Ortsbestimmungen von Manetin und Kaletz, Pilsen und Chotieschau; sammt Vorschlägen, die Gestalt der Erde aus Längenbestimmungen durch Blickfeuer und Sternbedeckungen zu berechnen.

K. böhm. Ges., Abhandl., IV, 1814, ii, 1–60.

[David (J.-P.).] Réplique à la lettre de M. de la Condamine par l'auteur de la dissertation sur la figure de la terre.

8°, A la Haye, 1769, pp. 64.

——— Dissertation sur la figure de la terre, où l'on prouve que d'après les expériences faites au Pérou et au cercle polaire, cette planète être allongée par les pôles. Nouvelle édition, augmentée d'une lettre de M. de la Condamine, et d'une réplique à cette lettre, dans laquelle on expose plusieurs faits probatoires de l'opinion de l'auteur; entre autres un précis et un résultat des ingénieuses expériences faites aux Alpes en 1767 et 1768, pour trouver le rapport de la pesanteur considérée au sommet au pied d'une de ces montagnes; et dans laquelle, en donnant la véritable cause des réfractions irrégulières et critiques sur la cause singulière que M. Bouguer assignoit à ce phénomène.

8°, A la Haye, 1771, pp. 58, 5 plates. (Paris, Observatory.)

Davidson (George). Improved clamp for telescope of the theodolite.

U. S. C. and G. Survey, Rep., 1874, 153.

——— Improved open vertical clamp for telescopes of theodolites and meridian instruments.

U. S. C. and G. Survey, Rep., 1877, 182.

——— Geodetic instruments of precision at the Paris exposition and in European workshops.*

Nat. Acad. Sci., Proc., 1878.

——— Report of the measurement of the Yolo base, California.

U. S. C. and G. Survey, Rep., 1882, 139–149.

——— *and* **Schott (C. A.).** Results for the length of the primary base line in Yolo County, Cal.

U. S. C. and G. Survey, Rep., 1883, 273–288.

——— The run of the micrometer.

U. S. C. and G. Survey, Rep., 1884, 377–385.

——— Standard geodetic data.

Cal. Acad. Sci., Bull., II, 1887, 319–324.

Contains revised positions of points on the Pacific coast.

Davis (C. H.). The Coast Survey of the United States.

8°, Cambridge, 1849, pp. 34. (Gore).

——— The Coast Survey of the United States.

8°, Washington, 1851, pp. 28. (Gore).

Davis (Jefferson). Speech on the subject of the Coast Survey of the United States; delivered in the Senate of the United States, Monday, Feb. 19, 1849.

8°, n. d., pp. 18, with pp. 19–40, appendix. (Gore.)

Containing letters and resolutions indorsing the work of the Coast Survey.

Davout. Sur la forme de la surface de la terre. (H.)

Acad. d. Sci. Paris, Comp. Rend., 1845, II.

Day (Murray S.). Report of the trigonometrical survey of the Island of Hokkaido for 1875.

4°, New York, 1876, pp. 91.

Debauve (Alphonse). Manuel de l'ingénieur des ponts et chaussées. 5me fascicule. Géodésie, nivellement, levé des plans.

8°, Paris, 1872, pp. 155, 7 pl. (British Museum).

Decher (O.). Die einfache und Doppelpunkteinschaltung im Dreiecks-Netze.

Zeits. f. Vermes., XVI, 1888, 140–152.

Decker (A.). Lehrbuch der höheren Geodäsie.

8°, Mannheim, 1836, pp. vi, 304, 3 plates.

Dedekind (Julius Wilhelm Richard). Ueber die Bestimmung der Präcision einer Beobachtungsmethode nach der Methode der kleinsten Quadrate.

Naturf. Ges. Zürich, Vierteljahrs., V, 1860, 76–83.

Defforges (G.). Mémoire sur la mesure de l'intensité de la pesanteur.
Int. Geod. Cong., Verhandl., 1887, V.c., 1-20

——— Sur la mesure de l'intensité absolue de la pesanteur.
Acad. d. Sci. Paris, Comp. Rend., CVI, 1888, 126-129, 191-194.

Deflers. Problème sur le pendule simple.
École Polytech., Corres., III, 1814-'16, 183-197.

De Forrest (E. L.). *See* **Forrest (E. L. De).**

DEGREE MEASUREMENT.

ABENDROTH (W.). Darstellung und Kritik der ältesten Gradmessungen.
Dresden, 1866.

ALEXANDER (J.). Concerning a place in New York for measuring a degree of latitude.
Roy. Soc. London, Phil. Trans., XLI, 1740, i, 383.

AMANTE (F.). Nouveau calcul de l'arc du méridien entre Montjouy et Formentera.
Naples, 1843.

ANVILLE (J.-B. d'). Proposition d'une mesure de la terre.
Paris, 1735.

——— Mesure conjecturale de la terre.
Paris, 1736.

ARGELANDER (F. W. A.). Die neue Längengradmessung auf dem 52. Parallel quer durch Europa.
Niederrh. Ges., Sitz.-Ber., I, 1864, 49-53.

B. Ueber die Längen-Gradmessung zwischen dem Tour de Cordorian und Fiume, im 45sten Parallel.
Hertha, IX, 1827, 277-288; XI, 1828, 448-456.

BAEYER (J. J.). Das Messen auf der sphäroidischen Erdoberfläche.
Berlin, 1862.

——— Zur Entstehungsgeschichte der europäischen Gradmessung.
Berlin, 1862.

——— Ueber den gegenwärtigen Stand der Gradmessung.
Geogr. Jahrb., 1866, 338 +.

——— Bericht über die Fortschritte der Gradmessungen.
Geogr. Jahrb. (Behm), III, 1870, 152-172; IV, 1872, 1-16.

BASSOT (L.). La méridienne de Laghouat.
Acad. d. Sci. Paris, Comp. Rend., CVI, 1888, 818-820.

BAUERNFEIND (C. M.). Die Bedeutung moderner Gradmessung.
München, 1866.

BECCARIA (J. B.). Gradus taurinensis.
Augustæ Taurinorum, 1774.

——— Lettere intorno alle reflessioni del Cassini de Thury sul grado Torinense.
Firenze, 1777.

BEEK-CALKOEN (J. F.). Ueber die Messung eines Breitengrades durch Snellius, verbessert von P. van Muschenbroek.
Allg. geogr. Eph., I, 1798, 625-639.

BIOT (J.-B.). Recueil d'observations géodésiques . . . pour déterminer la variation des degrés terrestres.
Paris, 1821.

BLAIR (J.). History of the rise and progress of geography.
London, 1784.

BLARAMBERG. Die Vermessung des Parallelbogens von 52° n. Breite durch ganz Europa . . .
Petermann's Mittheil., 1861, 209-212.

BLASS (F.). Einiges aus der Geschichte der Astronomie im Alterthum.
Kiel, 1883.

BONNE (R.). Notice sur la mesure de l'arc de longitude compris entre Munich et Brest . . .
Dépôt de la Guerre, Mém., III, 1826, 395-406.

DEGREE MEASUREMENT—Continued.

BOUGUER (P.). Opérations pour mesurer l'intervalle entre Ville Juive et Juvisy.
Acad. d. Sci. Paris, Mém., 1754, 172-186.

——— Observations faites . . . pour la vérification du degré du méridien compris entre Paris et Amiens.
Paris, 1757.

BREMIKER (C.). Ueber Gradmessungen.
Astron. Nachr., XLIII, 1856, 209-224.

BRINKLEY (J.). Elements of astronomy.
Dublin, 1819.

BROUSSEAUD. Mémoire sur la mesure d'un arc du parallèle moyen entre le pôle et l'équateur.
Paris, 1826; Limoges, 1839.

BRUHNS (C.). Gradmessung.
Ersch und Grüber, Encycl., I, 18-37.

——— Bericht über die neueste Fortschritte der europäischen Gradmessung.
Geogr. Jahrb. (Behm), V, 1874, 144-168; VI, 1876, 284-310; VII, 1878, 243-279; VIII, 1880, 275-303.

——— Die fünfte allgemeine Conferenz der Bevollmächtigten der europäischen Gradmessung.
Leopoldina, XIII, 1877, 184-188.

BURCKHARDT (J. K.). Remarques sur la mesure d'un arc du méridien . . . en Angleterre.
Bibl. Brit. Genève, XXVIII, 1805, 284-287.

C. The longest geodetic arc.
Journ. Frank. Inst., CX, 1880, 61.

CARLINI (F.). Dell' ampiezza dell' arco di meridiano che attraversando la pianura di Lombardia . . .
Eff. Astron., Milano, 1843, 3-68.

CASSINI (G.-D.). De la méridienne de l'Observatoire royal de Paris, prolongée jusqu'aux Pyrénées.
Acad. d. Sci. Paris, Mém., 1701, 171-184.

CASSINI (J.). Réflexions sur la mesure de la terre, rapportée par Snellius.
Acad. d. Sci. Paris, Mém., 1702, 60-66.

——— De la méridienne de l'observatoire.
Acad. d. Sci. Paris, Mém., 1732, 452-470.

——— De la perpendiculaire à la méridienne de Paris prolongée vers l'orient.
Acad. d. Sci. Paris, Mém., 1734, 434-452.

——— Des opérations géométriques que l'on emploie pour déterminer les distances sur la terre.
Acad. d. Sci. Paris, Mém., 1736, 64-86.

CASSINI (J.-D.). De la jonction des observatoires de Paris et de Greenwich.
Acad. d. Sci. Paris, Mém., 1788, 706-717; Paris, 1791.

CASSINI DE THURY (C.-F.). De la méridienne de Paris, décrite à la distance de 60,000 toises vers le midi.
Acad. d. Sci. Paris, 1735, 403-413; . . . vers le nord, 1736, 329-341; 1740, 276-292.

——— La méridienne de l'Observatoire de Paris, verifiée dans toute l'étendue . . .
Acad. d. Sci. Paris, Mém., 1742, 42-51.

——— Sur la jonction de la méridienne de Paris avec celle de Snellius.
Acad. d. Sci. Paris, Mém., 1748, 123-132.

——— Mémoire sur la prolongation de la perpendiculaire jusqu'à Vienne.
Acad. d. Sci. Paris, Mém., 1763, 299-317.

——— Relation de deux voyages faits en Allemagne . . . pour déterminer la grandeur des degrés de longitude.
Paris, 1763.

——— Description géométrique de la France.
Paris, 1783.

CONDAMINE (C.-M. DE LA). Extrait des opérations . . . faites pour la mesure des degrés du méridien aux environs de l'équateur.
Acad. d. Sci. Paris, Mém., 1746, 618-688; Amsterdam, 1746; Paris, 1751.

DEGREE MEASUREMENT—Continued.

Cruls (L.). Les travaux de la mesure d'un arc de méridien au Brésil.
Rio de Janeiro, 1876.

Cube (E.). Von den Erdmessungen.
Zeits. z. Pflege d. Math. u. Phys., III, 1874, 228–261.

Delambre (J.-B.-J.). Méthodes analytiques pour la détermination d'un arc du méridien.
Paris, 1799.

—— Einige Bemerkungen über Gradmessungs-Arbeiten.
Mon. Corr. (Zach), XIII, 1806, 346–370.

—— Exposé des résultats des grandes opérations géodésiques . . . pour la mesure d'un arc du méridien.
Conn. d. Temps, 1810, 485–488.

—— Réflexions sur un mémoire de Don J. Rodriguez, sur la mesure de trois degrés du méridien en Angleterre.
Conn. d. Temps, 1816, 256–274.

—— Histoire de la mesure de la terre.
Paris, 1827.

De l'Isle (J.-N.). Projet de la mesure de la terre en Russie.
St.-Pétersbourg, 1737; Roy. Soc. Lond., Phil. Trans., XL, 1737–'38, 27–51.

De Morgan (A.). On the history of Fernel's measure of a degree.
L., E., D. Phil. Mag., XIX, 1841, 445–447; XX, 1842, 116–117, 230–233, 408–411; XXI, 1842, 22–25.

Euler (L.). Methodus determinandi gradus meridiani pariter ac paralleli telluris . . .
Acad. de St.-Pétersbourg, Com., XII, 1740, 224–240.

Ferrero (A.). Rapport spécial sur les triangulations.
Int. Geod. Cong., Gen.-Ber., 1880, V, 1–76; Florence, 1884; 1887.

Firminger (T.). Observations on the measurement of an arc of the meridian.
Phil. Mag. (Tilloch), LIV, 1819, 60–62.

Forbiger (A.). Handbuch der alten Geographie.
Leipzig, 1842–'48.

Galbraith (W.). On the English arc of the meridian.
Edinb. Phil. Journ., XXXIV, 1843, 263–275.

Gautier (A.). Sur les mesures récentes d'arcs du méridien, effectuées dans la partie nord-est de l'Europe.
Bibl. Univ. Genève, Arch., XXIII, 1853, 275–278.

Gore (J. H.). The purposes and results of geodetic surveys.
Correspondence Univ. Journ., III, 1885, 18–20.

Gosselin (P.-F.-J.). Géographie des Grecs analysée.
Paris, 1790.

Grenus (T.). Ueber einige Bemerkungen, welche Svanberg über die Gradmessung von Peru gemacht hat.
Mon. Corr. (Zach), XIII, 1806, 398–404.

Guenther (S.). Die Erdmessung des Eratosthenes.
Geogr. Rundschau, III, 1881, 327–336.

Haupt (C.). Gradmessungs-Beiträge.
Astron. Nachr., CIX, 1884, 7–28.

Hirsch (A.). Sur les progrès des travaux géodésiques en Europe.
Soc. Sci. Nat. Neuchâtel, Bull., VII, 1866, ii, 387–402.

Ideler (C. L.). Ueber die Gradmessung der Alten.
Mon. Corr. (Zach), XXIII, 1811, 453–482.

Ivory (J.). . . . and the length of a degree perpendicular to the meridian at the latitude of Beachy Head.
Phil. Mag. (Taylor), IV, 1828, 6–11.

—— On measurements on the earth's surface perpendicular to the meridian.
Phil. Mag. (Taylor), IV, 1828, 189–194, 241–245.

Jadanza (N.). Sulla misura di un arco di parallelo terrestre.
Accad. Sci. Torino, Atti, XIX, 1886, 990–1004; XX, 1886, 326–330.

Jahn (G. A.). Geschichte der Astronomie.
Leipzig, 1844.

James (H.). Extensions of the triangulation . . . with the measurement of an arc of parallel in latitude 52° N.
London, 1863.

DEGREE MEASUREMENT—Continued.

Jordan (W.). Vergleichung der Genauigkeit verschiedener Gradmessungen.
Astron. Nachr., LXXX, 1872, 17–22, 67–70, 189–190.

—— Ueber die Methoden und Ziele der europäischen Gradmessung.
Carlsruhe, 1873.

—— Die Gradmessung der Araber, 827, n. C.
Zeits. f. Vermes., XVIII, 1889, 100–109, 159.

Juan (Jorge). Relacion histórica del viage á la América meridional.
Madrid, 1748; Leipzig, 1751; Paris, 1752; London, 1772; (Goes, 1771); Madrid, 1773.

Kaiser (F.). De eischen de medewerking aan de ontworpen graadmeting in midden Europa.
Amsterdam, 1864.

Klein (F.). Zweck und Aufgabe der europäischen Gradmessung.
Wien, 1882.

Klügel (G. S.). Aufgabe zur Meteorologie und Erdmesskunst.
Ann. d. Phys. (Gilbert), XIX, 1805, 115–117.

Knogler (G.) Nachricht . . . von einer chinesischen Grad-Messung.
Mon. Corr. (Zach), I, 1800, 241–251, 589–593.

Kutscher (G.). Beiträge zur Geschichte der Gradmessungen.
Zeits. f. Vermes., XIII, 1884, 282–285.

Lacaille (N.-L. de). Mesure du trente-quatrième degré de latitude australe.
Acad. d. Sci. Paris, Mém., 1751, 425–436; Hist., 158–169.

—— Éclaircissemens sur les erreurs qu'on peut attribuer à la mesure du degré entre Paris et Amiens.
Acad. d. Sci. Berlin, Hist., X, 1754, 337–346.

—— Sur la précision des mesures géodésiques . . . de Paris et Amiens.
Acad. d. Sci. Paris, Mém., 1755, 53–59.

—— Mémoire sur la vraie longueur des degrés du méridien en France.
Acad. d. Sci. Paris, Mém., 1758, 237–244.

Lalande (J.-J. de). Mesure de la méridienne.
Soc. Philom., Bull., I, 1791, 47.

—— Bericht über die französischen Gradmessungs-Arbeiten.
Allg. Geogr. Eph., I, 1798, 127–131.

—— Sur la mesure d'un degré de la terre en Laponie.
Journ. d. Phys., LVI, 1802, 400–401.

—— Bericht über Gradmessungsarbeiten.
Mon. Corr. (Zach), V, 1802, 55–56.

Lambton (W.). An account of the measurement of an arc of the meridian in India.
Asiatick Researches, VIII, 1805, 137–194; XII, 1818, 2–101, 294–359; XIII, 1820, 1–127.

Laplace (P. S. de). Sur les degrés mesurés des méridiens.
Acad. d. Sci. Paris, Mém., 1789, 18–43.

Largeteau (C.-L.). Rapport . . . sur la détermination de la longueur de l'arc entre Dunkerque et de Formentera.
Conn. d. Temps, 1844, 123–131.

Legendre (A. M.). Méthode pour déterminer la longueur exacte du quart du méridien.
Inst. de France, Mém., 1799–1819, IV, 1–16.

Le Monnier (P.). Premières observations faites . . . pour constater la grandeur du degré de France.
Paris, 1757.

Letronne. Mémoire sur les anciens, ont-ils éxécuté une mesure de la terre postérieurement à l'établissement de l'École d'Alexandrie?
Acad. d. Inscr., Mém., VI, 1822, 261–323.

Liesganig (J.). Extract of a letter . . . containing a short account of the measurement of three degrees of latitude under the meridian of Vienna.
Roy. Soc. London, Phil. Trans., LVIII, 1768, 15–17; Vindobonæ, 1770.

DEGREE MEASUREMENT—Continued.

LINDELÖF (L. L.). Om gradmatningen emellan Svartahafvet och Ishafvet.
Finska Veten. Helsingfors, Öfvers., V, 1863, 170–173.

LITTROW (J. J.). Theoretische und practische Astronomie.
Wien, 1821–'27.

MÄDLER (J. H.). Leitfaden der mathematischen und allgemeinen physischen Geographie.
Stuttgart, 1843.

MAIRE (C.). De litteraria expeditione ad dimetiendos duos meridiani gradus.
Romæ, 1755; Paris, 1770.

MARIENI (J.). Trigonometrische Vermessungen im Kirchenstaate und in Toscana.
Wien, 1846.

MASON (C.). Observations for determining the length of a degree of latitude in . . . North America.
Roy. Soc. London, Phil. Trans., LVIII, 1768, 274–328.

MECHAIN (P.-F.-A.). Base du système métrique.
Paris, 1806–'10.

MELANDERHJELM (D.). Nordische Gradmessung.
Mon. Corr. (Zach), I, 1800, 139–145, 372–380; II, 1800, 250–257; V, 1802, 156–169; VII, 1803, 561–568; IX, 1804, 491–495; Astron. Jahrb. (Bode), 1806, 219–223.

MICHELL (J. J.). Proposal of a method for measuring degrees of longitude.
Roy. Soc. London, Phil. Trans., LVI, 1766, 119–125.

MOLLWEIDE (C. B.). Beitrag zur trigonometrischen Differenz-Rechnung.
Mon. Corr. (Zach), XV, 1807, 441–451.

MÜFFLING (F.-F.-C. VON). Sur les travaux géodésiques entre Dunkerque et Seeberg.
Corr. Astron. (Zach), IV, 1820, 525–532, 533–537; Astron. Nachr., II, 1824, 37–38; Hertha, VII, 1826, i, 5–25.

MÜLLENHOFF. Die Erdmessung des Eratosthenes.

MÜLLER (Q.). Geschichte der Breitengradmessung bis zur peruanischen Gradmessung. 1871.

NAGEL (A.). Die Hauptmomente der Entwickelungeschichte der Gradmessungen.
Dresden, 1873.

NERENBURGER (A.-W.). Sur la mesure de l'arc de parallèle européen de plus grand développement.
Acad. de Belgique, Bull., XI, 1861, 457–467.

NICOLLET (J.-N.). Sur la mesure d'un arc du parallèle moyen entre le pôle et l'équateur.
Conn. d. Temps, 1829, 252–295.

NIESSL (G. von). Ueber die europäische Gradmessung.
Brün. Verhandl., Sitz.-Ber., VIII, 1869, 15–22.

NORWOOD (R.). The seaman's practice.
London, 1667.

——— Measure of the earth. 1794.

ORIANI (B.). Misura dell' arco del meridiano compreso fra Milano e Genova.
Eff. Astron., Milano, 1827, 25–33.

OUTHIER (R.). Journal d'un voyage au nord en 1736–'37.
Paris, 1744.

PASQUICH (J.). Ueber den Gebrauch der neuesten französischen Gradmessung.
Mon. Corr. (Zach), I, 1800, 435–447.

PATTENHAUSEN (B.). Ueber die Ausdehnung des Meridians von Paris bis zur Sahara.
Zeits. f. Vermes., X, 1881, 247–257.

PICARD (J.). La mesure de la terre.
Paris, 1671; 1684; Acad. d. Sci. Paris, Mém., VII, 1729, 1–59; 133–190.

——— Observations sur les diférentes méthodes employées pour mesurer la terre.
Acad. d. Sci. Paris, Hist., I, 82–87.

——— Degré du méridien entre Paris et Amiens.
Paris, 1740.

DEGREE MEASUREMENT—Continued.

PICTET (M. A.). Considerations of the convenience of measuring an arch of the meridian and of parallel in Italy.
Roy. Soc. London, Phil. Trans., LXXXI, 1791, 106–127.

PISIS (A.). Mesure de la méridienne du Chili.
Acad. d. Sci. Paris, Comp. Rend., LXIV, 1867, 265–267.

PLANA (G. A. A.). Relazione delle operazioni . . . per la misura di un parallelo terrestre.
Accad. Sci. Torino, Mem., XXXVIII, 1824.

POSCH (L.). Geschichte und System der Breitengrad-Messungen.
Freysing, 1860.

PRAZMOVSKI (A.). Rapport sur les travaux pour terminer les opérations de la mesure de l'arc du méridien.
Acad. de St.-Pétersbourg, Cl. Phys.-Math., Bull., XII, 1853, 84–86; Mél. Math., I, 1853, 593–608.

PROSPERIN (E.). Etwas über die schwedische Gradmessung in Lappland.
Astron. Jahrb. (Bode), 1806, 193–195.

PUISSANT (L.). Sur la détermination d'un arc perpendiculaire à une méridienne terrestre.
Conn. d. Temps, 1820, 281–304.

——— Détermination de la longueur de l'arc de méridien compris entre Montjouy et Formentera . . .
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 428–436; VI, 1838, 770; Mém., XVI, 1836, 1–25, 457–477.

——— Note sur un moyen fort simple d'appliquer la trigonométrie à la détermination d'un arc de méridien.
Acad. d. Sci. Paris, Comp. Rend., III, 1836, 739–742.

ROGG (J.). Tafel der zuverlässigsten Breiten-Grad-Messungen.
Petermann's Mittheil., 1864, 311–312.

ROSS (J.). A plan for measuring an arc of the meridian at Spitzbergen.
Roy. Astron. Soc., Month. Not., VII, 1845–'47, 175.

ROY (W.). Comparison of the celestial and terrestrial arcs between Greenwich and Perpignan.
Roy. Soc. London, Phil. Trans., LXXVII, 1787, 197–228.

——— An account of the mode to be followed in determining the relative situations of Greenwich and Paris.
Roy. Soc. London, Phil. Trans., LXXVII, 1787, 188–196, 197–228, 465–469; LXXX, 1790, 111–270; Paris, 1791.

SABINE (E.). On the measurement of an arc of the meridian at Spitzbergen.
Quart. Journ. Sci., XXI, 1826, 101–108.

——— An account of the arcs perpendicular to the meridian, which are now measuring on the continent of Europe.
Quart. Journ. Sci., I, 1827, 177–204.

SADEBECK (B. A. M.). Entwickelungsgang der Gradmessungs-Arbeiten.
Berlin, 1876.

SCHOTT (C. A.). Results of the measurement of an arc of the meridian.
U. S C. and G. Survey, Rep., 1868, 147–153.

——— The Pamplico-Chesapeake arc of the meridian.
U. S. C. and G. Survey, Rep., 1877, 84–95.

SÉDILLOT (A.). Sur les déterminations des arcs du méridien terrestre.
Soc. Géogr., Bull., I, 1851, 226–231.

SEIDEL (G. C. F.). Eratosthenes geographicorum fragmenta. Edita —.
Gœttingæ, 1789.

SEYFFER (K. F. VON). De positu basis et retis triangulorum per totam Bojoariam.
K. bayer. Ak. d. Wiss., Denkschr., III, 1811–'12, 449–521.

SKOGMAN (C.) Completion of the preliminary survey of Spitzbergen . . . ascertaining the practicability for the measurement of an arc of the meridian.
Roy. Soc. London, Proc., XIII, 1864, 551–553.

SMITH (W.) Terrestrial measurement between the observatories of Norriton and Philadelphia.
Am. Phil. Soc., Trans., I, 1771, 114–120.

DEGREE MEASUREMENT—Continued.

SNELL (W.). Eratosthenes Batavus.
Lugduni Batavorum, 1617.

SOLDNER (J. VON.) Vorschlag zu einer Grad-Messung in Afrika.
Mon. Corr. (Zach), IX, 1804, 357-362.

—— Ueber die swedische Messung des Meridiangrades.
Astron. Jahrb. (Bode), 1806, 268.

STRUVE (F. G. W.). Nachricht von der russischen Gradmessung.
Astron. Nachr., I, 1823, 67-68; II, 1824, 135-136, 145-148; VI, 1828, 391-394; VII, 1829, 385-400; X, 1833, 323-325; Corr. Astron. (Zach), XI, 1824, 23-33, 34-42; Dorpat, 1827; 1831; Dorpat, Jahrb., I, 1833, 87-89; Acad. de St.-Pétersbourg, Mém., II, 1833, 401-425; IV, 1850, 1-86; Recueil Séance publique, 1836, 103-108; Bull. Sci., VII, 1840, 280-288; XI, 1853, 113-136; St. Petersburg, 1852; 1857; K. k. Ak. d. Wiss., Sitz.-Ber., XXI, 1856, 3-5.

SVANBERG (J.). Ueber die alte nordische Gradmessung.
Mon. Corr. (Zach), II, 1800, 257-261; V, 1802, 161-169.

—— Berättelse öfver . . . den franska gradmätning en Omkring Tornea.
K. Vetens. Acad. Handl., XX, 1799, 279-291.

—— Exposition des opérations faites en Laponie pour la détermination d'un arc du méridien.
Stockholm, 1805.

SWINDEN (J. H. VAN). Rapport sur la mesure de la méridienne de France, et les résultats qui en ont été deduits pour déterminer les bases du nouveau système métr que.
Inst. de France, Cl. Math.-phys., Mém., II, 1802, 23-80 (Hist.); Journ. Nat. Phil. (Nicholson), III, 1800, 316-324, 365-369; Paris, 1799.

TÉDÉNAT. Mesure de la distance de la tour de Nismes à la méridienne de Paris.
Acad. du Gard, Notice d. Trav., 1808, 212-277.

TENNER (C.). Nachricht von der Vollendung der Gradmessung zwischen der Donau und dem Eismeer.
Acad. de St.-Pétersbourg.

TINTER (W. R.). Die europäische Gradmessung in ihrer Beziehung zu den früheren Gradmessungsarbeiten.
Allg. Bauzeitg. f. Architekten (Förster), XXXV, 1870, 151-173, 195-209.

—— Der Zweck der europäischen Gradmessung.
K. k. geogr. Ges., Mittheil., XIV, 1871, 81-90.

TODHUNTER (I.). On the arc of meridian measured in Lapland.
Phil. Soc. Camb., Trans., XII, 1873, 1-26.

—— On the arc of the meridian measured in South Africa.
Roy. Astron. Soc., Month. Not., XXXIII, 1873, 27-34.

TRALLES (J. G.). Behndlungen einiger Aufgaben die bei grösseren trigonometrischen Messungen vorkommen.
K. Ak. d. Wiss., Abhandl. math. Cl., 1804-'11, 11-27.

VINCENT (A.-J.-H.). Sur la mesure de la terre, attribuée à Ératosthène.
Acad. d. Sci. Paris, Comp. Rend., XXXVI, 1853, i, 317-321.

WEISS (E.). Ueber Geschichte der Gradmessung mit besonderer Beziehung auf den Zweck der mitteleuropäischen Gradmessung.
Verein naturwiss. Kenntnisse, Schriften, IV, 1863-'64.

WINSHEIM (C. N. DE). Determinatio exactior graduum parallelorum æquatoris et meridiani.
Acad. de St.-Pétersbourg, Com., XII, 1740, 222-231.

WOLF (R.). Ueber die Bedeutung der sogenannten mitteleuropäischen Gradmessung.
Naturf. Ges. Zürich, Vierteljahrs., VII, 1862, 337-345.

—— europäische Gradmessung.
Zürich, 1881-'84.

WOLFERS (J. P.). Nachricht von der Vollendung der Gradmessung zwischen der Donau und dem Eismeere.
Arch. d. Math. (Grunert), XXIII, 1854, 225-230.

DEGREE MEASUREMENT—Continued.

ZACH (A. VON). Méchain's Verlängerung der französischen Gradmessung bis auf die Balearischen Inseln.
Mon. Corr. (Zach), VII, 1803, 568-569; XVI, 1807, 434-442; XXI, 1810, 450-457.

ZACH (F. X. VON). Schwedische Gradmessung.
Mon. Corr. (Zach), XII, 1805, 421-449, 513-541; XIII, 1806, 3-20, 330-345; XIV, 1806, 210-224, 327-332.

—— Le degré du méridien mesuré en Piémont.
Accad. Sci. Torino, Mem., 1811-'12, 81-111; Mon. Corr. (Zach), XXVIII, 1813, 272-281.

—— Numerous short articles from 1812-'33.

ANON. Advertisement concerning the quantity of a degree of a great circle in English measure.
Roy. Soc. London, Phil. Trans., XI, 1676, 636-637.
Comparing the French measure with Norwood's.

—— Sur la différence de latitude et de longitude entre Alexandre et Syène.
Acad. d. Inscr., Mém., XXIX, 1764; Hist., 250-262.
Of value in estimating the measurement of Eratosthenes.

—— Sur la description du parallèle de Paris, ou de sa tangente.
Acad. d. Sci. Paris, Mém., 46-63 (Hist.).

—— Sur la prolongation de la méridienne de Paris.
Acad. d. Sci. Paris, Mém., 1700, Hist., 123-127.

—— Method employed between Melun and Lieusaint in France, to measure the base of a triangle, in order to determine the length of an arc of the meridian.
From: Journ. Phys., 1798. Phil. Mag. (Tilloch), I, 1799, 269-274.

—— Sur les degrés de la terre et sur les nouvelles mesures.
Conn. d. Temps, [1801], 455-474.

—— Ueber einige Breitenbestimmungen und über den daraus folgenden mittleren Werth eines Breiten-Grades am Aequator.
Mon. Corr. (Zach), XVI, 1807, 301-329.

—— Resultate der im Jahre 1802 beendigten neuen Englischen Gradmessung.
Mon. Corr. (Zach), XXV, 1812, 497-513; XXVI, 1812, 109-130, 213-219.

—— Opérations géodésiques et astronomiques pour la mesure d'un arc du parallèle moyen exécutées en Piémont et en Savoie par une commission composée d'officiers de l'état major général et d'astronomes piémontais et autrichiens en 1821, 1822 et 1823.
4°. Vol. I: Milan, 1825, pp. 237, 1 plate; vol. II: Milan, 1827, pp. 412. Folio of plates, no date. (Gore.)

—— Note sur la mesure de l'arc du parallèle moyen compris entre les tours de Fiume et de Cordorian.
Dépôt de la Guerre, Mém., III, 1826, 21-24.

—— On the measurement of the Indian meridional arc.
Gleanings in Science, I, 1831, 337-346.

—— Measurement of degrees.
Encycl. Americana, IV, 1848, 161-163.

—— Sur les mesures d'arc de méridien.
Soc. Géogr., Bull., XIV, 1850, 303-314.

—— Ueber die Vollendung der Gradmessung zwischen der Donau und dem Eismeere.
Arch. Russland (Erman), XIII, 1854, 492-496.

—— Die Grosse russisch skandinavische Breiten-Grad-Messung zwischen der Donau-Mündung und dem Nordende Europa's.
Geogr Mittheil (Petermann), 1857, 315-321.

—— Die mittel-europäische Gradmessung zwischen Palermo und Christiania.
Geogr. Mittheil. (Petermann), 1863, 86-92.

—— Die Gradmessung auf Spitzbergen.
Geogr. Mittheil. (Petermann), 1864, 67.

De la Barre. Sur les mesures géographiques des anciennes.
Acad. d. Inscr., Mém., XIX, 1753, 512-576.

Delambre (Jean-Baptiste-Joseph). Méthodes analytiques pour la détermination d'un arc du méridien; précédées d'un mémoire sur le même sujet par A.-M. Legendre.
4°, Paris, an VII [1879], pp. xxv, i, 176, 6 plates. (Gore.)

——— Des latitudes croissant sur le sphéroïde.
Conn. d. Temps, 1804, 342–343.

——— Recueil d'observations géodésiques. Revd. by —.
Acad. d. Sci. Paris, Hist., V, 85–90.

——— [Einige Bemerkungen über Gradmessungs-Arbeiten.]
Mon. Corr. (Zach), XIII, 1806, 346–370.

——— *et* **Méchain (P.-F.-A.).** Base du système métrique décimal.
Paris, 1806–'10.
Title in full under MÉCHAIN (P.-F.-A.).

———: **Mollweide (K. B.).** Beytrag zur trigonometrischen Differenzrechnung in Bezug auf —'s Méthodes analytiques.
Mon. Corr. (Zach), XV, 1807, 441–451.

———: **Svanberg (J.).** Exposition des opérations faites en Laponie pour la détermination d'un arc du méridien. Stockholm, 1805. Revd. by —.
Conn. d. Temps, 1808, 466–479.

——— Exposé des résultats des grandes opérations géodésiques, faites en France et en Espagne, pour la mesure d'un arc du méridien, et la détermination du mètre définitif; rédigé par une commission du bureau des longitudes.
Conn. d. Temps, 1810, 485–488.

——— Méthode sur les intégrales définies et leur application aux probabilités, et spécialement à la recherche du milieu qu'il faut choisir entre les résultats des observations, par M. le comte Laplace.
Inst. d. France, Mém., Cl. Sci. Math. et Phys., II, 1811, 1–18.

——— Abrégé d'astronomie, ou leçons élémentaires d'astronomie théorique et pratique; par M. Delambre.
8°, Paris, 1813, pp. xvi, 652, 14 plates. (Washington, Observatory.)
Grandeur et figure de la terre, 581–623.

——— Astronomie théorique et pratique.
Paris, 1814, I, pp. lxiv, 584, 11 plates; II, pp. 622, 6 plates; III, pp. 719, 10 plates. (Washington, Observatory.)
Grandeur et figure de la terre, III, 512–594.

———: **Gregory (O.).** Dissertations and letters by —, regarding the survey of England.
London, 1815.
Title in full under GREGORY (O.).

——— Réflexions sur un mémoire de Don J. Rodriguez, sur la mesure de trois degrés du méridien en Angleterre, imprimé dans les Roy. Soc. London, Phil. Trans., 1812.
Conn. d. Temps, 1816, 256–274.

——— Histoire de l'astronomie ancienne.
4°, Paris, 1817, I, pp. i, lxxii, 556, 1 plate; II, pp. vi, 639, 16 plates.
Géographie de Ptolémée, II, 520–542.

Delambre (Jean-Baptiste-Joseph)—Continued.

——— Exposé des opérations trigonométriques exécutées pour la description de l'Angleterre et du pays de Galles; par Mudge et Dalby.
Conn. d. Temps, 1818, 243–278.
A review of an account of the observations carried on for accomplishing a trigonometrical survey of England by Mudge and Dalby.

———: **Lambton (W.).** Mesure d'un arc du méridien entre les latitudes 8° 9′ 38″.39 et 10° 59′ 48″.93 nord, ou continuation de l'arc commencé en 1804 qui se terminait à 14° 6′ 19″ de latitude nord.
Conn. d. Temps, 1819, 292–302.

———: **Laplace (P.-S. de).** Application du calcul des probabilités aux opérations géodésiques de la méridienne de France. Notice by —.
Acad. d. Sci. Paris, Hist., 1819, i–iii.

——— Histoire de l'astronomie moderne.
Paris, I, 1821, pp. 715, 9 plates; II, pp. 804, lxxxii, 8 plates. (Washington, Observatory.)
SNELLIUS, II, 92–125; PICARD, 597–632.

——— Histoire de l'astronomie au XVIII^me^ siècle.
4°, Paris, 1827, pp. lii, 790, 2 plates.
Figure de la terre, 239–412.
Containing many interesting geodetic articles under the names of participants; as, CASSINI, MAUPERTUIS, etc.

——— Histoire de la mesure de la terre.
Paris, 1827.
Posthumous (POGGENDORFF), I, 539.

Delaunay (Charles-Eugène). Sur la géodésie française et sur le rôle qu'y ont joué l'Académie des sciences et le bureau des longitudes.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 149–154.

———, **Laugier** *et* **Faye.** Rapport sur l'état actuel de la géodésie et sur les travaux à entreprendre par le bureau des longitudes, de concert avec le Dépôt de la Guerre, pour compléter la partie astronomique du réseau français.
Conn. d. Temps, 1864, 1–20.

——— Cours élémentaire d'astronomie par Ch. Delaunay. Sixième édition, revue et complété par Albert Lévy.
12°, Paris, 1876, pp. viii, 766, 3 plates. *G. Masson.* (Washington, Observatory.)
Figure de la terre, 174–204.

Delcross: Eckhardt (C.-L.-P.) *et* **Schleyermacher.** Mémoire sur la mesure de la base de Darmstadt. Dressé sur les notes, etc., par —.
Bibl. Univ. Genève, XI, 1819, 3–17, 81–100.

De l'Isle (Josephus Nicol). Projet de la mesure de la terre en Russie.
4°, St.-Pétersbourg, 1737, pp. 22.
Lu dans l'assemblée de l'Académie des sciences de St.-Pétersbourg, 21 janvier 1737.

——— A proposal for the measurement of the earth in Russia, read at a meeting of the Academy of Sciences of St. Petersburg, Jan. 21, 1737. Translated from the French. Printed at St. Petersburg, 1737, by T. S.
Roy. Soc. London, Phil. Trans., XI, 1737–'38, 27–51.

De l'Isle de la Croyère (Louis). Observatio longitudinis penduli simplicio facta Archangelopoli a Ludovico de Lisle de la Croyére.
Acad. de St.-Pétersbourg, Comm., IV, 1729, 322–328.

Delporte (A.). Notice sur les travaux nécessaires pour compléter le réseau géodésique belge. (Gore).
8°, Bruxelles, 1884, pp. 47.

Delprat (Izaak Paul). Over het berekenen van de secondaire triangulatiën bij geodesische waarnemingen.
K. Nederl. Inst. Weten., Verhandl., XII, 1846, 1–16.

De Morgan (Augustus). On the history of Fernel's measure of a degree.
L., E., D. Phil. Mag., XIX, 1841, 445–447.

——— Additional notes on the history of Fernel's measure of a degree.
L., E., D. Phil. Mag., XX, 1842, 116–117.
A statement that Fernel's 68.096 Italian miles are not more than 69 English miles, as Delambre and others make them, but really less than 64½ English miles.

——— On Fernel's measure of a degree, in reply to Mr. Galloway's remarks.
L., E., D. Phil. Mag., XX, 1842, 230–233.
A statement that the geometrical foot used by Fernel was not the French foot of his day, and that the Italian mile, the same as the old Roman, was universal. Fernel gives this table:
4 barleycorns=1 digit.
4 digits=1 palm.
20 palms=1 pace.
125 paces=1 Italian stadio.
1,000 paces=1 Italian mile.

——— On Fernel's measure of a degree.
L., E., D. Phil. Mag., XX, 1842, 408–411; XXI, 1842, 22–25.

——— On the theory of errors of observations.
Camb. Phil. Soc., Trans., X, 1864, 409–427.

DENMARK.

ANDRAE (C. C. G.). Die dänischen Hauptdreiecke.
Int. Geod. Cong., Gen.-Ber., 1865, 4–9.

——— Bericht über die in Dänemark ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1868, 11–15; 1869, 5–9; 1872, 3; 1875, 167–169; 1877, 269–272; 1879, 84–87.

——— Den danske Gradmaaling.
Kjøbenhavn, 1867, 1872, 1878, 1884.

BUGGE (T.). Beschreibung der Ausmessungsmethode, welche bei den dänischen Karten angewendet worden.
Kjøbenhavn, 1779; Dresden, 1787.

SCHUMACHER (H. C.). Sur la triangulation de Danemark.
Corr. Astron. (Zach), I, 1825, 273–278.

ZACHARIAE (G.). Bericht über die geodätischen Arbeiten in Dänemark in den Jahren 1884–'86.
Int. Geod. Cong., Verhandl., 1884–'86, 122–123.

Denzler (Heinrich). Ueber die terrestrische Refraction.
Astron. Nachr., XIX, 1842, 347–350.

Denzler (Wilhelm). Ueber den Fundamentalsatz der Methode der kleinsten Quadrate.*
Naturf. Ges. Zürich, Mittheil., II, 1850–'52, 110–112.

Dépôt de la Guerre, Mém., *for* Mémorial général du Dépôt de la Guerre.
4°, Paris, 1829+. (Washington, Coast Survey.)

Deprez (M.). Sur un procédé permettant de compter mécaniquement les oscillations d'un pendule entièrement libre.
Acad. d. Sci. Paris, Comp. Rend., CII, 1886, 1523–1524.

Deratte. Mémoire sur la longitude et la latitude de Montpellier, déduits des triangles de la méridienne de l'Observatoire de Paris.
Soc. Sci. Montpellier, Rec. d. Bull., I, 1803, 63–68.

Derham (William). Experiments about the motion of pendulums in vacuo.
Roy. Soc. London, Phil. Trans., XXIV, 1704, 1785–1789.

——— Experiments concerning the vibration of pendulums. (H.)
Roy. Soc. London, Phil. Trans., XXXIX, 1735, 201–203.

Desaguliers (Jean-Théophile). A dissertation concerning the figure of the earth.
Roy. Soc. London, Phil. Trans., XXXIII, 1725, 201–222, 239–255, 277–304, 344–345.
Favors NEWTON's theory.

———: **Maupertuis (P.-L.-M. de).** Examen des trois dissertations que M. — a publiées sur la figure de la terre.
Roy. Soc. London, Phil. Trans.; Oldenbourg, 1738.
Title in full under MAUPERTIUS (P.-L.-M. DE).

[Desballe.] Traité de géodésie pratique, contenant de nouvelles méthodes à l'usage des arpenteurs et des géomètres du cadastre, pour calculer les surfaces et les diviser par les lignes qui coupent les côtés en parties proportionnelles; suivi d'un recueil de lois et de diverses formules de procès-verbaux concernant le ministère des arpenteurs.
8°, Paris, 1827, p. ii, p 70, 1 chart. (Berlin, Royal.)

Deville (E.). Examples of astronomic and geodetic calculations for the use of land surveyors.
8°, Quebec, 1878, pp. 109. *P. G. Delisle.* (Gore.)

Deville (Henri Saint-Claire). *See* **Saint-Claire-Deville (Henri).**

Diaz-Covarrubias (François). *See* **Covarrubias (François-Diaz).**

Dickson (Benjamin). On the general equations of geodesic lines and lines of curvature on surfaces.
Camb. Math. Journ. (Thomson), V, 1850, 166–171.

Dienger (Joseph). Ueber die Schwingungsdauer des einfachen und des zusammengesetzten Pendels.
Arch. d. Math. (Grunert), XVI, 1851, 477–481.

——— Bestimmung der geographischen Breite und Länge aus geodätischen Messungen.
Arch. d. Math. (Grunert), XVIII, 1852, 80–90.

——— Ueber die Ausgleichung der Beobachtungsfehler.
Arch. d. Math. (Grunert), XVIII, 1852, 149–193; XIX, 1853, 211–227.

——— Ueber die Bestimmung des Gewichts der nach der Methode der kleinsten Quadrate erhaltenen wahrscheinlichsten Werthe der Umbekannten, wenn Bedingungsgleichungen vorhanden sind.
Arch. d. Math. (Grunert), XIX, 1852, 197–202.

Dienger (Joseph)—Continued.

——— Ausgleichung der Beobachtungsfehler nach der Methode der kleinsten Quadrate. Mit zahlreichen Anwendungen, namentlich auf geodätische Messungen.

8°, Braunschweig, 1857, pp. viii, 168. (British Museum.)

——— Abbildung krummer Oberflächen auf einander und Anwendung derselben auf höhere Geodäsie.

8°, Braunschweig, 1858, pp. [ii], 79. (British Museum.)

——— Ueber die Ermittelung des Wahrscheinlichen Fehlers bei Längenmessungen.

Arch. d. Math. (Grunert), XXXI, 1858, 225–228.

——— Die Laplace'sche Methode der Ausgleichung von Beobachtungsfehlern bei zahlreichen Beobachtungen.

K. k. Ak. d. Wiss., math.-naturwiss. Cl., Denkschr., XXXIV, 1875, ii, 21–62.

Diesterweg (Friedrich Adolf Wilhelm). Lehrbuch der mathematischen Geographie und Himmelskunde zum Schulbrauch und Selbstunterricht. Dritte verbesserte und vermehrte Auflage.

8°, Berlin, 1848, pp. xxx, 312, 10 plates.

Gestalt und Figur der Erde, 49–68.

9th ed., 8°, Berlin, 1876, pp. xvi, 352, 3 plates. (British Museum.)

Gestalt und Figur der Erde, 43–76.

Dietze (Max). Beiträge zur Aufsuchung von Refractions-Coefficienten.

Zeits. f. Vermes., XIII, 1884, 245–259.

Dini (Ulisse). Sopra alcune formole di trigonometria sferoidica.*

Università Toscana, Ann., Pisa, 1870.

Formulæ for the computation of the geographic coordinates of the vertices of a geodetic net, also for computing the length of the arc of the meridian between the extreme points of the chain of triangles. Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869–'70, 842, by JUNG.

Dirksen (Erno Heron *or* Heeren). Historia progressum instrumentorum mensuræ angulorum accuratiori inserventium.

4°, Göttingæ, 1819, pp. 38. (Berlin, Royal.)

In which Meyer's method of angle measuring is given.

Dicuilus. De mensura orbis terræ ex duobus codd. MSS. Bibliothecæ Imperialis nunc primum in lucem editus a Carola Athanasio Walckenaer.

8°, Parisiis, 1807, pp. xvi, 77. (Oxford, Bodleian.)

Dittmann (A. F.). Die grossen Veränderungen der Erdoberfläche.*

Schlesw., 1858.

Dixon (J.) *and* Mason (C.). Astronomic observations made in the forks of the Brandywine to determine the difference of gravity between the Royal Observatory and that place.

Roy. Soc. London, Phil. Trans., 1768, 326–336.

Dobner *und* Ganahl. Bericht über die für die europäische Gradmessung ausgeführten Arbeiten 1873.

Int. Geod. Cong., Gen.-Ber., 1873, 7–10.

Döllen (Johann Heinrich Wilhelm). Resultate einer astronomisch-geodätischen Verbindung zwischen Pulkowa und den Ufern des Ladoga-See's.

Acad. de St.-Pétersbourg, Cl. Phys.-Math., Bull., XVII, 1859, 401–408.

——— Geodätische Längenmessungen mit Stahlbändern und Metalldräthen.*

St. Petersburg, 1885.

Dörgens (R.). Dimensionen des Erdsphäroids zwischen 46°—56° n. B.*

K. preuss. statistischen Bureau, Zeits., 1873.

Doll (M.). Geschichte der Katastervermessungen, zunächst derer am Rhein, in Frankreich, Bayern, Oesterreich, Württemberg, Hessen und Baden.*

Württemberg. Geometer-Zeitung.

——— Das Vermessungswesen im Grossherzogthum Baden.

8°, pp. 32.

Separatabdruck aus Zeits. f. Vermes., II, 1873, 34–54, 65–77.

——— Fehlergrenzen für Längenmessungen.

Zeits. f. Vermes., XVII, 1888, 233–235.

Donkin (William Fishburn). An essay on the theory of combination of observations.

Journ. Math. (Liouville), XV, 1850, 297–322.

——— On an analogy relating to the theory of probabilities, and on the principle of the method of least squares.

Quart. Journ. Math., I, 1857, 152–162.

Doolittle (C. L.). A treatise on practical astronomy as applied to geodesy and navigation by C. L. Doolittle.

8°, New York, 1885, pp. x, 642. *John Wiley & Sons.* (Gore.)

Least squares, 1–69.

Doolittle (Myrick Hascall). Closing of a circuit of triangulation.

U. S. C. and G. Survey, Rep., 1875, 282–292.

——— General method of solution of normal equation.

U. S. C. and G. Survey, Rep., 1878, 115–120.

——— The rejection of doubtful observations.

Phil. Soc. Wash., Bull., VI, 1883, 152–156.

Revd. in Jahrb. üb. d. Fortschr. d. Math., XVI, 1884, 184, by Ls. [LAZARUS].

Dorna (Alessandro). Sulla media aritmetica nel calcolo di compensazione.

Accad. Sci. Torino, Atti, IV, 1869, 757–763.

——— Relazione su: "Sullo scostamento della linea geodetica" di G. de Bernardinis.

Accad. Sci. Torino, Atti, XIX, 1886, 94–98.

Dorst (F. J.). Ueber die Grösse der Beobachtungsfehler beim Ablesen eingetheilter Instrumente.

Zeits. f. Instrumentenkunde, VI, 1886, 383–387.

Dove (Heinrich Wilhelm). Ueber Mass und Messen.

4°, Berlin, 1835, pp. 40. (Gore.)

In Programm des Friedrichs-Gymnasiums auf dem Werder.

Drobisch (Moritz Wilhelm). Ausführlicher Bericht über mehrere in den Jahren 1825 und 1826 in den Minen von Dolcoath zur Bestimmung der mittleren Dichtigkeit der Erde angestellte Pendel-Versuche.

Ann. d. Phys. (Poggendorff), X, 1827, 444–456; XIV, 1828, 409–426.

Drovetti: Jomard (E.). Un étalon métrique découvert à Memphis par —.
Paris, 1822.
Title in full under JOMARD (E.).

Drummond (Thomas). Description of an apparatus for producing intense light visible at great distances.
Edinb. Journ. Sci., v, 1826, 319–322.

——— On the means of facilitating the observation of distant stations in geodetical operations.
Roy. Soc. London, Phil. Trans., CXVI, 1826, 324–337.
Heliotropes and Drummond lights.

Drygalski (Erich von). Die Geoiddeformationen der Eiszeit.
8°, Berlin, 1887, pp. 63; Ges. f. Erdkunde, Zeits., 1887, 169–280.

Dubois (Edmond). Note sur le mouvement du plan d'oscillation d'un pendule.
Ann. Génie Civil, I, 1862, 313–328.

Dühring (Eugen). Kritische Geschichte der allgemeinen Principien der Mathematik von der philosophischen Facultät der Universität Göttingen mit dem ersten Preise der Beneke-Stiftung gekrönte Schrift. Zweite, theilweise umgearbeitete und mit einer Anleitung zum Studium der Mathematik vermehrte Auflage.
8°, Leipzig, 1877, pp. xx, 526. (British Museum.)
Good discussion of Huyghen's and Newton's principles of gravitation.

Dufour (G.-H.). Notice sur la mesure de la base d'Arberg en Suisse.
Bibl. Univ. Genève, LVII, 1834, 372–385.

Dufour (Wilhelm Heinrich). Sur les déviations apparentes du plan d'oscillation du pendule dans l'expérience de M. Foucault; nouvelles expériences faites par M. le général Dufour, de concert avec MM. Wartmann et Marignac.
Acad. d. Sci. Paris, Comp. Rend., XXXIII, 1851, 13–15; Bibl. Univ. Genève, Arch., XVII, 1851, 131–133.
The name is given DUFOUR (G.-H.) in the catalogue of the Royal Society.

——— Auszug aus dem Protokoll der schweizerischen geodätischen Commissions-Sitzung vom 4. April 1866.
Int. Geod. Cong., Gen.-Ber., 1866, 47–49.

D. (F.) [Dulong (F.)]. Expériences faites avec un pendule invariable à la Nouvelle-Galles; par Sir Thomas Brisbane.
Bull. Sci. Math. (Saigey), II, 1824, 123–124; Roy. Soc. London, Phil. Trans., 1823, 308.

Dumas (J. L.). Jonction géodésique de la France avec la Belgique en 1803, par ordre du gouvernement de France.*
Paris, n. d.

Dumas (Wilhelm August). De motu penduli sphærici rotatione terræ perturbato.
4°, Regiomonti, [1854], pp. 88. (Berlin, Royal.)

——— Ueber Schwingungen verbundener Pendel.
8°, Festschrift zu der dritten Säcularfeier des Berlinischen Gymnasiums zum grauen Kloster, Berlin, 1874, 97–113.

Dumur (J.) *et* **Hisch (A.).** Le réseau de triangulation suisse.
Lausanne, 1888.
Title in full under HIRSCH (A.).

Dunlop (James). A memoir on the controversy between William Penn and Lord Baltimore, respecting the boundaries of Pennsylvania and Maryland. Read at a meeting of the council of the Historical Society of Pennsylvania, November 10, 1825.
Olden Time, I, 1846, 530–548.

Dunnehauptius (A. C.). Sphærica telluris figura. (H.)
Vittembergæ, 1715.

Duperrey (Louis-Isidore). Observations du pendule invariable, de l'inclinaison et la déclinaison de l'aiguille aimantée, faites dans la campagne de la corvette de S. M. la Coquille, pendant les années 1822, 1823, 1824 et 1825.
8°, pp. 32. (Paris, Observatory.)
Lue à l'Acad. d. Sci. Paris, 2 mai 1827.

——— Rapport sur le voyage de découvertes.
Conn. d. Temps, 1828, 240–272.
Full title under ARAGO (D.-F.-J.).

——— Notice sur les expériences du pendule invariable faites dans la campagne de la corvette de S. M. la Coquille, pendant les années 1822, 1823, 1824 et 1825.
Conn. d. Temps, 1830, 83–99.

———: **Saigey.** Comparaison des observations du pendule à diverses latitudes, faites par —.
Bull. Sci. Math. (Saigey), VIII, 1827, 31–43, 171–184; Hertha, XIII, 1829, 287–290.

Duséjour (D.). Traité analytique des mouvements apparents des corps célestes.
4°, Paris, II, 1876, p. 75, *et seq.* Examen du rapport des axes de la terre que l'on peut conclure des observations faites dans les différents climats.
HOUZEAU, II, 1150.

Dyer (George Leland). The survey of the coast.
Naval Institution, Proc., XII, 1886, ii, 199–240.

Eames (John). An account of a dissertation containing remarks upon the observations made in France, in order to ascertain the figure of the earth, by Mr. Celsius.
Roy. Soc. London, Phil. Trans., IV, 1740, i, 371–382.
A notice of the report of CELSIUS on the Lapland work.

EARTH, DENSITY OF.

AIRY (G. B.). Account of pendulum experiments for determining the mean density of the earth.
Roy. Soc. London, Phil. Trans., CXLVI, 1856, 297–355.

BABINET (J.). L'expérience de Cavendish, relative à la masse et à la densité moyenne de la terre.
Cosmos, XXIV, 1864, 543–545.

BAILY (F.). Repetition of the Cavendish experiment for determining the mean density of the earth.
Roy. Astron. Soc., Month. Not., IV, 1839, 96–97.

——— Some experiments with the torsion rod for determining the mean density of the earth.
Roy. Astron. Soc., Month. Not., V, 1839–'43, 188–190 . . . ; VI, 1843–'45, 107–110.

CARLINI (F.). Sur la détermination de la densité moyenne de la terre.
Accad. Sci. Torino, Mem., II, 1840, 379–385.

CAVENDISH (H.). Experiments to determine the density of the earth.
Roy. Soc. London, Phil. Trans., LXXXVIII, 1798, 469–526; École Polytech., Journ., X, 1815, 263–320.

EARTH, DENSITY OF—Continued.

CORNU (A.). Détermination nouvelle de la densité moyenne de la terre.
Acad. d. Sci. Paris, Comp. Rend., LXXVI, 1873, 954–958; LXXXVI, 1878, 699–702.

DROBISCH (M. W.). Ausführlicher Bericht über mehrere . . . zur Bestimmung der mittleren Dichtigkeit der Erde Angestellte Pendel-Versuche.
Ann. d. Phys. (Poggendorff), X, 1827, 444–456; XIV, 1828, 409–426.

FAYE (H.-A.-E.-H.). . . . et sur la densité moyenne de la terre.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 557–566.

FOLIE (F.). Sur le calcul de la densité moyenne de la terre.
Acad. de Belgique, Bull., XXXIII, 1872, 389–409.

GOSSELIN (P.-F.-J.). Nouvel examen sur la densité moyenne de la terre.
Acad. de Metz., Mém., XL, 1859, 469–485.

HALL (A.). The density of the earth.
Analyst, IX, 1882, 129–132.

HAUGHTON (S.). On the density of the earth as deduced from the experiments at the Harton coal pit.
L., E., D. Phil. Mag., XII, 1856, 50–51, etc.

HICKS (W. M.). On some irregularities in the values of the mean density of the earth.
Phil. Soc. Camb., Proc., V, 1886, 156–161.

HUTTON (C.). An account of the calculations made . . . to ascertain the mean density of the earth.
Roy. Soc. London, Phil. Trans., LXVIII, 1778, ii, 689–788; Phil. Mag. (Tilloch), XXXVIII, 1811, 112–116; 1821, 3–13.

JACOB (W. S.). On the causes of the great variation among the different measures of the earth's mean density.
Roy. Soc. London, Proc., VIII, 1857, 295–299.

LAPLACE (P.-S. DE). Sur la densité moyenne de la terre.
Ann. de Chim., XIV, 1820, 410–417.

LAPPARENT (A. DE). Sur les conditions de forme et de densité de l'écorce terrestre.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 1040–1042.

LIPSCHITZ (R. O. S.). Gesetz der Dichtigkeitsänderung der Schichten im Innern der Erde.
K. Ak. d. Wiss., Monatsber., 1862, 601–607.

MÄDLER (J. H.). Leitfaden der mathematischen und allgemeinen physischen Geographie.
Stuttgart, 1843.

MAYER (A. M.). Methods of determining the density of the earth.
Nature., XXXI, 1885, 408–409.

MENABREA (F. L.). Calcul de la densité de la terre.
Accad. Sci. Torino, Mem., II, 1840, 305–368.

MONTIGNY (C.). Mémoire relatif aux expériences pour déterminer la densité de la terre.
Acad. de Belgique, Bull., XIX, 1852, ii, 476–481.

PLANA (G.). Note sur la densité . . . du sphéroïde terrestre.
Corr. Astron. (Zach), V, 1821, 97–125, 191–214.

——— Note sur la densité moyenne de l'écorce superficielle de la terre.
Astron. Nachr., XXXV, 1853, 177–192; Roy. Astron. Soc., Month. Not., XIII, 1852–'53, 59–60; Edinb. Phil. Journ., LV, 1853, 152–153.

REICH (F.). Ueber die mittlere Dichtigkeit der Erde.
Phys. Wörterbuch (Gehler), III, 940–970; Acad. d. Sci. Paris, Comp. Rend., V, 1837, 697–700; Freiberg, 1838; Ann. d. Phys. (Poggendorff), LXXXV, 1852, 189–198; Ann. de Chim., XXXVIII, 1853, 382–383; Phil. Mag. (Tilloch), V, 1853, 154–159; K. sächs. Ges. d. Wiss., math.-phys. Cl., Abhandl., I, 1852, 383–430.

ROCHE (E.-A.). Sur la loi de la densité à l'intérieur de la terre.
Acad. d. Sci. Montpellier, Mém., III, 1855–'57, 107–124; Acad. d. Sci. Paris, Comp. Rend., XXXIX, 1854, 1215–1217.

SANG (E.). On our means for estimating the density and temperature of the earth.
Roy. Scottish Soc. Arts, Trans., X, 1883, 278–285.

EARTH, DENSITY OF—Continued.

SCHEFFLER (H.). Ueber die mittlere Dichtigkeit der Erde.
Zeits. f. Math. (Schlömilch), X, 1865, 224–227.

STIELTJES (M. T. J.). Quelques remarques sur la variation de la densité dans l'intérieur de la terre.
Arch. Néerl., XIX, 1884, 435–460.

STOKES (G. G.). On the effect of rotation and ellipticity upon the Harton pendulum experiments.
Roy. Soc. London, Phil. Trans., 1856, 353–355.

STRUVE (F. G. W. VON). Ueber die Bestimmung der Dichtigkeit der Erde.
Astron. Nachr., XXII, 1845, 37.

WALTERHÖFFER (O.). How the earth is weighed.
Pop. Sci. Month., XIX, 1881, 743–749.

WILSING (J.). Bestimmung der mittleren Dichtigkeit der Erde mit Hülfe eines Pendelapparates.

YOUNG (T.). Remarks on the . . . density of the earth.
Roy. Soc. London, Phil. Trans., 1819, 70–75; Quart Journ. Sci., IX, 1820, 32–34.

ZACH (F. VON). Ueber Densität der Erde und deren Einfluss auf geographische Ortsbestimmungen.
Mon. Corr. (Zach), XXI, 1810, 293–310.

ANON. A new weighing of the earth.
Pop. Sci. Month., XXI, 1882, 565.
Account of the observations of Jolly of Munich. D = 5.692 ± 0.068.

——— Proposed new method of measuring the density of the earth.
Science, V, 1885, 217–218.
Referring to method of Arthur König and Franz Richarz.

EARTH, FIGURE OF.

ABRAHAM BEN CHIJA. De forma terræ.
Basel, 1546.

ADAN (E.-H.-J.). Grandeur et forme de la terre, déterminées par les mesures d'arcs.
Bruxelles, 1876.

——— Déterminées par les oscillations du pendule.
Bruxelles, 1876.

——— Note sur la figure de la terre.
Int. Geod. Cong., Gen.-Ber., 1880, 7–8.

ADRAIN (R.). Investigation of the figure of the earth.
Am. Phil. Soc., Trans., I, 1818, 119–135, 353–366.

AIRY (G. B.). . . . The figure of the earth.
Cambridge, 1826; Roy. Soc. London, Phil. Trans., CXVI, 1826, 548–578; Brit. A. A. S., Rep., I–II, 1832, 165–169, 178–180; Encycl. of Astron., London, 1848, 165–240; Encycl. Met., London. XXXV, 1849, 165–240.

ALEMBERT (J. D'). Recherches sur la précession des équinoxes.
Paris, 1749.

——— Opuscules mathématiques.
Paris, 1761–'68.

AMMON (F.). Lehrbuch der mathematischen und physikalischen Erdbeschreibung.
Augsburg, 1829.

ANDRES (T.). Die Zahlenformel für den mittleren Krümmungshalbmesser des Erdsphäroids.
Arch. d. Math. (Grunert), XXXV, 1860, 72–80.

ANDRONOWITZ. Von der Gestalt und Grösse der Erde.
Belgrade, 1886.

APPELGREN (S. W.). De figura telluris ope pendulorum determinanda.
Aboæ, 1810.

ARENA (F.). Dissertatio geographica de dimensione et figura telluris.
Panormi, 1757.

AVOUT (D'). Mémoire sur la figure de la terre.
Paris, 1852.

BABINET (J.). Le rayon moyen de la terre.
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 121–124.

EARTH, FIGURE OF—Continued.

BABINET (J.). Sur la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 732–735.

BAEYER (J. J.) Ueber die Grösse und Figur der Erde.
Berlin, 1861.

BAILLY (J.-S.). Histoire de l'astronomie, ancienne et moderne.
Paris, 1785; 1805.

BARTLETT (W. H. C.). Elements of natural philosophy.
N. d.

BAUERNFEIND (C. M.). Geodätische Bestimmung der Erdkrümmung.
K. bay. Ak. d. Wiss., math.-phys. Cl., Abhandl., XI, 1873, 1–40.

BEARDSLEY. The reputed figure and motion of the earth.
Eng. Mech., XI, 1870, 134.

BEEK-CALKOEN (J. F.). Ueber die Bestimmung des Erd-Ellipsoids.
Mon. Corres. (Zach), XII, 1805, 256–266.

BÉGAT. Traité élémentaire de géographie mathématique.
Paris, 1834.

BERTRAND (J.). Figure de la terre.
Journ. d. Sav., 1874, 697–719.

BESSEL (F. W.). Bestimmung der Axen des elliptischen Rotationssphäroids.
Astron. Nachr., XIV, 1837, 333–346.

——— Ueber einen Fehler in der Rechnung der französischen Gradmessung und seinen Einfluss auf die Bestimmung der Figur der Erde.
Astron. Nachr., XIX, 1841, 97–116.

——— Ueber die Gestalt der Erde.
Ann. d. Phys. (Poggendorff), LV, 1842, 529–530.

——— Populäre Vorlesungen über wissenschaftliche Gegenstände.
Hamburg, 1848.

BIANCO (O. Z.). Sopra una vecchia e poco nota misura del semidiametro terrestre.
Accad. Sci. Torino, Atti., XIX, 1886, 791–795

BIOT (J.-B.). Rapport fait à l'Institut . . . et sur l' aplatissement de la terre qui en résulte.
Bibl. Brit., Genève, XLII, 1809, 20–26.

——— Notice sur les opérations entreprises pour déterminer la figure de la terre.
Paris, 1815.

——— Notices sur les voyages entrepris pour mesurer la courbure de la terre . . .
Acad. d. Sci. Paris, Mém. (Hist.), III, 1818, 73–172, etc; Bibl. Univ., Genève, X, 1819, 225–238.

——— Mémoire sur la figure de la terre.
Acad. d. Sci. Paris, Mém., VIII, 1829, 1–56.

BIRNBAUM (J. H. L.). Grundzüge der astronomischen Geographie.
Leipzig, 1862.

BISCHOF (G.). Die Gestalt der Erde und der Meeresfläche . . .
Bonn, 1867.

BJÖRCK (E. D.). Theoremata magnitudini telluris. .
Gryphiswaldiæ, 1794.

BLACKSTONE (D. P.). The attraction and the figure of the equilibrium of a rotating fluid mass . . .
Madison, 1885.

BLAKEWELL (F. C.). New theory of the figure of the earth.
Civ. Eng. and Arch. Journ., XXIV, 1861, 232–235, 313–314, 345–346.

——— Considerations respecting the figure of the earth in the relation to the action of centrifugal force.
London, 1862.

BLAU (F.). Commentatio de ambitu terræ . . .
Nordhausæ, n. d.

BODE (J. E.). Anleitung zur physischen, mathematischen und astronomischen Kenntniss der Erdkugel.
Berlin, 1786.

BOHNENBERGER (J. G. F.). Astronomie.
1811.

EARTH, FIGURE OF—Continued.

BONNE (R.). Principes sur les mesures en longueur . . . et de la grandeur de la terre.
Paris, 1790.

BONNET (P.-O.). Sur la figure de la terre considérée comme peu différente d'une sphère.
Ann. Sci. Mat. e Fis. (Tortolini), II, 1859, 46–59, 113–131, 180–184.

BONSDORFF (J. G.) De figura telluris ope pendulorum determinanda.
Aboæ, 1815.

BORDEN (S.). Comparison of the dimensions of the earth obtained from measurements made in the survey of the State of Massachusetts.
Am. Phil. Soc., Proc., III, 1843, 130–132.

BORENIUS (H. G.). Ueber die Berechnung . . . der Abplattung der Erde.
Acad. de St.-Pétersbourg, Cl. Math.-Phys., Bull., I, 1843, 1–29.

BOSCOVICH (R. G.). Dissertatio de telluris figura.
Romæ, 1739.

——— De veterum argumentis pro telluris sphericitate.
Romæ, 1739.

——— De inequalitate gravitatis . . . et figura ipsius telluris et æquilibro.
Phil. Recent. (Stay), II, 1760, 359–380.

——— De veterum conatibus pro magnitudine terræ determinanda.
Phil. Recent. (Stay), II, 1760, 385–390, 390–393.

——— De figura et magnitudine terræ ex plurium gradum comparatione.
Phil. Recent. (Stay), II, 1760, 400–406.

——— De deviationibus pendulorum . . . et methodo definiendi massam terræ.
Phil. Recent. (Stay), II, 1760, 380–385.

——— De recentissimis graduum dimensionibus et figura ac magnitudine terræ inde derivanda.
Phil. Recent. (Stay), II, 1760, 406–426.

BOUÉ (A.). Ueber die geometrische Regelmässigkeit des Erdballes.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Sitz.-Ber., XXIII, 1850, 255–269.

BOUGUER (P.). Comparaison des deux loix que la terre et les autres planètes doivent observer dans la figure que la pesanteur leur fait prendre.
Acad. d. Sci. Paris, Mém., 1734, 21–54.

——— De la manière de déterminer la figure de la terre par la mesure des degrés de latitude et de longitude.
Acad. d. Sci. Paris, Mém., 1736, 443–468.

——— Relation abrégée du voyage au Pérou . . . et en conclure la figure de la terre.
Acad. d. Sci. Paris, Mém., 1744, 289–297.

——— La figure de la terre.
Paris, 1749. Acad. d. Sci. Paris, Mém., 1751, 64–86.

BOULENGER. Traité de la sphère du monde . . .
Paris, 1628.

BOWDITCH (N.). On the calculation of the oblateness of the earth by means of the observed lengths of a pendulum in different latitudes.
Am. Acad., Mem., IV, 1818, 30–49.

BRANDES (H. W.). Vorlesungen über die Astronomie.
Leipzig, 1827.

BRASSINE (E.). Proposition sur une question de mécanique relative à la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XCVII, 1883, 637–639, 1137–1139.

BRETTNER (H. A.). Mathematische Geographie.
Leipzig, 1868.

BREWER (J. P.). Anfangsgründe der mathematischen Geographie.
Düsseldorf, 1828.

EARTH, FIGURE OF—Continued.

BRUHNS (C.). Ueber die Bestimmung der Grösse und Figur unserer Erde durch Gradmessungen.
Dresden, 1876.

BRUNS (H.). Die Figur der Erde.
Berlin, 1878.

C. (H. T.). On fluidity and an hypothesis concerning the structure of the earth.
Quart. Journ. Sci., IX, 1820, 52–61.

CAGNOLI (A.). Nuovo e sicuro mezzo per riconoscere la figura della terra.
Soc. Italiana, Mem., VI, 1792, 227–235; Phil. Mag. (Tilloch), LIII, 1819, 350–360, 406–416.

CALLANDREAU (O.). Mémoire sur la théorie de la figure de planètes.
Obs. de Paris, Ann., XIX.

—— Remarques sur la théorie de la figure de la terre.
Bull. Astron., 1888, 1–8.

CAMERER (J. W.). Noch etwas über den französischen Mètre.
Mon. Corres. (Zach), IX, 1804, 220–223.

CASATI (P.). Terra machinis mota ejusque gravitas et dimensio.
Romæ, 1655.

CASSINI (J.). De la figure de la terre.
Acad. d. Sci. Paris, Mém., 1713, 187–199; 1718, 245–256; Paris, 1720; Amsterdam, 1723; Acad. d. Sci. Paris, Mém., 1732, 497–513.

—— Méthode de déterminer si la terre est sphérique ou non . . .
Acad. d. Sci. Paris, Mém., 1735, 71–86, 255–261; Paris, 1738; Zürich, 1741.

CELSIUS (A.) Bref om jordens figur.
Upsala, 1736.

—— De observationibus pro figura telluris determinanda in Gallia habitis disquisitio.
Upsaliæ, 1738.

—— Anmerkung von dem Nutzen, der Erde rechte Gestalt und Grösse zu wissen.
K. Svenska Vetens. Handl., Transl. von Holzbecher u. Kästner, III, 1741, 298–304.

—— Tractatus de de Maupertuis de figura telluris à dubiis Zellerianis vindicatur.
Upsaliæ, 1743.

CHESEAUX (J.-P.-L. DE). Sur la grandeur et la figure de la terre.
Lausanne, 1754.

CHRISTOFFEL (E. B.). Ueber die Bestimmung der Gestalt einer krummen Oberfläche durch lokale Messungen auf derselben.
Journ. d. Math. (Crelle), LXIV, 1865, 193–209.

CLAIRAUT (A.-C.). Détermination géométrique de la perpendiculaire à la méridienne . . . avec plusieurs méthodes d'en tirer la grandeur et la figure de la terre.
Acad. d. Sci. Paris, Mém., 1733, 406–416; 1739, 83–96; 1735, 117–122; 1736, 111–120.

—— Investigationes aliquot, ex quibus probetur terræ figuram secundum leges attractionis . . .
Roy. Soc. London, Phil. Trans., XL, 1738, 19–25.

—— La théorie de la figure de la terre, tirée des principes de l'hydrostatique.
Paris, 1743, 1808; Roy. Soc. London, Phil. Trans., XLVIII, 1753, i, 73–85.

—— Une nouvelle théorie de la figure de la terre.
Journ. Sav., 1759.

CLARAMONTIUS (S.). Opuscula varia . . . de diametro terræ.
Bononiæ, 1653.

CLARKE (A. R.). On the figure, dimensions of the earth . . .
Roy. Soc. London, Phil. Trans., 1856, 607–626.

EARTH, FIGURE OF—Continued.

CLARKE (A. R.) On the figure of the earth.
Roy. Astron. Soc., Month. Not., XIX, 1859, 36–38, 263–264; Mem., XXIX, 1861, 25–44; L., E., D. Phil. Mag., XXXI, 1866, 193–196; XXXII, 1866, 236–237; Encycl. Brit., 9th ed., VII, 1877, 597–608; L., E., D. Phil. Mag., VI, 1878, 81–93; Nature XVIII, 1878, 556–558, 577–580, 602, 604.

CLAUSEN (T.). Ueber die Bestimmung der Abplattung des Erdsphäroids.
Astron. Nachr., XXI, 1844, 333–336.

CLAY (J.). Observations on the figure of the earth.
Am. Phil. Soc., Trans., V, 1802, 312–319.

COUSIN (J. A. J.). De figura terræ commentatio.
Acad. Mogunt., Acta, II, 1777, 209–216.

COVARRUBIAS (F. D.). Recherches relatives à l'influence de la chaleur solaire sur la figure de la terre.
Paris, 1881.

CRAM (T. J.). On the length of a degree of the terrestrial meridian . . . Am. Journ. Sci., XXXI, 1837, 222–235.

CRAMER (W.). Beiträge zur Geschichte der Vorstellung von der Gestalt der Erde.
N. d.

CZERNY. Die Wirkung der Winde auf die Gestaltung der Erde.
Petermanns's Mittheil., XXII, 1876.

DAVID (A.). Geographische Ortsbestimmungen . . . die Gestalt der Erde aus Längenbestimmungen . . . zu berechnen.
Böhm. Ges. d. Wiss., Abhandl., IV, 1814, II, 1–60.

DAVID (J.-P.). Replique à la lettre de M. de la Condamine par l'auteur de la dissertation sur la figure de la terre.
La Haye, 1769.

—— Dissertation sur la figure de la terre.
La Haye, 1771.

DAVOUT. Sur la forme de la surface de la terre.
Acad. d. Sci. Paris, Comp. Rend., 1845, ii.

DELAMBRE (J.-B.-J.). Abrégé d'astronomie.
Paris, 1813.

—— Astronomie théorique et pratique.
Paris, 1814.

—— Histoire de l'astronomie au XVIII^me siècle.
Paris, 1827.

DELAUNAY (C.-E.). Cours élémentaire d'astronomie.
Paris, 1876.

DESAGULIERS (J. T.). A dissertation concerning the figure of the earth.
Roy. Soc. London, Phil. Trans., XXXIII, 1725, 201–222, 239–255, 277–304, 344–345.

DIESTERWEG (F. A. W.). Lehrbuch der mathematischen Geographie und Himmelskunde.
Berlin, 1848.

DICUILUS. De mensura orbis terræ.
Parisiis, 1809.

DUNNEHAUPTIUS (A. C.). Spærica telluris figura.
Vittembergæ, 1715.

EAMES (J.). An account of a dissertation containing remarks upon the observations to ascertain the figure of the earth.
Roy. Soc. London, Phil. Trans., XLI, 1740; I, 371–382.

EISENSCHMIDT (J. C.). Diatribe de figura telluris.
Argentorati, 1691.

—— Sur la figure de la terre.
Acad. d. Sci. Paris, Mem., 1713, 190–191.

ENCKE (J. F.). Ueber die Dimensionen des Erdkörpers . . .
Astron. Jahrb., 1852, 318–342.

FAREY (J.). Remarks and suggestions as to the state of the trigonometrical survey with regard to the figure of the earth.
Phil. Mag. (Tilloch), LVIII, 1821, 54–57.

FAYE (H.-A.-E.-A.). Sur les propositions . . . relatives à la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 669–674.

EARTH, FIGURE OF—Continued.

FAYE (H.-A.-E.-A.). Sur les variations séculaires de la figure mathématique de la terre.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1185–1191.

—— Sur une lettre du général Stebnitzki relative à la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XCVII, 1883, 508–515; CIII, 1886, 1093–1101, 1221–1224.

FERGOLA (E.). Dimensione della terra . . .
Napoli, 1876.

FERGUSON (J.). Introduction to astronomy.
London, 1779.

FERNEL (J.). Cosmotheoria.
Paris, 1528.

FISCHER (A.). Die Gestalt der Erde.
Astron. Nachr., LXXXVIII, 1876, 81–98, 203–208, 247–252.

FISCHER (P.). Untersuchungen über die Gestalt der Erde.
Darmstadt, 1868.

FISHER (G.). On the figure of the earth, as deduced from the measurements of arcs of the meridian and observations on pendulums.
Quart. Journ. Sci., VII, 1819, 299–312.

FRANCOEUR (L. B.). Résultats des expériences du Sabine pour déterminer . . . l'aplatissement du globe terrestre.
Soc. Philom., Bull., 1826, 65–66.

FREDERICI (K. M.) Gestalt und Grösse der Erde.
Nature, XVIII, 1878, 556–558, 577–580, 602–604.

FRISI (P.). Disquisitio mathematica in causam physicam figuræ et magnitudinis telluris nostræ.
Mediolani, 1751.

GALBRAITH (W.). On the figure of the earth.
Phil. Mag. (Tilloch), LXVII, 1826, 161–167; II, 1827, 48–54; III, 1828, 321–331.

GALLOWAY (T.). The figure of the earth.
Encycl. Brit., IX, 547–575.

GEISWEIT (G.). Dissertatio philosophica de figura telluris sphærica.
Trajecti ad Rhenum, 1729.

GERBER. Bestimmung der Erdachse aus der Polhöhe.
Berlin, 1833.

GERLACH (F. W. A.). Die Bestimmung der Gestalt und Grösse der Erde.
Wien, 1782.

GERLING (C. L.). Ueber die Abplattung der Erde.
Astron. Nachr., X, 1833, 7–10.

GLEICHEN (F. W.) Von der Entstehung . . . und Bestimmung des Erdkörpers.
Dessau, 1782.

GODFRAY (H.). A treatise on astronomy.
London, 1880.

GOURNERIE (DE LA). La première contestation . . . relative à la détermination de la figure de la terre.
Paris, 1876.

GRAMMATICO (N.). Dissertatio astronomica.
Ingolstadtii, 1734.

GRANT (A.). Discours sur la figure de la terre.
Tournay, 1739.

GRANT (R.). History of physical astronomy.
London, 1852.

—— Remarks on the early history of astronomers relative to the spheroidal figure of the earth.
Roy. Astron. Soc., Month. Not., XIV, 1854, 232–240.

GREAVES (J.). Astronomia . . . de terra magnitudine.
Londini, 1652.

GREENHILL (A. G.). On the differential equation of the ellipticities of the strata in the theory of the figure of the earth.
Quart. Journ. Sci., XVII, 1879, 203–208.

GREGORY (O. G.). A treatise on astronomy.
London, 1803.

EARTH, FIGURE OF—Continued.

GRUTERUS (J.). Disputatio philosophica de terræ rotunditate.
Lugduni Batavorum, 1668.

GUMPACH (J. VON). A letter on the figure of the earth.
Literary Gazette, 1861, 372.

—— The true figure and dimensions of the earth.
London, 1862.

HALL (A.). The figure of the earth and the motion of the moon.
Ann. of Math., II, 1886, 111–112.

HAMILTON (J. A.). An essay on the present state of astronomical certainty with regard to the quantity of the earth's magnitude.
Roy. Irish Acad., Trans., XI, 1810, 13–24.

HAMPDEN (J.). Is the world flat or round?
1871.

HANN (J.). Die Gestallt der Erde und die Pendelmessungen.
Astron. Nachr., LXXXVIII, 1876, 203–208, 305–308.

HARGREAVE (C. J.). On the calculation of attractions, and the figure of the earth.
Roy. Soc. London, Phil. Trans., CXXXI, 1841, 75–98.

HEEL (J. N.) Gestalt und Grösse der Erde.
Speier, 1865.

HEGER (R.). Bemerkung zu der Bestimmung der Abplattungsgrenzen für das Erdsphäroid aus der Nutation.
Zeits. f. Math. (Schlömilch). XV, 1870, 293–296.

HELMERT (F. R.). Zur Frage der Beweiskraft der Gradmessungen für die Existenz der näherungsweise rotationsförmiger Gestalt der Erde.
Zeits. f. Vermes., IX, 1880, 269–277.

HENNERT (J. F.). Onderzoekning omtrent de waare gedaante der aarde.
Genootsch. Vlissingen, Verbandl, III, 1773, 529–575; IV, 1775, 499–544.

—— Dissertations physiques et mathématiques.
Utrecht, 1778.

HENNESSY (H.). On the changes of the earth's figure resulting from forces acting at its surface.
Geol. Soc. Dublin, Journ., 1848–'50, 139–141.

—— The figure and primitive formation of the earth.
Roy. Soc. London, Phil. Trans., CXLI, 1851, 495–510, 511–548.

—— On the connexion between geological theories and the theory of the figure of the earth.
Brit. A. A. S., Rep., XXII, 1852, 21.

HERSCHEL (J.). On the figure of the earth.
Nature, XX, 1879, 33–35; XXI, 1880, 599–602.

HERSCHEL (J. F. W.). Outlines of astronomy.
London, 1867.

HESSE (W. G.). Dissertatio de vi centrifuga * * * magnitudinem terræ.
Erford., 1757.

HIND (H. T.). The figure of the earth in relation to geological inquiry.
Nature, X, 1874, 165–167.

HIRSCH (A.). Note sur la figure de la terre.
Soc. Sci. Neuchâtel, Bull., V, 1859–'61, 578–582.

HOPKINS (W.). On the form, solidification, and thickness of the earth's crust.
Brit. A. A. S., Rep., XVII, 1847, 40–57.

HOSSARD (P.) *et* ROZET. Sur les causes probables des irrégularités de la surface de niveau.
Acad. d. Sci. Paris, Comp. Rend., XVIII, 1844, 180–185.

HOSZFELD (J. W. A.). Auszug aus der geometrischen Attractionslehre und ihrer Anwendung auf Berchnung der Figur der Erde.
Ann. d. Phys. (Gilbert). XLV, 1813, 74–107, 185–208.

HUBE (J. M.). De telluris forma.
Varsaviæ, 1780.

HUTTON (J.). Theory of the earth.
Edinburgh, 1795.

EARTH, FIGURE OF—Continued.

IVORY (J.). Remarks on the figure of the earth.
Phil. Mag. (Tilloch), LXIII, 1824, 339–348; LXV, 1825, 241–249; LXVIII, 1826, 3–10, 92–101, 246–251, 321–326; III, 1828, 165–173, 206–210, 241–243, 343–349, 431–436; VII, 1830, 241–244, 412–416.

—— Some arguments tending to prove that the earth is a solid of revolution.
Phil. Mag. (Taylor), V, 1829, 205–209.

J. Die Bessel'schen Erddimensionen.
Zeits. f. Vermes., XIV, 1885, 22–28.

JACKSON (R.). A new theory of the figure of the earth.
London, 1748.

JAHN (G. A.). Praktische Anleitung zum gründlichen Studium der Erdkunde.
Leipzig, 1847.

JAMES (H.). On the figure, dimensions, and mean specific gravity of the earth.
Roy. Soc. London, Phil. Trans., CXLVI, 1856, ii, 607–626; London, 1858.

JERWOOD (J.). On the application of weight to test the figure of the earth.
Devonshire A. A. S., Trans., III, 1869, 166–178.

JÜRGENSEN (C.). Om den Formel der tjener til at bestemme Jordklodens Figur.
K. danske Viden., Forhandl., 1843, 65–72.

JUNG (J.). De structura globi terraquei.
Moguntinæ, 1767.

KÄSTNER (A. G.). Weitere Ausführung der mathematischen Geographie.
Göttingen, 1795.

KAHLER (J.). De terra ejusque figura . . .
Rintuli, 1682.

KLEIN (F.). Die Figur der Erde.
K. k. geogr. Ges., Mittheil., XXVI, 1883, 161–173, 217–241; Geogr. Mittheil. (Petermann), XV, 1869, 114–116.

KLINGENSTIERNA (S.). Von Erfindung der Grösse und Gestalt der Erde aus Vergleichung von zwei Meridiangradgn.
Stockholm, 1744.

KLÖDEN (K. F.). Ueber die Gestalt und die Urgeschichte der Erde.
Berlin, 1829.

KLÜNER. Ueber die Abweichung der Abplattung unserer Erde . . .
Deutsch. Naturf.-Versamml., Bericht, 1844, II, 38–41.

KLÜGEL (G. S.). Ueber die Figur der Erde.
Astron. Jahrb., 1787, 165–172; 1788, 208–213; 1800, 133–144.

KÖCHER (F. A.). Darstellung der mathematischen Geographie.
Breslau, 1839.

KOELHER (J.). Dissertationes geographicæ de terra ejusque magnitudine, figura.
Reutuli, 1682.

KOPPE (K.). Die mathematische Geographie.
Essen, 1872.

KORISTKA (K. F. E.). [Results of the measurements of the earth's magnitude.]
Ziva, XI, 1863, 141–154.

KRAFFT (G. W.). De figura terræ.
Acad. de St.-Pétersbourg, Com., VIII, 1736, 220–252; Accad. Sci. Bologna, Com., VIII, 1785, 199–228.

KUPFFER (A.). Sur une nouvelle méthode pour déterminer la figure de la terre.
Acad. de St.-Pétersbourg, Cl. Phys.-Math., Bull., XVII, 1859, 237–240; Mél. Phys.-Chim., III, 1859, 493–497.

LALANDE (J.-J. DE). Mémoire sur la détermination de . . . courbure de la terre.
Acad. d. Sci. Berlin, Mém., VI, 1750, 236–279, 379–411; Acad. d. Sci. Paris, Mém., 1752, 78–114; Hist., 103–110.

—— Sur la quantité de l'aplatissement de la terre.
Acad. d. Sci. Paris, Mém., 1758, 1–8.

EARTH, FIGURE OF—Continued.

LALANDE (J.-J. DE). Sur la mesure de la terre.
Acad. d. Sci. Paris, Mém., 1787, 216–225.

—— Astronomie.
Paris, 1792.

—— Dimensions de l'ellipsoïde terrestre.
Mon. Corr. (Zach), II, 1800, 82.

LANGHAUSEN (C.). De figura telluris.
Regiomonti, 1724.

LAPLACE (P.-S. DE). Mémoire sur . . . la figure de la terre.
Mém. Math.-Phys., VII, 1773, 503–540.

—— Mémoire sur la figure de la terre.
Acad. d. Sci. Paris, Mém., 1783, 17–48; III, 1817, 137–184 . . .; Ann. d. chim., VIII, 1818, 312–318 . . .

—— Exposition du système du monde.
Paris, 1808.

LEGENDRE (A.-M.). Recherches sur la figure des planètes.
Acad. d. Sci. Paris, Mém., 1784, 370–389; Hist., 1789, 372–454.

—— Sur les opérations trigonométriques dont les résultats dépendent de la figure de la terre.
Acad. d. Sci. Paris, Mém., 1787, 352–383.

LIEDBECK. De necessitate sphæroidis telluris.
Londini, 1748.

LINDENAU (B. A. VON). Ueber die Benutzung der Beobachtungen des Mondes zur Bestimmung der Abplattung der Erde.
Mon. Corr. (Zach), XIV, 1806, 310.

—— Ueber den Gebrauch der Gradmessungen zur Bestimmung der Gestalt der Erde.
Mon. Corr. (Zach), XIV, 1806, 113–158, 309–326, 374–376.

—— Abplattung der Erde aus Bessel's Præcessionbestimmung.
Astron. Jahrb., 1820, 212.

—— Nouvelles recherches sur le degré moyen, et sur l'aplatissement de la terre.
Corr. Astron. (Zach), I, 1825, 125–139.

—— Kann die Erdmasse als unveränderlich betrachtet werden?
Astron. Nachr., XXXI, 1851, 151–164.

LINDMANN (C. F.). Om jordens afplattning och massa.
K. Veten. Acad., Förhandl., X, 1853, 85–98.

LIOUVILLE (J.). Sur les figures ellipsoïdales à trois axes inégaux . . .
Journ. d. Math. (Liouville), XVI, 1851, 241–254.

LIPSCHITZ (R. O. S.). Ergebnisse einer Untersuchung über die Gestalt unserer Erde.
Niederrhein. Ges., Sitz.-Ber., XXVI, 1865, 451–453.

LISTING (J. B.). Ueber unsere jetzige Kenntniss der Gestalt und Grösse der Erde.
K. Ges. d. Wiss., Göttingen, Nachr., 1873, 33–98.

—— Neue geometrische und dynamische Constanten des Erdkörpers.
Astron. Nachr., XCIII, 1878, 317–318; Göttingen, 1878.

LOUPOT (C.). Élémens d'astronomie . . .
Paris, 1842.

LÜCKENHOF (J. C.). Lehrbuch der mathematischen Geographie.
Münster, 1833.

LULOFS (J.). Anleitung zu der mathematischen und physikalischen Kenntniss der Erdkugel.
Göttingen, 1755.

MÄDLER (J. H.). Leitfaden der mathematischen und allgemeinen physischen Geographie.
Stuttgart, 1843.

MAIN (R.). Practical and spherical astronomy.
Cambridge, 1863.

MAIRAN (J.-J. D'O. DE). Sur la diminution des degrés terrestres vers les pôles.
Acad. d. Sci. Paris, Mém., 1720, 231–277.

—— Sur la figure de la terre.
Acad. d. Sci. Paris, Hist., 1742, 86–104.

EARTH, FIGURE OF—Continued.

MAKO (P.). Dissertatio de figura telluris.
Olomut., 1767.

MALLET (F.). De figura et magnitudine telluris.
Upsaliæ, 1750.

—— Genaueste Berechnung der Gestalt der Erde durch Vergleichung der Längen des Pendels.
K. Veten. Ak., Abhandl. üb. Holzbecher u. Kästner, XXIX, 1767, 168–174, 206–222.

MANFREDI (E.). Méthode de vérifier la figure de la terre par la parallaxe de la lune.
Acad. d. Sci. Paris, Mém., 1734, 1–20.

MANSFIELD (J.). On the figure of the earth.
Connecticut Acad. Sci., Mem., I, 1810, 111–118.

MARÉCHAL. Mémoire sur la théorie mathématique de la terre.
Acad. d. Sci. Metz, Mém., XXXIV, 1853, i, 156–241.

MARTIN (T.-H.). Histoire des hypothèses astronomiques grecques qui admettent la sphéricité de la terre.
Acad. d. Inscr., Mém., XXIX, 1879, ii, 305–318.

MARTUS (H. C. E.). Astronomische Geographie.
Leipzig, 1880.

MATHIEU (C.-L.). Sur . . . la figure de la terre par les mesures géodésiques.
Conn. d. Temps, 1829, 229–235.

MAUPERTUIS (P.-L.-M. DE). Sur la figure de la terre.
Acad. d. Sci. Paris, Mém., 1733, 153–164; 1734, 55–122; 1735, 98–105; 1737, 389–466.

—— La figure de la terre.
Paris, 1738; London, 1738; Oldenbourg, 1738; Paris, 1739; Amsterdam, 1741; Zürich, 1741; Upsaliæ, 1743; Dresdæ, 1752; Lyons, 1756–'68.

MAYER (E.). Ueber die Gestalt und Grösse der Erde.
Fiume, 1876.

MEISSNER (F.). Dissertatio de figura terraquei.
Vratisl., 1765.

MENIUS (M.). De rotunditate terræ et aquæ.
Danzig, 1586.

MERINO (M.). Figura de la tierra.
Anuario del Obs. de Madrid, 1862, pp. 118; Smithsonian Inst., Rep., 1863, 306–330.

MERRIMAN (M.). On the size and shape of the earth.
Van Nostrand's Mag., XXII, 1880, 53–62, 115–128, 233–241; New York, 1881.

MOLL (J. G.). De ratione terrarum magnitudine . . .
Stuttgart, 1801.

MONTUCLA (J.-E.). Histoire des mathématiques.
Paris, 1799–1802.

MÜLLER (T.). Die Erdmassenberechnung.
Zeits. f. Vermes., X, 1881, 137–144.

MURDOCH (P.). Mercator's sailing applied to the true figure of the earth . . .
London, 1741.

MUSCHENBROEK (P.). Dissertationes physicæ.
Lugduni Batavorum, 1729.

NARRIEN (J.). Historical account of the origin and progress of astronomy.
London, 1850.

NEGELEIN (J. A.). De figura telluris ad sensum sphærica.
Regiomonti, 1724.

NERENBURGER (A. W.). Sur la figure de la terre.
Acad. de Belgique, Bull., XXII, 1855.

NEUMANN (C.). Ueber die Frage, ob die Erde eine Voll- oder Halbkugel sei.
Naturwiss. Isis, Dresden, Sitz.-Ber., 1871, 5.

NICOLLET (J.-N.). Sur la détermination de la grandeur et de la figure de la terre.
Bibl. Univ. Genève, XVIII, 1821, 165–174.

NIESSL (G. VON). Ueber die mathematische Gestalt der Erde.
Brünn., Verhandl., Sitz.-Ber., IV, 1865, 34–37, 42–52.

O'BRIEN (M.). Mathematical tracts.
Cambridge, 1840.

EARTH, FIGURE OF—Continued.

OESTERBLAD (J.). De figura telluris ope pendulorum determinanda.
Aboæ, 1810.

OGILBY (W.). New theory of the figure of the earth.
London, 1872.

OLDENBURG (H.). A breviate of Picart's account of the measure of the earth.
Roy. Soc. London, Phil. Trans., X, 1675, 261–272.

OLTMANNS (J.). Abplattung der Erde nach Pendelbeobachtungen.
Mon. Corr. (Zach), XXI, 1810, 536.

PASQUICH (J.). Ueber die Krümmungs-Ellipsoide für die nördliche Hälfte unserer Halbkugel.
Mon. Corr. (Zach), III, 1803, 411–417.

PAUCKER (M. G. VON). Die Gestalt der Erde.
Acad. de St.-Pétersbourg, Bull. Phys.-Math., XII, 1854, 97–128; XIII, 1855, 49–89, 225–249; Mél. Math., I, 1853, 609–648; II, 1859, 113–172, 297–330.

PEIRCE (C. S.). On the deduction of the ellipticity of the earth from pendulum experiments.
U. S. C. and G. Survey, Rep., 1881, 442–456.

PESCHEL. Ueber die Gestalt der Erde.
Abhandl. zur Erd- und Völkerkunde, 1878, 210.

PETERS (C. F. W.). Astronomische Tafeln und Formeln.
Hamburg, 1871.

PEUCERO (G.). De dimensione terræ . . .
Witterbergæ, 1554.

PICCOLOMINI (A.). Della grandezza della terra e dell' acqua.
Venezia, 1558; 1561; 1568.

PICK. Die Kugelgestalt der Erde.
Zeits. f. math. u. naturwiss. Unterricht, II, 1871, 504.

PLANA (G.). Note sur la figure de la terre.
Astron. Nachr., XXXV, 1853, 371–378.

PLANA (J.). Mémoire sur la théorie mathématique de la figure de la terre publiée par Newton en 1687.
Astron. Nachr., XXXVI, 1853, 149–176.

PLANMAN. De figura telluris pendulorum ope definienda.
Aboæ, 1778.

PLAYFAIR (J.). Investigation of certain theorems relating to the figure of the earth.
Journ. Nat. Phil. (Nicholson), VII, 1804, 102–116, 167–176.

POINCARÉ (H.). Sur la figure de la terre.
Bull. Astron., VI, 1889, 1–5, 49–60.

POSELGER (F. T.). Ueber die Figur der Erde.
K. Ak. d. Wiss., math. Cl., Abhandl., 1827, 57–84.

PRATT (J. H.). A treatise on attractions . . . and the figure of the earth.
Cambridge, 1860–'61–'65–'71.

—— Tests of the truth of the fluid theory of the figure of the earth.
L., E., D. Phil. Mag., XXIV, 1862, 409–417, 430–435, 507–508.

—— Figure of the earth from geodetic data.
L., E., D. Phil. Mag., XXXII, 1866, 17–22, 313–315; XXXIII, 1867, 10–16, 145–152; Dehra, 1868.

PROBST (J.). Klima und Gestaltung der Erdoberfläche in ihren Wechselwirkungen.
Stuttgart, 1887.

PRONY (R. DE). Formules pour déduire le rapport des axes de la terre de la longueur de deux arcs du méridien.
Soc. Philom., Bull., I, 1797, 5–6.

PROTEUS (P.). On the figure of the earth.
Jour. Nat. Phil. (Nicholson), VIII, 1804, 12–19, 151–161.

PSELLUS (M.). De terræ situ, figura et magnitudine.

PUISSANT (L.). Formules pour ramener à une valeur quelconque d'aplatissement terrestre.
Conn. d. Temps, 1823, 239–257; 1872, 230–232; Bull. Sci. Math. (Saigey), I, 1824, 271–274.

—— Note sur une formule générale propre à donner l'aplatissement terrestre par la comparaison de deux arcs.
Bull. Sci. Math. (Saigey), III, 1825, 74–76.

EARTH, FIGURE OF—Continued.

PUISSANT (L.). Mémoire sur la détermination de la figure de la terre par les mesures géodésiques.
Dépôt de la Guerre, Mém., III, 1826, 61–100; Inst. Journ., I, 1833, 85–86.

R. New theory of the figure of the earth.
Civil Eng. and Arch. Journ., XXIV, 1861, 278.

RATZEL (F.). Die Erde in gemeinverständlichen Vorträgen.
Stuttgart, 1881.

RAY (J.). The wisdom of God manifested . . . in the earth, its figure . . .
London, 1722.

REICH (F.). Gestalt und Grösse der Erde.
Phys. Wörterbuch (Gehler), III, 832–940.

REICHENBACH (O.). Die Gestaltung der Erdoberfläche.
Berlin, 1870.

REILIN (A.). Dissertatio academica de figura ope pendulorum determinanda.
Aboæ, 1810.

REUTER (A. P.). Vollständiges Handbuch der mathematischen Geographie.
Mainz, 1828.

—— Lehrbuch der mathematischen Geographie.
Nürnberg, 1830.

RHIND (W.). On the irregularities of the earth's surface.
Roy. Phys. Soc. Edinb., Proc., III, 1867, 149–152.

RICCARDI. Sopra un antico metodo per determinare il semidiametro della terra.
Bologna, 1887.

RICCIOLI (G. B.). Almagestum novum . . .
Bononiæ, 1651.

—— De semidiametro terræ.
Bononiæ, 1655.

RITTER (E.). Recherches sur la figure de la terre.
Soc. Phys. de Genève, Mém., XV, 1860, 441–465; XVI, 1862, 165–194.

ROBERTS (F. C.). The figure of the earth.
Van Nostrand's Mag., XXXII, 1885, 228–242; New York, 1885.

ROCHE (E.-A.). Recherches sur la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XXVII, 1848, 443.

RODRIGUEZ (J.). Ueber die Grössenverhältnisse des Erd-Sphäroids.
Zeits. f. Astron. (Lindenau), III, 1817, 71–81.

RUMOVSKI (S.). Meditatio de figura telluris exactius cognoscenda.
Acad. de St.-Pétersbourg, Acta, XIII, 1802, 407–417.

RUSSEL (W. H. L.). On the calculation of the potential of the figure of the earth.
Brit. A. A. S., Trans., XXXV, 1865, 8.

SABINE (E.). An account of experiments to determine the figure of the earth.
London, 1825.

SADEBECK (M.). Ueber die neueren, zur Bestimmung der Gestalt und Grösse der Erde unternommenen Messungen.
Schles. Ges., Breslau, Jahresber., XLI, 1863, 23–24.

SAIGEY (J.-F.). Sur la figure de la terre.
N. d.

SANSONE (F.). Measuring the earth's surface.
Popular Sci. Month., XXX, 1886, 242–255.

SANTINI (G.). Elementi di astronomia.
Padova, 1830.

—— Delle recenti ricerche intorno alla vera figura della terra.
Ist. Veneto, Mem., XI, 1862, 219–267.

SCHÄFER (W.). Entwickelung der Ansichten des Alterthums über die Gestalt und Grösse der Erde.
Insterburg, 1868.

SCHAUBACH (J. K.). Geschichte der griechischen Astronomie.
Göttingen, 1802.

EARTH, FIGURE OF—Continued.

SCHMIDT (J. K. E.). Bestimmung der Grösse der Erde.
Astron. Nachr., VII, 1829, 329–332; Roy. Astron. Soc., Mem., VI, 1833, 139; Phil. Mag. (Taylor), VII, 1830, 409–412; Astron. Ephem. (Harding u. Wiesen), 1831, 105–108; Astron. Nachr., IX, 1831, 315–316, 371–372.

—— Lehrbuch der mathematischen und physischen Geographie.
Göttingen, 1829–'30; 1832.

SCHUBERT (F. T.). Populäre Astronomie.
Hamburg, 1834.

SCHUBERT (T. F. DE). Essai d'une détermination de la véritable figure de la terre.
Acad. de St.-Pétersbourg, Mém., I, 1859, vi, 1–32 . . .; Astron. Nachr., LV, 1861, 97–112.

SCHWAHN (PAUL). Ueber Aenderungen der Lage der Figur und der Rotations-Axe der Erde.
Berlin, 1887.

SEDLMAYER (VON). Theoretische Bestimmungen über die Grösse des Erd-Halbmessers.
Sirius, VIII, 1875, 128.

SIEFERT (O.). Entwickelung der Ansichten des Alterthums über Gestalt und Grösse der Erde.

SIGORNE (DE). Démonstration . . . de l'impossibilité des causes physiques pour la formation de sa figure.
Bibl. Brit. Genève, XXXVIII, 1809, 99.

SIMPSON (T.). Mathemathical dissertations.
London, 1740.

SIRAPED (W. S. DE). De la forme de la terre.
Paris, 1828.

STEINHAUSER (A. VON). Sur . . . la figure de la terre.
Wittemberg, 1807.

—— Neue Berechnung der Dimensionen des Erd-Sphäroids.
Geogr. Mittheil. (Petermann), 1858, 465–468.

STERLING (J.). Of the figure of the earth, and the variation of gravity on the surface.
Roy. Soc. London, Phil. Trans., XXXIX, 1735, 98–105.

STRÖMER. Tentamina pro invenienda figuram telluris.
Upsaliæ, 1750.

STRUYCK (N.). Van de groote der aarde.
Amsterdam, 1740.

STUART (J.). The figure of the earth.
Nature, VI, 1872, 79–80.

STUDNIČKA (F. J.). [Mathematical geography.]
Prag, 1882.

SVANBERG (J.). Historisk öfversigt af problemet om jordens figur . . .
K. Vetens. Acad., Handl., XXV, 1804, 125–140.

TABSIUS (J. A.). Geographiæ universalis.
Hamburgi, 1679.

TELLKAMPF (A. J. D. A.). Darstellung der mathematischen Geographie.
Hannover, 1824.

TENGSTRÖM (J. M.). Dissertatio de figura telluris.
Aboæ, 1815.

TENNANT (J. F.). An examination of the Indian meridian . . .
Roy. Astron. Soc., Month. Not., XVII, 1857, 58–63.

—— On the effect of local attraction in modifying the apparent form of the earth.
Roy. Astron. Soc., Month. Not., XVII, 1857, 236–241.

—— An examination of the figure of the Indian meridian.
Roy. Astron. Soc., Month. Not., XVII, 1857, 58–63; Asiat. Soc., Journ., XXVIII, 1859, 17–22.

THEUNUIS (H.). Dissertatio cosmographica de magnitudine telluris ad cœlum comparate.
Jenæ, 1658.

TIMMERMANS (J. A.). De figura telluris.
Gandæ, 1822.

EARTH, FIGURE OF—Continued.

TODHUNTER (I.). On the equation which determines the form of the strata in Legendre's and Laplace's theory of the figure of the earth.
Phil. Soc. Camb., Trans., XII, 1873, 301-318.

—— A history . . . of the figure of the earth.
London, 1873.

TREW (A.) Disputatio de immobilitate terræ contra Copernicum.
Altdorf., 1636.

TRIESNECKER (F. DE P.). Dissertatio de figura telluris e solis eclipsibus deducta.
Eph. Astron., a Hell et Triesnecker, anni 1791, 307-412.

UNFERDINGER (F.). Ueber die Bestimmung der Abplattung der Erde aus den gleichzeitigen Angaben eines Quecksilber- und eines Aneroid-Barometers.
Arch. d. Math. (Grunert). XLII, 1864, 443-452.

VOIRON. Histoire de l'astronomie.
Paris, 1810.

WAGNER (H.). Die Dimensionen des Erdsphäroids nach Bessel's Elementen.
Geogr. Jahrb. (Behm), 1870, i-lxi.

WALBECK (H. J.). Dissertatio de forma et magnitudine telluris ex dimensio arcubus meridiani definiendis.
Aboæ, 1819.

WALCH (A. G.). De dimensionibus nonnullis terræ per antiquos factis.
Schlesingæ. 1740.

WALLER (R.). The measure of the earth.
London, 1688.

WARGENTIN (P. V.). Om jordens skapnad och storlek.
K. Svenska Vetens. Acad., Handl., X, 1749, 233-245; XI, 1750, i-ii, 81-94.

WATTS (W.). On the ellipticity of the earth.
Edinb. Phil. Journ., III, 1820, 288-293.

WEISBACH (J.). Vorträge über mathematische Geographie.
Freiburg, 1878.

WILLIAMS (T.). . . . method of proceeding to discover the variation of the earth's diameters.
London. 1786.

WINDSHEIM (C. N. DE). Determinatio exactior graduum in figura telluris hypothetice sphærica aut sphæroida.
Acad. de St.-Pétersbourg, Comm., 1740, 222-231.

WITTSTEIN (T. L.). Abplattung des Erdsphäroids.
Int. Geod. Cong., Gen.-Ber., 1870, 40.

WOLFERS (J. P.). Ueber die Gestalt und Grösse der Erde nach Bessel.
Ges. d. Erdkunde, Monatsber., III, 1842, 197-199; Zeits. f. allg. Erdkunde, XI, 1861, 1-6; XIII, 1862, 413-415.

WOODWARD (R. S.). On the form and position of the sea level.
Ann. Math., II, 1886, 97-103, 121-131; III, 1887, 11-25; Washington, 1888.

YOUNG (T.). Remarks on the . . . figure of the earth.
Quart. Journ. Sci., IX, 1820, 32-34.

—— Estimate of the effect of the terms involving the square of the disturbing force on the figure of the earth.
Quart. Journ. Sci., XXI, 1826, 346-347.

YVON-VILLARCEAU (A.-J.-F.).

ZACH (F. X. VON). Ueber die Möglichkeit, die Gestalt der Erde aus Gradmessungen zu bestimmen.
Mon. Corr. (Zach), XIII, 1806, 222-255; XX, 1809, 3-9.

ZACH (F. X. VON). Considérations sur l'aplatissement de la terre.
Bibl. Brit. Genève, XLIV, 1810, 295-302; Giorn. d. Fis. (Brugnatelli), III, 1810, 429-434; Mon. Corr. (Zach), XXV, 1812, 569-575; Bibl. Univ. Genève, XLIV, 1830, 1-11.

ZANOTTI-BIANCO (O.). Il problema meccanico della figura della terra.
Firenze, 1880-'85.

ZNACEKSKI (A. A.). De figura et magnitudine terraqua.
Cracow, 1776.

EARTH, FIGURE OF—Continued.

ANON. Earth, figure of.
Cyclopædia (Rees), XIII, under "Earth."

—— Mesure de la terre.
Acad. d. Sci. Paris, Hist., I, 1733, 124-131.

—— Sur la figure de la terre.
Acad. d. Sci. Paris, Mém., 1742, 86-104.

—— Figure de la terre.
Encyclopédie, par Diderot, VI, Paris, 1756, 749-761.

—— Instruction sur les mesures déduites de la grandeur de la terre, uniformes pour toute la république; et sur les calculs relatifs à leur division décimale. Par la commission temporaire des poids et mesures républicaines; en exécution des décrets de la Convention nationale.
Séconde édition, revue, corrigée et augmentée, 8°, Paris, (an 3, 1797]), pp. xxviii, 224, 1 plate, 14 tables.

—— Folgerungen aus der Præcession und Nutation für die Mondsmasse Erdabplattung, und mittlere Aequatorial-Parallaxe des Mondes.
Mon. Corr. (Zach), XII, 1805, 336-340.

—— [Werthe der Abplattung der Erde durch verschiedene Methode erlangt.]
Mon. Corr. (Zach), XXIII, 1811, 254.

—— Translation of a letter from a learned foreigner to a friend in this country, on the figure of the earth, and on the length of the seconds pendulum in different latitudes.
Quart. Journ. Sci., V, 1817, 235-245.

—— Note upon the knowledge which the Egyptians appear to have had of the figure of the earth.
Quart. Journ. Sci., V, 1817, 245-247.

—— Erde, Figur und Gestalt.
Pierer's Universal-Lexikon, V, Altenburg, 1858, 828-832.

—— The form and magnitude of the earth.
Encycl., Chambers, III, 1864, 735-737.

—— Die Gestalt der Erde.
Allg. deutsche Real-Encyklopädie, V, 1865, 894-900.

—— Dimension de la terre.
Grand Dictionnaire Universel du XIX^e siècle, Paris, XIV, 1875, 1649-1650.

—— Mass and density of the earth.
Encyclopedia, Chambers, III, 1876, 736.

—— The shape of the earth.
Pop. Sci. Month., XV, 1879, 857-858.
Regarding the discussion of Hampden and Proctor, the former insisting that the earth is flat.

—— Earth.
Am. Cyclopædia, New York, VI, 1883, 354-359.

—— Density and figure of the earth.
From: Comptes Rendus, Feb. 16, 1885, Journ. Frank. Inst., CXX, 1885, 392.

Eckhardt (Christian Ludwig Philipp). [Messung einer Basis mit Platinastäben.]
Astron. Corr. (Zach), XXIII, 1811, 507-509.

—— *et* **Schleyermacher.** Mémoire sur la mesure de la base de Darmstadt, exécutée en octobre 1808. Dressé sur les notes et les manuscrits originaux communiqués par les auteurs de cette mesure. Par Delcross.
Bibl. Univ. Genève, II, 1819, 3-16, 81-100.

—— Vorläufige Nachrichten von den geodätischen Operationen zur Verbindung der Observatorien von Göttingen, Seeberg, Darmstadt, Mannheim, Speier, und Strassburg. Vorgetragen in der ersten Sitzung der physikalischen Sektion der Versammlung der Naturforscher in Stuttgart den 19. September 1834
4°, Stuttgart, 1834, pp. 7-13. (Washington, Coast Survey).
Lithographed results of observations and adjustments.

Eckhardt (Christian Ludwig Philipp)—Continued.
——— Ueber die geodätischen Arbeiten zwischen Strassburg und Göttingen.
Astron. Nachr., XII, 1835, 127–134; Kästner's Archiv Naturl., XXVI, 1834, 296–308.

École Norm. Sup., Ann., *for* Annales scientifiques de l'École normale supérieure.
4°, Paris, 1864+. (Washington, Observatory.)

École Polytech. Journ., *for* Journal polytechnique.
4°, Paris, 1794.

Edgeworth. Letter respecting the triangles of the county of Roscommon, 1823.
Roy. Irish Acad., Trans., XIV, 1825, 63–69.

Edgeworth (F. Y.). The method of least squares.
L., E., D. Phil. Mag., LXVI, 1883, 360–375.

Edinb. Phil. Jour., *for* Edinburgh New Philosophical Journal.
4°, Edinburgh, 1819+. (Washington, Patent Office.)

Eff. Astron. Milano, *for* Effemeridi astronomiche di Milano.
8°, Milano, 1806+. (Washington, Observatory.)

Eisenschmidius [Eisenschmidt] (Johann Casper). Diatribe de figura telluris elliptico, ubi exhibetur ejus magnitudo per singular dimensiones consensu omnium observationum comprobata.
4°, Argentorati, 1691, pp. 52. (British Museum.)
This work was the first occasion of the dispute concerning the pretended elongation of the earth; this did not cease until 1736.—Lalande, Bibl. Astr., 324.

——— De ponderibus et mensuris veterum Romanorum, Græcorum, Hebræorum; nec non de valore pecuniæ veteris disquisitio nova: testimoniis vetustis, rationibus. Experimentis, calculis, recens factis suffulta.
12°, Argentorati, 1708, pp. [xxii], 197. (British Museum.)
Terræ magnitudo, 121–123.

——— [Sur la figure de la terre.]
Acad. d. Sci. Paris, Mém., 1713, 190–191.

Élie de Beaumont (J.-B.-A.-L.-L.). *See* **Beaumont (J.-B.-A.-L.-L. Élie de).**

Ellis (R. L.). On the method of least squares.
Camb. Soc., Trans., VIII, 1824, ii, 204–219.

Elvius (Peter *or* Pehr). Theorema de oscillationibus pendulorum in arcubus circularibus.
Soc. Sci. Upsala, Acta, III, 1734, 71–75.

Emelin (E. H.). Zusammenstellung und Erklärung einiger altrömischer Maassbestimmungen, Eintheilungen und Benennungen, zur Erleichterung des Studium der römischen Rechtsgeschichte und Alterthümer.
Ak. d. Wiss. Bern, Arch., III, 1813, 501–521.
A good discussion of Roman units of length.

Emory (W. H.): Francoeur (L. B.). Extracts from the treatise on geodesy. Translated by —.
Journ. Frank. Inst., XXXI, 1841, 309–319, 369–374; XXXII, 1841, 15–23, 145–154, 217–224, 289–298.

Encke (Johann Franz). Ueber die Begründung der Methode der kleinsten Quadrate.
Astron. Jahrb. (Bode), 1834, 249–304; 1835, 253–320; 1836, 252–310; Corres. Math. (Quetelet), VII, 1832, 1–12.

——— Beitrag zur Begründung der Methode der kleinsten Quadrate.
K. Ak. d. Wiss., Ber., 1850, 211–214.

——— Ueber die Dimensionen des Erdkörpers, nebst Tafeln nach Bessels Bestimmungen.
Astron. Jahrb. (Bode), 1852, 318–342.

——— Ueber die Anwendung der Wahrscheinlichkeitsrechnung auf Beobachtungen.
Astron. Jahrb. (Bode), 1853, 310–352.

——— Gesammelte mathematische und astronomische Abhandlungen.
8°, Berlin, 1888. *Ferd. Dümmlers.* (Washington, Observatory.)
Methode der kleinsten Quadrate, II, 1–248.

Engel. Die mitteleuropäische Gradmessung, und die erste allgemeine Conferenz der von den Regierungen der betheiligten Staaten dazu Bevollmächtigten in Berlin vom 15. bis 22. October 1864.
Fol., Berlin, 1864, pp. 8. (Vienna, War Office.)
Separatabdruck, Zeits. d. k. preuss. statistisch. Bureaus, IV, 1864, x.

Engelbreit (Karl). Instrumente der höheren und niedren Geodäsie und die Hydrometrie mit erläuterndem Texte.
Fol., Nürnberg, 1852, 26 pl. (Münich, Royal.)

Engelmann (Rudolf). Abhandlungen von Bessel.
Leipzig, 1875–'76.
Title in full under BESSEL (F. W.).

ENGLAND.

ADĒLOS. The geodesy of Britain.
London, 1859.

CLARKE (A. R.). Some details respecting the trigonometrical survey of the British Isles.
Roy. Astron. Soc., Month. Not., XVIII, 1858, 113–114.

DALBY (I.). Remarks on Major Roy's account of the trigonometrical operations.
Roy. Soc. London, Phil. Trans., LXXX, 1790, 593–614.

DELAMBRE (J.-B.-J.). Exposé des opérations trigonométriques exécutées pour la description de l'Angleterre.
Conn. d. Temps, 1818, 243–278.

GALBRAITH (W.). Recomputation of Roy's triangulation for connecting the observatories of Greenwich and Paris.
Roy. Astron. Soc., Month. Not., V, 1839–'43, 292–293.

GALLOWAY (T.) . . . the probable error of observation in a portion of the Ordnance Survey.
Roy. Astron. Soc., Mem., XV, 1846, 23–69.

GREGORY (O. G.). Remarks on Rodriguez's animadversions on part of the trigonometrical survey of England.
Phil. Mag. (Tilloch), XLI, 1813, 178–194.

——— Dissertations and letters by Rodriguez . . . to defend or impugn the trigonometrical survey of England.
London, 1815.

JAMES (H.). On the geodetic operations of the Ordnance Survey.
Roy. Inst., Proc., II, 1854–'58, 516–521.

——— Ordnance trigonometrical survey . . . ; account of the observations and calculations of the principal triangulation.
London, 1858.

——— Extensions of the triangulation of the Ordnance Survey into France and Belgium.
London, 1863.

ENGLAND—Continued.

KATER (H.). An account of trigonometrical operations in 1821-'23. for determining the difference of longitude between Paris and Greenwich.
Roy. Soc. London, Phil. Trans., CXVIII, 1828, 153-239.

MOSSMAN (S.). Origin of the trigonometrical survey.
Geogr. Mag., V, 1878, 176-179.

—— Primary base on Hounslow Heath.
Geogr. Mag., V, 1878, 282-286.

MUDGE (W.). An account of the trigonometrical survey [of England].
Roy. Soc. London, Phil. Trans., LXXIV, 1795, 414-591; 1797, 432-541; 1800, 539-724; XCIII, 1803, 383-508; London, 1799, 1801, 1811.

PALMER (H. S.). The Ordnance Survey of the Kingdom.
London, 1873.

RODRIGUEZ (J.). Observations on the measurement of three degrees of the meridian in England.
Roy. Soc. London, Phil. Trans., CII, 1812, 321-351; Phil. Mag. (Tilloch), XLI, 1813, 20-31, 90-100.

RYDE (E.). The Ordnance Survey of the United Kingdom.
Surveyors' Inst., Trans., XV, 1882-'83, ii, 25-62.

W. (B.). The Ordnance Survey.
Dub. Univ. Mag., XI, 1838, 353-357.

WHITE (T. P.). The Ordnance Survey of the United Kingdom.
London, 1886.

ANON. The English and Irish Ordnance Surveys.
Penny Mag. XIII, 1844, 389-391, 402-403.

—— Geodetic work. [Mention of geodetic work in report of council.]
Roy. Astron. Soc., Month. Not., VII, 1845-'47, 228-231.

—— Notice of the trigonometrical survey of London.
Journ. Frank. Inst., XLVII, 1849, 122-123.
A short description of the scaffold (91 feet high) that was built around the dome of St. Paul.

—— Trigonometrical survey, Great Britain. Memorial of the British Association for the Advancement of Science, printed by order of the House of Commons, Feb., 1836.
Edinb. Rev., XCV, 1852, 179-213.

—— Report from the select committee on the Ordnance Survey (Scotland); together with the proceedings of the committee, minutes of evidence, etc. Printed by order of the House of Commons, July, 1851.
Edinb. Rev., XCV, 1852, 179-213.

—— The Ordnance and Topographical Surveys.
Chambers' Journ., XLVIII, 1871, 14-16.

—— The Ordnance Survey of Great Britain.
From "The Architect."
Van Nostrand's Mag., VIII, 1873, 338-342.

—— The progress of the Ordnance Survey.
Geogr. Mag., III, 1876, 192-193.

—— Something about the Ordnance Survey.
All the Year Round, XXXIII, 1877, 224-228.

—— Notes on the government surveys of the principal countries, with the civil and military divisions and area of each country, measures of length and surface, lists of government maps, conventional signs and abbreviations employed, and useful table for map reading; to which is added a list of colonial and extra-Continental possessions and a list of map agents.
8°, London, 1882, pp. 166, 22 plates. (Southampton, Ordnance Survey.)

Eng. Soc. Lehigh Univ., Journ., *for* Journal of the Engineering Society of Lehigh University.
8°, Bethlehem, Pa.

Enneper (Alfred). Bemerkungen über geodätische Linien.
Zeits. f. Math. (Schlömilch), XVIII, 1873, 613-618.

Enneper (Alfred)—Continued.

—— Ueber Flächen mit besonderen Meridiankurven.
K. Ges. d. Wiss. Göttingen, math. Cl., XXIX, 1882, 1-87.

Eph. Astron. (Hell), *for* Ephemerides astronomi ad meridianum Vindobonensem (Hell).
8°, Wien, 1756-1805 (50 vols.). (Paris, Observatory.)

Erfurth. Technischer Betrieb der Feldarbeiten der Triangulation 1. Ordnung bei der trigonometrischen Abtheilung der preussischen Landesaufnahme.
Zeits. f. Vermes., XVI, 1887, 377-383, 421-437.

Erman (Georg Adolph). Ueber geodätische Arbeiten und astronomischen Ortsbestimmungen durch Offiziere des russischen Generastabes.
Arch. Russ. (Erman), I, 1841, 17-34.

—— Ueber die Resultate von General Schubert's Triangulation des Petersburger und der angränzenden Gouvernements.
Arch. Russ. (Erman), IV, 1845, 274-319.
A review of "Trigonometrische Aufnahme des Petersburger, Pskower, Witebsker und eines Theils des Novgoroder Gouvernements, auf allerhöchsten Befehl in den Jahren 1820 bis 1832 ausgeführt durch General-Lieutenant Schubert, Petersburg, 1842" (3 vols.).

ERROR, MEAN. *See* **MEAN ERROR.**

ERROR, PROBABLE. *See* **PROBABLE ERROR.**

ERRORS OF OBSERVATION.

ABBE (D. E.). Gesetzmässigkeit in der Vertheilung der Fehler bei Beobachtungsreihen.
Jena, 1863.

ADAN (E.). Loi générale de la probabilité des erreurs . . .
Acad. de Belgique, Bull., XXIII, 1867, 148-187.

AIRY (G. B.). On the algebraical and numerical theory of errors of observation.
London, 1861.

BERTRAND (J.). Sur la loi des erreurs d'observation.
Acad. d. Sci. Paris, Comp. Rend., CV, 1887, 1147-1148.

—— Sur la loi de probabilité des erreurs d'observation.
Acad. d. Sci. Paris, Comp. Rend., CVI, 1888, 153-156.

BESSEL (F. W.). Untersuchungen über die Wahrscheinlichkeit der Beobachtungsfehler.
Astron. Nachr., XV, 1838, 369-404.

BÖRSCH (O.). Die Genauigkeit der Winkel- und Linien-Messungen.
Zeits. f. Math. (Schlömilch), VIII, 1863, 321-341.

CLOTTEN (M.). Ueber konstante Messungsfehler in Polygonzügen.
Zeits. f. Vermes., XII, 1883, 641-646.

CROFTON (M. W.). On the proof of the law of errors of observations.
Roy. Soc. London, Phil. Trans., CLX, 1870, 175-188.

DE MORGAN (A.). On the theory of errors of observations.
Phil. Soc. Camb., Trans., X, 1864, 409-427.

DIENGER (J.). Ueber die Ausgleichung der Beobachtungsfehler.
Arch. d. Math. (Grunert), XVIII, 1852, 149-193; XIX, 1853, 211-227; Braunschweig, 1857; K. k. Ges. d. Wiss., math.-naturwiss. Cl., Denkschr., XXXIV, 1875, ii, 21-62.

DONKIN (W. F.). An essay on the theory of combination of observations.
Journ. d. Math. (Liouville), XV, 1850, 297-322.

DORST (F. J.). Ueber die Grösse der Beobachtungsfehler beim Ablesen eingetheilter Instrumente.
Zeits. f. Instrumentenkunde, VI, 1886, 383-387.

ENCKE (J. F.). Ueber die Anwendung der Wahrscheinlichkeits-Rechnung auf Beobachtungen.
Astron. Jahrb. (Bode), 1853, 310-352.

ERRORS OF OBSERVATION—Continued.

GAUSS (C. F.). Bestimmung der Genauigkeit der Beobachtungen.
Zeits. f. Astron. (Lindenau), I, 1816, 185–197.

—— Theoria combinationis observationum erroribus minimis obnoxiæ.
K. Ges. d. Wiss. Göttingen, Com., V, 1819–'22, 33–90.

GLAISHER (J. W. L.). On the law of the facility of errors of observations.
Roy. Astron. Soc., Mem., XXXIX, 1872, 75–124; Month. Not., XXXII, 1872, 241–242.

HELMERT (F. R.). Ueber den Maximalfehler einer Beobachtung.
Zeits. f. Vermes., VI, 1877, 131–147.

KÜTTNER (W.). Einführung unvollständiger Beobachtungen in die Wahrscheinlichkeitsrechnung.
Zeits. f. Vermes., XXIX, 1884, 193–211.

KUMMELL (C. H.). New investigation of the law of errors of observation.
Analyst, III, 1877, 133–140, 165–171; VI, 1879, 80–81.

LIAGRE (J.-B.-J.). Sur la probabilité de l'existence d'une cause d'erreur dans une série d'observations.
Acad. de Belgique, Bull., XXII, 1855, ii, 9–13, 15–54.

MAGGI (G.-A.). Intorno ad alcune formole relative al calcolo degli errori d' osservazione.
Ist. Lombardo, Rend., XV, 1882, ii, 351–358.

MANNING (R. A.). Method of correcting errors in the observation of the angles of plane triangles.
Inst. Civ. Eng., Proc., LXXIII, 1883, 289–310.

MOROZOWICZ (O. VON). Ueber den mittleren Fehler der Winkelmessung.
Zeits. f. Vermes., VI, 1877, 383–395.

PEIRCE (C. S.) On the theory of errors of observations.
U. S. C. and G. Survey, Rep., 1870, 200–224.

POISSON (S.-D.). Sur la probabilité des résultats moyens des observations.
Conn. d. Temps, 1827, 273–302; 1832, 3–22.

RITTER (F.). Ueber die Fehler der Winkelmessungen mittelst theodolit.
Allg. Bauzeit. (Förster), XXXIII–XXXIV, 1868–'69, 112–125.

SADEBECK (B. A. M.). Schreiben an den Herausgeber.
Aston. Nachr., LXXXIX, 29–32.

SANG (E.). Notice of an erroneous method of using the theodolite.
Edinb. Phil. Journ., XXVI, 1838, 173–182.

SCHLÖMILCH (O.). Ueber die Bestimmung der Wahrscheinlichkeit eines Beobachtungsfehlers.
Zeits. f. Math. (Schlömilch), XVII, 1872, 87–88.

SCHOTT (C. A.). Probable error of observation, derived from observations of horizontal angles at any station.
U. S. C. and G. Survey, Rep., 1854, 86–95.

VOGLER (C. A.). Genauigkeit einiger Näherungsformeln zum Zerlegen mittlerer Beobachtungs-Fehler.
Zeits. f. Vermes., VI, 1877, 396–412.

Eschmann (Johannes). Ergebnisse der trigonometrischen Vermessung in der Schweiz. Nach Befehl der hohen Tagsatzung aus den Protokollen der eidgenossischen Triangulirung bearbeitet und herausgegeben von J. Eschmann.
4°, Zürich, 1840, pp. xvi, 237, 1 chart. (Gore.)

ETHIOPIA.

ABBADIE (A. D'). Résumé géodésique des positions déterminées en Éthiopie.
Leipzig, 1859.

—— Géodésie d'une partie de la haute Éthiopie.
Paris, 1860–'63; Paris, 1873.

GILBERT (P.). Compte rendu de la géodésie d'Éthiopie.
Rev. Quest. Sci., I, 1877, 318–319.

Espinosa y Tello (José). Memorias sobre las observaciones astronómicas hechas por los navigantes españoles en distintos lugares del globo. (H.)
4°, 2 vols., Madrid, 1809.
The second memoir has an appendix describing the results of pendulum operations under Malespina.

Euler (J. Albrecht). Versuch die Figur der Erden durch Beobachtungen des Mondes zu bestimmen.
K. bayer. Ak. d. Wiss., Abhandl., V, 1763, 197–214.

[**Euler (Leonhard).**] Methodus viri celeberrimi Leonh. Euleri determinandi gradus meridiani pariter ac paralleli telluris secundum mensuram a celeb. de Maupertuis cum sociis institutam.
Acad. de St.-Pétersbourg, Comm., XII, 1740, 224–240.

——: **Lacaille (N.-L. de).** Sur la précision des mesures géodésiques, faites en 1740, à l'occasion d'un mémoire de M. —.
Acad. d. Sci. Paris, Mém., 1755, 53–59.

—— De oscillationibus minimis penduli quotcunque ponduscnlis onusti.
Acad. de St.-Pétersbourg, Comm., XIX, 1775, 38–39.

—— De motu oscillatorio penduli cujuscunque, dum arcus datæ amplitudinis absolvit.
Acad. de St.-Pétersbourg, Acta, I, 1777, ii, 159–182.

—— Theoria parallaxeos ad figuram terræ sphæroidicam accommodata.
Acad. de St.-Pétersbourg, Acta, I, 1799, 241–278.

—— Enodatio difficultatis super figura terræ a vi centrifuga oriunda.
Acad. de St.-Pétersbourg, Acta, II, 1887, 121.

Everest (George). On the triangulation of the Cape of Good Hope.
Roy. Astron. Soc., Mem., I, 1822–'25, 255–270.

—— On the corrections requisite for the triangles which occur in geodesic operations.
Roy. Astron. Soc., Mem., II, 1826, 37–44.

—— On the errors likely to arise in the determination of the length of the pendulum from a false position of the fixed axis.
Roy. Astron. Soc., Mem., IV, 1830–'31, 25–37; Month. Not., I, 1827–'30, 117–119.

—— An account of the measurement of an arc of the meridian between 18° 3′ and 24° 7′, being a continuation of the great meridional arc of India, as detailed by the late Lieut.-Col. Lambton in the volumes of the Asiatic Society of Calcutta.
4°, London, 1830, pp. xii, 337, 5 maps. (British Museum.)
Revd. in Calcutta Review, VII, 1845, 62–95.

—— On the formulæ for calculating azimuth in trigonometrical operations.
Asiatic Researches, XVIII, 1833, ii, 93–106.

—— On the compensating measuring apparatus of the great trigonometrical survey of India.
Asiatic Researches, XVIII, 1833, ii, 189–214.

—— Some account of the progress of the trigonometrical survey now carrying on in India.
Roy. Astron. Soc., Month. Not., IV, 1836–'39, 206–210.

—— On the geodetical operations of India.
Brit. A. A. S., Rep., XIV, 1844, 3–4.

Everest (George)—Continued.

—— An account of the measurement of two sections of the meridional arc of India conducted under the orders of the honorable East India Company, bounded by the parallels of 18° 3′ 15″, 24° 7′ 11″, and 29° 30′ 48″.
4°, London, 1847, pp. xii, clxxxvii, 439, 31 plates. (Washington, Congress.)
Revd. in Edinb. Rev., LXXXVII, 1848, 392–418.

—— Rectification of logarithmic errors in the measurements of two sections of the meridional arc of India.
Roy. Soc. Lond., Proc., IX, 1858, 620–626.
Errors were in the 12th and 20th triangles in the published account of 1847. Attention is also called to the correction due to reduction to sea level, using recent determinations of altitudes.

EXPANSION. *See* **STANDARDS OF LENGTH.**

Eytelwein (Johann Albert). Ueber die Prüfung der Normal-Maasse und Gewichte für den königlich-preussischen Staat und ihre Vergleichung mit den französichen Maassen und Gewichten.
K. Ak. d. Wiss., math. Cl., Abhandl., 1825, 1–21.

—— Vergleichung der neuesten englischen Maasse und Gewichte mit den preussischen.
A. Ak. d. Wis., math. Cl., Abhandl., 1827, 1–8.

F. Report of the Superintendent of the Coast Survey, showing the progress of the work during the year ending October, 1847.
Journ. Frank. Inst., XLV, 1848, 213–217.
A brief review of the work of the year. Two extracts: one on use of electro-magnetic telegraph for differences of longitude, and one on base line at Dauphin's Island.

—— Report of the Superintendent of the Coast Survey, showing the progress of the work for the year ending November 13, 1848.
Journ. Frank. Inst., XLVII, 1849, 141–144.
A short review of the work for that year.

—— Report of Prof. Alexander D. Bache, Superintendent of the Coast Survey, showing the progress of that work for the year ending October, 1849.
Journ. Frank. Inst., L, 1850, 72.

—— Report of the Superintendent of the United States Coast Survey, showing the progress of the work for the year ending November, 1850.
Journ. Frank. Inst., LI, 1851, 359–360.

Faà de Bruno (Francesco). Démonstration élémentaire du théorème fondamental des lignes géodésiques.
Les Mondes, VIII, 1865, 739–740; Nouv. Ann. Math., IV, 1865, 108–109.

—— Traité élémentaire du calcul des erreurs, avec des tables stéréotypées, ouvrage utile à ceux qui cultivent les sciences d'observation.
8°, Paris, 1869, pp. v, 72. (Heidelberg.)
Bibliography, xliii–xlv.

Fallon (Ludwig August von). [Sur les différences géographiques de quelques villes de l'Italie et sur les différences que l'on y a remarquées entre les déterminations astronomiques et trigonométriques.]
Corr. Astron. (Zach), V, 1821, 39–54.
Notes by ZACH, 126–139.

Fallon (Ludwig August von)—Continued.

—— *Archiv der astronomisch-trigonometrischen Vermessung der k. k. österreichischen Staaten.* *
Wien, 1824.
Title from Ann. d. Phys. (Poggendorff), V, 1825.

Fallows (Fearon). Observations made with the invariable pendulum (No. 4, Jones) at the Royal Observatory, Cape of Good Hope, for the purpose of determining the compression of the earth, with note by Captain Sabine.
Roy. Soc. London, Phil. Trans., 1830, 153–175.
Revd. in Bull. Sci. Math (Saigey), XIV, 1830, 187–188.

Farley (J.). Description and drawing of a convenient signal for observing on secondary stations.
U. S. C. and G. Survey, Rep., 1855, 363–364.

Farey (John). Remarks and suggestions as to the state and progress of the government trigonometrical survey, with regard to the dimensions, figure, and structure of the earth.
Phil. Mag. (Tilloch), LVII, 1821, 54–57.
Favoring an extension of the survey so as to include a mineralogical and stratigraphical survey.

Farquhar (Henry). Form of least-square computation.
Phil. Soc. Wash., Bull., VI, 1883, 150–152.

Favaro (A.). Procedimento grafico per la riduzione degli angoli al centro di stazione.*
Ingegneria Civile, Torino, V, 1879, 1–8.

Faye (Hervé-Auguste-Étienne-Albans). Sur la détermination géodésique des latitudes, avec une réponse (en forme de note) à la dernière critique de M. Arago.
Acad. d. Sci. Paris, Comp. Rend., XXXVI, 1853, 267–276, 309–317, 359–366.

—— Sur les propositions de M. de Struve [relatives aux opérations géodésiques et à la figure de la terre] et sur la question académique qu'elles ont soulevée.
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 669–674.

—— Réponse aux observations de M. Verrier relativement à un rapport dans la séance précédente sur les entreprises géodésiques en Allemagne.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 66–72.

—— Nouvel appareil pour mesurer les bases géodésiques.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 372–380.
Remarks by LE VERRIER, 380–381.

—— Sur les instruments géodésiques et sur la densité moyenne de la terre.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 557–566.

—— (*rapporteur*). Rapport verbal sur le protocole de la conférence géodésique tenue à Berlin en avril 1862.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 28–34.
Remarks by LE VERRIER, 34–37.

—— Sobre un nuevo aparato para medir bases geodésicas. [Comptes Rendus, 2 de marzo de 1863.]
Rev. d. Prog. d. Ciencias, XIII, 1863, 193–204.

—— (*rapporteur*). Commissionaires: Delaunay, Laugier. Rapport sur l'état actuel de la géodésie et sur les travaux à entreprendre par le bureau des longitudes, de concert avec le dépôt de la guerre, pour compléter la partie astronomique du réseau géodésique français.
Bur. d. Long., Ann., 1864, 385–451; Conn. d. Temps, 1864, 1–24.

Faye (Hervé-Auguste-Étienne-Albans)—Continued.

—— Sur la triangulation géodésique du premier ordre, qui sert de fondement à la nouvelle carte de l'Algérie du dépôt de la guerre.
Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1142-1146.

—— Note accompagnant la présentation d'une notice autographiée sur la méthode des moindres carrés.
Acad. d. Sci. Paris, Comp. Rend., LXXX, 1875, 252-357.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 111, by B[RUNS].

—— Sur un incident qui s'est produit au Congrès de Stuttgart.
Acad. d. Sci. Paris, Comp. Rend., LXXXV, 1877, 645-646.
Regarding the geodetic connection of France and Spain.

——: **Peirce (C. S.)**. On a method of swinging pendulums for the determination of gravity proposed by —.
Am. Journ. Sci., XVIII, 1879, 112-119.

—— Sur les variations séculaires de la figure mathématique de la terre.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1185-1191.

—— Sur la réduction des observations du pendule au niveau de la mer.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1443-1447.

—— Rapport sur un mémoire de M. Peirce concernant la constante de la pesanteur à Paris et les corrections exigées par les anciennes déterminations de Borda et de Biot.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1463-1466.
See PEIRCE. Sur la valeur, etc.

—— Sur une lettre du général Stebnitzki relative à la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XCVII, 1883, 508-515.
By order of the Academy this communication was printed in full.

—— Cours d'astronomie de l'École polytechnique. Première partie. Astronomie sphérique—description des instruments, théorie des erreurs, géodésie et géographie mathématique.
8°, Paris, 1881, pp. vi, 374. *Gauthier-Villars.* (Berlin, Royal).
Revd. in Jahrb. üb. d. Fortschr d. Math., XV, 1883, pp. 956-958, by LP. [LAMPE].

—— Sur les rapports de la géodésie avec la géologie.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 99-103, 295-299, 841-844.

——: **Lapparent (A. de)**. Sur les rapports de la géodésie avec la géologie. Réponse aux observations de M. —.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 772-774.

—— Réponse à une note de M. de Lapparent, en date du 22 novembre (C. R., CIII, 1886, 1040-1042), sur les conditions de forme et de densité de l'écorce terrestre.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 1093-1101, 1221-1224.

Fearnley (C.). Bericht über die Gradmessungsarbeiten Norwegen.
Int. Geod. Cong., Gen.-Ber., 1865, 39-42.

—— Bericht über die geodätischen Arbeiten in Norwegen für das Jahr 1871.
Int. Geod. Cong., Gen.-Ber., 1871, 58-63.

—— Bericht über die geodätischen Arbeiten in Norwegen pro 1875.
Int. Geod. Cong., Gen. Ber., 1875, 180-181.

—— *und* **Haffner (N.)**. Bericht der norwegischen Commission. [Geodetic.]
Int. Geod. Cong., Gen.-Ber., 1877, 292-294.

—— Bericht über die geodätischen Arbeiten in Norwegen für das Jahr 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 90.

—— Bericht über die geodätischen Arbeiten in Norwegen für das Jahr 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 22-23.

——, **Mohn (H.)**, **Schrötz (O.)** *und* **Haffner (W.)**. Geodätische Arbeiten. Publication der norwegischen Commission der europäischen Gradmessung.
I. Die Basis auf Egelberg bei Christiania und die Basis auf Rindenleret bei Levanger, 4°, Christiania, 1882, pp. [iii], 42 [86], 2 maps.
II. Die Verbindung der Basis bei Christiania mit der Hauptdreiecks-Seite Toaas-Kolsaas, Christiania, 1880, pp. 68, 1 map.
III. Die Verbindung der Basis auf den Rindenleret mit der Hauptdreiecks-Seite Stokvola Haarskallen, Christiania, 1882, pp. 74-176, 1 map.
IV. Das nördliche Dreiecksnetz zur Verbindung der Haupt-Dreieckseiten Haarskallen-Stokvola und Spaatind-Näverfjeld, Christiania, 1885, pp. 180-288, 3 maps. (Gore.)
V. Das mittlere Dreiecksnetz, Christiania, 1887, pp. 73, 1 map.
VI. Das südliche Dreiecksnetz, Christiania, 1888, pp. 71, 1 plate.

—— Bericht über die geodätischen Arbeiten in Norwegen für die Jahre 1881 und 1882.
Int. Geod. Cong., Gen.-Ber., 1881-'82, 148-150.

—— Zur Theorie der terrestrischen Refraction.
Int. Geod. Cong., Gen.-Ber., 1883, 13-27, Appendix 7.

—— Bericht über die geodätischen Arbeiten in Norwegen für das Jahr 1883.
Int. Geod. Cong., Gen.-Ber., 1883, 294-295.

—— [Bericht über die geodätischen Arbeiten in Norwegen, 1885-'86.]
Int. Geod. Cong., Verhandl., 1884-'86, 149-157.

Fechner (Gustav Theodor). Ueber die Bestimmung des wahrscheinlichen Fehlers eines Beobachtungsmittels durch die Summe der einfachen Abweichungen.
Ann. d. Phys. (Poggendorff), Jubelband, 1874, 66-81.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VI, 1874. 729.

—— Ueber den Ausgangswerth der kleinsten Abweichungssumme, dessen Bestimmung, Verwendung und Verallgemeinerung.
Ak. d. Wiss. Leipzig, math.-phys. Cl., Abhandl., XI, 1874, 1-76.

Fedorow (Vasily Theodorovich). Vorläufige Berichte über die von ihm in den Jahren 1832 bis 1837 auf allerhöchsten Befehl in West-Sibirien ausgeführten astronomisch-geographischen Arbeiten. In Auftrag der kaiserl. Akademie der Wissenschaften herausgegeben von F. G. W. Struve.
8°, St. Petersburg, 1883, pp. xii, 179, 1 map. (British Museum.)

Feer [*sometimes* **Fehr**] **(Johann).** Ueber die trigonometrische und astronomische Vermessung des Rheinthales der Schweiz.
Geogr. Eph. (Zach), III, 1799, 350-362, 462-472.

Feldt (Laurentius). Formulæ conditionæ Gaussianæ de lineis in superficie curva brevissimis evolutio.*
Brunsbergæ, 1844.

——— Formulæ Besselianæ de latitudine locorum geographica evolutio.*
Brunsbergæ, 1848.

Fenner von Fenneberg (Ludwig Ferdinand). Ueber die Verschiedenheit der griechischen Stadien und Fussmaasse.
8°, Berlin, 1858, pp. iv, 136. (Gore.)
Inaugural-Abhandlung, welche mit Genehmigung der philosophischen Facultaet zu Marburg zur Erlangung der Doctorwuerde eingericht.

Fenner (P.). Das Verbindungsviereck zwischen den Dreiecksnetzen von Spanien und Algier.
Zeits. f. Vermes., II, 1882, 303-308.

——— Die strenge Ausgleichung regelmässiger Polygonzüge nach der Methode der kleinsten Quadrate und ihre Anwendung zur Näherungs-Ausgleichung beliebiger Polygonzüge.
Zeits. f. Vermes., XVI, 1887, 249-271, 287-297.

Fergola (Emanuele). Sulla posizione dell' asse di rotazione della terra, rispetto all' asse di figura.
4°, Napoli, 1874, pp. 32. (Gore.)
Taken from Atti della R. Accademia delle scienze fisiche e matematiche di Napoli, VI, 1874.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VI, 1824, pp. 725-726, by B[RUNS]; HELMERT, Astron. Gesell., Viertel-jahrs., XI, 1876, 94-103.

——— Dimensioni della terra e ricerca della posizione del suo asse di figura rispetto a quello di rotazione.
4°, Napoli, 1876, pp. 26. (Gore.)
Taken from Atti della R. Accademia delle scienze fisiche e matematiche di Napoli, VII, 1875.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 700-701, by JG. [JUNG]; HELMERT, Astron, Gesell., Viertel-jahrs., XI, 1876, 380-287.

Fergola (Francesco). Relazione delle operazioni geodetiche eseguite nelle provincie settentrionali del regno di Napoli riguardanti la congiunzione della specola reale di Capodimonte alla cupola di S. Pietro in Roma, e la rete de' triangoli che si lega alla triangolazione proveniente dall' alta Italia.
4°, Napoli, 1838, pp. 27. (British Museum.)
Reprint from Annali civili del regno delle due Sicilie, XVIII, 1838.

——— Cenno storico dei lavori geodetici e topografici eseguite nel R. officio topografico di Napoli, 1851.*

Ferguson (James). Introduction to astronomy; describing the figure, motions, and dimensions of the earth; the different seasons; gravity and light; the solar system; the transit of Venus; the moon's motion; the eclipses of the sun and moon, etc., with plates.*
8°, 1799.

Fernandez (Leandro) *y* Jiminez (Francisco). Determinacion de la longitud del péndulo de segundos en México.
8°, México, 1879, pp. 61.
Separate from Observatorio astronómico central, 1878-'79.

Fernelius (Johannis) [Jean Fernel]. Cosmotheoria libros duos complexa. Prior, mundi totius et formam et compositionem: ejus subinde partium (quæ elementa et cœlestia sunt corpora) situs et magnitudines: obiu tandem motus quosius solerter referat. Posterior, ex motibus, sidem loca et passiones disquisit: interspersis documentis haud pœnitendu aditum ad astronomicas tabulas suppeditatibus hæc, sejunctim tandem expedite præbet planethodium.
Fol., Parisiis, 1582, pp. [vii], 46, 36, 42. (Oxford, Bodleian.)

———: **Lalande (J. de).** Sur la mesure de la terre, que publia in 1828.
Acad. d. Sci. Paris, Mém., 1878, 216-225.

———: **De Morgan (A.).** On the history of —'s measure of a degree.
L., E., D. Phil. Mag., XIX, 1841, 445-447; XX, 1842, 116-117, 230-233, 408-411; XXI, 1842, 22-25.

———: **Galloway (T.)** Remarks on —'s measure of a degree.
L., E., D. Phil. Mag., XXI, 1842, 25-28; XX, 1855, 90-98.

Ferreira de Castro (A. G.). Trabalhos geodesicos en Angola, reconhecimento do terreno para o estabelecimento de uma base geodesica e escolha de pontos para uma triángulação de primeira orden.
8°, n. d., pp. 112, 3 plates. (Berlin, Geodetic Institute.)

Ferrero (Annibale). Memoria sobre la forma mas conveniente de los triángulos geodésicos.
4°, Madrid, 1853; Acad. d. Sci. Paris, Mém., II, 1853, 77-84.

——— Esposizione del metodo dei minimi quadrati.
8°, Firenze, 1876, pp. x, 228, 1 plate. (Southampton, Ordnance Survey.)
Abstract by PEIRCE (C. S.), Am. Jour. Math., I, 1878, 59-63.

——— Sur la compensation d'un réseau trigonométrique.
Int. Geod. Cong., Gen.-Ber., 1877, 217-224.

——— Note sur un procédé pratique pour établir l'accord entre plusieurs bases d'une triangulation.
Astron. Nachr., XCVII, 1880, 179-182.

——— Note sur la possibilité de calculer a priori le poids et la précision des résultats d'une triangulation par la connaissance de son canevas.
Int. Geod. Cong., Gen.-Ber., 1880, 1-5.

——— Rapport spécial sur les triangulations.
Int. Geod. Cong., Gen.-Ber., 1880, 1-76, App. 5.

——— Avancement des travaux géodésiques en Italie.
A. Franç. A. S., 1882, 86-91.

——— Rapport sur l'état actuel des travaux [géodésiques] en Italie [en 1883].
Int. Geod. Cong., Gen.-Ber., 1883, 252-257.

——— Sur les triangulations de l'Europe avec un canevas général à l'échelle de 1: 10,000,000.
4°, Florence, 1884, pp. 91; Int. Geod. Cong., Gen.-Ber., 1884, ii, 1-91.

Ferrero (Annibale)—Continued.

——— Lavori geodetici [Italy], 1884–'86.
Int. Geod. Cong., Verhandl., 1884–'86, 143–145.

——— Association géodésique internationale. Comptes rendus de la session de la commission permanente à Nice, en 1887. Supplément: rapport sur les triangulations avec canevas général.
4°, [Florence, 1887], pp. 127. (Gore.)

——— Rapport sur les travaux [géodésiques] de l'Italie.
Int. Geod. Cong., Verhandl., 1887, VI, 1–2.

Fester (Diderich Christian). Betragtning over Middags-Linien og Jordens Figur.
K. Norske Videns., Saml., II, 1788, 7–52.

FIGURE OF THE EARTH. *See* **EARTH, FIGURE OF.**

FIGURE, ADJUSTMENT OF.

ANDRAE (C. C. G.). Ueber die Ausgleichung eines Dreiecksnetzes.
Int. Geod. Cong., Gen.-Ber., 1877, 244-252.

BAEYER (J. J.). Die Auflösung grosser sphäroidischen Dreiecke.
Astron. Nachr., LXI, 1863, 225-240.

——— Ueber die Berechnung sphäroidischer Dreiecke.
Astron. Nachr., LXXI, 1868, 289-314.

——— Ausgleichung eines Dreiecksnetzes nach der Bessel'schen Methode.
Berlin, 1871.

——— Die Vertheilung der Fehler nach Winkelgleichung und nach Seitengleichung.
Berlin, 1871.

——— Zerlegung eines Dreiecksnetzes nach Gruppen.
Int. Geod. Cong., Gen.-Ber., 1877, 203-207.

——— Vergleichung einiger Hauptdreiecksketten mit der Bessel'schen Methode.
Berlin, 1879.

BAUR (C. W.). Die Ausgleichung der Richtungen in einem Dreiecksnetz mit unvollständigem Centralsystem.
Stuttgart, 1857.

BIVER (P.-E.). Sur une nouvelle méthode de conduire et de calculer les triangulations géodésiques.
Acad. de Belgique, Bull., XXIII, 1856, 99-148.

BÖKLEN (O.). Ueber die Winkelsumme in Dreiecken . . .
Arch. d. Math. (Grunert), XLIII, 1865, 18-25.

BÖRSCH (A.). Ueber den Einfluss der Wahl verschiedener Nullrichtungen auf die Ausgleichung von Richtungsbeobachtungen.
Astron. Nachr., XCVII, 1880, 181-186.

BÖRSCH (O.). Ueber die Ausgleichung einer um ein Polygon gelegten geodätischen Dreieckskette.
Astron. Nach., LXXXI, 1868, 265-268, 379-380.

BREMIKER (C.). Ueber Winkelmessung und Ausgleichung.
Astron. Nach., LXXXIX, 1877, 65-78.

——— Das rheinische Dreiecksnetz. Die Netzausgleichung.
Berlin, 1876 (1882).

COLE (W. H.). Note on the simultaneous reductions.
India, Trig. Survey, VI, 1880, 161-164.

DOOLITTLE (M. H.). Closing of a circuit of triangulation.
U. S. C. and G. Survey, Rep., 1875, 282-292.

EVEREST (G.). On the corrections requisite for the triangles which occur in geodesic operations.
Roy. Astron. Soc., Mem., II, 1826, 37-44.

FENNER (P.). Die strenge Ausgleichung regelmässiger Polygonzüge . . .
Zeits. f. Vermes., XVI, 1887, 249-271, 287-297.

FERRERO (A.). Note sur un procédé pratique pour établir l'accord entre plusieurs bases d'une triangulation.
Astron. Nachr., XCVII, 1880, 177-182.

FOLQUE (F.). Taboa para determinar a influencia do erro dos angulos sobre o calculo dos lados do triangulo.
Lisboa, 1854.

FIGURE, ADJUSTMENT OF—Continued.

FOREST (E. L. DE). On adjustment formulas.
Analyst, IV, 1877, 79-86, 107-113.

——— On repeated adjustments, and on signs of residuals.
Analyst, V, 1878, 65-72.

——— On the limit of repeated adjustments.
Analyst, V, 1878, 129-140.

HANSEN (P. A.). Ueber die Anwendung der Wahrscheinlichkeitsrechnung auf geodätische Vermessung.
Astron. Nachr., IX, 1831, 189-219, 237-262.

——— . . . Ableitung des Ausgleichungsverfahrens eines Dreiecksnetzes.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Ber., XX, 1868, 129-150.

——— Entwickelung eines neuen veränderten Verfahrens zur Ausgleichung eines Dreiecksnetzes.
K. sächs. Ges., Abhandl., XIV, 1869, 185-287.

HELMERT (F. R.). Beiträge zur Theorie der Ausgleichung trigonometrischer Netze.
Zeits. f. Math. (Schlömilch), XIV, 1869, 174-208.

——— Die Ausgleichung nach der Methode der kleinsten Quadrate.
Leipzig, 1872.

HELMERT (F. R.). Ausgleichung von symmetrisch angeordneten Richtungsbeobachtungen einer Station.
Zeits. f. Vermes., XIV, 1885, 263-266.

HENNESSEY (J. B. N.). On the dispersion of circuit errors of triangulation after the angles have been corrected for figural conditions.
India, Trig. Survey, II, 1873, viii, 151-176.

——— Reduction of the N. W. quadrilateral.
India, Trig. Survey, II, 1873, x, 177-253; XII, 283-318.

JORDAN (W.). Eine Inconsequenz in manchen Dreiecksnetzausgleichungen.
Astron. Nachr., LXXXV, 1875, 69-72.

——— Ausgleichung eines Triangulirungsnetzes mit Repetitionswinkelmessung.
Zeits. f. Vermes., VII, 1878, 18-34, 120.

——— Ueber die günstigste Seitengleichung im Viereck.
Zeits. f. Vermes., IX, 1880, 65-73.

——— Zur Theorie der Polygonzüge.
Zeits. f. Vermes., XIII, 1884, 197-203, 229-238; XV, 1886, 332-335.

KERSCHBAUM (G.). Ueber Winkelausgleichung.
Zeits. f. Vermes., III, 1874, 85-89.

KUMMELL (C. H.). Strenge Gleichungen zwischen den Seiten eines Dreiecksnetzes.
Astron. Nachr., LXXXIX, 1877, 49-58.

LAPLACE (P.-S. DE). Application du calcul des probabilités aux opérations géodésiques.
Journ. d. Phys., LXXXV, 1817, 145-148 . . .; Ann. d. Chim., XII, 1819, 37-41.

LIAGRE (J.-B.-J.). Sur la compensation d'un réseau trigonométrique.
Int. Geod. Cong., Gen.-Ber., 1877, 224-226.

MAREK (J.). Ueber die Ausgleichung trigonometrischer Anschlussnetze.
Zeits. f. Vermes., III, 1874, 159-176.

NELL (A. M.). Schleiermachers Methode der Winkelausgleichung in einem Dreiecksnetze.
Zeits. f. Vermes., X, 1881, 1-11, 109-121; XII, 1883, 313-320.

PETERS (C. A. F.). Ueber die Zerlegung eines Dreiecksnetzes nach Gruppen und ihre Ausgleichung . . .
Int. Geod. Cong., Gen.-Ber., 1877, 210-216.

PROUDZYNSKI (B. VON). Ueber die Aufstellung Bedingungsgleichungen geodätischer Dreiecksketten.
Astron. Nachr., LXXI, 1868, 145-154; LXXV, 1869, 81-90.

PUISSANT (L.). . . . sur l'application du calcul des probabilités aux mesures géodésiques.
Acad. d. Sci. Paris, Mém., XI, 1832, 123-156.

SADEBECK (B. A. M.). Das hessische Dreiecksnetz.
Berlin, 1882.

FIGURE, ADJUSTMENT OF—Continued.

SCHIAPARELLI (G. V.). Sulle compensazioni delle reti trigonometriche di grande estensione.
Ist. Lombardo, Rend., II, 1865, 348–359; III, 1866, 27–41.

SCHOLS (CH. M.). Over de aansluiting van een driehoeksnet van lagere orde aan een driehoeksnet van hoogere orde.
K. Ak. van Wetens. Amsterdam, Versl., XVI, 1880, 297–349.

SCHOTT (C. A.). Method of adjustment of the secondary triangulation of Long Island Sound.
U. S. C. and G. Survey, Rep., 1868, 140–146.

——— Method of closing a circuit of triangulation under certain conditions.
U. S. C. and G. Survey, Rep., 1875, 279–292.

SCHREIBER (O.). Die Anordnung der Winkelbeobachtung im Göttinger Basisnetz.
Zeits. f. Vermes., XI, 1882, 129–161.

VELTMANN (W.). Bestimmung der Unbekannten einer Ausgleichungsaufgabe . . .
Zeits. f. Vermes., XVI, 1887, 345–356.

VORLÄNDER (J. J.). Ausgleichung der Fehler polygonometrischer Messungen.
Leipzig, 1858.

——— Bemerkungen über das numerische Eliminiren bei geodätischen Operationen.
Zeits. f. Math. (Schlömilch), III, 1858, 16–22.

——— Zur praktischen Geometrie.
Zeits. f. Math. (Schlömilch), III, 1858, 189–193.

——— Ueber die Fehlerausgleichung der Liniennetze.
Zeits. f. Vermes., III, 1874, 390–401; V, 1876, 155–174.

WRIGHT (T. W.). On the adjustment of observations.
Van Nostrand's Mag., XXVIII, 1883, 419–436, 473–505; New York, 1884.

ANON. Bericht der Special-Commission über Punkte 5A und 5B des Programs der im Jahre 1876 in Brüssel vereinigten permanenten Commission der europäischen Gradmessung.
4°, Berlin, 1877, pp. 33.
Regarding different methods of adjusting a chain of triangles.

Finger (Joseph). Ueber ein Analogon des Kater'schen Pendels und dessen Anwendung zu Gravitationsmessungen.
K. k. Ak. d. Wiss., Sitz.-Ber., LXXXIV, 1881, ii, 168–193.

Finska Vetens. Soc., Öfvers., *for* Öfversigt af Finska vetenskaps societeten forhandlingar.
4°, Helsingfors, 1838+. (Washington, Congress.)

Fiorini (Matteo). Sulle triangolazioni topografiche.
Accad. Sci. Bologna, Rend., 1861–'62, 107–111.

Firmenich. Directe trigonometrische Berechnung der Aufgabe der unzugänglichen Entfernungen.
Zeits. f. Vermes., VIII, 1879, 254–255.

Firmenger (Thomas). A copy of the experiments made at the Royal Observatory, with a view to establish a standard of weights and measures by determining the length of the seconds pendulum.
Phil. Mag. (Tilloch), XLV, 1815, 33–38.

——— Observations on the measurement of an arc of the meridian.
Phil. Mag. (Tilloch), LIV, 1819, 60–62.
Advances as to the new theory that "in an ellipse no two points have the same radius of curvature in the same quadrant; taking, therefore, any part of a meridional line upon the earth's surface, and conceiving this as an arc of an ellipse, the radius of curvature at each extremity of the arc will not have the same centre; and therefore the difference of the zenith distances of any star, taken at the two extremities, will not be a correct measure of the elliptic arc, or rather of an arc of a circle of curvature, which the former requires."

Fischer (A.). Die Gestalt der Erde und die Pendelmessungen.
Astron. Nachr., LXXXVIII, 1876, 81–98.
Letter from HANN (J.), 203–208; reply, 247–252.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VIII, 1876, 726–728, by B[RUNS].

———: **Hann (J.).** Ueber "die Gestalt der Erde und die Pendelmessungen" von —.
Astron. Nachr., LXXXVIII, 1876, 203–208, 305–308.

——— Bericht über die Arbeiten des geodätischen Instituts, 1878, 1879, 1880, 1881–'82, 1883.
Title in full under BAEYER (J. J.).

——— Der Einfluss der Lateralrefraktion auf das Messen von Horizontalwinkeln.
4°, Berlin, 1882, pp. 73. (Gore.)
Publication des königl. preuss. geodätischen Instituts.

——— Versuche, den Gang der Temperaturen des Platin-, Iridium- und des Messing-Stabes am Brunner'schen Basis-Apparat, sowie den Temperaturunterschied beider Stäbe selbst durch Thermo-Elemente zu Bestimmen.
Astron. Nachr., CIII, 1882, 33–46.

——— Lothabweichungen in der Umgebung von Berlin.
4°, Berlin, 1889, pp. vi, 155, 6 plates. (Gore.)

Fischer (Johann Carl). Anfangsgrunde der Feldmesskunst, zum Gebrauch der Vorlesungen, entworfen von —.
8°, Jena, 1795, pp. [iv], 408, 8 plates.
2d ed., Leipzig, 1831.

Fischer (Philipp). Lehrbuch der höheren Geodäsie. Erster Abschnitt, enthaltend: Die Theorie der Beobachtungsfehler und ihre Ausgleichung durch die Methode der kleinsten Quadrate.
8°, Darmstadt, 1845, pp. viii, 186.
Zweiter Abschnitt, enthaltend: Die Beobachtungsarbeiten und Instrumente.
Darmstadt, 1846, pp. vi, 266, 4 plates.
Dritter Abschnitt, enthaltend: Die Berechnungen.
Darmstadt, 1846, pp. vi, 303, 1 plate. (Gore.)

——— Untersuchungen über die Gestalt der Erde.
8°, Darmstadt, 1868, pp. viii, 318. *Diehl.* (Gore.)
Revd. in Jahrb. üb. d. Fortschr. d. Math., I, 1868, 390–391, by B[RUNS].

Fisher (George). On the figure of the earth, as deduced from the measurements of arcs of the meridian and observations on pendulums.
Quart. Journ. Sci., VII, 1819, 299–312.
In this he refuted the accepted theory that the measured length of arcs of the meridian are proportional to the radii of curvature at the middle point of the arcs; to which is added a table showing the amount of error in the amplitude of the celestial arc subtending each degree of latitude. This table was computed by estimating the efficacy of that part of the centrifugal force in every degree of latitude, by which a plumb-line will deviate towards the southward from a line drawn to the earth's center from a point on the surface, supposing the earth a perfect sphere, and the difference of the deflections at each extremity of the measured arc will be the error in the celestial angle subtending that arc.

Fisher (Osmond). On the inequalities of the earth's surface, viewed in connection with the secular cooling.
Phil. Soc. Camb., Trans., XII, 1879, 414–433.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 774–775, by GLR. [GLAISHER].

Fisher (Osmond)—Continued.

——— On the inequalities of the earth's surface as produced by lateral pressure, upon the hypothesis of a liquid substratum.
Phil. Soc. Camb., Trans., XII, 1879, 434–454.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 775, by GLR. [GLAISHER].

——— On the variation of gravity at certain stations of the Indian arc of the meridian in relation to their bearing upon the constitution of the earth's crust.
L., E., D. Phil. Mag., XXII, 1886, 29.
Revd. in Ann. d. Phys. (Poggendorff), 1887, 5.

Flammarion. How the earth was regarded in old times. (From the French of Flammarion.)
Pop. Sci. Month., X, 1876, 542–553.

Fliedner (Conrad). De pendulo imprimis de pendulo centrifugo.
4°, Hersfeldæ, 1841, pp. 20, 1 plate. (Berlin, Royal.)

Fligely. Bericht über die im Sommer 1863 in Böhmen ausgeführten geodätischen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1863, 15–16.

——— Bericht anschliessend an den Oesterreich betreffenden Absatz des General-Berichtes pro 1863.
Int. Geod. Cong., Gen.-Ber., 1864, 24–26.

——— Bericht über die von der Triangulirungs- und Calcul-Abtheilung des militär-geographischen Institutes im Sommer 1865 für die mitteleuropäische Gradmessung ausgeführten astronomisch - geodätischen Arbeiten. (Austria.)
Int. Geod. Cong., Gen.-Ber., 1865, 17–19.

——— Bericht über die für die mitteleuropäische Gradmessung im Jahre 1866 von Seite Oesterreichs ausgeführten astronomisch-geodätischen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1866, 53–55.

——— Bericht über die für die europäische Gradmessung im Jahre 1868 ausgeführten astronomischen und geodätischen Arbeiten. (Austria.)
Int. Geod. Cong., Gen.-Ber., 1868, 57–59.

——— Bericht über die im Sommer 1869 in der österreichisch-ungarischen Monarchie ausgeführten astronomisch-geodätischen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1869, 80–83.

——— Bericht über die in der österreichisch-ungarischen Monarchie im Sommer 1870 ausgeführten astronomisch geodätischen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1870, 27–29.

Flint (A. R.) *and* **Woodward (R. S.).** Results of some experiments made to determine the variations in length of certain bars at the temperature of melting ice.
Am. Journ. Sci., XXV, 1883, 448–459.

Fockens (Gerard Regner). Tubi culminatorii varii usus, tum in astronomia tum in geodesia, experantur et exemplis illustrantur.
Acad. Lugd.-Bat., Ann., 1836–'37, 1–110.

Foerster (W.). Sur la toise de Pérou. Lettre de M. Foerster à M. Wolf.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 122–124.
Remarks by M. Wolf. 124.

Foerster (W.)—Continued.

——— Schreiben an die permanente Commission der europäischen Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1880, 48–49.
Concerning the length of a standard toise.

———: **Baeyer (J. J.).** Antwort auf einen Brief von —.
Int. Geod. Cong., Gen.-Ber., 1880, 50–53.

———: **Peters (C. F. W.).** Bestimmung der Länge des einfachen Secundenpendels in Altona, Berlin und Königsberg. Mit einer Bemerkung von —.
Astron. Nachr., XCIX, 1881, 379–382.

——— *und* **Paschen (P.).** Grossherzoglich mecklenburgische Landesvermessung.
Schwerin, 1882.
Title in full under PASCHEN (P.).

Folie (F.). Sur le calcul de la densité moyenne de la terre, d'après les observations d'Airy.
Acad. de Belgique, Bull., XXXIII, 1872, 389–409.
Rapport de M. Laigre, 369–311: rapport de M. Gilbert, 371–372.

——— *et* **Liagre (J.-B.-J.).** Rapport à la commission permanente de l'Association géodésique internationale.
Acad. de Belgique, Bull., XLI, 1876, 397–407.

——— *et* **Houzeau (J.-C.).** Sur la triangulation du royaume.
Acad. de Belgique, Bull., I, 1881, 867–872.

——— Sur les travaux nécessaires pour compléter le réseau géodésique belge.
Acad. de Belgique, Bull., VI, 1883, 422–423.

Folque (Filippe). Memorias sobre os trabalhos geodesicos executados em Portugal. Publicada por ordem sua magestade.
4°, Lisboa, 1841, pp. 859, 4 plates. (Washington, Congress.)

——— Memoria sobre os trabalhos geodesicos executados em Portugal.
Acad. Sci. Lisboa, Mem., I, 1843, 1–140; II, 1843, 1–291; II, 1843, ii, 1–163; III, 1843, 1–59, 233–333; III, 1843, ii, 1–435.

——— Instrucções pelas se devem regular o director e officiaes encanegados dos trabalhos geodesicos e topographicos do reino.
8°, Lisboa, 1850, pp. 43, 14. Supplementos, Lisboa, 1851, pp. 27; Lisboa, 1853, pp. 11. (Vienna, Geographic Institute.)

——— Taboas para o calculo da reducção ao centro.
8°, Lisboa, 1823, pp. 35. (Vienna, Geographic Institute.)

——— Taboa para determinar a influencia do erro dos angulos sobre o calculo dos lados do triangulo.
8°, Lisboa, 1854, pp. 12. (Vienna, Geographic Institute.)

——— Taboas para o calculo das distancias á meridiana e á perpendicular.
Lisboa, 1855, pp. 95. (Vienna, Geographic Institute.)

——— Instrucções para a execução, fiscalisação, e remuneração dos trabalhos geodesicos e chorographicos do reino.
8°, Lisboa, 1858, pp. 79, 3 plates. (Vienna, Geographic Institute.)

Folque (Filippe)—Continued.

—— Diccionario do serviço dos trabalhos geodesicos do reino.
8°, Lisboa, 1861, pp. 19. (Vienna, Geographic Institute.)

—— Collecção de taboas para facilitar varias calculos astronomicos e geodesicos.
8°, Lisboa, 1865, pp. 151, 1 chart. (Washington, Congress.)
In the inner title "geodesicos" is omitted.

—— Rapport sur les travaux géodésiques du Portugal et sur l'état actuel de ces mêmes travaux pour être présenté à la commission permanente de la conférence internationale.
4°, Lisbonne, 1868, pp. 20, 1 map. (Gore.)

—— Relatorio dos trabalhos executados no Instituto geographico durante o anno economico 1866-'67.
8°, Lisboa, 1868, pp. 30. (Vienna, Geographic Institute.)

—— Instrucções sobre o serviço geodesico de primeira ordem.
8°, Lisboa, 1870, pp. 69. (Vienna, Geographic Institute.)

—— Direcção geral dos trabalhos geodesicos, topographicos, hydrographicos e geologicos do reino. Relatorio dos trabalhos executados n'esta direcção desde o 1°. julho de 1868 a 31 de dezembro de 1869.
8°, Lisboa, 1872, pp. 23. (Vienna, Geographic Institute.)
Durante o anno de 1870, Lisboa, 1872, pp. 21.
Durante o anno de 1871, Lisboa, 1872, pp. 20.
Durante o anno de 1872, Lisboa, 1873, pp. 19.
Durante o anno de 1873, Lisboa, 1874, pp. 17.

—— Instrucções e regulamento para execução e fiscalisação dos trabalhos geodesicos, chorographicos e hydrographicos do reino.
8°, Lisboa, 1874, pp. 152, 7 charts. (Brussels, Cartographic Institute.)

Fontana (Gregorio). Sopra alcune particolarità concernenti la gravità terrestre.
Soc. Italiana, Mem., VIII, 1799, 124-134.

Fontenelle. Sur la longueur du pendule dans la zone torride. (H.)
Acad. d. Sci. Paris, 1736; Hist., 115-117.

Fonvielle (Wilfrid de). Le mètre international définitif.
12°, Paris, 1875, pp. xvi, 140. (British Museum.)

Forbiger (Albert). Handbuch der alten Geographie, aus den Quellen bearbeitet.
8°, Leipzig, 1842, pp. xvi, 668; Leipzig, 1844, pp. x, 918; Leipzig, 1848, pp. vi, 1180. (Oxford, Bodleian.)
Vol. 1 contains scattered references to the length of degrees as determined by the ancient Greeks and Egyptians.

Fordyce (George). Account of a new pendulum.
Roy. Soc. London, Phil. Trans., LXXXIV, 1794, 2-20.

Forest (E. L. de). On adjustment formulas.
Analyst, IV, 1877, 79-86, 107-113.

—— On repeated adjustments, and on signs of residuals.
Analyst, V, 1878, 65-72.

Forest (E. L. de)—Continued.

—— On the limits of repeated adjustments.
Analyst, V, 1878, 119-140.

—— Law of facility of errors in two dimensions.
Analyst, VII, 1880, 169-176; VIII, 1881, 3-9, 41-48.

—— On the elementary theory of errors.
Analyst, VIII, 1881, 137-148.

Forrest (James): Hamilton-Smythe (A.). Comparison of British and metric measures. Edited by —.
London, 1885.
Title in full given under HAMILTON-SMYTHE (A.).

Forsch (E. von). Memoirs of the army topographic department of Russia. Vols. XXIX-XLI.
St. Petersburg, 1868-'86.

—— Bericht über die geodätischen Arbeiten in Russland.
Int. Geod. Cong., Gen.-Ber., 1871, 42-52.

—— Rapport sur les travaux géodésiques en Russie pendant l'année 1874.
Int. Geod. Cong., Gen.-Ber., 1874, 75-76.

—— Rapport sur les travaux géodésiques en Russie en 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 213-214.

—— Rapport sur les travaux géodésiques en Russie en 1876.
Int. Geod. Cong., Gen.-Ber., 1876, 121-122.

—— Bericht über die geodätischen Arbeiten in Russland für das Jahr 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 105-106.

—— Bericht über die geodätischen Arbeiten in Russland für das Jahr 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 35.

—— General-Bericht über die im letzten Triennium in Russland ausgeführten astronomisch-geodätischen Operationen.
Int. Geod. Cong., Gen.-Ber., 1881-'82, 125-126.

—— Note sur les expériences avec le pendule, exécutées en Russie dans les derniers temps.
Int. Geod. Cong., Gen.-Ber., 1883, 29-30.

Forti (Augusto Ottavio). Geometria pratica. La teorica degli errori, ed il metodo dei minimi quadrate con applicazioni alle scienze d' osservazione.
8°, Milano, 1880, pp. viii, 93, 3 tables. (British Museum.)

Foster (Henry) *and* Hall (Basil). Details of experiments made with an invariable pendulum.
Roy. Soc. London, Phil. Trans., CXIII, 1826, 211-288.

——: **Pouillet (C.-S.-M.).** Lettre du Capitaine B. Hall au —. Sur les observations du pendule invariable à Londres, aux îles Galapagos, etc.
Bull. Sci. Math. (Saigey), I, 1824, 151-152.

—— Account of experiments made with an invariable pendulum at the Royal Observatory at Greenwich and at Port Bowen on the eastern side of Prince Regent's Inlet.
Roy. Soc. London, Phil. Trans., IV, 1826, 1-70.

—— [Notice of his pendulum observations in different parts of the world.]
Roy. Astron. Soc., Month. Not., III, 1831-'33, 66-68.

Foster (Henry)—Continued.

——: **Baily (F.)**. Experiments made by the late Capt. F. with the pendulum in his scientific voyage, 1828–'31.
Roy. Astron. Soc., Mem., VII, 1834, 1-378; Month. Not., III, 1833–'36, 1-3.

—— *and* **Hall (B.)**. Experiments made with an invariable pendulum near the equator and on the coast of Mexico and Brazil.
Edinb. Phil. Journ., X, 1824, 91-95.

Foucault (Léon): **Grunert (J. A.)**. Theorie der Pendelversuche von — mit Rücksicht auf die ellipsoidische Gestalt der Erde.
Arch. d. Math. (Grunert), XXVIII, 1857, 223-248.

Fouchy (G. de). Sur la comparaison des différentes toises qui ont servi à la mesure des degrés terrestres. (H.)
Acad. d. Sci. Paris (Hist.), 1772, 8-13.

FRANCE.

BEAUMONT (É. DE). Rapport sur les travaux géodésiques relatifs à la nouvelle détermination de la méridienne de France.
Acad. d. Sci. Paris, Comp. Rend., LXXVIII, 1874, 723-736.

BESSEL (F. W.). Ueber einen Fehler in der Rechnung der französischen Gradmessung . . .
Astron. Nachr., XIX, 1841, 97-116.

BONNE (R.). Opérations géodésiques [in France].
Dépôt de la Guerre, Mém., I, 1829, 25-78.

DAUSSY. Précis des opérations géodésiques . . . des côtes occidentales de France.
Paris, 1829.

DELAUNAY (C.-E.). Rapport sur l'état actuel de la géodésie . . . pour compléter la partie astronomique du réseau français.
Conn. d. Temps, 1864, 1-20.

FAYE (H.-A.-E.-A.). Rapport sur l'état actuel . . . du réseau géodésique français.
Bur. d. Long., Ann., 1864, 385-451.

KLOSTERMANN. Recherches sur le degré du méridien entre Paris et Amiens et sur la jonction de Paris et Greenwich.
St.-Pétersbourg, 1789.

LAPLACE (P.-S. DE). Application du calcul des probabilités aux opérations géodésiques de la méridienne de France.
Ann. de Chim., XII, 1819, 37-41.

LAUSSEDAT (A.). Note relative au prolongement de la méridienne de France et d'Espagne en Algérie.
Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1492-1500.

PERRIER (F.). De la méridienne de France.
A. Française, Comp. Rend., I, 1872, 101-130; Soc. Géogr., Bull., III, 1872, 613-653; Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1682-1686; LXXX, 1876, 1277-1280.

—— Prolongation de la méridienne de France jusqu'au Sahara.
Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1237-1244, 1696-1699; Paris, 1885.

—— Rapport sur les travaux géodésiques . . . en France.
Int. Geod. Cong., Gen. Ber., 1874, 25; 1875, 169-175; 1876, 98-100; 1877, 283-286; 1878, 82-85; 1879, 87; 1880, 9-11; 1881–'82, 75-77; 1883, 230-233; 1884–'86, 128-129; 1887, V, 1-6.

PUISSANT (L.). Note sur les opérations géodésiques de France.
Soc. Géog., Bull., IV, 1825, I, 311-315; Soc. Philom., Bull., 1825, 161-163, 177-178.

—— Nouvelle description géométrique de la France.
Dépôt de la Guerre, VI, 1832, 1-616; II, 1840, 1-678; IX, 1853, 1-540; Acad. d. Sci. Paris, Mém., XIV, 1838, 1-80.

—— Nouvelles remarques sur la comparaison des mesures géodésiques et astronomiques de France.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 50-53.

ANON. Instruction générale sur le service des officiers du corps royal des ingénieurs-géographes chargés des opérations géodésiques et topographiques, ainsi que de la statistique de la nouvelle carte de France.*
8°, Paris.

Francoeur (Louis-Benjamin). Solution d'un problème de géodésie; par M. Ivory.
Bull. Sci. Math. (Saigey), II, 1824, 279-280; Phil. Mag. (Tilloch), 1824, 35.

—— Résultats des expériences du capitaine Edward Sabine pour déterminer le longueur du pendule à secondes à diverses latitudes, et l'aplatissement du globe terrestre.
Soc. Philom., Bull., 1826, 65-66.

—— Géodésie, ou traité de la figure de la terre et de ses parties, comprenant la topographie, l'arpentage, le nivellement, la géomorphie terrestre et astronomique, la construction des cartes, la navigation. Leçons données à la Faculté des sciences de Paris.
8°, 1re éd., Paris, 1835.
2e éd., Paris, 1840, pp. xiv, 472, 9 plates. (Gore.)
3e éd., Paris, 1853, 10 plates.
4e éd., Paris, 1865, augmentée par Hossard.
5e éd., Paris, 1879, augmentée par Hossard et Perrier.

—— Extracts from the treatise on geodesy. Translated by W. H. Emory, Lieut. U. S. Topographial Engineers.
Journ. Frank. Inst., XXXI, 1841, 309-319, 369-374, XXXII, 1841, 15-23, 145-154, 217-224, 289-298.

Franke (J. H.). Die Dreiecksnetze vierter Ordnung als Grundlagen geodätischer Detail-Aufnahmen zu technischen oder staatswirthschaftlichen Zwecken. Ein Handbuch für Geometer, Ingenieure und Ingenieur-Geographen. Mit einem Vorwort von Dr. Carl Maximilian Bauernfeind.
8°, München, 1871, pp. xii, 261. (Gore.)

—— Ueber die Fehler bei Längenmessungen mit Kette und Latten.
Zeits. f. Vermes., I, 1872, 120-129.

—— Die Einschaltung trigonometrischer Punkte in ein gegebenes Dreiecksnetz.
Zeits. f. Vermes., III, 1874, 207-239.
Remarks by JORDAN (W.), 297.

—— Die trigonometrische Punktbestimmung im Netzanschlusse mit besonderer Rücksicht auf eine rationelle Fehler-Ausgleichung.
8°, München, 1875, pp. viii, 69. (Munich, Royal.)

—— Winkel-Centrirung.
Zeits. f. Vermes., V, 1876, 41-42.

—— Coordinaten-Abweichungen.
Zeits. f. Vermes., V, 1876, 97-107.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VIII, 1876, 730-731, by B[RUNS].

—— Die Grundlehren der trigonometrischen Vermessung im rechtwinkligen Koordinaten-System. (Munich, Royal.)
8°, Leipzig, 1879, pp. xv, 406, 4 plates.
Revd. in Zeits. f. Vermes., IX, 1880, 256-259, by HELMERT.

—— Die Koordinaten-Ausgleichung nach Näherungsmethoden in der Klein-Triangulierung und Polygonalmessung. Mit einer Aufstellung und Vergleichung von Fehlergrenzen für die Hauptoperationen der trigonometrischen Katastervermessung.
8°, München, 1884, pp. viii, 156, 1 chart, *Grubert*. (Munich, Royal.)
Revd. in Jahrb. üb. d. Fortschr. d. Math., XVI, 1884, 1085-1086, by P[ETZOLD].

Frederici (Karl Maria). Die Gestalt und Grösse der Erde.

Nature, XVIII, 1878, 556–558, 577–580, 602–604.

Trans. by CLARKE (A. R.), with notes.

Freeden (W. von). Die Praxis der Methode der kleinsten Quadrate für die Bedürfnisse der Anfänger bearbeitet von —.

8°, Braunschweig, 1863, pp. viii, 114. (Berlin, Geodetic Institute.)

Fréret (Nicolas). Observations sur le rapport des mesures grecques et des mesures romaines.

Acad. d. Inscr., Mém., XXIV, 1754, 548–568.

——— Sur les mesures longues des anciennes.

Acad. d. Inscr., Mém., XXIV, 1754, 432–547.

De la mesure de la terre, et de la véritable grandeur des distances géographiques, 507–522.

Frescoln (Samuel W.). Deflection of the plumb-line at the Sayre Observatory, Lehigh University, South Bethlehem, Pa.

Eng. Soc. of Lehigh University, Journ., III, 1888, 82–86.

Freycinet (Claude-Louis-Desaulses de). Zwei Berichte von der in den Jahren 1817–'20 zu wissenschaftliche Zwecken angestellten Seereise um die Welt, unter dem kön. Schiffskapitän Louis von Freycinet.

Ann. d. Phys. (Gilbert), LXX, 1822, 54–103.

Pendulum observations at various places.

——— Note sur les observations du pendule faites pendant le voyage des corvettes l'Uranie et la Physicienne.

Soc. Philom., Bull., 1825, 70.

——— Voyage autour du monde, entrepris par ordre du roi, sous le ministère et conformément aux instructions de S. Exc. M. le vicomte du Bouchage, secrétaire d'état au département de la marine. Exécuté sur les corvettes de S. M. l'Uranie et la Physicienne pendant les années 1817, 1818, 1819 et 1820.

4°, Paris, 1826, pp. [ii], 290. (British Museum.)

Observations du pendule.

———: **Ivory** (J.). Abstract of —'s pendulum experiments.

Phil. Mag. (Taylor), LXVIII, 1826, 350–353.

———: **Saigey.** Comparaison des observations du pendule à diverses latitudes, faites par —.

Bull. Sci. Math. (Saigey), VII, 1827, 31–43, 171–184; Hertha, XIII, 1829, 287–290.

Friesach (Karl). Ueber die Schwere an der Oberfläche einer gleichförmig dichten durch Umdrehung einer Ellipse um ihre kleinere Axe erzeugten Rotationssphäroides.

Arch. d. Math. (Grunert), XLIV, 1865, 355–358.

Frisani. Sulla più vantaggiosa combinazione delle osservazioni.

Ist. Lomb., Mém., XI, 1870, 1–21.

Frisius (Paulus) [Paolo Frisi]. Disquisitio mathematica in caussam physicam figuræ et magnitudinis telluris nostræ.

4°, Mediolani, 1751, pp. [xii], 86. (Gore.)

———: **Short (James).** An account of a book entitled, Disquisitio mathematica in caussam physicam figuræ et magnitudinis telluris nostræ, by —.

Roy. Soc. London, Phil. Trans., 1753, 5–17.

Frodsham (W. J.). Experiments on the variation of the pendulum.

Roy. Soc. London, Proc., IV, 1838, 78; Brit. A. A. S., Rep., 1839, ii, 24; Ann. Electr. (Sturgeon), IV, 1839–'40, 365–371.

Frome (General). An outline of the method of conducting a trigonometrical survey for the formation of geographical plans, and instructions for filling in the interior detail, both by measurement and sketching; military reconnaissance, levelling, etc., with the explanation and solution of some of the most useful problems in geodesy and practical astronomy; to which are added a few formulæ and tables of general utility for facilitating their calculation.

8°, London, 1840, pp. ix, 200. (Washington, Geological Survey.)

Frommius [Fromm] (Georg). Arithmeticæ danica sic brevis ac perspicua instituto arithmetica vulgaris, astronomicæ et geodeticæ.*

Havn., 1649, 1660.

POGGENDORFF, I, 811.

Fuhrmann (Arwed). Ueber die geschichtliche Entwickelung der Geodäsie und ihre Beziehung zur neueren Geometrie.

Civ.-Ing., XXIII, 1877, 61–74.

Aus einer Festrede, gehalten in der Aula des Polytechnikums zu Dresden am 23. April 1875.

Fuss (Nicolaus von). Determinatio motuum penduli compositi bifili ex primis mechanicæ principiis petita.

Acad. de St.-Pétersbourg, Acta, I, 1787, 184–212.

———: **Struve (F. G. W.).** Résultats des opérations géodésiques de — . . . en 1836 et 1837.

Acad. de St.-Pétersbourg, Cl. Phys.-Math., Bull., VIII, 1850, 337–368; Conn. d. Temps, 1853, 49–78; Acad. d. Sci. Paris, Comp. Rend., XXX, 1850, 541–549.

G. Die rheinbayerische Grundlinie Speyer-Oggersheim und die muthwillige Zerstörung der Endpunktes Oggersheim.

Zeits. f. Vermes., XVI, 1887, 234–236.

G. (J.). Remarks on a paper of Mr. Boswell on invariable pendulums.

Journ. Nat. Phil. (Nicholson), XV, 1806, 84–86.

Gaede. Beiträge zur Kenntniss von Gauss' praktisch-geodätischer Arbeiten.

Zeits. f. Vermes., XIV, 1885, 113–137, 145–157, 161–173, 177–207, 225–245.

Galbraith (William). Remarks on the experiments of the pendulum made by Kater, M. Biot, etc.

Phil. Mag. (Tilloch), LXIV, 1824, 161–170; LXV, 1825, 12–23.

——— On the figure of the earth.

Phil. Mag. (Tilloch), LXVII, 1826, 161–167.

A criticism on Sabine's pendulum experiments.

——— On the method of the least squares as employed in determining the figure of the earth, from experiments with the pendulum as well as by the measurements of arcs.

Phil. Mag. (Taylor), II, 1827, 48–54.

Reason why observations made or arcs measured at a distance apart are more worthy of confidence than those close together, so that they should not be weighted equally.

Galbraith (William)—Continued.

—— On the ellipticity of the earth as deduced from experiments with the pendulum, and on the formulæ employed for obtaining it.

Phil. Mag. (Taylor), III, 1828, 321-331.

States that the earth not being a sphere, it is incorrect to assume that the length of the pendulum increases towards the pole as the square of the sine of the latitude observed; it should be as the sine of the reduced latitude.

—— Formulæ for trigonometrical surveying.

Edinb. Phil. Journ., XVI, 1834, 110-114.

—— On geodetical surveying and trigonometrical levelling.

Roy. Scott. Soc. of Arts, Trans., I, 1841, 249-263; Edinb. Phil. Journ., XXVI, 1838, 158-172.

Describes methods of using his tables for facilitating computations of latitudes, longitudes, and azimuths based on an oblate spheroid with ellipticity of 1: 300, $R_e = 20,922,642$ ft., and $R_p = 20,852,900$ ft.

—— Recomputation of Roy's triangulation for connecting the observations of Greenwich and Paris.

Roy. Astron. Soc., Month. Not., V, 1839-'43, 292-293.

—— On trigonometrical surveying and levelling, and on the effects of a supposed local attraction at the Calton Hill.

Edinb. Phil. Journ., XXX, 1841, 326-346.

—— On the English arc of the meridian.

Edinb. Phil. Journ., XXXIV, 1843, 263-275.

—— Land surveying.

Edinburgh, 1849.

Title in full under AINSLIE (JOHN).

Galen (Petrus van). De pendulo ejusque adplicatione ad telluris figuram determinandam. Dissertationes mathematicæ Belgicæ.

4°, Amsterdam, 1830, pp. [ii], 66. (Oxford, Bodleian.)

Galle (Johann Gottfried). Bericht über die Thätigkeit der geographischen Section im Jahre 1879.

8°, [Breslau, 1880], pp. 23. (Gore.)

Neumessung der schlesischen Grundlinie bei Strehlen, pp. 5-9.

Galloway (Thomas). On the application of the method of least squares to the determination of the most probable errors of observation in a portion of the Ordnance Survey of England.

Roy. Astron. Soc., Month. Not., V, 1839-'43, 262-264; Mem., XV, 1846, 23-69.

—— On Fernell's measure of a degree.

L., E., D. Phil. Mag., XXI, 1842, 25-28.

——: **De Morgan (A.).** On Fernell's measure of a degree, in reply to —.

L., E., D. Phil. Mag., XX, 1842, 230-233.

—— The figure of the earth.

Encyc. Brit., 8th ed., IX, 547-575.

The article was brought up to 1855 by "C. P. S."

—— Remarks on Fernell's measure of a degree.

L., E., D. Phil. Mag., XX, 1855, 90-98.

Ganahl. Bericht über die geodätischen Arbeiten in Oesterreich-Ungarn für das Jahr 1870.

Int. Geod. Cong., Gen.-Ber., 1871, 33-38.

Ganahl—Continued.

—— Die astronomisch-geodätischen Arbeiten des k. k. militär-geographischen Institutes in Wien.

I, 4°, Wien, 1871. Enthaltend: Die Grundlinie bei Josefstadt in Böhmen und das Dreiecksnetz zur Verbindung der österreichischen mit den preussischen Dreiecken, pp. viii, 194, 6 plates.

II, Wien, 1873. Enthaltend: Die Grundlinie von Sinj und das Dreiecksnetz in Dalmatien, dann die Verbindung desselben mit den italienischen Dreiecken in Apulien quer über das Adriatische Meer, pp. viii, 175, 3 plates.

III, Wien, 1875. Enthaltend: Die Grundlinie von Skutari, die nordöstlich derselben bis Ragusa abzweigende Dreieckskette, dann jene zwischen Skutari und Corfu mit dem Anschlusse an die italienischen Dreiecke auf Terra di Otranto quer über das Meer, pp. ix, 259, 2 charts.

IV, Wien, 1876. Enthaltend: Die astronomischen Bestimmungen auf den trigonometrischen Punkten 1. Ordnung, pp. 171, 4 plates. (Gore.)

—— Bericht über die im Jahre 1872 vom k. k. militär-geographischen Institute in Wien für Zwecke der europäischen Gradmessung ausgeführten Arbeiten.

Int. Geod. Cong., Gen.-Ber., 1872, 16-17.

—— Rapport sur les travaux géodésiques de l'Institut militaire-géographique à Vienne.

Int. Geod. Cong., Gen.-Ber., 1874, 67-74.

—— Bericht über die geodätischen Arbeiten des k. k. militär-geographischen Institutes in Wien für das Jahr 1876.

Int. Geod. Cong., Gen.-Ber., 1876, 106-113.

—— Ueber die Ausgleichung eines Dreiecksnetzes.

Int. Geod. Cong., Gen.-Ber., 1877, 208-209.

—— *und* **Dobner.** Bericht über die im Jahre 1873, für Zwecke der europäischen Gradmessung ausgeführten Arbeiten. (Austria.)

Int. Geod. Cong., Gen.-Ber., 1873, 7-10.

——, **Oppolzer (Theodor R. von)** *und* **Tinter (W.).** Bericht über die von der Triangulirungs-Abtheilung des k. k. militär-geographischen Institutes in Wien im Jahre 1875, für Zwecke der europäischen Gradmessung ausgeführten Arbeiten.

Int. Geod. Cong., Gen.-Ber., 1875, 181-189.

—— *und* **Oppolzer.** Bericht über die geodätischen Arbeiten des k. k. militär-geographischen Institutes in Wien für das Jahr 1877.

Int. Geod. Cong., Gen.-Ber., 1877, 294-298.

Gannett (Henry). The geodetic work of the Hayden and Wheeler surveys.

Science, III, 1884, 447-448.

In reference to the triangulation for topographic purposes.

Gardiner (James T.). Reports of the New York State Survey.

10 vols., 8°, Albany, 1876-'85.

Gardner (Martin). On practical geodesy.

8°, Melbourne, 1876, pp. 66, 1 plate.

Read before the Royal Society of Victoria, 11th May, 1876.

Garnault (**E.**) *et* **Pourian** (**A.**). Instrumens de précision de physique et de navigation et les appareils météorologiques enregistreurs de l'Exposition universelle de 1878.
8°, Paris, 1878, pp. xii, [iv], 167, 16 plates. (British Museum.)
Métrologie, 15–44.

Gaucherel (**M.-E.**). Note sur la forme préférable des triangles géodésiques.
Ann. d. Math. (Gergonne), xiv, 1855, 321–343.
Concludes that the quadrilateral is the best form.

Gaudin. Méthode pratique de tracer sur terre un parallèle par un dégré de latitude donné; et du rapport du même parallèle dans le sphéroïde oblong et dans le sphéroïde applati.
Acad. d. Sci. Paris, Mém., 1733, 223–232.

Gauss (**Carl Friedrich**). Ueber Attraction der Sphäroide. Auszug aus einer Abhandlung: "Theoria attractionis corporum sphæroidicorum, ellipticorum, homogeneorum, methodo tractata."
Mon. Corr. (Zach), xxvii, 1813, 421–431.

——— Bestimmung der Genauigkeit der Beobachtungen.
Zeits. f. Astron. (Lindenau), i, 1816, 185–197.
Also Werke, iv (Göttingen 1873, 4°), 109–117.
Merriman, p. 174.

——— Ueber einige Berichtungen am Borda'sche Wiederholungskreise.
Zeits. f. Astron. (Lindenau), v, 1818, 276–277.

——— [Triangulation von Hannover.]
Astron. Nachr., i, 1823, 105–106, 463–464.

——— Anwendung der Wahrscheinlichkeitsrechnung auf eine Aufgabe der praktischen Geometrie.
Astron. Nachr., i, 1823, 81–86.
Regarding the Pothenot problem.

——— Theoria combinationis observationum erroribus minimis obnoxiæ.
K. Ges. d. Wiss. Göttingen, Com., v, 1819–'22, 33–90; Supplementum, vi, 1826, 57–98.

——— Beobachtete und berechnete Triangulirung im Hannöverischen, Braunschweigischen und Lüneburgischen.
Astron. Jahrb. (Bode), 1826, 89–99.

——— Ueber die vortheilhafteste Anwendung der Methode der kleinsten Quadrate.
Zeits. f. Astron. (Lindenau), v, 1827, 230.

——— Bestimmung des Breitenunterschiedes zwischen den Sternwarten von Göttingen und Altona durch Beobachtungen am Ramsden'schen Zenithsextor.
8°, Göttingen, 1828, pp. 84. (Gore.)
The results are applied towards determining the figure of the earth on 72–74 and 82–84.

——— Untersuchung über Gegenstände der höheren Geodäsie.
K. Ges. d. Wiss. Göttingen, math. Cl., Abhandl., ii, 1842–'44, 3–45.
Separately, 4°, Göttingen, 1844, pp. 45. (Gore).

———: **Sawitsch** (**Alexis**). Auszug aus —'s Untersuchungen über die Berechnung trigonometrischer Messungen.
Acad. de St.-Pétersbourg, Cl. Phys.-Math., Bull., vi, 1848, 257–266.

Gauss (**Carl Friedrich**)—Continued.

——— Untersuchungen über Gegenstände der höheren Geodäsie. Zweite Abtheilung.
K. Ges. Wiss. Göttingen, Abhandl., iii, 1847, 3–43. Göttingen, Nachrichten, 1846, 210–917.
Published separately, 4°, Göttingen, 1847, pp. 43.

——— Questions de trigonométrie.
Nouv. Ann. d. Math., x, 1851, 363–364.
An extract from "Untersuchungen über Gegenstände der höheren Geodesie."

———: **Bertrand** (**J.**). Combinaison des observations par —.
Paris, 1855.
Title in full under Bertrand (J.).

——— Werke, herausgegeben von der königlichen Gesellschaft der Wissenschaften zu Göttingen.
4°. (Berlin, Geodetic Institute.)
Vol. iv, Göttingen, 1873, contains: Theoria combinationis observationum erroribus minimis obnoxiæ, 1–53. From: K. Ges. d. Wiss. Göttingen, v, 1823, 33–90.
Supplementum, 55–93. From: K. Ges. d. Wiss. Göttingen, vi, 1823'–27, 94–108.
Bestimmung der Genauigkeit der Beobachtungen, 109–117, 119–118. From: Zeits. f. Astron. (Lindenau), i, 1816, 185–197.
Untersuchungen über Gegenstände der höheren Geodäsie, 259–340. From: K. Ges. d. Wiss. Göttingen, ii, 1842–'44, 3–45; iii, 1842–'44, 3–43.
Bericht über die Resultate der trigonometrischen Messungen, 481.
Entwurf zur Gradmessung, 482–485.
Ueber die Fortsetzung der dänischen Gradmessung durch Hannover, 485–489.

——— Briefwechsel zwischen — und Bessel.
Leipzig, 1880.
Title in full under Bessel (F. W.).

———: **Gaede.** Beiträge zur Kenntniss von —'s praktisch-geodätischen Arbeiten.
Zeits. f. Vermes., xiv, 1885, 113–137, 145–157, 161–173, 177–207, 225–245.

——— Abhandlungen zur Methode der kleinsten Quadrate. In deutscher Sprache herausgegeben von Dr. A. Börsch und P. Simon, Assistenten am königl. preussischen geodätischen Institut.*
8°, Berlin, 1887, pp. 208. *Stankiewicz.*
Revd. in Zeits. f. Vermes., xvi, 1887, 655–656, by J.; Literarisches Centralblatt, 1877, 708; Arch. f. Math. (Grunert), xix, 1887, 31; Civil-Ingenieur, 1887, 183; Technische Blätter, 1887, 76; Zeits. d. Arch.- u. Ingenieur-Ver. zu Hannover, 1887, 733.

Gautier (**Adolphe**). The St. Gothard tunnel.
Nature, xxi, 1880, 581–586.
The determination of the axis of the tunnel by triangulation.

——— Sur les mesures récentes d'arcs du méridien, effectuées dans la partie nord-est de l'Europe.
Bibl. Univ. Genève, Arch., xxiii, 1853, 275–278.

Geer (**P. van**). De geodetische lijnen of de ellipsöide.*
8°, Leiden, 1862. (Excerpt.)

——— Over het gebruik van determinanten bij de methode der kleinste kwadraten.
Arch. voor Wiskunde, Amsterdam, i, 1875, 179–188.
Showing how determinants can be used to advantage in the solution of normal equation.
Revd. in Jahrb. üb. d. Fortschr. d. Math., vii, 1875, 114, by G[eer van].

Geer (P. van)—Continued.

—— Sur l'emploi des déterminants dans la méthode des moindres carrés.
Arch. Néerl., XVIII, 1883, 127–137.
A translation of the foregoing.

—— Geschichte der geographischen Vermessungen und der Landkarten Nordalbingiens vom Ende des 15. Jahrhunderts bis zum Jahre 1859, mit einer kritischen Uebersicht aller bezüglichen geographischen, geognostischen, ethnographischen und historischen Karten und Pläne, nebst Beiträge zur physischen Geographie und Topographie.
8°, Berlin, 1859, pp. xiii, 227. (Munich, Royal.)

Geisenheimer (L.). Ueber Wahrscheinlichkeitsrechnung.*
Berlin, 1880.

Geisweit (G.). Dissertatio philosophica de figura telluris sphærica.*
4°, Trajecti ad Rhenum, 1729.

Gelcich (Eugen). Ueber den Vorschlag des Marino Ghetaldi, die Grösse der Erde zu bestimmen.
Zeits. f. Math. (Schlömilch), XXVII, 1883, ii, 130–133.

Gelpke (O.). Bericht über die Bestimmung der St. Gotthard-Tunnel-Axe.
Civ.-Ing., XVI, 1870, 143–168.

—— Beschreibung eines neuen Basismessapparates, entworfen von Wild in Zürich und angewandt zur Längenbestimmung des grossen St. Gotthardtunnels.
Civ.-Ing., XVIII, 1872, 465–479.

—— Die letzten Richtungsverification und der Durchschlag am grossen St. Gotthardtunnel.
Zeits. f. Vermes., IX, 1880, 101, 116, 137–163.

Gendre (A.-M.-le). *See* **Le Gendre** [*or* **Legendre**] (**A.-M.**).

Genocchi (A.). Rassegna di scritti intorno alle deviazioni dei pendoli e alla sperienza del Foucault.*
Bibl. e di Storia d. Sci. Mat. e Fis., Bull., CXV, 1883.

Gentilli (Amadeo). Ein Fortschritt der Geodäsie mit Hinblick auf dessen Wichtigkeit für Eisenbahn-Studien.
8°, Wien, 1865, pp. 28, 4 plates. (Munich, Royal.)

GEODESY.

ADAN (E.-H.-J.). Cours de géodésie.
Bruxelles, 1864.

AINSLIE (J.). . . . geodetical surveying.
Edinburgh, 1819.

AIRY (G. B.). On a problem of geodesy.
L., E., D. Phil. Mag., XXXVI, 1850, 96–99.

ALSTED (J. H.). Elementale mathematicum . . . geodæsia.
Francofurti, 1611.

AMANTE (F.). Elementi di geodesia.
Napoli, 1847.

ANDERSSON (J. O.). Geodetisk mätningskunskap.
Stockholm, 1876.

ANDRAE (C. C. G.). Problèmes de haute géodésie.
Copenhague, 1881–'83.

ANGER (C. T.). Ueber eine Aufgabe der Geodäsie.
Astron. Nachr., IX, 1831, 359–364.

ASSELIN (F.). Problèmes de géométrie . . . et quelques notions de géodésie.
Amiens, 1865.

GEODESY—Continued.

BACKELJAU (F.). Éléments . . . de géodésie.
Gand, 1884.

BARFUSS (F. W.). Handbuch der höheren und niederen Messkunde.
Weimar, 1847.

BAUERNFEIND (C. M.). Elemente von Vermessungskunde.
Stuttgart, 1869.

BÉGAT (P.). Traité de géodésie à l'usage des marins.
Paris, 1839.

BENOIT (P.-M.-N.). Cours complet de topographie et de géodésie.
Paris, 1822–'25.

BESSEL (F. W.). Abhandlungen.
Geodäsie, III, Leipzig, 1876, 1–140.

BOHN (C.). Die Landmessung.
Berlin, 1886.

BOLOTOF (A. P.). Complete course in surveying and geodesy. (Russian.)
St. Petersburg, 1837, 1845, 1849.

BORDONI (A.). Trattato di geodesia elementare.
Milano, 1825.

BREMIKER (C.). Studien über höhere Geodäsie.
Berlin, 1869.

BÜRJA (A.) Erleichteter Unterricht in der höheren Messkunst.
Berlin, 1788.

BURNS (A.). Geodæsia improved.
Chester, 1771.

BUTTMANN (W.). Die niedere Geodäsie.
Berlin, 1875.

CASA (V. DE LA). Opusculo analitico di geodesia sublime.
Vienna, 1824.

CELSIUS (N.). Geodesia brevibus thesibus problematibus explicata.
Upsaliæ, 1696.

CHASLES (S.). Cours d'astronomie et de géodésie.
Paris, 1847.

CLARKE (A. R.). Geodesy.
Encycl. Brit., X, 1879, 163–172.

—— Geodesy.
Oxford, 1880.

COLLIGNON (E.). Problème de géodésie.
A. Franç. A. S., 1879, 129–137.

CONRATEN (J.). Geodaisia.
Strassburg, 1580.

COVARRUBIAS (F. D.). Tratado de topografia y de geodesia.
México, 1869.

CROIZET (V.). Géodésie générale.
Paris, 1840.

D. On the general principles of geodesy.
Gleanings in Science, II, 1830, 1–9.

DADDI (G. B.). Corso di geodesia.
Torino, 1876.

DEBAUVE (A.). Manuel de l'ingénieur . . . geodésie . . .
Paris, 1872.

DECKER (A.). Lehrbuch der höheren Geodäsie.
Mannheim, 1836.

DELAUNAY (C.-E.). Sur la géodésie française.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 149–154.

DESBALLE. Traité de géodésie pratique.
Paris, 1827.

DOOLITTLE (C. L.). A treatise on practical astronomy as applied to geodesy.
New York, 1885.

FAYE (H.-A.-E.-A.). Cours d'astronomie . . . géodésie.
Paris, 1881.

—— Sur les rapports de la géodésie avec la géologie.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 99–103, 295–299, 841–844.

GEODESY—Continued.

FISCHER (P.). Lehrbuch der höheren Geodäsie.
Darmstadt, 1845, 1846.

FRANCOEUR (L.-B.). Solution d'un problème de géodésie.
Bull. Sci. Math. (Saigey), II, 1824, 279–280.

——— Géodésie.
Paris, 1835–'79.

FROME. An outline of the method of conducting a trigonometrical survey.
London, 1840.

FUHRMANN (A.). Ueber die geschichtliche Entwickelung der Geodäsie.
Civ.-Ing., XXIII, 1877, 61–74.

GARDNER (M.). On practical geodesy.
Melbourne, 1876.

GAUSS (C. F.). Untersuchungen über Gegenstände der höheren Geodäsie.
K. Ges. d. Wiss. Göttingen, math.-phys. Cl., Abhandl., II, 1842–'44, 3–45; III, 1847, 3–43.

GENTILLI (A.). Ein Fortschritt der Geodäsie.
Wien, 1865.

GILETTA (L.). Lezioni di geodesia.
Torino, 1880.

——— Lezioni complementari di geodesia.
Torino, 1885.

GOCLENIUS (R.). Isagoge optica . . . hoc est geodæsia.
Francofurti, 1593.

GORE (J. H.). Elements of geodesy.
New York, 1886, 1888.

GRUNERT (J. A.). Elemente der . . . Trigonometrie mit Anwendung auf Geodäsie.
Leipzig, 1837.

——— Ueber eine geodätische Aufgabe.
Arch. d. Math. (Grunert), I, 1841, 238–248, 413–430; III, 1843, 35–40; IV, 1844, 385–408; V, 1844, 212–215; VII, 1846, 238–259; VIII, 1846, 433–450; XXI, 1853, 330–342; XXV, 1855, 197–210, 455–471.

——— Geodäsie.
Leipzig, 1842.

GRÜSON (J. P.). Geodäsie.
Berlin, 1811.

HANDRIKOFF. Solution d'un problème fondamental de géodésie.
Soc. Naturalistes Moscou, Bull., XXXVIII, 1865, i, 246–266

HANSEN (P. A.). Geodätische Untersuchungen.
K. sächs. Ges. d. Wiss., math.-phys. Cl., VIII, 1865, 1–224; IX, 1871, 1–355; Ber., XVIII, 1866, 132–151; Abhandl., XIV, 1869, 1–185, 289–356.

HARTNER (J.). Handbuch der niederen Geodäsie.
Wien, 1852, 1885.

HELFENZRIEDER (J. E.). Abhandlung von der Geodäsie.
Ingolstadt, 1776.

HELMERT (F. R.). Studien über rationelle Vermessungen im Gebiete der höheren Geodäsie.
Zeits. f. Math. (Schlömilch), XIII, 1868, 73–120, 163–186.

——— Die mathematischen und physikalischen Theorieen der höheren Geodäsie.
Leipzig, 1880, 1884.

HENNESSY. Une question de géodésie.
A. Franç. A. S., XI, 1883, 149.

HENNON (V.). Géodésie pratique des forêts.
Paris, 1860.

HEUSSI (J.). Lehrbuch der Geodäsie.
Leipzig, 1861.

HIERL (J. E.). Lehrbuch der höheren Vermessungskunde.
Augsburg, 1842.

HILGARD (J. E.). Progress of geodesy.
A. A. A. S., 1876, 1–16.

——— Geodesy.
Johnson's Cycl., II, 1878, 473–477.

GEODESY—Continued.

HOPTON (A.). Baculum geodæticum.
London, 1610.

IVORY (J.). Solution of a geodetical problem.
Phil. Mag. (Tilloch), LXIV, 1824, 35–39.

JACOBI (C. G. J.). Nouvelles formules de géodésie.
Astron. Nachr., XLI, 1855, 209–215.

JADANZA (N.). Alcuni problemi di geodesia.
Accad. Sci. Torini, Atti, XVII, 742.

JAHN (G. A.). Aufgaben auf die . . . Geodäsie.
Leipzig, 1842.

JAMES (H.). Geodetical tables.
London, 1858.

JORDAN (W.). Taschenbuch der praktischen Geometrie.
Stuttgart, 1874, 1877–'78.

——— Das deutsche Vermessungswesen.
Stuttgart, 1882.

——— Neue Auflösung der geodätischen Hauptaufgabe.
Zeits. f. Vermes., XII, 1883, 65–82.

KATER (H.). Contributions to astronomy and geodesy.
London, 1851.

KERWIJK. Geodesie.
N. d.

KEXLER (S.). Arithmetica geodætica denaria.
Aboæ, 1649.

LALMAND (A.-A.). Géodésie.
Paris, 1793.

LANGSDORFF (G. W. VON). Gründriss der Geodäsie.
Mannheim, 1843–'46.

LAPLACE (P. S. DE). Application du calcul des probabilités aux opérations géodésiques.
Journ. d. Phys., LXXXV, 1817, 145–148 . . .; Ann. de Chim., XII, 1819, 37–41.

LAPPARENT (A. DE). Sur les rapports de la géodésie avec la géologie.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 772–774,

LAURR (J. A.). Géodésie pratique.
Bruxelles, 1855; Leipzig, 1857.

LEE (T. J.). Tables and formulæ useful in surveying, geodesy, etc.
Washington, 1853, 1873.

LEFÈVRE (A.). Manuel du trigonométrie, etc.
Paris, 1826.

——— Application de la géométrie à la mesure des lignes inaccessibles.
Paris, 1827.

——— Développement d'un nouveau mode d'observer les angles d'une triangulation.
Paris, 1837.

LEHAGRE (A.). Cours de topographie.
Paris, 1876–'80.

LENOIR (T.-A.). Principes élémentaires et pratiques de géodésie . . .
Clermont, 1853.

LEONHARDI (F. G.). Anleitung zum Unterricht für Geodäten.
Dresden, 1852.

LIAGRE (J.-B.-J.). Calcul des probabilités . . . avec des applications . . . à la géodésie.
Bruxelles, 1852–'79.

LIAIS (E.). Traité d'astronomie et de géodésie.
Paris, 1867.

LIVET. Cours de géodésie.
Metz, 1843.

LOVE (JOHN). Geodæsia.
London, 1768–'71; New York, 1793.

MATTHEWSON (R. C.). . . . geodetical formulas.
Math. Monthly, III, 1861, 71–78.

MAYER (E.). Ueber Küstenaufnahmen. Ein Beitrag zu den Lehr- und Handbüchern der Geodäsie.
Leipzig, 1880.

GEODESY—Continued.

MENESES (F. S.). Discurso sobre los progresos de la geodésia.
Acad. de Cien. Madrid, Mem., I, 1863, iii, 641-664.

MERCIER (A.). Tables géodésiques.
Beauvais, 1853.

MEYER (A.). Cours de géodésie.
Bruxelles, 1845.

——— Rapport sur les méthodes géodésiques en usage en Allemagne.
Bruxelles, 1846.

MINDING (E. F. A.). Ueber einige Grundformeln der Geodäsie.
Acad. de St.-Pétersbourg, Cl. Sci. Math., Bull., VIII, 1850, 88-92; Mél. Math. Astron., I, 1853, 44-51.

MOKRMAN (C.). Géodésie théorique et pratique.
Bruxelles, 1877.

MOESSARD (P.). Topographie et géodésie.
Paris, 1882.

MONTANUS (A. S.). Systematisches Handbuch der gesammten Land- und Erd-Messung.
Berlin, 1819.

NARRIEN (J.). Practical astronomy and geodesy.
London, 1845.

NELL (A. M.). Zur höheren Geodäsie.
Zeits. f. Math. (Schlömilch), XIX, 1874, 324-353.

NETTO (F. W.). Handbuch der gesammten Vermessungskunde.
Berlin, 1820.

OLIVER (J. R.). A course of practical astronomy . . . with the elements of geodesy.
Kingston, 1883.

PATTENHAUSEN (B.). Geodäsie und Topographie auf den dritten geographischen Congresse.
Zeits. f. Vermes., XI, 1882, 73-94, 105-122, 169-181, 433-455.

POLINSKIEGO (M. P.). O geodezyi.
Wilmie, 1816.

POSELGER (F. T.). Anleitung zu Rechnungen der Geodäsie.
Berlin, 1831.

PRESSLER (M.-R.). Traité de géodésie.
Paris, 1819.

PRINSEP (J.). On the general principles of geodesy.
Gleanings in Sci., II, 1830, 18-21.

PUCCI (E.). Fondamenti di geodesia.
Milano, 1883-'87; Ann. d. Mat. (Brioschi), XIV, 1886-'87.

PUILLE (D.). Traité complet de . . . géodésie.
Paris, 1858.

PUISSANT (L.). Analyse appliquée aux opérations géodésiques.
Dépôt de la Guerre, Mém., II, 1831, 379-429.

——— Traité de géodésie.
Paris, 1805, 1819, 1843.

QUEIPO (V.). Contestacion sobre al discurso sobre los progresos de geodésia.
Acad. de Cien. Madrid, Mem., I, 1863, iii, 645-664.

QUETELET (L.-A.-J.). Histoire des sciences mathématiques et physiques chez des Belges.
Bruxelles, 1864, 1871.

REGNAULT (E.-E.). Traité de topographie et de géodésie.
Nancy, 1844.

REYMERS (N.). Geodæsia Ranzoviana.
Lipsiæ, 1583.

RYFF (P.). Quæstiones geometricæ . . . quibus geodæsiam.
Francofurti, 1606; Oxoniæ, 1665.

SALNEUVE (J.-F.). Cours de topographie et de géodésie.
Paris, 1850.

SCHIAVONI (F.). Principii di geodesia.
Napoli, 1880.

SCHLEICHER (F. K.). Beiträge zur praktischen Messkunst.
Frankfurt, 1793.

GEODESY—Continued.

SCHLIEBER (W. E. A.). Hand- und Lehrbuch der gesammten Feldmesskunst.
Quedlinburg, 1861.

SCHNEITLER (C. F.). Lehrbuch der gesammten Messkunst.
Leipzig, 1854.

SCHULTZ (M.). Die Landmesser und Feldmesser.
Berlin, 1884.

SCHWEINS (F. F.). Handbuch der Geodäsie.
Giessen, 1811.

SERENI (C.). Geodesia.
Roma, 1829.

SHORTREDE (R.). Logarithmic and new astronomical and geodetical tables.
Edinburgh, 1884.

SLOUDSKY (TH.). Problème principal de la haute géodésie.
Moscou, 1883, 1884.

SONDERHOF (A.). Ein Beitrag zur höheren Geodäsie.
Zeits. f. Math. (Schlömilch), XVII, 1872, 89-128, 177-231; Leipzig, 1872.

SPÄTH (J. L.). Geodäsie.
Allg. litt. Zeit., 1790, ii, 267; Göttingen gelehrte Anzeiger, 1791, ii, 800.

——— Die höhere Geodäsie.
München, 1816.

STEINHEIL (K. A. VON). Beitrag zur Geodäsie.
K. bayer. Ak. d. Wiss., Sitz.-Ber, II, 1868, 465-469.

STERNICKEL (F. W.). Praktische Geodäsie.
Sondershausen, 1830.

STRANGE (A.). Geodesy.
United Service Journ., VI, 1863, 457-486.

SYLOW (T.). Geodäsie.
Christiania, 1859.

TASSIUS (J. A.). Geodæsiæ.
Hamburgi, 1677.

TESTU (P.). Topographie et géodésie élémentaire.
Paris, 1849.

THOREL (J.-B.-A.). Arpentage et géodésie pratiques.
Paris, 1853.

THUILLIER (H. R.). A manual of surveying.
Calcutta, 1851, 1875.

TILLMAN (S.). Geodetic computations.
U. S. Eng., Rep., 1878, NN.

TINTER (W.). Vorträge über höhere Geodäsie.
Wien, 1872.

TREW (A.). Geodæsia universalis.
Nürnberg, 1641.

UNGER (E. S.). Anleitung zum Feldmessen.
Gotha, 1828.

VACOSSAINT (C.-N.). Traité de géodésie pratique.
Oisemont, 1863.

VORLÄNDER (J. J.). Anleitung zum Feldmessen.
Berlin, 1871.

WALLACE (W.). Geometrical theorems and formulæ particularly applicable to some geodetical problems.
Phil. Soc. Camb., Trans., VI, 1836, 107-140; Edinburgh, 1839.

WELLTMANN. Formeln der niederen und höheren Mathematik.
Bonn, 1886.

WILLIAMS (J. B.). Practical geodesy.
London, 1842, 1846.

WINCKLER (A.). Bemerkungen über einige Formeln der Geodäsie.
Journ. f. Math. (Crelle), L, 1855, 32-40.

WOLF (R.). Taschenbuch für Mathematik, Physik, Geodäsie, und Astronomie.
Bern, 1856, 1877.

——— Handbuch der Mathematik, Physik, Geodäsie, and Astronomie.
Zürich, 1870.

GEODESY—Continued.

YOLLAND. Geodesy.
London, 1853.

ZACHARIAE (G.). Die geodätischen Hauptpunkte.
Kjöbenhavn, 1876; Berlin, 1878.

ZOLLMANN (J. W.). Vollständige Anleitung zur Geodäsie.
Halle, 1744.

ANON. Note on geodesies.
Ox., Camb. and Dub. Messenger of Math., v, 1869, 87–88. Revd. in Jahrb. üb. d. Fortschr. d. Math. II, 1869–'70, 842, by HENRICI.

—— Geodesy.
Encycl. (Breton), III, 922–923.

—— Geodesy.
Penny Cycl., XI, 1838, 122–124.

—— Geodesy.
English Cyclo. (Knight), IV, 1860, 341–365.

—— Geodesy.
All the Year Round, XXXVI, 1876, 136–138.

—— Géodésie.
Grand Dictionnaire Universel du XIX^e Siècle, VIII, 1872, 1176–1178.

—— Problem in geodesy.
U. S. C. and G. Survey, 1864, 116–119.

—— Notions de géodésie expéditive, ou coup-d'œil sur les méthodes qui peuvent servir à former le canevas d'une carte de reconnoissance.
Dépôt de la Guerre, Mém., I, 1829, 23–541.

GEODETIC INSTRUMENTS.

ABBADIE (A. D'). Description d'un instrument pour la pratique de la géodésie expéditive.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 1195–1199.

CÖSTER (A.). Beschreibung der Sammlung geodätischer Apparate im königlichen Museum zu Cassel.
Cassel, 1878.

DAVIDSON (G.). Geodetic instruments of precision at the Paris Exposition and in European workshops.
Nat. Acad. Sci., Proc., 1878.

DRUMMOND (T.). Description of an apparatus for producing intense light, visible at great distances.
Edinb. Journ. Sci., v, 1826, 319–322; Roy. Soc. London, Phil. Trans., CXVI, 1826, 324–337.

ENGELBREIT (K.). Die Instrumente der höheren und niederen Geodäsie.
Nürnberg, 1852.

FAYE (H.-A.-E.-A.). Sur les instruments géodésiques.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 557–566.

HADLEY (J.). The description of a new instrument for taking angles.
Roy. Soc. London, Phil. Trans., XXXVII, 1731, 147–157.

HAÑEZ. Sur l'origine . . . des instruments de géodésie.
Presse Scientifique, I, 1863, 427–433.

HAUPT (L. A.). On the use of the heliotrope in geodetic surveys.
Journ. Frank. Inst., CVI, 1878, 416–418.

HOFMANN (A. W.). Bericht über die wissenschaftlichen Apparate auf der Londoner Ausstellung.
Braunschweig, 1878–'81.

HOFMANN (H.). De octantis instrumenti novi geodætis.
Jenæ, 1612.

HÜNÄUS (G. C. K.). Die geometrischen Instrumente.
Hannover, 1862–'64.

IBAÑEZ (C.). Discurso sobre el origen y progresos de los instrumentos de . . . geodesia.
Acad. Cien. Madrid, Mem., I, 1863, ii, 1–45.

KLEIN (F.). Die wissenschaftlichen Instrumente auf die niederösterreichische Gewerbeausstellung.
Centralzeit. f. Optik u. Mech., I, 1880, 186–187.

KORISTKA (K. F. E.). Bericht über die Werkstätten für geodätische Instrumente in Deutschland und Frankreich.
Prag, 1854.

GEODETIC INSTRUMENTS—Continued.

KREPLIN (H.). Ueber die Construction von geodätischen Instrumenten.
Zeits. f. Vermes., X, 1881, 122–126.

KUPKA (P. F.). Geodätische Instrumente.
Wien, 1877.

LEGNAZZI (E. N.). Del catasto romano e di alcuni strumenti antichi di geodesia.
Verona, 1887.

LENOIR (P. E. M.). Sur les instruments de géodésie.
Paris, 1827.

LOEWENBERG (L.). Bericht über die wissenschaftlichen Instrumente auf der Berliner Gewerbeausstellung.
Berlin, 1880.

MARME (J. B. DE). Des instruments pour la mesure des distances.
Paris, 1880.

MAYER (C.). Pantometrum . . . seu instrumentum pro eliciendа . . . distantia loci inaccessa.
Mannheim, 1762.

NAGEL (A.). Centrirapparat für Theodolit- und Signalaufstellung.
Civ.-Ing., XXXII, 1886, 179–192; Zeits. f. Vermes., XVII, 1888, 39–50.

PICTET (M.-A.). Sur un appareil géodésique très complet et très portatif.
Bibl. Brit., Genève, LII, 1813, 105–137.

PORRO (I.). Mémoire sur de nouveaux instruments et procédés de géodésie.
Ann. Ponts et Chauss., Paris, IV, 1852, 273–387.

RAMSDEN (J.). Description of an engine for dividing mathematical instruments.
London, 1777.

SCHLESINGER (J.). Der geodätische Tachygraph.
Wien, 1877.

SCHNEITLER (C. F.). Die Instrumente der höheren und niederen Messkunst.
Leipzig, 1852.

SENARMONT (H.-H.). Sur quelques instruments imaginés par M. Porro, pour abréger et simplifier les opérations de la géodésie.
Ann. d. Mines, Paris, XVI, 1849, 383–426.

SIEBERT (J. S.) The heliotrope and its uses.
Eng. Soc. Lehigh Univ., Jour., I, 1885, 31–34.

STAMPFER (S.). Ueber die technische Bearbeitung der Rotationszapfen an . . . geodätischen Instrumenten.
Polytech. Inst., Jahrb., XIX, 1837, 1–33.

STANSEL (V.). Dioptra geodætica.
Pragæ, 1653.

STRANGE (A.). Announcement of new instruments to be supplied by government to the great trigonometrical survey of India.
Roy. Astron. Soc., Month. Not., XXII, 1862, 261–263.

TINTER (W. R.). Mathematische, geodätische und astronomische Instrumente.
Wien, 1874.

TISSOT (A.). Dilatation des métaux employés à la construction des instruments géodésiques.
Les Mondes, VI, 1864, 317.

GEODETIC LINES.

ALLÉGRET. Mémoire sur la flexion des lignes géodésiques.
Acad. d. Sci. Paris, Comp. Rend., LXVI, 1868, 342–344.

AOUST (L.). Sur une forme de l'équation de la ligne géodésique ellipsoïdale.
Acad. d. Sci. Paris, Comp. Rend., L, 1860, 484–489.

BACHOVEN VON ECHT. Die Kürzeste auf dem Erdsphäroid.
Coesfeld, 1865.

BAEYER (J. J.). Ueber den Lauf der geodätischen Linie.
Astron. Nachr., LXXI, 1868, 289–314.

BELTRAMI (E.). Sulla teoria delle linee geodetiche.
Ist. Lomb., Rend., I, 1868, 708–718.

GEODETIC LINES—Continued.

BERG (F. J. VAN DEN). Sur les écarts de la ligne géodésique.
Arch. Néerl., XII, 1877, 353–398.

BRUCKE (K.). Die geodätischen Linien und die Krümmungskurven auf den dreiachsigen Ellipsoid.
Halle, 1885.

BOEKLEN (O.). Ueber die geodätischen Linien auf dem Ellipsoid.
Arch. d. Math. (Grunert), XXXV, 1860, 101–103.

—— Zur Theorie der geodätischen Linien.
Arch. d. Math. (Grunert), XXXIX, 1862, 189–198.

—— Ueber geodätische Linien.
Zeits. f. Math. (Schlömilch), XXVI, 1881, 264–269.

BONNET (P.-O.). Sur quelques propriétés des lignes géodésiques.
Acad. d. Sci. Paris, Comp. Rend., XL, 1855, 1311–1313; XLI, 1855, 32–35.

—— Note sur la courbure géodésique.
Acad. d. Sci. Paris, Comp. Rend., XLII, 1856, 1137–1139.

BRANDE (W. T.). A brief investigation of the properties of the geodetic curve.
Quart. Journ. Sci., XXI, 1826, 136–137.

—— A simple rectification of the geodetic curve.
Quart. Journ. Sci., XXI, 1826, 153–155.

BRAUNMÜHL (A.). Ueber geodätische Linien auf Rotationsflächen . . .
München, 1878.

—— Ueber Enveloppen geodätischer Linien.
Math. Ann. (Clebsch), XIV, 1879, 557–566; XX, 1882, 557–586.

—— Ueber die reducirte Länge eines geodätischen Bogens . . .
K. bay. Ak. d. Wiss., math.-phys. Cl., Abhandl., XIV, 1883, iii, 93–110.

BRILL (A.). Zur Theorie der geodätischen Linie und des geodätischen Dreiecks.
K. bayer. Ak. d. Wiss., math.-phys. Cl., Abhandl., XIV, 1883, ii, 209–140.

BRIOSCHI (F.). Sulla integrazione della equazione delle linee geodetiche.
Ann. Sci. Mat. e Fis. (Tortolini), IV, 1853, 133–135.

BRUNS (H.). Bemerkung über die geodätische Linie.
Zeits. f. Vermes., X, 1881, 298–301.

CAYLEY (A.). On the geodesic lines on an oblate spheroid.
L., E., D. Phil. Mag., XL, 1870, 328–340.

—— On geodesic lines, in particular those of a quadric surface.
Math. Soc. London, Proc., IV, 1871–'73, 191–211, 368–380.

—— On the geodesic lines on an ellipsoid.
Roy. Astron. Soc., Month. Not., XXXII, 1872, 31–53, 55–56; Astron. Ges., Vierteljahrs., IX, 1874, 47–51.

CHASLES (M.). Sur les lignes géodésiques et les lignes de courbure des surfaces du second degré.
Journ. Math. (Liouville), XI, 1846, 5–15, 105–119; Acad. d. Sci. Paris, Comp. Rend., XXII, 1846, 313–318.

CLARKE (A. R.). On the course of geodesic lines on the earth's surface.
L., E., D. Phil. Mag., XXXIX, 1870, 352–363.

DARBOUX (G.). Sur une série de lignes analogues aux lignes géodésiques.
École Norm., Ann., VII, 1870, 175–180.

DICKSON (B.). On the general equations of geodesic lines.
Camb. Math. Journ. (Thomson), V, 1850, 166–171.

DORNA (A.). Relazione su "Scostamento della linea geodetica . . ."
Accad. Sci. Torino, Atti, XIX, 1886, 94–98.

ENNEPER (A.). Bemerkungen über geodätische Linien.
Zeits. f. Math. (Schlömilch), XVIII, 1873, 613–618.

FAÀ DE BRUNO (F.). Démonstration élémentaire du théorème fondamental des lignes géodésiques.
Les Mondes, VIII, 1865, 739–740.

GEODETIC LINES—Continued.

FELDT (L.). Formulæ conditionæ Gaussianæ de lineis curva brevissimis evolutio.
Brunsbergæ, 1844.

GAUDIN. Méthode pratique de tracer sur terre un parallèle par un degré de latitude donné.
Acad. d. Sci. Paris, Mém., 1833, 223–232.

GEER (P. VAN). De geodetische lijn op de ellipsoid.
Leiden, 1862.

GORDAN (P. A.). De linea geodetica.
Berolini, 1862.

GRAVES (C.). On geodetic lines in surfaces of the second order.
Roy. Irish Acad., Proc., IV, 1850, 283–287.

GUDERMANN (C.). Fundamenta trigonometriæ . . . de lineis brevissimis, vulgo dictis geodæticis.
Journ. d. Math. (Crelle), XLIII, 1852, 294–339.

HART (A. S.). Geodetic lines through the umbilic of an ellipsoid.
Roy. Irish Acad., Proc., IV, 1847–'50, 274.

—— Geometrical demonstrations of some properties of geodesic lines.
Camb. Math. Journ. (Thomson), IV, 1849, 80–84.

—— On geodesic lines traced on a surface of the second degree.
Camb. Math. Journ. (Thomson), IV, 1849, 192–194.

HELMERT (F. R.). . . . Fundamentalsatz für die geodätische Linie auf Umdrehungsflächen.
Zeits. f. Vermes., IX, 1880, 338–339.

IVORY (J.). On the properties of a line of shortest distance on an oblate spheroid.
Phil. Mag. (Tilloch), LXVII, 1826, 241–249, 340–352.

—— A direct method of finding the shortest distance between two points on the earth's surface.
Phil. Mag. (Taylor), VIII, 1830, 30–34.

JACOBI (C. G. J.). Note von der geodätischen Linie auf einem Ellipsoid.
Journ. f. Math. (Crelle), XIX, 1839, 309–313, etc.

—— Bestimmungen der geodätischen Linie auf einem dreiaxigen Ellipsoid.
K. Ak. d. Wiss., Ber., 1846, 351–355.

JADANZA (N.). Sul calcolo della distanza di due punti le cui posizioni geografiche son note.
Accad. Sci. Torino, Atti, XIX, 1886.

JEFFREY (H. M.). On the duals of geodesics and lines of curvature.
Quart. Journ. Math., XII, 1873, 322–345.

JORDAN (W.). Elementare Begründung des Fundamentalsatzes über die geodätische Linie auf einer Umdrehungsfläche.
Zeits. f. Vermes., IX, 1880, 297–298.

—— Bemerkung zur rectification eines Meridian-Bogens.
Zeits. f. Vermes., XI, 1882, 622–625.

—— Elementare Begründung der Beziehung zwischen der geodätischen Linie und den Normalschnitten.
Zeits. f. Vermes., XII, 1883, 238–241.

KRETSCHNER. Zur Theorie der geodätischen Linien auf den Rotationsflächen.
Berlin, 1864.

KRÜGER (L.). Die geodätische Linie des Sphäroids.
Berlin, 1883.

KUMMELL (C. H.). To find the least distance between two places given by latitude and longitude, taking into account the polar compression.
Analyst, IV, 1877, 117–120; Astron. Nachr., CXII, 1885, 97–108.

—— Alignment curves on any surface.
Phil. Soc. Wash., Bull., VI, 1884, 123–132.

LANGENBECK (R.). Ueber diejenigen geodätischen Linien, welche durch einen der Nabelpunkte gehen.
Göttingen, 1877.

GEODETIC LINES—Continued.

LEVY (M.). *Sur les intégrals rationnelles du problème des lignes géodésiques.*
Acad. d. Sci. Paris, Comp. Rend., LXXXV, 1877, 1065–1068.

LIE (S.). Untersuchungen über geodätische Curben.
Math. Ann., XX, 1882, 357–454; Arch. f. Math. og Naturvid., VIII, 1882, 490–501.

LIOUVILLE (J.). De la ligne géodésique sur un ellipsoïde quelconque.
Journ. d. Math. (Liouville), IX, 1844, 401–408; XI, 1846, 21–24; XII, 1847, 255; Acad. d. Sci. Paris, Comp. Rend., XXII, 1846, 11–113; Journ. d. Math. (Liouville), XIX, 1854, 368.

LUROTH (J.). Notiz über die Rectification eines Ellipsenbogens.
Zeits. f. Vermes., X, 1881, 225–226.

M. *Mode of tracing a curve of very large radius, adopted in the survey of the northern boundary of Delaware in 1701.*
Journ. Frank. Inst., IV, 1842, 11–15.

MÄDLER (J. H.). Leitfaden der mathematischen und allgemeinen physischen Geographie.
Stuttgart, 1843.

MASCOW (O.). Ueber die geodätische Linie auf dem abgeplatteten Rotationsellipsoid.
Greifswald, 1873.

MICHAELIS (G.). De lineis imprimis linea geodetica.
Berolini, 1837.

MOLINS (H.). Sur les lignes . . . géodésiques.
Journ. d. Math. (Liouville), IV, 1859, 347–365; Acad. de Toulouse, Mém., V, 1861, 401–412.

MORSTEIN. Ueber die kürzesten Linien auf die dreiaxigen Ellipsoid.
Posen, 1871.

POSELGER (F. T.). Ortsentfernung auf der Oberfläche des Erdsphäroids.
K. Ak. d. Wiss., math. Cl., Abhandl., 1833, 59–76.

PUISSANT (L.). Moyen d'évaluer rigoureusement la longueur d'une ligne géodésique.
Soc. Philom., Bull., 1824, 17–20, 145–146.

——— . . . la plus courte distance de deux points sur le sphéroïde terrestre.
Soc. Géogr., Bull., IX, 1828, 184–187; Conn. d. Temps, 1832, 34–48; 1833, 77–85.

——— Note sur un nouveau moyen d'abréger considérablement les calculs rélatifs à la rectification d'un arc de méridien.
Acad. d. Sci. Paris, Comp. Rend., XIII, 1841, 53–58.

RESAL (E.-H.). Sur la courbure des lignes géodésiques.
Ann. d. Math., 1887, 57.

ROBERTS (M.). Sur quelques propriétés des lignes géodésiques.
Journ. d. Math. (Liouville), XI, 1846, 1–4; XII, 1847, 491–492; XIII, 1848, 1–11; II, 1857, 213–216.

SCHLAEFI (L.). Bemerkungen über confocale Flächen zweiten Grades und geodätische *Linie auf dem Ellipsoid.*
Naturf., Ges., Bern., 1847, 90–101.

SCHOLS (C.-M.). La courbure de la projection de la ligne géodésique.
École polytech., Ann., II, 1886, 179–230.

SCHWERING (K.). Neue geometrische Darstellung der geodätischen Linie auf dem Rotationsellipsoid.
Zeits. f. Math. (Schlömilch), XXIV, 1879, 405–407.

SOLDNER. Ueber die kürzeste Linie auf dem Sphäroide.
Mon. Corr. (Zach), XI, 1805, 7–22.

STAUDE. Ueber geodätische Bogenstücke von algebräischer Längendifferenz auf dem Ellipsoid.
Ann. d. Math. (Schlömilch), XX, 1882, 185.

TORTOLINI (B.). Sulla determinazione della linea geodesica descritta sulla superficie di un' ellissoide a tre assi inequali.
Accad. d. Lincei, Atti, IV, 1850–'51, 287–324; Ann. di Mat. (Tortolini), II, 1851, 345–357.

GEODETIC LINES—Continued.

VOSS (A.). Ueber diejenigen Flächen, auf denen zwei Schaaren geodätischer Linien ein conjugirtes System bilden.
K. bayer. Ak. d. Wiss., math.-phys. Cl, Sitz.-Ber., 1888, 95–102.

WEIERSTRASS (K.). Ueber die geodätischen Linien auf dem dreiachsigen Ellipsoid.
K. Ak. d. Wiss., Monatsber., II, 1861, 986–997.

WEINGARTEN (J.). Allgemeine Untersuchung über die geodätischen Linien.
Berlin, 1862, K. Ak., d. Wiss., Sitz.-Ber., XLII, 1882, 453–456; XLIII, 1883, 1163–1166; Journ. f. Math. (Crelle), XCIV, 1883, 181–202.

WENDT (A. T. A.). *Zur Theorie der geodätischen Linie.*
Berlin, 1880.

WIENER. . . . über die geodätische Linie auf einer Umdrehungsfläche.
Zeits. f. Vermes., IX, 1880, 337–338.

WINTERBERG (C.). Ueber die geodätische Linie.
Astron. Nachr., LXXXIX, 1876, 103–110, 112–128, XCI, 1877, 113–120, CV, 1879, 223–228, 238–250, 271–280.

YOUNG (T.). A brief investigation of the properties of the geodetic curve.
Quart. Journ. Sci., XXI, 1826, 136–137.

YOUNG (THOMAS). A simple rectification of the geodetic curve.
Quart. Journ. Sci., XXI, 1826, 150–155.

YVON-VILLARCEAU (A.-J.-F.). De la limite des erreurs . . . en appliquant la théorie des lignes géodésiques aux observations des angles des triangles.
Acad. d. Sci. Paris, Comp. Rend., LXII, 1866, 850–852.

GEODETIC TRIANGLES.

BONNET (P.-O.) Démonstration du théorème de Gauss relatif aux petits triangles géodésiques . . .
Acad. d. Sci. Paris, Comp. Rend., LVIII, 1864, 183–188.

CHRISTOFFEL (E. B.). Allgemeine Theorie der geodätischen Dreiecke.
K. Ak. d. Wiss., math.-phys. Cl., Abhandl., 1868, 119–176.

FERRERO (A.). Memoria sobre la forma mas conveniente de los triángulos geodésicos.
Acad. de Cien. Madrid, Mém., II, 1853, 77–84.

GAUCHEREL (M.-E.). Note sur la forme préférable des triangles géodésiques.
Ann. de Math., XIV, 1855, 321–343.

GILETTA (L.). Studio sul triangolo geodetico.
Roma, 1880.

HAUPT (C.). Die Ausgleichung grosser geodätischer Dreiecke.
Astron. Nachr., CVII, 1883, 65–84.

JORDAN (W.). Ueber die Bestimmung des mittleren Winkelmessungsfehlers einer nach der Bessel'schen Methode ausgeglichenen Triangulirung.
Astron. Nachr., LXXXIX, 1876, 27–30.

PIOBERT (G.). De la forma mejor que conviene dar á los triángulos geodésicos.
Revista Cien. Fis., Madrid, I, 1850, 373–380; Acad. d. Sci. Paris, Comp. Rend., XXXI, 1850, 151–159.

——— Sur la rectification des angles dans le calcul des triangles géodésiques.
Acad. d. Sci. Paris, Comp. Rend., XXXI, 1850, 409–418.

Geogr. Jahrb. (Behm), *for* **Geographisches Jahrbuch (Behm, later, Wagner).**
8°, Gotha, 1666.

Geogr. Mittheil. (Petermann), *for* **Mittheilungen aus Justus Perthes geographischer Anstalt über wichtige neue Erforschungen auf dem Gesammtgebiete der Geographie (Petermann).**
4°, Gotha, 1855–'79, (Behm), 1879.

GEOGRAPHIC POSITION.

ALBRECHT (T.). Formeln und Hilfstafeln für geographische Ortsbestimmungen.
Leipzig, 1873.

GEOGRAPHIC POSITION—Continued.

AMANTE (F.). Considerazioni sulle formole per calcolare le posizioni geografiche dei vertici dei triangoli geodetichi.
Napoli, 1852.

ANDRAE (C. C. G.). Om beregningen af brede, langde, og azimuth paa Sphæroiden.
K. Svenska Vetens., Öfvers., 1858, 230-269; 1859, 27-69.

ANDRES (T.). Berechnung der geodätischen Coordinaten und der geographischen Position der Dreieckspunkte.
Arch. d. Math. (Grunert), LIII, 1871, 364-378.

BESSEL (F. W.). Die Berechnung der geographischen Längen und Breiten aus geodätischen Vermessungen.
Astron. Nachr., IV, 1826, 241-254.

BÖRSCH (O.). Anleitung zur Berechnung der rechtwinkeligen sphärischen Coordinaten der Dreieckspunkte.
Cassel, 1868, 1885.

——— Tafeln für geodätischen Berechnungen zwischen den Breiten von 35° bis 70° . . .
Cassel, 1869.

BOHNENBERGER (J. G. F.). Anleitung zur geographischen Ortsbestimmung.
Göttingen, 1795.

BOHNENBERGER (T. G. F.). Berechnung der trigonometrischen Vermessung mit Rücksicht auf die sphäroidische Gestalt der Erde.
Stuttgart, 1885.

BUZENGEIGER (K. H. I.). Berechnung der Länge und Breite eines Orts aus gegebenen Perpendikel und Abstand vom Meridian eines gegebenen Orts.
Mon. Corres. (Zach), XXV, 1812, 478-483.

COUTO (M. V.). Memoria sobre la methodo de calcular a longitude geografica de un logar.
Acad. d. Sci. Lisboa, Mem., II, 1848, 301-316.

CZUBER (E.). Genauigkeit der geodätischen Punkbestimmung durch zwei und mehrere Grade.
Techn. Blätter, X, 1878, 1-24, 65-88.

DIENGER (J.). Bestimmungen der geographischen Breite und Länge aus geodätischen Messungen.
Arch. d. Math. (Grunert), XVIII, 1852, 80-90.

FAYE (H.-A.-E.-A.). Sur ta détermination géodésique de latitudes.
Acad. d. Sci. Paris, Comp. Rend., XXXVI, 1853, 267-276, 309-317, 359-366.

FELDT (L.). Formulæ Besselianæ de latitudine locorum geographica evolutio.
Brunsbergæ, 1848.

FRANKE (J. H.). Die trigonometrische Punktbestimmung.
München, 1875.

——— Ueber die graphische Bestimmung von Coordinaten-Abweichung.
Zeits. f. Vermes., V, 1876, 97-107.

GRUNERT (J. A.). Lagenbestimmung auf der Kugel.
Arch. d. Math. (Grunert), XXXVI, 1861, 51-79.

——— Ueber Länge und Breite . . . auf dem dreiaxigen Ellipsoid.
Arch. d. Math. (Grunert), XXXVI, 1861, 79-100.

HELMERT (F. R.). Die geodätische Uebertragung geographischer Coordinaten.
Astron. Nachr., XCIV, 1879, 313-320.

IVORY (J.). On the method in the trigonometrical survey for finding the difference in longitude of two stations.
Phil. Mag. (Taylor), IV, 1828, 432-435; V, 1829, 24-28, 106-109.

JACOBI (C.-G.-J.). Solution nouvelle d'un problème fondamental de géodésie.
Journ. f. Math. (Crelle), LIII, 1857, 335-341.

JADANZA (N.). Sulla latitudine, longitudine ed azimut dei punti di una rete trigonometrica.
Giorn. Math. Univ. Italiana, XVIII, 1880, 137-139.

LAMONT (J. VON). Astronomisch-geodätische Bestimmungen des bayerischen Dreiecksnetzes.
München, 1871.

GEOGRAPHIC POSITION—Continued.

LEVRET (H.). Détermination des positions géographiques sur un ellipsoïde quelconque.
Acad. d. Sci. Paris, Comp. Rend., LXXVI, 1873, 410-413.

LÖW (M.). Astronomisch-geodätische Ortsbestimmung im Harz.
Berlin, 1882.

LUROTH (J.). Eine Gleichung zwischen den Längen, Breiten und Azimuthen dreier Erdorte.
Zeits. f. Vermes., XV, 1886, 529-535.

MACLAURIN (C.). A rule for finding the meridional parts to any spheroid.
Roy. Soc. London, Phil. Trans., XLI, 1741, ii, 808-809.

NELL (A. M.). Geodätische Bestimmung der geographischen Breite und Länge aus Linear-Coordinaten.
Zeits. f. Vermes., XIII, 1884, 421-434.

O'FARRALL (J.). Account of the graphic method in use for determining geographic co-ordinates.
London, 1886.

OLTMANNS (J.). Aus beobachteten Höhen, Winkeln und Azimuthen die Distanz und relative geographische Lage zweier Oerter herzuleiten.
Astron. Jahrb. (Bode), 1811, 213-215.

——— Hilfstafeln zur Berechnung der Länge und Breite aus gemessenen Meridian- und Perpendicular-Abständen.
Astron. Jahrb. (Bode), 1825, 196-199; Berlin, 1826.

ORIANI (B.). Formeln zur Berechnung der Länge und Breite auf dem Erd-Sphäroid.
Mon. Corr. (Zach), X, 1804, 244-251; Eff. Astron., Milano, 1807, 3-34; Milano, 1806-'21; Astron. Nachr., IV, 1826, 461-466.

OUDEMANS (J. A. C.). Ueber das Problem, aus dem Breiten- und Längen-Unterschiede zweier Oerter ihre Entfernungen und die Azimuthe zu berechnen.
Astron. Nachr., LXXXI, 1873, 305-320.

PRONY (R. DE). Mémoire sur le calcul des longitudes et des latitudes.
Conn. d. Temps, 1808, 366-379.

PUCCI (E.). Sulle posizioni geografiche.
Giorn. Math. d. Univ. Italiane, XVIII, 1880, 358-367.

ROGG (J.). Ueber geodätische Ortsberechnungen.
Stuttgart, 1856; Zeits. f. Math. (Schlömilch), VI, 1861, 58-67.

SCHOLS (C. M.). Le calcul de la distance et de l'azimut au moyen de la longitude et de la latitude.
Arch. Néerl., XVII, 1882, 101-167.

SCHUBERT (T. F. VON). Anleitung zu den Berechnungen einer trigonometrischen Aufnahme.
St. Petersburg, 1826.

STEIN (J. P. W.). Geographische Trigonometrie.
Mainz, 1825.

STONE (E.). Some reflections on the uncertainty of many geographical positions . . .
London, 1766.

——— Reduction of latitude . . . with Clarke's values.
Roy. Astron. Soc., Month. Not., XLIII, 1882-'83, 102-110.

TIARKS (J. L.). On Mr. Dalby's method of finding the difference of longitude between two points of a geodetical line on a spheroid.
Phil. Mag. (Taylor), IV, 1828, 364-376.

TRALLES (J. G.). Algebraische Bestimmungsmethode der Länge, Breite und Azimuthe bei geodätischen Vermessungen.
K. Ak. d. Wiss., math. Cl., Abhandl., 1818-'19, 49-56.

TREPIED (C.). Sur le calcul des coordonnées géodésiques.
Acad. d. Sci. Paris, Comp. Rend., LXXX, 1875, 36-40.

ULFFERS (D. W.). Praktische Anleitung zur Berechnung von Dreiecks- . . . Netzen.
Koblenz, 1870.

VALENTINER (W.). Beiträge zur kürzesten und zweckmässigsten Behandlung geographischer Ortsbestimmungen mit Hülfstafeln.
Leipzig, 1869.

GEOGRAPHIC POSITION—Continued.

WEYPRECHT (C.). Astronomische und geodätische Bestimmungen.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Denkschr., XXXV, 1877, 47–71.

YOUNG (T.). Computation of longitude on a spheroid.
Quart. Journ. Sci., II, 1828, 418–420.

ZACH (F. X. VON). Allgemeine Tafeln zur Berechnung der geographischen Längen und Breiten.
Mon. Corr. (Zach), VII, 1803, 522–528; VIII, 1808, 81–89.

ANON. Formulæ for computing latitudes, longitudes, and azimuths, with an example as used in the Coast Survey Office, together with tables.
U. S. C. and G. Survey, Rep., 1860, 361–391.

——— Formulæ and factors for the computation of geodetic latitudes, longitudes, and azimuths.
Based on the Bessel spheroid, U. S. C. and G. Survey, Rep., 1875, 315–368; based on the Clarke spheroid, U. S. C. and G. Survey, Rep., 1884, 323–375.

——— Tables for the projection of maps based upon a polyconic development of the Clarke spheroid, and computed from the equator to the pole.
U. S. C. and G. Survey, Rep., 1884, 135–321.

Geol. Soc., Journ., *for* Journal of the Geological Society.
8°, Dublin, 1833+. (Washington, Congress.)

Gerard (Alexander). On pendulum observations.
Edinb. Phil. Journ., LV, 1853, 14–16.

Gerber. Bestimmung der Erdachsen aus der Polhöhe. (H.)
Berlin, 1833.

Gergonne (J.-D.): **Zach (F. X.)**. Les attractions des montagnes. Revd. by —.
Acad. du Gard, Aperçu, 1812–'22, 150–155.

——— Note sur la mesure de l'intensité, au moyen d'un pendule à trois axes.
Ann. de Math. (Gergonne), XVII, 1826–'27, 155–158.

Gerke (R.). Uebersicht der Literatur für Vermessungswesen von den Jahren 1879 und 1880.
Zeits. f. Vermes., X, 1881, 1–44. (Appendix.)

——— Uebersicht der Literatur für Vermessungswesen von dem Jahre 1881.
Zeits. f. Vermes., II, 1882, 185–232.

——— Uebersicht der Literatur für Vermessungswesen von dem Jahre 1882.
Zeits. f. Vermes., XII, 1883, 369–404.
Geodäsie, 396–399.

——— Uebersicht der Literatur für Vermessungswesen von dem Jahre 1883.
Zeits. f. Vermes., XIII, 1884, 437–478.

——— Die Triangulation und Polygonisirung der Stadt M.—Gladbach im Regierungsbezirk Düsseldorf.
Fol., Hannover, 1885, pp. 94, 25, 6 plates. (Washington, Coast Survey.)
Revd. in Zeits. d. rheinisch-westphal. Landmesser-Verein, IV, 1884, 57–67.

——— Uebersicht der Literatur für Vermessungswesen von dem Jahre 1884.
Zeits. f. Vermes., XIV, 321–351.

——— Uebersicht der Literatur für Vermessungswesen von dem Jahre 1885.
Zeits. f. Vermes., XV, 1886, 401–428, 433–457.

——— Uebersicht der Literatur für Vermessungswesen von dem Jahre 1886.
Zeits. f. Vermes., XVI, 1887, 473–502, 514–519.

Gerlach (Friedrich Wilhelm Anton). Die Bestimmung der Gestalt und Grösse der Erde, wie auch der Verrückung der Nachtgleichen, Schwankung der Erdaxe, Verhältniss der Massen von Sonne, Erd und Mond.
8°, Wien, 1782, pp. viii, 240, 3 plates. (Gore.)

Gerland (E.) *und* **Cöster (A.)**. Beschreibung der Sammlung geodätischer Apparate.
Cassel, 1878.
Title in full under CÖSTER (A.).

Gerling (Christian Ludwig). Beiträge zur Geographie Kurhessens und der umliegenden Gegenden, vermittelst der kurhessischen Triangulirung vom Jahr 1823 abgeleitet aus der holsteinschen Basis und der hannöverschen Gradmessung.
8°, Cassel, 1831, pp. viii, 234. (Washington, Coast Survey.)

——— [Ueber die Abplattung der Erde.]
Astron. Nachr., X, 1833, 7–10.

——— Die Pothenot'sche Aufgabe in praktischer Beziehung dargestelt von —.
8°, Marburg, 1840, pp. vi, 54.

——— Die Ausgleichungsrechnungen der praktischen Geometrie, oder die Methode der kleinsten Quadrate mit ihrer Anwendung auf geodätische Aufgaben.
8°, Hamburg, 1843, pp. xiv, 409.
Nachträge zur Ausgleichungs-Rechnung: Arch. f. Math. (Grunert), VI, 1845, 141–146, 375–378.

——— [Geodätische Festlegung des Domberger Hof-Thurms zu Marburg.]
Astron. Nachr., XX, 1843, 25–28.

——— Nachträge zur Ausgleichungs-Rechnung.
Arch. d. Math. (Grunert), VI, 1845, 141–146, 375–378.
Ueber die Genauigkeit der Ketten-Messungen (dritter Nachtrag).

——— Ueber die Schätzung des mittleren Fehlers directer Beobachtungen.
Archiv d. Math. (Grunert), XXV, 1855, 219–222.
Corrections and errata to "Ausgleichungsrechnungen."

——— Bemerkungen über das indirecte Eliminiren bei geodätischen Arbeiten.
Zeits. f. Math. (Schlömilch), III, 1858, 377–382.

——— Ueber Genauigkeit der Functionen bedingter Beobachtungen.
Archiv d. Math. (Grunert), XXXVIII, 1862, 379–381.
Contains corrections to "Ausgleichungsrechnung."

Germain. Observation de la déviation de la verticale sur les côtes sud de France.
Acad. d. Sci. Paris, Comp. Rend., CII, 1886, 1100–1103.

Ges. f. Erdk., Monatsber., *for* Gesellschaft für Erdkunde, Monatsberichte über die Verhandlungen.
8°, Berlin, 1840–'53 (14 vols.). (Berlin, Royal.)

Ges. Württemberg, Abhandl., *for* Naturwissenschaftliche Abhandlungen, herausgegeben von einer Gesellschaft in Württemberg.
8°, Württemberg, 1826+. (Oxford, Bodleian.)

Giesler (E. A.). Standard measures.
Journ. Frank. Inst., XCVI, 1888, 115–133.

Gilbert (Davies). On the vibration of heavy bodies in cycloidal and in circular arcs as compared with their descent through space, including an estimate of the variable excess in vibrations continually decreasing.
Quart. Journ. Sci., xv, 1823, 20–103; xx, 1826, 69–73.

Gilbert (Grove Karl). On the Kanab base-line and a proposed new method of base measurement.
Phil. Soc. Wash., Bull., III, 1878–'80, 34–36.

Gilbert (P.): Folie (F.). Sur le calcul de la densité de la terre. Rapport de —.
Acad. d. Belgique, Bull., XXXIII, 1872, 371–372.

——— Compte rendue de la géodésie d'Éthiopie par A. d'Abbadie.*
Revue des Questions Scientifiques, Bruxelles, I, 1877, 318–319.

Giletta (Luigi). Studio sullo sviluppo delle reti geodetiche.*
Roma, 1879.

——— Studio sul triangolo geodetico.
8°, Roma, 1880, pp. 93, 3 plates. (Southampton, Ordnance Survey.)

——— Intorno ai fondamenti del principio dei minimi quadrati.
Giorn. Mat. (Battaglini), XVIII, 1880, 159–174.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XII, 1880, 163–164, by L. [LAZARUS].

——— Lezioni di geodesia presentate alla Scuola di guerra.*
Torino, 1880.

——— Lezioni complementari di geodesia professate alla Scuola di guerra dal —.
8°, Torino, 1885, pp. viii, 240, 3 plates. (Vienna, Geographic Institute.)

——— Le nostre reti geodetiche considerate in rapporto colla rinnovazione delle mappe cadastali.
8°, Roma, 1885, pp. 82, 1 chart. (Vienna, Geographic Institute.)
From: Rivista militare italiana, 1885.

Giorn. d. Fis. (Brugnatelli), *for* Giornale di fisica, chimica e storia naturale (Brugnatelli).
8°, Pavia, 1808–'17. (Oxford, Bodleian.)

Giorn. Mat. (Battaglini), *for* Giornale matematiche ad uso degli studenti delle università italiane (Battaglini).
4°, Napoli, 1863. (Oxford, Bodleian.)

Girault (Ch.). De la résistance de l'air dans le mouvement oscillatoire du pendule.
Acad. d. Sci. Caen, Mém., 1860, 3–45; 1862, 3–30.

Giulio (Charles-Ignace): Carlini (F.). Sur la densité moyenne de la terre. Note de —.
Accad. Sci. Torino, Mem., II, 1840, 379–385.

——— Recherches expérimentales sur la résistance de l'air au mouvement des pendules.
Accad. Sci. Torino, Mem., XIII, 1853, 299–357.

Glaisher (J. W. L.). On the law of the facility of errors of observations, and on the method of least squares.
Roy. Astron. Soc., Mem., XXXIX, 1872, 75–124; Month. Not., XXXII, 1872, 241–242.

——— Remarks on certain portions of Laplace's proof of the method of least squares.
L., E., D. Phil. Mag., XLIII, 1872, 194–201.

Glaisher (J. W. L.)—Continued.

——— The method of least squares.
Nature, VI, 1872, 140–141.

——— On the solution of the equations in the method of least squares.
Roy. Astron. Soc., Month. Not., XXXIV, 1874, 311–314; XL, 1880, 600–614; XLI, 1881, 18–83.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VI, 1874, 145–146; XII, 1880, 162–163.

——— Note on a point in the method of least squares.
Mess. Math., II, 1880, 132.
If the number of equations exceed the number of unknowns by 1 the probable error is a linear function of the observed quantities.

Gleanings in Science.
8°, Calcutta, 1829–'31. (British Museum.)

Gleichen (Friedrich Wilhelm von) [*sometimes called* **Rusworm**]. Von der Entstehung, Bildung, Umbildung, und Bestimmung des Erdkörpers.
Dessau, 1782. (From Archiv d. Natur u. Physik.)
POGGENDORFF, I, 911.

Goclenius (Rodolphus). Isagoge optica cum disceptatione geometrica de universo geometria magisterio, hoc est geodæsia rectarum per radium, et aliis quæstionibus philosophicis, juxta auream, P. Rami methodum concinnata.
4°, Francofurti, 1593, pp. [xii], 46. (British Museum.)

Godfray (Hugh). A treatise on astronomy for the use of colleges and schools. Third edition.
8°, London, 1880, XVI, pp. 320. (Washington, Observatory.)
Figure of the earth, 195–197.

Godin (Louis). La longueur du pendule simple, que bat les secondes du temps moyen, observée à Paris et au Petit Goave en l'isle de St.-Dominique.
Acad. d. Sci. Paris, Mém., 1735, 505–521.

Goldbach (Christian Friedrich). Bestimmung der geographischen Länge und Breite einiger Städte in Russland, nebst einer Ankündigung einer geodätischen and astronomischen Vermessung in Gouvernement Moskau's.
Astron. Jahrb. (Bode), 1811, 211–212.

Goldingham (John). Observations for ascertaining the length of the pendulum of Madras, in the East Indies, latitude 13° 4′ 9″, with corrections drawn from the same.
Roy. Soc. London, Phil. Trans., 1822, 127–170.

——— Report of the length of the pendulum at the equator.
Ann. Nat. Phil. (Thomson), XII, 1826, 281–299, 342–354.
Also printed as a separate, perhaps at Madras, no date, folio, pp. 268.

Gompertz (Benjamin). On the convertible pendulum.
Roy. Astron. Soc., Month. Not., I, 1827–'30 129–131.

Gordon (P. A.). De linea geodetica.*
Berolini, 1862.

Gore (James Howard). The geodetic survey. An account of the immense triangulations now being made by the United States.
Philadelphia Press, September 9, 1884, p. 7.

——— The purposes and results of geodetic surveys.
Correspondence Univ. Journ., III, 1885, 18–20.

Gore (James Howard)—Continued.

——— Elements of geodesy.

8°, New York, 1886, pp. iv, 282. *John Wiley & Sons.* (Gore.)

2d ed., New York, 1888. *John Wiley & Sons.*

——— The geodetic work in the United States. I. Mason and Dixon, 1764-'68.

Railroad and Engineering Journ., LXI, 1887, 104-106; Zeits. f. Vermes., XVII, 1888, 33-39.

——— The geodetic work in the United States. II. Borden's Survey of Massachusetts.

Railroad and Engineering Journ., LXI, 1887, 152-153; Zeits. f. Vermes., XVII, 1888, 203-207.

——— The geodetic work in the United States. III. The United States Lake Survey.

Railroad and Engineering Journ., LXI, 1887, 200-203; Zeits. f. Vermes., XVII, 1888, 385-395.

——— Geodetic work in the United States. IV. The U. S. Coast and Geodetic Survey.

Railroad and Engineering Journ., LXI, 1887, 247-249, 299-300, 350-352.

——— A bibliography of geodesy.

U. S. C. and G. Survey, Rep., 1887, App. 16, Washington, 1889.

Goss (J. W.). Begründung der Methode der kleinsten Quadrate.*

8°, 1871.

Gosselin (Pascal-François-Joseph). Géographie des Grecs analysée; ou le système d'Eratosthènes, de Strabon, et de Ptolémée, comparés entre eux, et avec nos connoissances modernes.

4°, Paris, 1790, pp. [iv], 148, 8 tables, 27 pp. contents, 10 plates. (Oxford, Bodleian.)

Special attention is paid to the degree measurements of the Greeks.

——— Recherches sur la géographie systématique et positive des anciens; pour servir de base à l'histoire de la géographie ancienne.

4 vols., 4°, Paris, 1798-1813, pp. viii, 271, 322, 355, 463. (Oxford, Bodleian.)

——— Recherches sur le principe, les bases et l'évaluation des différens systèmes métriques linéaires de l'antiquité.

Acad. Inscr., Mém., VI, 1822, 44-164.

——— Nouvel examen sur la densité moyenne de la terre.

Acad. de Metz, Mém., XL, 1859, 469-485.

Gött. Anzeigen, *for* Göttingsche Anzeigen von gelehrten Sachen.

8°, Göttingen, 1753-1801 (117 vols.) (Washington, Congress.)

Gött. Nachr., *for* Nachrichten von der königl. Gesellschaft der Wissenschaften und der Georg-Augustus-Universität.

16°, Göttingen, 1864+. (Washington, Congress.)

Gould (Benjamin Apthorp). Peirce's criterion for the rejection of doubtful observations.

U. S. C. and G. Survey, Rep., 1854, 131-138.

——— Remarques sur les attractions locales.

Acad. d. Sci. Paris, Comp. Rend., LXIX, 1869, 814-815.

Gournerie (de la). La première contestation entre les académiciens envoyés au Pérou dans le XVIII^e siècle pour des opérations relatives à la détermination de la figure de la terre. Lu dans la séance publique annuelle des cinq académies le mercredi 25 octobre 1876.

4°, Paris, 1876, pp. 11.

Govi (Gilberto). Metodo per determinare la lunghezza del pendolo.

Accad. Sci. Torino, Atti, I, 1866, 505-513.

——— Sur l'invention de quelques étalons naturels de mesure.

Accad. Sci. Torino, Atti, VII, 1871-'72, 362-376.

——— Nouvelle méthode pour déterminer la longueur du pendule simple. Note de M. G. Govi.

Acad. d. Sci. Paris, Comp. Rend., XCI, 1880, 105-106; Ann. d. Phys. (Poggendorff), IV, 1880, 754.

Graham (G.): **Bradley (J.)**. An account of some pendulum observations by — in London.

Roy. Soc. London, Phil. Trans., XXXVIII, 1735, 302-314.

Title in full under BRADLEY (J.).

——— An account of the proportions of the English and French measures and weights, from the standards of the same kept at the Royal Society. (H.)

Roy. Soc. London, Phil. Trans., 1742, 185-188.

Graham (J. D.) Messages from the governors of Maryland and Pennsylvania, transmitting the reports of the joint commissioners, and of Lieut. Col. Graham, U. S. Topographical Engineers, in relation to the intersection of the boundary lines of the States of Maryland, Pennsylvania, and Delaware, being a portion of Mason and Dixon's line.

8°, Chicago, 1862, 2d ed., pp. 95, 1 map. (Washington, Congress.)

Grammaticus (Nicaise). Dissertatio astronomica de ratione corrigendi typos et calculos eclipsium solis et lunæ in hypothesi telluris sphæricæ, cum ista reapse sit figuræ sphæroidalis.*

4°, Ingolstadti, 1734.

Upon the prolate spheroid hypothesis.—POGGENDORFF, i, 939.

Grant (Alexis). Discours sur la figure de la terre.*

8°, Tournay, 1739; Tournay, 1748.

Lalande, 411.

Grant (Robert). History of physical astronomy from the earliest ages to the middle of the nineteenth century, comprehending a detailed account of the establishment of the theory of gravitation by Newton and its development by his successors; with an exposition of the progress of research on all the other subjects of celestial physics.

8°, London, 1852, pp. XX, 637. (Gore.)

——— Remarks on the early history of astronomers relative to the spheroidal figure of the earth.

Roy. Astron. Soc., Month. Not., XIV, 1854, 232-240.

——— Note on the origin of the attempts made in the seventeenth century to derive from physical principles an invariable standard of measure.

Roy. Astron. Soc., Month. Not., XV, 1855, 36-40.

Grant (S. C. N.) *and* **Kitchener (H. H.)**. Trigonometrical survey of the island of Cyprus.*

London, 1885.

Gravelaar (N. L. W. A.). Het gebruik van determinanten bij de methode der kleinste kwadraten.
Wiss. Genoots. Amsterdam, Arch., x, 1883, 107–112.
Revd. in Jahrb. üb. d. Fortschr. d. Math., xv, 1883, 163–164, by G[EER (VAN)].

Graves (Charles). On geodetic lines in surfaces of the second order.
Roy. Irish Acad., Proc., IV, 1850, 283–287.

GRAVITY, DIRECTION OF.

ABBADIE (A. D'). Directions de la pesanteur.
Acad. d. Sci. Paris, Comp. Rend., LXI, 1865, 838.

——— Études sur la verticale.
Ass. Sci. de France, Bull., XIII, 1874, 162–164.

——— Sur les variations de la verticale.
Acad. d. Sci. Paris, Comp. Rend., LXXXIX, 1879, 1016–1017.

ADAN (E.-H.-J.). Déviations de la verticale.
Ixelles, 1876.

BACALOGLO (E.). Observations relatives à la direction de la verticale à différentes hauteurs audessus du sol.
Arch. d. Math. (Grunert), XLII, 1864, 271–275.

HOSSARD (P.) *et* ROZET. . . . des anomalies observées dans la direction de la verticale.
Acad. d. Sci. Paris, Comp. Rend., XVIII, 1844, 180–185.

GRAVITY, INTENSITY OF.

ABBADIE (A. D'). Sur les variations dans l'intensité de la gravité.
Acad. d. Sci. Paris, Comp. Rend., LII, 1861, 911–912.

ADCOCK (R. J.). Force of gravity at any latitude.
Analyst, IV, 1877, 20.

ADRAIN (R.). Gravity in different latitudes.
Am. Phil. Soc., Trans., I, 1818, 119–135.

ARCY (P. D'). Les degrés d'ellipticité des sphéroïdes, par rapport à l'intensité de l'attraction.
Acad. d. Sci. Paris, Mém., 1738, 318–320.

BABINET (J.). Appareil pour la mesure statique de la pesanteur.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 244–248.

BARRAQUER (J.-M.). La mesure de la pesanteur.
Int. Geod. Cong., Gen.-Ber., 1883, 286–289.

BERTIER (R.-P.). . . . démonstrant que la pesanteur augmente à mesure qu'on s'élève dans l'atmosphère.
Journ. de Phys. (Rozier), II, 1773, 251.

BIDONE (G.). . . . sur l'intensité de la gravité terrestre.
Ann. de Math. (Gergonne), XVIII, 1827–'28, 341–352.

BIOT (J.-B.). Recueil d'observations géodésiques . . . pour déterminer la variation de la pesanteur.
Paris, 1821.

BORENIUS (H. G.). De gravitate ope penduli ex dato situ geopraphico determinanda.
Helsingfors, 1845.

BOSCOVICH (R. G.). De inequalitate gravitatis in diversis terræ locis.
Romæ, 1741; Phil. Recent. (Stay), II, 1760, 359–380.

BROUN (J. A.). On an apparatus for the statical measure of gravity.
L., E., D. Phil. Mag., XXVI, 1863, 158–160.

CAZIN (A.). Intensité de la pesanteur à l'île St.-Paul.
Acad. d. Sci. Paris, Comp. Rend., LXXXII, 1876, 1248–1250.

CELLÉRIER (C.). Sur la mesure de la pesanteur par le pendule.
Soc. Phys. Genève, Mém., XVIII, 1866, ii, 197–218.

CLYRTON (W. E.). Determination of the acceleration of gravity at Tokio, Japan.
L., E., D. Phil. Mag., IX, 1880, 292–301.

CORNU (A.). Détermination nouvelle de la constante de l'attraction.
Acad. d. Sci. Paris, Comp. Rend., LXXVI, 1873, 954–958.

DEFFORGES (G.). Mémoire sur la mesure de l'intensité de la pesanteur.
Int. Geod. Cong., Verhandl., 1887, v, 1–20; Acad. d. Sci. Paris, Comp. Rend. CVI, 1888, 126–129, 191–194.

GRAVITY, INTENSITY OF—Continued.

FAYE (H.-A.-E.-A.). Rapport sur . . . la constante de la pesanteur à Paris.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1463–1466.

FONTANA (G.). Sopra alcune particolarità concernenti la gravità terrestre.
Soc. Italiana, Mem., VIII, 1799, 124–134.

GERGONNE (J.-D.). Note sur la mesure de l'intensité de la pesanteur.
Ann. de Math. (Gergonne), XVII, 1826–'27, 155–158.

GRISCHOW (A.-N.). Observationes et experimenta circa gravitatem mediante pendulo
Acad. de St.-Pétersbourg, Com., 1758–'59, 447–520.

GRUBER (L.). Ueber einen Apparat zu Coincidenzbeobachtungen bei Schwerebestimmungen mit Hülfe des Reversionspendels.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Sitz.-Ber., LXX, 1874, ii, 565–570.

ISSEL (A.). Note sur un instrument destiné à mesurer l'intensité de la pesanteur.
Bull. d. Naturalistes, Moscou, 1882, i, 134–139.

KÖNIG (A.). Eine neue Methode zur Bestimmung der Gravitationsconstante.
K. Ak. d. Wiss., Sitz.-Ber., 1884, 1203–1205.

KRAFFT (G. W.). De gravitate terrestri.
St.-Pétersbourg, 1749.

LAPLACE (P.-S. DE). Sur la figure de la terre et la loi de la pesanteur à sa surface.
Ann. de Chim., VIII, 1818, 312–318.

——— Sur la loi de la pesanteur en supposant le sphéroïde terrestre homogène . . .
Conn. d. Temps, 1821, 284–290.

LESAGE. Expériences et vues sur l'intensité de la pesanteur dans l'intérieur de la terre.
Journ. de Phys. (Rozier), VI, 1775.

LIOUVILLE (J.). Sur la loi de la pesanteur à la surface ellipsoïdale d'équilibre d'une masse liquide . . .
Journ. d. Math. (Liouville), VIII, 1844, 360–378.

MENDENHALL (T. C.). Force of gravity at Tokyo.
Am. Journ. Sci., XX, 1880, 124–132; XXI, 1881, 99–104; Tokio, 1881.

MORET (T.). De ponderum gravitate.
Pragæ, 1663.

OLTMANNS (J.). Beobachtungen über die Schwere.
Jour. f. Math. (Crelle), IV, 1829, 72–84.

OPPOLZER (T. VON). Bericht über die Bestimmung der Schwere mit Hilfe verschiedener Apparate.
Int. Geod. Cong., Gen.-Ber., 1883, vi, 1–28.

PEIRCE (C. S.). Measurements of gravity at initial stations in America and Europe.
U. S. C. and G. Survey, Rep., 1876, 202–337, 410.

——— Sur la valeur de la pesanteur à Paris.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1401–1403; U. S. C. and G. Survey, Rep., 1881, 461–463.

——— Ueber eine Methode mit Pendeln, die Schwere zu bestimmen.
Ann. d. Phys. (Poggendorff), IV, 1880, 240.

——— Determinations of gravity at Alleghany, Ebensburgh, and York, Pa.
U. S. C. and G. Survey, Rep., 1883, 473–487.

PERROT. Appareils destinés à rendre manifestes et mesurables les variations occasionnées dans l'intensité de la pesanteur à la surface de la terre.
Acad. d. Sci. Paris, Comp. Rend., LIV, 1862, 728–729, 851–852.

PETIT (F.). Détermination . . . de l'intensité de la pesanteur à Toulouse.
Acad. de Toulouse, Mém., VI, 1850, 166–190.

PLANA (G.). Note sur . . . la loi de la pesanteur . . . d'après l'hypothèse d'Huygens publiée en 1690.
Astron. Nachr., XXXV, 1853, 371–378.

GRAVITY, INTENSITY OF—Continued.

PLANA (G.). Mémoire sur la loi de la pesanteur à la surface de la mer.
Astron. Nachr., XXXVIII, 1854, 225–238.

PLANTAMOUR (E.). Nouvelles . . . détermination de la pesanteur à Genève et au Righi-Kulm.
Genève, 1872.

—— Tableau . . . des travaux . . . pour la détermination de la pesanteur à l'aide du pendule à réversion.
Int. Geod. Cong., Gen.-Ber, 1880, ii, 1–8.

PRESTON (E. D.). Determinations of gravity . . . Caroline Islands.
U. S. C. and G. Survey, Rep., 1883, 379–381.

RESPIGHI (E.). Esperienze fatte per la determinazione del valore della gravità.
Accad. d. Lincei, Atti, XII, 1882, 346–369.

SECCHI (A.). Sugli sperimenti del pendolo fatti in Roma . . . per la determinazione assoluta della gravità.
Accad. d. Lincei, Atti, IV, 1850–'51, 325–346.

SMITH (E.). Determinations of gravity with the Kater pendulums . . .
U. S. C. and G. Survey, Rep., 1884, 439–473.

STERNECK (R. VON). Ueber den Einfluss des Mondes auf die Richtung und Grösse der Schwerkraft auf der Erde.
Wien, 1876.

STERNECK (R. VON). Untersuchungen über die Schwere im Innern der Erde.
K. k militär-geogr. Inst., Mittheil., II, 1882, 77–120; III, 1883, 59–94; IV, 1884, 89–155; VI, 1886, 92–119; Int. Geod. Cong., Gen.-Ber., 1884–'86, 177–178.

GRAVITY, VARIATION OF.

BOUCHEPORN. Note sur la variation de la pesanteur.
Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 1005–1007.

BROCH (O.-J.). Accélération de la pesanteur sous différentes latitudes et à differntes altitudes.
Int. Bureau Weights and Measures, Trav. et Mém., I, 1881, 1–15.

BROUN (J. A.) Notice of an instrument intended for the measurement of small variations of gravity.
Roy. Soc. Edinb., Proc., IV, 1862, 411–412.

DARWIN (G. H.). On an instrument for detecting and measuring small changes in the direction of the force of gravity.
Brit. A. A. S., Rep., 1881–'82.

FISHER (O.). On the variation of gravity at certain stations of the Indian arc.
L., E., D. Phil. Mag., XXII, 1886, 1–29.

GUIOT (A.). Essai sur les variations de la pesanteur terrestre.
Acad. d. Sci. Paris, Comp. Rend., XXV, 1847, 195–197.

HENNESSY (A.). On the variation of gravity at the earth's surface.
Geol. Soc. Dublin, Journ., IV, 1848–'50, 147–149.

HERSCHEL (J.). Note on the difference of variation of gravity at Revel and at St. Petersburg.
Roy. Astron. Soc., Month. Not., XL, 1879–'80, 2–5.

—— On the determination of the acceleration of gravity for Tokio, Japan.
N. d.

MASON (C.). Astronomic observations made in Pennsylvania . . . to find the difference of gravity between Greenwich and this place.
Roy. Soc. London, Phil. Trans., LVIII, 1768, 326–336.

PRATT (J. H.). On the variation of gravity . . . produced by the irregularities of the earth's crust.
Dehra, 1869.

PRESTON (E. D.). On the . . . variations of gravity in the Hawaiian Islands.
Am. Journ. Sci., CXXXVI, 1888, 305–317.

SAWITSCH (A.-N.). Les variations de la pesanteur dans les provinces occidentales de l'empire russe.
Roy. Astron. Soc., Month. Not., XXXI, 1871, 221–224; Mem., XXXIX, 1872, 19–29.

GRAVITY, VARIATION OF—Continued.

STOKES (G. G.). On the variation of gravity at the surface of the earth.
Phil. Soc. Camb., Trans., VIII, 1849. 672–695; L., E., D. Phil. Mag., XXXV, 1849, 228–229.

Greaves [**Grave** *or* **Gravius**] (**John**). Astronomica quædam ex traditione Shah Cholgii Persæ, una cum hypothesibus planetarum et cum excerptis quibusdam ex Alfergani elementis astronomicis, et Alii Kughgii de terra magnitudine et sphærarum cœlestium a terra distantiis.*
4°, Londonii, 1652.
POGGENDORFF, I, 945.

Green (**George**). On the determination of the exterior and interior attractions of the ellipsoids of variable densities.
Phil. Soc. Camb., Trans., V, 1835, 395–430.

—— Researches on the vibrations of pendulums in fluid media.
Roy, Soc. Edinb., Trans., XIII, 1836, 54–62; Proc., I, 1845, 36–37.

Greene (**F. V.**). Local deflections of the plumb-line near the 49th parallel. Read before the Essayons Club of the Corps of Engineers, November 14, 1876.
Printed Papers, XLI, 1876, 171–184.

Greenhill (**A. G.**). On the differential equation of the ellipticities of the strata in the theory of the figure of the earth.
Quart. Journ. Sci., XVII, 1879, 203–208.

Gregory (**Olinthus Gilbert**). A treatise on astronomy, in which the elements of the science are deduced in a natural order from the appearances of the heavens to an observer on the earth, demonstrated on mathematical principles, and explained by an application to the various phenomena.
8°, London, 1803, pp. xiv, 522, 9 plates.
On the figure and dimensions of the earth, 1–11.

—— Remarks on Don Joseph Rodriguez's animadversions on part of the trigonometrical survey of England.
Phil. Mag. (Tilloch), XLI, 1813, 178–194.

—— Dissertations and letters by Don Joseph Rodriguez, the Chevalier Delambre, Baron de Zach, Dr. Thomas Thomson, Dr. Olinthus Gregory, and others, tending either to impugn or defend the trigonometrical survey of England and Wales, carried on by Col. Mudge and Capt. Colby. Collected, with notes and observations, including an exposure of the misrepresentation and contradictions of Dr. Thomson, and a defence of the late astronomer royal against the imputations of Baron de Zach.
8°, London, 1815, pp. v, 101. (Gore.)

—— On the different rates of Pennington's clock at the island of Balta, in Zetland, and at Woolwich Common, Kent, with remarks upon the results of the various other pendulum experiments.
Phil. Mag. (Tilloch), LIII, 1819, 426–445.

Grenus (**Theodor**). Ueber einige Bemerkungen, welche Herr Svanberg über die Gradmessung von Peru in seiner "Exposition des opérations faites en Lapponie, etc., 1805," gemacht hat.
Mon. Corr. (Zach), XIII, 1806, 398–404.

Grenus (Theodor)—Continued.

——— Resultate einer Vergleichung der Werke von Bouguer, Condamine und Ulloa über die peruanische Gradmessung.

Mon. Corr. (Zach), XVI, 1807, 238–256.

Grimaldi *et* Riccioli. De semidiametro terræ.

Bononiæ, 1655.

Grischow (Augustin Nathanael). Relatio observationum et experimentorum, quorum instituendorum iter anno 1757 in insulam Osiliam susceptum occasionem præbuit.

Acad. de St.-Pétersbourg, Com., 1758–'59, 445–520.

Observationes et experimenta circa gravitatem mediante pendulo, 447–520.

———: **Herschel (J.).** Note on —'s pendulum observations.

Roy. Astron. Soc., Month. Not., XL, 1879–'80, 2–5.

Gronau (Johann Friedrich Wilhelm). Ueber die Bewegung schwingender Körper in widerstehendem Mittel, mit Rücksicht auf die Newton'schen Pendelversuche.

4°, Danzig, 1850, pp. 14. (Oxford, Bodleian.)

——— Historische Entwickelung der Lehre von Luftwiderstande.*

Danzig. Schriften, II, 1868, 1.

Gruber (Ludwig). Ueber einen Apparat zu Coincidenzbeobachtungen bei Schwerebestimmungen mit Hilfe des Reversionspendels.

K. k. Ak. d. Wiss., math.-naturwiss. Cl., Sitz.-Ber., LXX, 1874, ii, 565–670.

——— Bestimmung der Schwere in Budapest vermittelst des Reversionpendels.*

Budapest, 1880.

Grüson (Johann Philip). Von der Geodäsie oder Feldtvertheilung.

8°, Berlin, 1811, pp. 640, 18 plates.

Simple surveying.

Grunert (Johann August). Sphäroidische Trigonometrie.

4°, Berlin, 1833, pp. iv, 311. (British Museum.)

——— Elemente der ebene sphärischen und sphäroidischen Trigonometrie in analytischer Darstellung mit Anwendung auf Geodäsie und Astronomie, zum Gebrauche bei Vorlesungen.

8°, Leipzig, 1837, pp. xiv, 339, 2 plates. (British Museum.)

——— Das Pothenot'sche Problem, in erweiterer Gestalt; nebst Bemerkungen über seine Anwendung in der Geodäsie.

Arch. d. Math. (Grunert), I, 1841, 238–248.

——— Ueber eine geodätische Aufgabe.

Arch. d. Math. (Grunert), I, 1841, 423–430; III, 1843, 35–40; VII, 1846, 238–259; VIII, 1846, 433–450.

A special case of the three-point problem.

——— Geodäsie, oder Lehre von Aufnahmen, Niveliren und die Markscheidekunst. Vol. 2 of Lehrbuch der Mathematik und Physik.

8°, Leipzig, 1842, pp. x, 486, 13 plates. (Berlin, Royal.)

——— Einige Bemerkungen über fehlerzeigende Dreiecke.

Arch. d. Math. (Grunert), IV, 1844, 348–355.

Grunert (Johann August)—Continued.

——— Ueber eine geodätische Aufgabe.

Arch. d. Math. (Grunert), IV, 1844, 385–408.

A special case of the three-point problem.

——— Geodätische Aufgabe.

Arch. d. Math. (Grunert), V, 1844, 212–215.

——— Völlig strenge und allgemeine Auflösung der Hauptaufgabe der höheren Geodäsie.

Arch. d. Math. (Grunert), VII, 1846, 68–93.

The three-point problem, in which the height is also computed.

——— Ueber Distanzmesser.

Arch. d. Math. (Grunert), VIII, 1846, 254–267.

——— Ueber die atmosphärische, vorzüglich die terrestrische Refraction, und über Refractionscurven im Allgemeinen.

Arch. d. Math. (Grunert), X, 1847, 1–41.

——— Ueber eine vorzüglich zur Anwendung bei geodätischen Messungen geeignete Methode zur Bestimmung der Polhöhe oder geographischen Breite.

Arch. d. Math. (Grunert), XIX, 1852, 457–468.

——— Ueber eine neue geodätische Aufgabe.

Arch. d. Math. (Grunert), XXI, 1853, 330–342.

An extension of the three-point problem.

——— Ueber eine neue bei der Ausführung höherer geodätischer Messungen und Rechnungen in Anwendung zu bringende Methode.

Arch. d. Math. (Grunert), XXIV, 1855, 121–203.

——— Das sphärische Dreieck mit seinem Sehnendreiecke verglichen, mit besonderer Rücksicht auf Geodäsie.

Arch. d. Math. (Grunert), XXV, 1855, 197–210.

——— Ueber eine geometrische Aufgabe von der Kugel, mit Rücksicht auf Geodäsie.

Arch. d. Math. (Grunert), XXV, 1855, 455–471.

——— Theorie des Foucault'schen Pendelversuchs, aus neuen Gesichtspunkten dargestellt, mit Rücksicht auf die ellipsoidische Gestalt der Erde.

Arch. d. Math. (Grunert), XXVIII, 1857, 223–248.

——— Ueber den Gebrauch der Spiegel-Sextanten bei geodätischen Messungen.

Arch. d. Math. (Grunert), XXVIII, 1857, 420–435.

——— Drei Grössen x, y, z, deren Summe die gegebene Grösse ist, sind durch Messung bestimmt worden, und man habe dadurch für diese drei Grössen respective die Werthe a, b, c, erhalten. Da diese Werthe mit Beobachtungsfehler behaftet sind, und ihre Summe also im Allgemeinen nicht genau s ist, so soll man dieselben so verbessern, dass die verbesserten Werthe genau die Summe s geben, und die Summe der quadrate der Verbesserungen ein Minimum ist.

Arch. d. Math. (Grunert), XXXI, 1858, 480–481.

———: **Unferdinger (F.).** Neuer Beweis des von — in der Abhandlung: Das sphärische Dreieck mit besonderer Rücksicht auf Geodäsie.

Arch. d. Math. u. Phys., XXV, 1855, 197–210; Arch. d. Math. (Grunert), XXXIII, 1859, 89–91.

——— Lagenbestimmungen auf der Kugel, eine Ergänzung der sphärischen Trigonometrie, mit besonderer Rücksicht auf Geodäsie.

Arch. d. Math. (Grunert), XXXVI, 1861, 51–79.

Grunert (Johann August)—Continued.

——— Ueber Länge und Breite, reducirte Länge und reducirte Breite auf dem dreiaxigen Ellipsoid.
Arch. d. Math. (Grunert), XXXVI, 1861, 79–100.

——— Ueber die Excentricität der Bonssole.
Arch. d. Math. (Grunert), XXXVII, 1861, 458–475.

——— Geometrische Aufgaben, welche zur Anwendung in der nautischen Geodäsie geeignet sind.
Arch. d. Math. (Grunert), XXXVIII, 1862, 81–133.

——— Ueber die Normalschnitte des allgemeinen dreiaxigen Ellipsoids mit besonderer Beziehung auf höhere Geodäsie, namentlich auch über neue merkwürdige Ausdrücke der grössten und kleinsten Krümmungshalbmesser und einen neuen geometrisch merkwürdigen und für Geodäsie wichtigen Satz von diesen Krümmungshalbmessern.
Arch. d. Math. (Grunert), XL, 1863, 259–354.

——— Noch zu der Kugel der mittleren Krümmung des Ellipsoids.
Arch. d. Math. (Grunert), XLIII, 1865, 361–364.

——— Neue Auflösungen einer nautisch-astronomischen und einer geodätisch-astronomischen Aufgabe.
Arch. d. Math. (Grunert), LIV, 1872, 419–476.

Gruterus (Johannes). Disputatio philosophica de terræ rotunditate.
8°, Lugduni Batavorum, 1668, pp. [6]. (British Museum.)

Grye (de la). *See* **Bouguet de la Grye.**

Guarducci (F.). Metodo grafico per la riduzione delle osservazioni geodetiche azimutali a centro trigonometrico.*
Torino, —.

Gudermann (Christoph). De pendulis sphæricis et de curvis, quæ ab ipsis describuntur.
Journ. d. Math. (Crelle), XXXVIII, 1849, 185–215.

——— Fundamenta trigonometriæ sphæroidicæ exacta; imprimis de lineis brevissimis, vulgo dictis geodæticis, in superficie sphæroidica.
Journ. d. Math. (Crelle), XLIII, 1852, 294–339.

Günther (Siegmund). Studien zur Geschichte der mathematischen und physikalischen Geographie.
8°, Halle, 1879, pp. 405.
Heft 1. Die Lehre von der Erdrundung und Erdbewegung im Mittelalter bei den Occidentalen. Halle, 1877, pp. 56. (Oxford, Bodleian.)
Bibliography of history, of mathematical and physical geography, 399–405.

——— Die Erdmessung des Eratosthenes.
Geogr. Rundschau, III, 1881, 327–336.

——— Die neueren Bemühungen um schärfere Bestimmungen der Erdgestalt.*
Berlin, 1883.

Guillaume (Ch. Ed.). Sur la détermination des coefficients de dilatation au moyen du pendule.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 689–691.

Guiot (Auguste). Essai sur les variations de la pesanteur terrestre.
Acad. d. Sci. Paris, Comp. Rend., XXV, 1847, 195–197.

Gumpach (Johannes von). A letter on the figure of the earth to G. B. Airy.
Literary Gazette, 1861, 372.

Gumpach (Johannes von)—Continued.

——— A letter to George Stokes on the subject of the true figure and dimensions of the earth.
8°, Guernsey, 1862, pp. 14. (British Museum.)
Printed for private circulation among the members of the Royal Society.

——— The true figure and dimensions of the earth, newly determined from the results of geodetic measurements and pendulum observations, compared with the corresponding theoretical elements, for the first time deduced upon purely geometrical principles, and considered both with reference to the progress of scientific truth and as bearing upon the practical interests of British commerce and navigation; in a letter addressed to George Biddell Airy, astronomer royal.
2d ed., entirely recast, London, 1862, pp. xi, 266, 30 diagrams. (Gore.)
To prove that the earth, instead of being flattened, is elongated at the poles.

Guyot (Jules). Le pendule n'est pas perpendiculaire à la surface des eaux tranquilles.
Acad. d. Sci. Paris, Comp. Rend., XXVII, 1851, 705; Cosmos, II, 1853, 447–449.

Gyldén (H.). Untersuchungen über die Constitution der Atmosphäre und die Strahlenbrechung in derselben.
Acad. de St.-Pétersbourg, Mém., 1866, 1–82; XII, 1868, 1–58.

(H.) after titles means that they were furnished by Colonel **John Herschel**, R. E.

H. Documentary publications and science in the Coast Survey report for 1853.
Am. Journ. Sci., XVIII, 1854, 200–212.
A cursory review of the above-named report.

Haas (August). Versuchung einer Darstellung der Geschichte des Krümmungsmasses.
4°, Tübingen, 1881, pp. 77. (Oxford, Bodleian.)

Hadley (John). The description of a new instrument for taking angles.
Roy. Soc. London, Phil. Trans., XXXVII, 147–157.
The instrument is "Hadley's quadrant."

Haedenkamp (Herrmann). Gleichungen der Bewegung eines Pendels auf der sich um ihre Axe drehenden Erde.
Arch. d. Math. (Grunert), XX, 1853, 238–243.
With an appendix of one page by the editor. A modification of Foucault's theorem, taking into consideration the rotation of the earth.

——— Ueber die Veränderungen der Rotationsaxe der Erde durch Veränderungen auf der Erdoberfläche.
Ann. d. Phys. (Poggendorff), XC, 1853, 342–347.

Hällstrom (G. G.). De longitudine penduli pro Aboa. (H.)
Aboæ, 1805.

Haffner (W.) *und* **Fearnley (C.).** Publication der norvegischen Commission der Gradmessung.
Christiania, 1880–'82.
Title in full under FEARNLEY (C.).

Hagen (G. H. L.). Grundzüge der Wahrscheinlichkeitsrechnung.*
Berlin, 1837.

——— Die wahrscheinlichen Fehler der Constanten.
K. Ak. d. Wiss., Sitz.-Ber., XLIV, 1843, 1169–1172.

Haig (**C. T.**) *and* **Cole** (**W. H.**). General description of the Jodhpore and the eastern Sind meridional series of the Northwest quadrilateral.
India, Trig. Survey, IV, A., 1886, xvii, 73; xx, 227, 2 plates.

——— *and* **Thuillier** (**H. R.**). Auxiliary tables to facilitate the calculations of the survey of India.
Dehra Dún, 1887.
Title in full under THUILLIER (H. R.).

Halacsy (**A. von**). Bestimmung der Hauptpunkte der Triangulation der Umgegend von Pest.*
Pest, 1867.

Hall (**Asaph**). The density of the earth.
Analyst, IX, 1882, 129–132.
D = 5.6747 ± 0.0038.

——— The figure of the earth and the motion of the moon.
Ann. of Math., II, 1886, 111–112.

Hall (**Basil**). Details of experiments made by him and Mr. Henry Foster with an invariable pendulum in London; at the Galapagos Islands, in the Pacific Ocean, near the equator; at San Blas de California, on the northwest coast of Mexico; at Rio de Janeiro, in Brazil. With an appendix containing the second series of experiments in London on the return.
Roy. Soc. London, Phil. Trans., CXIII, 1823, 211–288.

——— *and* **Foster** (**H.**). Experiments made with an invariable pendulum on the coast of Mexico and Brazil.
Edinb. Phil. Journ., X, 1824, 91–95.

Hall (**B**): **Pouillet** (**C.-S.-M.**). Lettre du Capitaine — sur les observations du pendule invariable, à Londres, aux îles Galapagos, etc.
Bull. Sci. Math. (Saigey), I, 1824, 151–152.

Halley (**Edmund**). Discourse concerning gravity and its properties, wherein the descent of heavy bodies, and the motions of projects is briefly but fully handled.
Roy. Soc. London, Phil. Trans., XVI, 1686, 3–21.

Hamilton (**James Archibald**). An essay on the present state of astronomical certainty, with regard to the quantity of the earth's magnitude, the distance of that planet from the sun, and the absolute limit of the smallest possible interval from the sun to any one of the fixed stars.
Roy. Irish Acad., Trans., XI, 1810, 13–24.

Hamilton-Smythe (**Arthur**). Comparison of British and metric measures for engineering purposes, with an abstract of the discussion upon the paper. Edited by James Forrest.
8°, London, 1885, pp. 66, 1 plate.
Excerpt minutes of the Proc. Institution of Civil Engineers, LXXX, 1884–'85, ii.

Hammer: **Bohnenberger**. Berechnung der trigonometrischen Vermessungen in Rücksicht auf die sphäroidische Gestalt der Erde von Bohnenberger. Bearbeitung von —.
8°, Stuttgart, 1885, pp. viii, 65. (Berlin, Geodetic Institute.
Revd. in Zeits. f. Vermes., XV, 44; Zitos. d. hannoverischen Architekten- und Ingenieurvereins, XXII, 170.

——— [Bericht über die geodätischen Arbeiten in Württemberg in den Jahren 1884–'86.]
Int. Geod. Cong., Verhandl., 1884–'86, 238–239.

Hampden (**J.**) *and* **Peacock** (**G.**). Is the world flat or round?*
8°, 3d ed., 1871.

Handrikoff. Solution d'un problème fondamental de géodésie.
Soc. Nat. Moscou, Bull., XXXVIII, 1865, i, 246–266.

Haner. Basisapparat.
Eisenbahn, XIV, 1882, 19.
Title from Zeits. f. Vermes., XII, 1883, 396.

Hañez. Sur l'origine et les progrès des instruments d'astronomie et de géodésie.
Presse Scientifique, I, 1863, 427–433.

Hann (**J.**). [Ueber die in Astronomische Nachrichten, 2094–2095, enthaltene Arbeit "Die Gestalt der Erde und die Pendelmessungen von A. Fischer."]
Astron. Nachr., LXXXVIII, 1876, 203–208, 305–308.

Hansen (**Peter Andreas**). Ueber die Anwendung der Wahrscheinlichkeitsrechnung auf geodätische Vermessung im Allgemeinen, und über die Maupertuis'sche Gradmessung.
Astron. Nachr., IX, 1831, 189–219, 237–262.

——— Darlegung einer neuen Methode, bei Anwendung der Methode der kleinsten Quadrate, die gewichte der unbekannten Grössen zu berechnen.
Astron. Nachr., VIII, 1831, 463–468.

——— Auflösung einer allgemeinen Aufgabe aus der Warscheinlichkeitsrechnung.
Astron. Nachr., XVI, 1839, 9–16.

——— Eine Aufgabe aus der practischen Geodäsie und deren Auflösung. Die Lage zweier unbekannten Punkte durch Hülfe der Lage zweier bekannten Punkte zu bestimmen, ohne jene von diesen aus zu beobachten.
Astron. Nachr., XVIII, 1841, 165–176.

——— Instruction für die Triangulation von Thüringen.*
Weimar, 1848.

——— Theorie der Pendelbewegung mit Rucksicht auf die Gestalt und Bewegung der Erde. Gekrönte Preisschrift.
Naturf. Ges. Danzig, neueste Schriften, XV, 1853, 1–96.
Revd. in Roy. Astron. Soc., Month. Not., XIV, 1854, 53–59; Ann. d. Phys. (Poggendorff), XCII, 1854, 21–33.

——— Ueber die Anziehung eines Revolutions-Ellipsoids und die Wirkung desselben auf die Pendelbewegung.
Astron. Nachr., XXXVIII, 1854, 129–138.

——— Von der Methode der kleinsten Quadrate im Allgemeinen und in ihrer Anwendung auf die Geodäsie.
K. sächs. Ges., math.-phys. Cl., Abhandl., VIII, 1865, 573–806.

——— Geodätische Untersuchungen.
4°, Leipzig, 1865, pp. 224 (Gore); K. sächs. Ges. d. Wiss., math.-phys. Cl., Abhandl., VIII, 1865, 1–224; IX, 1871, 1–355; Ber., XVIII, 1866, 132–151.

——— Kurzgefasste rationelle Ableitung des Ausgleichungsverfahrens eines Dreiecksnetzes, nach der Abhandlung: "Von der Methode der kleinsten Quadrate u. s. w.," mit Weglassung aller Nebenbetrachtungen.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Ber., XX, 1868, 129–150.

Hansen (Peter Andreas)—Continued.

——— Gegenbericht an die permanente Commission der europäischen Gradmessung von —. Auf Veranlassung des Berichts des Herrn General-Lieutenant z. D. Baeyer, Exc. an dieselbe Commission über ein schriftliches Gutachten des oben Genannten über die Arbeiten der königl. preuss. Landestriangulation, welcher Bericht ganz kürzlich, von zwei Beilagen begleitet, im Druck erschienen ist.
4°, Gotha, 1868, pp. 17. (Southampton, Ordnance Survey.)

——— Fortgesetzte geodätische Untersuchungen.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Abhandl., XIV, 1869, 1-185, 289-356.

——— Entwickelung eines neuen veränderten Verfahrens zur Ausgleichung eines Dreiecksnetzes mit besonderer Betrachtung des Falles in welchem gewisse Winkel voraus bestimmte Werthe bekommen sollen.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Abhandl., XIV, 1869, 185-287.

——— Reflexionen über die Reduction der Winkel eines sphäroidischen Dreiecks von kleinen Seiten auf die Winkel des ebenen oder sphärischen Dreiecks von denselben Seiten.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Ber., XXI, 1869, 138-144.

——— Bemerkungen zu einem von der permanenten Commission der europäischen Gradmessung am 21. September vorigen Jahres zu Wien gehaltener Vorträge.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Ber., XXIV, 1872, 1-15.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IV, 1872, 579-585, by [WITTSTEIN].
In reply to strictures on Geodätische Untersuchungen by WEINGARTEN.

——— Darlegung einer unbedeutend scheinenden Umformung der Endgleichungen des "Supplements zu den geodätischen Untersuchungen" durch welche aber eine weit grössere Genauigkeit in den numerischen Werthen derselben erlangt wird.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Ber., XXIV, 1872, 15-25.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IV, 1872, 585-586, by [WITTSTEIN].

——— Von der Bestimmung der Theilungsfehler eines geradlinigen Maassstabes.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Abhandl., XV, 1874, 527-667.

Hansteen (C.) : **Struve (F. G. W.)**. Arc du méridien de 25° 20′ mesuré depuis 1816 jusqu'en 1850 sous la direction de —.
St.-Pétersbourg, 1857-'60.
Title in full under STRUVE (F. G. W.).

Hargreave (C. J.). On the calculation of attractions, and the figure of the earth.
Roy. Soc. London, Phil. Trans., CXXXI, 1841, 75-98.

Harkness (William). On the progress of science as exemplified in the art of weighing and measuring. To which are appended some historical notes and a bibliography.
Phil. Soc. Wash., Bull., x, 1888, xxxix-lxxxvi.

Harper's Mag., *for* Harper's Monthly Magazine.
8°, New York.

Hart (Andrew S.). [Geodesic lines through the umbilic of an ellipsoid.]
Roy. Irish Acad., Proc., IV, 1847-'50, 274.

——— Geometrical demonstrations of some properties of geodesic lines.
Camb. Math. Journ. (Thomson), IV, 1849, 80-84.

——— On geodesic lines traced on a surface of the second degree.
Camb. Math. Journ. (Thomson), IV, 1849, 192-194.

Hartl (Heinrich). Ueber den zusammenhang zwischen der terrestrischen Strahlenbrechung und den meteorologischen Elementen.
Oester. Ges. f. Meteorologie, Zeits., XVI, 1881, 129.

———: **Sterneck (R. von)** *und* **Kalmár (von)**. Bericht über die Leistung der astronomisch-geodätischen Gruppe des k. k. militär-geographischen Instituts.
Int. Geod. Cong., Verhandl., 1884-'86, 154-177.

——— *und* **Kalmár (A. von)**. Bericht über die Gradmessungs-Arbeiten des k. k. militär-geographischen Institnts im Jahre 1887.
Int. Geod. Cong., Gen.-Ber., 1887, viii, 1-18.

——— Materialien zur Geschichte der astronomisch-trigonometrischen Vermessung der österreichisch-ungarischen Monarchie.
K. k. militär-geogr. Inst., Mittheil., VII, 1877, 117-228.

Hartmann (Johann Georg Friedrich). Ueber die Correction der mit dem doppelt repetirenden Theodoliten gemessenen Winkel, wegen der Excentricität des zweiten sogenannten versicherungs-Fernrohrs.
Astron. Nachr., VII, 1829, 227-230.

——— Ueber die Correction der gemessenen Horizontal-Winkel wegen excentrischer Aufstellung des Instrumentes.
Astron. Nachr., VII, 1829, 232-236.

——— Ueber die Benutzung des sogenannten Fehlerzeigenden Dreiecks zur Bestimmung der Correctionen der angenährten Coordinanten des unbekannten vierten Punktes.
Astron. Nachr., VII, 1829, 235-238.

——— Ueber die Benutzung von zwei gleichen entgegengesetzt liegenden fehlerzeigenden Dreiecken zur Bestimmung der unbekannten Beobachtungsstelle.
Astron. Nachr., VII, 1829, 237-240.

——— Directe Bestimmung der Coordinaten von zwei unbekannten Punkten, wenn man in jedem dieser Punkte dieselben beiden bekannten Punkte und auch den andern unbekannten Punkt sieht.
Astron. Nachr., VII, 1829, 239-242.

——— Ueber die Ausgleichung des Einflusses der Excentricität bei eingetheilten Kreisen, durch das Ablesen an verschiedenen Nonien.
Astron. Nachr., VII, 1829, 241-246.

——— Ueber die Ausgleichung des Fehlers in den gemessenen Horizontalwinkeln, welcher nur durch das Ablesen auf dem nicht genau horizontalliegenden eingetheilten Kreise entsteht.
Astron. Nachr., VII, 1829, 247-248.

——— [Ueber die Theilungen der Instrumente von Ertel und Honbaum.]
Astron. Nachr., X, 1832, 309-312.
Used by Gauss in the Hannover degree-measurements from 1823-'33.

Hartner (J.). Handbuch der niederen Geodaesie, nebst einem Anhange über die Elemente der Markscheidekunst. Zum Gebrauche der technischen Lehranstalten, sowie für das Selbststudium. Zweite vermehrte und verbesserte Auflage.
8°, Wien, 1856, pp. xvi, 610, 2 plates; 4th ed., Wien, 1872.
VI. Auflage, bearbeitet und vermehrt von J. Wastler, Wien, 1885.
Revd. in Zeits. f. Vermess., xv, 123, 405; Zeits d. Vereins deutscher Ingenieure, xxx, 1886, 392.

Hassler (Ferdinand Rudolph). An account of pyrometric experiments made at Newark, N. J., in April, 1817.
Am. Phil. Soc., Trans., I, 1818, 210–227.
Determining the length of the base apparatus.

——— Paper on various subjects connected with the survey of the coast of the United States.
Am. Phil. Soc., Trans., II, 1825, 232–419.

———: **Bessel** (F. W.). Ueber die von — Vermessung der Küste der Vereinigten Staaten.
Astron. Nachr., VI, 1828, 349–356.
Translated by Renwick (J.), Am. Jour. Sci., XVI, 1829, 225–234.

——— Principal documents relating to the survey of the coast of the United States since 1816.
8°, New York, 1834, pp. 180, iv. (Gore.)
Revd. in N. Am. Rev., XLII, 1836, 75–94.

——— Second volume of the principal documents relating to the survey of the coast of the United States, from October, 1834, to November, 1835.
8°, New York, 1835, pp. 156, iii. (Gore.)

——— Documents relating to the construction of standards of weights and measures for the custom-houses, from March to November, 1835.
8°, New York, 1835, pp. 31. (Gore.)

——— Third volume of the principal documents relating to the survey of the coast of the United States, and the construction of uniform standards of weights and measures for the custom-houses and States, from November, 1835, to November, 1836.
8°, New York, 1836, pp. iii, 123. (Gore.)

——— Documents relating to the construction of uniform standards of weights and measures for the United States, from 1832 to 1835.
8°, New York, 1836, pp. 25. (Gore.)

——— Eighth report of F. R. Hassler as superintendent of the survey of the coast of the United States and of the construction of standards of weights and measures, rendering account of the works of 1839. From Congressional Documents, Twenty-sixth Congress, first session, December 27, 1839.
Journ Frank. Inst., XXIX, 1840, 91–97.

——— Bericht über die Küsten-Vermessung in Nord-America.
Astron. Nachr., XIX, 1842, 353–368, 377–384.

Hatt. Sur l'emploi des boules-panorama, comme signaux solaires.
Acad. d. Sci. Paris, Comp. Rend., CI, 1885, 1125–1126.

——— Valeur théorique de l'attraction locale à Nice.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886.

——— Sur l'évaluation des erreurs inhérentes au système des coordonnées rectangulaires.
Acad. d. Sci. Paris, Comp. Rend., CVI, 1888, 921–924.

Hauber (Carl Friedrich). Ueber die Bestimmung der Genauigkeit der Beobachtungen.
Zeitz. f. Phys. (Baumgartner), VII, 1830, 406–429.

——— Theorie der mittleren Werthe.
Zeits. f. Phys. (Baumgartner), VIII, 1830, 25–56, 147–179, 295–315, 443–455; IX, 1831, 302–322; X, 1831, 425–457.

Haughton (Samuel). On Clairaut's theorem.
Camb. Math. Journ. (Thomson), VI, 1851, 182–185.

——— On the density of the earth, deduced from the experiments of the astronomer royal, in the Harton coal pit.
L., E., D. Phil. Mag., XII, 1856, 50–51; Ann. de Phys. (Poggendorff), XCIX, 1856, 332–334.

Haupt (C.). Ein Mittel zur Steigerung der Genauigkeit von Basismessungen.
Zeits. f. Instrumentenkunde, II, 1882, 241–252.

——— Die Ausgleichung grosser geodätischer Dreiecke.
Astron. Nachr., CVII, 1883, 65–84.

——— Gradmessungs-Beiträge.
Astron. Nachr., CIX, 1884, 7–28.

——— Ueber die Anordnung trigonometrischer Rechenformulare.
Zeits. f. Vermes., XVII, 1888, 407–425.

Haupt (L. M.). On the use of the heliotrope in geodetic surveys.
Journ. Frank. Inst., CVI, 1878, 416–418.

——— Geodetic surveys. On the heliotrope.
Scientific American Supplement, VII, 1879, 2589.

Hayden (F. V.): **Gannett** (H.). The geodetic work of the — survey.
Science, II, 1884, 447–448.

Hayes (Isaac I.). Physical observations in the Arctic seas. Made on the west coast of north Greenland, the vicinity of Smith Strait and the west side of Kennedy Channel during 1860 and 1861. Reduced and discussed by Charles A. Schott.
Smithsonian Contributions to Knowledge, XV, 1867.
Pendulum experiments, 29–68.

Hazzidakis (J. N.). Ueber die Curven, welche sich so bewegen können, dass sie stets geodätische Linien der von ihnen erzeugten Fläche bleiben.
Journ. f. Math. (Crelle), XCV, 1883, 120–139.

Hearn (George Whitehead). On the causes of the discrepancies observed by Mr. Baily with the Cavendish apparatus for determining the mean density of the earth.
Roy. Phil. Soc. Edinb., Trans., 1847, 217–230.

Heaviside (W. J.). Preliminary abstract of approximate mean results with the invariable pendulum.
Roy. Soc. London, Proc., XXIII, 1875, 316–317.

Heel (Joh. Nep.). Gestalt und Grösse der Erde.
4°, Speier, 1865, pp. 23, 1 plate.

Heger (Richard). Bemerkung zu der Bestimmung der Abplattungsgrenzen für das Erdsphäroid ($\frac{1}{107}$ und $\frac{1}{578}$) aus der Nutation.
Zeits. f. Math. (Schlömilch), XV, 1870, 293–296.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869–'70, 838–839, by Ohrtmann.

Heine (Heinrich Eduard). Theorie der Anziehung eines Ellipsoids.
Journ. d. Math. (Crelle), XLII, 1851, 70–82.

Heldenfeld (A. Mayer von). Neuestes astronomisch-trigonometrisches Netz über die ganze österreichische Monarchie.
Mon. Corr. (Zach), XV, 1807, 461-467; XVIII, 1808, 17-33.

Helfenzrieder (Johann Evangelist). Abhandlung von der Geodäsie oder dem praktischen Feldmessen, darinnen verschiedene neue Instrumente beschrieben, oder neue Vortheile vorgetragen werden, wodurch die Arbeit entweder erleichtert, oder sicherer und genauer wird.
4°, Ingolstadt und Augsbung, 1776, pp. [xii], 387, 5 plates. (Dresden, Royal.)

Helmert (Friedrich Robert). Studien über rationelle Vermessungen im Gebiete der höheren Geodäsie.
Zeits. f. Math. (Schlömilch), XIII, 1868, 73-120, 163-186.
As a separate, 8°, Leipzig, 1868, pp. 72, 1 pl.
Revd. in Jahrb. üb d. Fortschr. d. Math., I, 1868, 389-390, by B[RUNS].

—— Beiträge zur Theorie der Ausgleichung trigonometrischer Netze.
Zeits. f. Math. (Schlömilch), XIV, 1869, 174-208.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869-'70, 834-835, by B[RUNS].

—— Account of the operations of the great Trigonometrical Survey of India. Vol. 1. Revd. by —.
Astron. Ges., Vierteljahrs., VIII, 1873, 14-15.

—— Die Ausgleichungsrechnung nach der Methode der kleinsten Quadrate mit Anwendungen auf die Geodäsie und die Theorie der Mess-Instrumente.
8°, Leipzig, 1872, pp. xi, 348. (Gore.)
Revd. in Jahrb. üb. d. Fortschr. d. Math., V, 1873, 593-594, by [OHRTMANN].

—— Bestimmung des mittleren Fehlers der Längenmessungen aus den Differenzen von Doppelmessungen.
Astron. Nachr., LXXXI, 1873, 48-53.

—— Einfache Ableitung Gaussischer Formeln für die Auflösung einer Hauptaufgabe der sphärischen Geodäsie.
Zeits. f. Vermess., IV, 1875, 153-156.
Revd. in Liter. Arbeiten aus d. Gebiete d. reinen u. angewandten Math., Leipzig, I, 162-165.
This is ascribed to G. HELMERT in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 782.

—— Einige Nachrichten über einen Mikroskop-Theodolit.
Zeits. f. Vermess., IV, 1875, 327-341.

—— Ueber die Berechnung des wahrscheinlichen Fehlers aus einer endlichen Anzahl wahrer Beobachtungsfehler.
Zeits. f. Math. (Schlömilch), XX, 1875, 300-303.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 113.

—— Ueber die Formeln für den Durchschnittsfehler.
Astron. Nachr., LXXXV, 1875, 354-366.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 113.

—— Die Genauigkeit der Formel von Peters zur Berechnung des wahrscheinlichen Fehlers directer Beobachtungen gleicher Genauigkeit.
Astron. Nachr., LXXXVIII, 1876, 113-132.

—— Discussion der Beobachtungsfehler in Koppe's Vermessung für die Gotthardtunnelachse.
Zeits. f. Vermess., V, 1876, 146-155.
Revd. in Liter. Arbeiten aus dem Gebiete d. reinen u. angewandten Math., Leipzig, I, 380-388.

Helmert (Friedrich Robert)—Continued.

——: **Plantamour (E.).** Nouvelles expériences faites avec le pendule à Genève et au Righikulm. Revd. by —.
Astron. Ges., Vierteljahrs., XI, 1876, 13-15.

——: **Peters (C. F. W.).** Beobachtungen mit dem Bessel'schen Pendelapparate in Königsberg und Güldenstein, etc. Revd. by —.
Astron. Ges., Vierteljahrs., XI, 1876, 33-61.

——: **Fergola (E.).** Sulla posizione dell' asse di rotazione della terra, etc. Revd. by —.
Astron. Ges., Vierteljahrs., XI, 1876, 94-103.

——: **Fergola (E.).** Dimensioni della terra e ricerca della posizione del suo asse di figura. Revd. by —.
Astron. Ges., Vierteljahrs., XI, 1876, 280-287.

—— Ueber die Wahrscheinlichkeit der Potenzsummen der Beobachtungsfehler und über einige damit im Zusammenhange stehende Fragen.
Zeits. f. Math. (Schlömilch), XXI, 1876, 192-218.

—— Uebersicht der Literatur für Vermessungswesen.
Zeits. f. Vermess., V, 1876 (1)-(64).

—— Untersuchungen über den Einfluss eines regelmässigen Fehlers im Gange der Ocularröhre des Visirfernrohrs auf Messungen, insbesondere auf das geometrische Nivellement.
Zeits. des Architecten- und Ingenieur-Vereins in Hannover, XXII, 1876, 417-424.

——: **Andrae (C. G.).** "Den danske Gradmessung." Vol. 1 and 2. Revd. by —.
Astron. Ges., Vierteljahrs., XII, 1877, 184-209; XIII, 1878, 57-80.

—— Die Bestimmung des Fehlergesetzes aus Beobachtungen auf graphischen wege.
Zeits. f. Vermess., 1877, 22-26.

—— Ableitung eines Satzes für die Krümmung des Rotationsellipsoides.
Zeits. f. Vermess., VI, 1877, 26-28.

—— Strenger Ausdruck für den mittleren Fehler eines Polygonwinkels.
Zeits. f. Vermes., VI, 1877, 112.

—— Ueber den Maximalfehler einer Beobachtung.
Zeits. f. Vermes., VI, 1877, 131-147.

—— Triangulirung and Projectionsmethoden.
Zeits. f. Vermess., VI, 1877, 606-614.

—— Uebersicht der Literatur für Vermessungswesen auf 1876.
Zeits. f. Vermes., VI, 1877 (1)-(68).
Geodäsie (65)-(71).

—— Zur Bestimmung des Gewichts von Beobachtungen, deren mittleren Fehlerquadrat sich aus mehreren Theilen zusammensetzt.
Astron. Nachr., LXXXIX, 1877, 225-246.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 155-156, by B[RUNS].

—— *und* **Peters.** Zur Berechnung der Loth-Ablenkung durch den Mond.
Astron. Nachr., XCI, 1877, 235-238.

—— Das Theorem von Clairaut.
Zeits. f. Vermes., VII, 1878, 121-145.
Revd. in Jahrb. üb. d. Fortschr. d. Math., X, 1878, 768, by B[RUNS].

Helmert (Friedrich Robert)—Continued.

——— Instrumente für höhere Geodäsie.
Braunschweig, 1878.
Separatabdruck aus dem Berichte über die wissenschaftlichen Apparate auf der Londoner Aufstellung im Jahre 1876, 155–188.

——— Die geodätische Uebertragung geographischer Coordinaten.
Astron. Nachr., XCIV, 1879, 313–320.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XI, 1879, 795, by B[RUNS].

——— Die mathematischen und physikalischen Theorieen der höheren Geodäsie. Einleitung und erster Theil: Die mathematischen Theorieen.
8°, Leipzig, 1880, pp. xiv, 631. *Teubner.*
Zweiter Theil: Die physikalischen Theorieen, mit Untersuchungen über die mathematische Erdgestalt auf Grund der Beobachtungen. xv, 640, 2 plates, Leipzig, 1884. (Gore.)
Revd. in Jahrb. üb. d. Fortschr. d. Math., XVI, 1884, 1080–1881, by P[ETZOLD]; Zeits. f. Vermes., IX, 1880, 359–368, by JORDAN; Astron. Ges., Vierteljahrs., XX, 1885, 182–193, by BRUNS; Zeits. f. Vermes., XIV, 1885, 451–457, by REBSTEIN; Astron. Ges., Vierteljahrs., XVI, 1881, 170–180, by JORDAN.

——— Zur Frage der Beweiskraft der Gradmessungen für die Existenz der Näherungsweise rotationsförmiger Gestalt der Erde.
Zeits. f. Vermes., IX, 1880, 269–277.

——— Nochmals der Fundamentalsatz für die geodätische Linie auf Umdrehungsflächen.
Zeits. f. Vermes., IX, 1880, 338–339.
See JORDAN, Elementare Begründung, etc.
See WERNER, zusatz zu der elementaren, etc.

———: **Oudemans (J. A. C.).** Die Triangulirung von Java, ausgeführt vom Personale des topographischen Dienstes in Niederländisch-Ostindien. Revd. by —.
Astron. Ges., Vierteljahrs., XVI, 1881, 120–134.

———: **Bruhns (C.)** *und* **Nagel (A.).** Die Grossenhainer Grundlinie, Berlin, 1882. Revd. by —.
Zeits. f. Vermes., XII, 1883, 596–604.
Title in full under BRUHNS (C.).

———: **Paschen.** Grossherzoglich mecklenburgische Landesvermessung. Revd. by —.
Astron. Ges., Vierteljahrs., XIX, 1884, 39–58.

——— Ausgleichung von symmetrisch angeordneten Richtungsbeobachtungen einer Station.
Zeits. f. Vermes., XIV, 1885, 263–266.

——— Die Bessel'schen Erddimensionen.
Zeits. f. Vermes., XIV, 1885, 90–91.

——— Bericht des königl. preussischen Geodätischen Instituts.
Int. Geod. Cong., Verhandl., 1884–'86, 187–199.

——— Lothabweichungen. Heft 1. Formeln und Tafeln sowie einige numerische Ergebnisse für Norddeutschland. Veröffentlichung des königl. preussischen geodätischen Instituts.
4°, Berlin, 1866, pp. x, 94, 26, 3 maps. (Gore.)

——— Uebersicht der Arbeiten des königl. geodätischen Instituts unter Generallieutenant z. D. Dr. Baeyer, nebst einem allgemeinen Arbeitsplane des Instituts für das nächste Decennium. Publication des königl. preuss. geodätischen Instituts.
4°, Berlin, 1886, pp. 40, 9, 2 maps. (Gore.)
Zeits. f. Vermes., XV, 1886, 497.
This contains a complete list of all the publications of the Institut.

Helmert (Friedrich Robert)—Continued.

——— Jahresbericht des Direktors des königlichen geodätischen Instituts für die Zeit vom April 1886 bis April 1887.
8°, Berlin, 1887, pp. 32. (Gore.)

——— Rapport sur les déviations de la verticale.
Int. Geod. Cong., Verhandl., 1887; Annexe I, 1–54 French, 1–53 German, 3 charts.

——— Rapport sur les mesures de pendule exécutées dans les derniers années.
Int. Geod. Cong., Verhandl., 1887, Annexe II, 1–17.

——— Bericht des königlich. preussischen geodätischen Instituts.
Int. Geod. Cong., Verhandl., 1887, Annexe X, 1–5.

——— Jahresbericht des Direktors des königlichen geodätischen Instituts für die Zeit vom April 1887 bis April 1888. (Als Manuskript gedruckt.)
4°, Berlin, 1888, pp. 39. (Gore.)

——— Kurzer Bericht über die Versammlung der permanenten Commission der internationalen Erdmessung zu Nizza in der Zeit vom 21 bis 29 October 1887.
Zeits. f. Vermes., XVIII, 1888, 129–140.
Also as a separate, p. 12.

——— Bericht über die Versammlung der permanenten Commission der internationalen Erdmessung zu Salzburg im September 1888 mit einigen Ausführungen über den Stand des Erdmessungsunternehmens.
Zeits. f. Vermess., XVIII, 1889, 65–84.

Hemming (John) *and* **Portlock (Lt.-Col.).** Brief account of some survey operations undertaken at the Cape of Good Hope for the verification of the labours of Lacaille, and some notice of the country.
Roy. Engineers Papers, I, 1851, 27–45.

Henderson: Sabine (E.). Reply to —'s remarks on Captain Sabine's pendulum observations.
Phil. Mag. (Taylor), II, 1827, 176–177.

Henneberg (Lebrecht). Ueber diejenige Minimalfläche, welche die Neil'sche Parabel zur ebenen geodätischen Linie hat.
Naturf. Ges. Zürich, Vierteljahrs., XXI, 1876, 67–70.

Hennequin (E.). Rapport sur les travaux exécutés en 1881 et 1882 par la section géodésique de l'Institut cartographique militaire de Belgique.
Int. Geod. Cong., Gen.-Ber., 1881–'82, 144–148.

——— Rapport sur les travaux géodésiques en Belgique pendant l'année 1883.
Int. Geod. Cong., Gen.-Ber., 1883, 227–229.

——— Triangulation du royaume de Belgique, publiée avec l'autorisation de M. le Ministre de la guerre par l'Institut cartographique militare, observations et calculs de la triangulation de premier ordre. Tome second.
4°, Bruxelles, 1885, pp. viii, 585, 7 charts. (Gore.)

——— [Rapport sur les travaux géodésiques dans Belgique, 1884–'86.]
Int. Geod. Cong., Verhandl., 1884–'86, 121–122.

Hennert (Johann Freedrich). Ondezoeking omtrent de waare gedaante der aarde.
Genootsch. Vlissingen, Verhandel., III, 1773, 529–575.

Hennert (Johann Freedrich)—Continued.

——— Onderzoek of de onzekerheid omtrent de waare gedaante der aarde eenen merkelyken invloed hebbe op de sterrekunde en navigatie.
Genootsch. Vlissingen, Verhandel., IV, 1775, 499–544.

——— Dissertations physique et mathématique.
8°, Utrecht, 1778, pp. [xv], 214, 3 plates. (British Museum.)
Sur la figure de la terre, 167–208.

Hennessy (Henry). On the attractions of spheroids.
L., E., D. Phil. Mag., XXXIII, 1848, 24–28.

——— On the change in the earth's figure and climate, resulting from forces acting at its surface.
Geol. Soc. Dublin, Journ., IV, 1848–'50, 139–141.

——— On the variation of gravity at the earth's surface, on the hypothesis of its primitive solidity.
Geol. Soc. Dublin, Journ., IV, 1848–'50, 147–149.

——— The figure and primitive formation of the earth, or researches in terrestrial physics.
Roy. Soc. London, Phil. Trans., CXLI, 1851, 495–510, 511–548.

——— On the connexion between geological theories and the theory of the figure of the earth.
Brit. A. A. S., Rep., XXII, 1852, 21.

Hennessey (J. B. N.) *and* **Branfil (B. R.).** Computation of Indian arcs.
India, Trig. Survey, VII–VIII, 1882.
Title in full under BRANFIL (B. R.).

——— *and* **Cole (W. H.).** Computation of meridional arcs.
India, Trig. Survey, IV, VI, VIII.
Title in full under COLE (W. H.).

——— Calcutta base-line.
India, Trig. Survey, I, 1870–'71, 23.

——— Dehra Doon base-line.
India, Trig. Survey, I, 1870, ii, 48.

——— Sironj base-line.
India, Trig. Survey, I, 1870, iii, 26.

——— Bider base-line.
India, Trig. Survey, I, 70, iv, 28.

——— Sonakhoda base-line.
India, Trig. Survey, I, 1870, v, 32.

——— Chach or Atlok base-line.
India, Trig. Survey, I, 1870, vi, 31.

——— Karachi base-line.
India, Trig. Survey, I, 1870, vii, 30.

——— Vizagapatam base-line.
India, Trig. Survey, I, 1870, viii, 32.

——— Bangalore base-line.
India, Trig. Survey, I, 1870, ix, 48.

——— The micrometer-microscope theodolites.
India, Trig. Survey, II, 1873, ii, 11–76.

——— Comparison between the 10-feet standard bars 1 *s* and *A* for determining the expansion of bar *A*.
India, Trig. Survey, II, 1873, vi, 24–36.

——— On the dispersion of circuit errors of triangulation after the angles have been corrected for figural conditions.
India, Trig. Survey, II, 1883, viii, 151–176.

——— Reduction of the NW. quadrilateral. The non-circuit triangles and their final figural adjustment.
India, Trig. Survey, II, 1873, x, 177–253.

Hennessey (J. B. N.)—Continued.

——— Simultaneous reduction of the NW. quadrilateral. The computations.
India, Trig. Survey, II, 1873, xii, 283–318

——— *and* **Keelan (H.).** Sutlej meridional series.
India, Trig. Survey, IV, VIII, 60.

——— *and* **Walker (J. T.).** Meridional arc series.
India, Trig. Survey, III, VII.
Title in full under WALKER (J. T.).

——— ——— Cape Comorin base-line.
India, Trig. Survey, I, 1870, x, 35.

——— *and* **Wood (C.).** Meridional series.
India, Trig. Survey, VII, 1882, viii, 1882.

——— Une question de géodésie.
A. Franç. A. S., Bull., 1883, 149.

Hennon (V.). Géodésie pratique des forêts, à l'usage des agents forrestiers, propriétaires, régisseurs, agents voyers et autres personnes s'occupant de l'estimation et de aménagement des bois.
8°, Nevers, 1846; Paris, 1860, pp. [iii], 172, 8 plates. (British Museum.)
Trigonometric surveying.

Henry (Joseph). The Coast Survey. An article from the Princeton Review for April, 1845.
8°, Princeton, 1885, pp. 24.

Henry (Maurice). Essai sur la détermination de la longueur du pendule simple sous la latitude de St.-Pétersbourg.
Acad. de St.-Pétersbourg, Acta, XI, 1793, 524–530.

——— Ueber die Landesmessung von Bayern.
Mon. Corr. (Zach), VI, 1802, 36–45.

Herbert (J. D.) *and* **Hodgson (J. H.).** Account of the trigonometrical determinations of peaks in the Himalaya Mountains.
Asiatic Researches, XIV, 1822, 187–368.

Hermann (Friedrich). Ueber die neuen metrischen Probemasse.
Naturf. Ges. Bern, Mittheil., 1870, 243–247.

Herr. Mittheilung über die Glasstäbe.
Int. Geod. Cong., Gen.-Ber., 1871, 70–71.

Herrig (N.). Ueber Winkelmessen mit dem Repetitions-Theodoliten mit centrischem Fernrohr bei Polygonmessungen.
Zeits. f. d. Berg-, Hütten- und Salinenwesen, XXXIV, 1886, 156–157.

Herschel (John) *and* **Cole (W. H.).** East coast series.
India, Trig. Survey, VI.

——— On the local deviation of the plumb-line from the true vertical, as affecting the accuracy of a trigonometrical survey.
Indian Eng. (Medley), I, 1864, 315–323.

——— Note on the difference of variation of gravity at Revel and St. Petersburg; and on Grischow's pendulum observations at other stations.
Roy. Astron. Soc., Month. Not., XL, 1879–'80, 2–5.
See GRISCHOW, Acad. de St.-Pétersbourg, Com., VII, 447–451.

——— A bibliographical list of works relating to pendulum operations in connection with the problem of the figure of the earth.
India, Trig. Survey, V, 1879, 103–126.

Herschel (John)—Continued.

——— On the figure of the earth.
Nature, xx, 1879, 33-35.
Advocating the bestowal of increased attention upon the investigation of the causes of irregularity of the earth, and therefrom to deduce the figure of the earth.

——— Table of provisional equatorial vibration-numbers of pendulums used differentially since 1800; followed by a synopsis of pendulum observations from 1672 to 1874, partly reduced to common terms by the help of the above table.*
Calcutta, 1879.

——— On the employment of the pendulum for determining the figure of the earth.
Nature, XXI, 1880, 599-602.

——— On the determination of the acceleration of gravity for Tokio, Japan.*
1880.

———: **Clarke (A. R.)**. Geodesy. Revd. by —.
Nature, XXI, 1880, 605-609.

———: **Kelly (P.)**. Metrology. London, 1816. Notice of, by —.
Nature, XXIV, 1881, 237-238.
Title in full under KELLY (P.).

——— Note on the length of the pendulum observed by de l'Isle de la Croyère, at Archangel, in 1728.
Astron. Register, XIX, 1882, 5.

——— Pendulum observations in London.
Nature, XXV, 1882, 196-197.

Herschel (John Frederick William). A brief notice of the life, researches, and discoveries of Bessel.
8°, London, 1847, pp. 16. (Oxford, Bodleian.)
Account of geodetic work, pp. 11-15.
Extract from the Annual Report of the Royal Astronomical Society.

——— Outlines of astronomy. Ninth edition.
8°, London, 1867, pp. xxiv, 741, 6 plates. (Washington, Observatory.)
Figure of the earth, 129-150.

——— Familiar lectures on scientific subjects.
8°, London, 1871, pp. xii, 507.
The yard, the pendulum, and the metre, 419-451.

Hertha, *for* Hertha. Zeitschrift für Erd-, Völker- und Staatenkunde.
8°, Stuttgart, 1825-'29 (14 vols.). (Washington, Congress.)

Hesse (Wilhelm Gottlieb). Dissertatio de vi centrifuga planetarum. Progymnasmata magnitudinem terræ in astronomia sphærica recte nihil instar considerari.*
Erford., 1757.
POGGENDORFF, I, 1095.

Hesse (von). Die königlich preussische Landes-Triangulation. Triangulation der Umgegend von Berlin zwischen 52° 12′ und 52° 48′ Breite und 30° 30′ und 31° 30′ Länge.
4°, Berlin, 1867, pp. iv, 516, 36, 2 plates, 4 charts. (Berlin, Landesaufnahme.)
Herausgegeben vom Bureau der Landes-Triangulation. Owing to the loss of many of the station-marks, this work is being reobserved and new results will soon be published.

Heussi (Jacob). Ueber eine Verbesserung an den Repetitions-Theodoliten und den Nivellir-Instrumenten.
Ann. d. Phys. (Poggendorff), CIV, 1858, 443-448.

Heussi (Jacob)—Continued.

——— Lehrbuch der Geodäsie. Nach dem gegenwärtigen Zustande der Wissenschaft für Feldmesser, Militär und Architekten.
8°, Leipzig, 1861, pp. xxiv, 583. (Berlin, Royal.)

Hicks (W. M.). On some irregularities in the values of the mean density of the earth as determined by Baily.
Phil. Soc. Camb. Proc., v, 1886, 156-161.

Hiecke (R.) *und* **Czermak (P.)**. Pendelversuche.
Wien, 1885.

Hierl (Johann Eduard). Lehrbuch der höheren Vermessungskunde, oder Anleitung zur trigonometrischen Bestimmung der Punkte auf der Erdoberfläche und der Höhen der Berge.
8°, Augsburg, 1842, pp. x, 157, 3 plates. (Munich, Royal.)

Hilgard (Julius Erasmus). Discussion of probable error of observation.
U. S. C. and G. Survey, Rep., 1854, 121.

——— Triangulation of the Mississippi Sound.
U. S. C. and G. Survey, Rep., 1856, 291-292.

——— Subsidiary base apparatus. Description of a modification devised to ascertain the temperature of rods in use.
U. S. C. and G. Survey, Rep., 1856, 308-310.

——— Theodolite test.
U. S. C. and G. Survey, Rep., 1856, 310-316; 1860, 357-361.
Examination and trials of a 10-inch theodolite, applicable to the testing of instruments of like construction.

——— Description of base apparatus for measuring subsidiary lines.
U. S. C. and G. Survey, Rep., 1857, 395-398.

——— Base-measuring apparatus. Abstract of experiments for determining the length and expansion by heat of the standard bar, with table of comparisons of standard bar with 6 metres.
U. S. C. and G. Survey, Rep., 1862, 248-255.

——— Description of a new form of geodetic signals.
U. S. C. and G. Survey, Rep., 1867, 145.

——— On the use of railways for geodetic surveys.
U. S. C. and G. Survey, Rep., 1867, 140-144.

——— Intervisibility of stations.
U. S. C. and G. Survey, Rep., 1873, 137.

——— Account of a base-line measurement three times repeated in the U. S. Coast Survey.
A. A. A. S., Proc., 1875, 90-98.
With plates of the Bache-Würdemann apparatus.

——— The measurement of a base-line for the primary triangulation of the United States Coast Survey near Atlanta, Ga.
Phil. Soc. Wash., Bull., 1875-'80, 50-51.

——— The relations of the lawful standards of measure of the United States to those of Great Britain and France.
U. S. C. and G. Survey, Rep., 1876, 402-406.

——— An examination of three new 20-inch theodolites.
U. S. C. and G. Survey, Rep., 1877, 114-147.

——— [Progress of geodesy.]
A. A. A. S., Proc., 1876, 1-16.
Address as retiring president of the American Association for the Advancement of Science for 1876.

Hilgard (**Julius Erasmus**)—Continued.

——— Comparison of American and British standard yards.

U. S. C. and G. Survey, Rep., 1877, 148–181.

Including a discussion by J. Homer Lane, on the coefficient of expansion of the British standard yard bar, bronze No. 11. O. H. Tittman, on the relative expansion of bronze 12, and Low Moor iron.

——— Geodesy.

Johnson's Universal Cyclopedia, II, 1878, 473–477.

——— Pendulum observations.

Johnson's Universal Cyclopedia, III, 1878, 1143.

——— An account of a perfected form of the contact-slide base apparatus used in the Coast and Geodetic Survey.

U. S. C. and G. Survey, Rep., 1880, 341–344.

——— Letter of the Superintendent on the proposed transfer to the Navy Department [of the United States Coast and Geodetic Survey].

8°, Washington, 1883, pp. 8. (Gore.)

Containing also a letter from Richard D. Cutts in answer to a report of Charles D. Sigsbee.

——— Inquiry of the National Academy of Sciences concerning the operations of the Coast and Geodetic Survey.

8°, [Washington], 1884, pp. 11.

Hind (**Henry Youle**). The figure of the earth in relation to geological inquiry.

Nature, x, 1874, 165–167.

Suggests that known geological facts may serve to point out a line of investigation which may lead to a more correct knowledge than we appear to possess at present of the figure of the earth, the probable changes which are slowly taking place, and the relation which these bear to geological inquiry.

Hirsch (**Adolph**). Note sur la figure de la terre.

Soc. Sci. Nat. Neuchâtel, Bull., v, 1859–'61, 578–582.

——— Sur une déviation remarquable du fil à plomb, découverte récemment à Moscou.

Soc. Sci. Nat. Neuchâtel, Bull., VI, 1861–'63, 319–325.

——— Sur les progrès des travaux géodésiques en Europe.

Soc. Sci. Nat. Neuchâtel, Bull., VII, 1866, ii, 387–402.

——— Nouvelles recherches sur l'équation personnelle.

Soc. Sci. Nat. Neuchâtel, Bull., VII, 1866, ii, 277–284.

——— Sur la méthode trigonométrique employée dans le lever du cadastre et spécialement sur son application dans le grand-duché de Hesse.

Soc. Sci. Nat. Neuchâtel, Bull., VII, 1865, 26–37.

——— Sur les progrès des travaux géodésiques en Europe. (Nivellement.)

Soc. Sci. Nat. Neuchâtel, Bull., VII, 1866, ii, 422–430.

——— Bericht über die geodätischen Arbeiten in der Schweiz für das Jahr 1870.

Int. Geod. Cong., Gen.-Ber., 1870, 63–68.

——— Bericht über die geodätischen Arbeiten in der Schweiz für das Jahr 1871.

Int. Geod. Cong., Gen.-Ber., 1871, 63–65.

——— General-Bericht pro 1872 über die geodätischen Arbeiten in der Schweiz.

Int. Geod. Cong., Gen.-Ber., 1872, 58–73.

——— Rapport sur les travaux géodésiques en Suisse pendant l'année 1874.

Int. Geod. Cong., Gen.-Ber., 1874, 79–82.

Hirsch (**Adolph**)—Continued.

——— Rapport sur les travaux géodésiques en Suisse en 1875.

Int. Geod. Cong., Gen.-Ber., 1875, 217–219.

——— Rapport sur les travaux géodésiques en Suisse en 1876.

Int. Geod. Cong., Gen.-Ber., 1876, 123–125.

——— Rapport sur les observations de pendule.

Int. Geod. Cong., Gen.-Ber., 1877, 307–308.

——— Rapport sur les travaux géodésiques dans la Suisse pendant l'année 1880.

Int. Geod. Cong., Gen.-Ber., 1880, 38–41.

——— Rapport sur les travaux géodésiques dans la Suisse pendant les années 1881 et 1882.

Int. Geod. Cong., Gen.-Ber., 1881–'82, 130–134.

——— Rapport sur les travaux géodésiques en Suisse pendant l'année 1883.

Int. Geod. Cong., Gen.-Ber., 1883, 279–283.

——— [Rapport sur les travaux géodésiques dans la Suisse pendant les années 1884–'86.]

Int. Geod. Cong., Verhandl., 1884–'86, 232–238.

——— Rapport sur les travaux [géodésiques] en Suisse [pour l'année 1887].

Int. Geod. Cong., Verhandl., Annexe XII, 1–5.

——— : **Dumur** (**J.**). Le réseau de triangulation suisse, publié par la Commission géodésique suisse. Troisième volume. La mensuration des bases. (Association géodésique internationale.)

4°, Lausanne, 1888, *Corbez*, pp. 104, 6 plates. (Gore.)

Historical Mag., *for* Historical Magazine.

8°, Boston, 1857–'75 (23 vols.). (Washington, Congress.)

Hodgson (**John Anthony**) *and* **Herbert** (**J. D.**). An account of trigonometrical and astronometrical operations for determining the heights and positions of the principal peaks of the Himalaya Mountains.

Asiatic Researches, XIV, 1822, 187–368; Edinb. Phil. Journ., IX, 1823, 312–313; Ann. de Chimie, XXV, 1824, 205–208.

Hoffmann (**August Wilhelm**). Bericht über die wissenschaftlichen Apparate auf der Londoner internationalen Ausstellung im Jahre 1876.

8°, Braunschweig, 1878 and 1881, pp. xxvi, 846. (British Museum.)

Messapparate, 3–24; Höhere Geodäsie, 155–188, by Helmert (F. R.).

Revd. in Zeits. f. Vermess., x, 1881, 369.

Hofmann (**Heinrich**). De octantis instrumenti mathematici novi geodætis astronomis geographio nautis architectis militibus et fodinarum præfectis perquam utilis et accommodati usu et utilitate libellus.

4°, Jenæ, 1612, pp. [xiii, 62]. (British Museum.)

Holfeld (**J.**). Neue Theorie von dem Wahle der Standlinien, nebst trigonometrische Berechnung der Fehler im Winkelmessen, die von der unrechten Lage des Gradbogens und des Visirstrahles herrühren.*

Lemberg, 1793.

HOLLAND.

Kaiser (F.). Ueber die holländische Gradmessungsarbeiten. Int. Geod. Cong., Gen.-Ber., 1864, 16–18; 1865, 11–12; 1866, 13–15; 1868, 16–24; 1869, 12–16.

HOLLAND—Continued.

KRAIJENHOFF (C. R. T.). Précis historique des opérations géodésiques faites en Hollande.
La Haye, 1815; 1827.

OUDEMANS (J. A. C.) Rapport sur les travaux géodésiques dans les Pays-Bas.
Int. Geod. Cong., Gen.-Ber., 1880, 18-20.

SANDE-BAKHUYZEN (H. G. VAN DE). Résumé des travaux géodésiques exécutées dans les Pays-Bas.
Int. Geod. Cong., Gen.-Ber., 1881-'82, 84-85; 1883, 257-259; 1884, 259-261; 1884-'86, 178-182; 1887, viii, 1-3.

STAMKART (F. J.) Bericht über die geodätischen Arbeiten in Holland.
Int. Geod. Cong., Gen.-Ber., 1870, 8-10; 1873, 4; 1875, 179-180; 1876, 105-106; 1878, 86; 1879, 92-94; 1880, 20-22.

Holman (Silas W.). Discussion of the precision of measurements.
Technology Quarterly (Boston, Mass.), I, 1887, 121-140.

Holmquist: Svanberg (J.). Exposition des opérations faites en Lapponie pour la détermination d'un arc du méridien, par — . . .
Stockholm, 1805.
Title in full under SVANBERG (J.).

Hopkins (William). On the form, solidification, and thickness of the earth's crust.
Brit. A. A. S., Rep., XVII, 1847, 40-57.

Hoppe (R.). Anwendung Thetafunctionen auf geodätische Strecken und Winkel.
Arch. d. Math. (Grunert), III, 1886, 75-83.

Hopton (Arthur). Baculum geodæticum, sive viaticum, or the geodeticall staffe, containing eight books: the contents whereof followe after the epistles.
8°, London, 1610, pp. [xiv], 347. (Oxford, Bodleian.)
Bound with The art of dialling.

Horsley (Samuel). Remarks on the observations made in the late voyage toward the North Pole for determining the acceleration of the pendulum in latitude 79° 50′. In a letter to Constantine John Phipps.
4°, London, 1774, pp. 15. (British Museum.)

Hossard (P.) *et* Rozet. Sur les causes probables des irrégularités de la surface du niveau du globe terrestre, des anomalies observées dans la direction de la vertical, la marche du pendule et la hauteur de la colonne barométrique ramenées à cette même surface.
Acad. d. Sci. Paris, Comp. Rend., XVIII, 1844, 180-185.

——: **Francœur (L.-B.).** Géodésie. Augmentée par —.
Paris, 1865.
Title in full under FRANCŒUR (L.-B.).

Hossfeld (Johann Wilhelm.) Auszug aus der geometrischen Attractionslehre und ihrer Anwendung auf Berechnung der Figur, Abplattung, Grösse und innern Masse der Erde.
Ann. d. Phys. (Gilbert), XLV, 1813, 74-107, 185-208.

Hourcastremé. Dissertation sur les causes qui ont produit l'espèce de contradiction que l'on remarque entre deux decrets de l'Association nationale. (H.)
8°, Paris, [1792], pp. 60.

Houzeau de la Haye (Jean-Charles). Rapport sur ce mémoire. [ADAN (E.). Attractions locales.]
Acad. de Belgique, Bull., XLVI, 1878, ii, 6-11.

Houzeau de la Haye (Jean-Charles)—Continued.

—— Catalogue des ouvrages d'astronomie et de météorologie qui se trouvent dans les principales bibliothèques de la Belgique, préparé et mis en ordre à l'Observatoire royal de Bruxelles; suivi d'un appendice qui comprend tous les autres ouvrages de la bibliothèque de cet établissement.
8°, Bruxelles, 1878, pp. xxiii, 645. (Brussels, Royal.)
Géodésie, 239-243, 465-474.

——, **Folie *et* Liagre.** Sur la triangulation du royaume. Mesure d'une troisième base géodésique; par M. Adan.
Acad. de Belgique, Bull., I, 1881, 867-872.

—— *et* **Lancaster (A.).** Bibliographie générale de l'astronomie, ou catalogue méthodique des ouvrages, des mémoires et des observations astronomiques publiés depuis l'origine de l'imprimerie jusqu'en 1880. Tome second. Mémoires et notices.
8°, Bruxelles, 1882. *Havermans.* (Gore.)
Dimensions and flattening of the earth, 1148-1166, 1721-1723.
Houzeau is used as an abbreviation for the second volume.

Hube (Johann Michael). De telluris forma. Liber singularis.
Varsaviæ, 1780, pp. 87, 1 pl. (British Museum.)

Huber (Ernst). Die Störungen der Rotationsaxe der Erde.
4°, Luzern, 1880, pp. 28, 1 plate. (Berlin, Geodetic Institute.)

Hügel. Bericht über die im Grossherzogthum Hessen zum Zwecke der europäischen Gradmessung im Jahre 1869 vorgenommenen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1869, 10-11.

[Hugon]: Maire (C.) *et* Boscovich (R. J.). Voyage astronomique et géographique pour mesurer deux degrés du méridien. Translated by —.
Paris, 1770.
Title in full under MAIRE (C.).

Hultsch (Friedrich). Griechische und römische Metrologie.
Berlin, 1862; 2d ed., pp. xiv, 745; Berlin, 1882. (Oxford, Bodleian.)
History of units of length, 27-74.

Humboldt (Friedrich Heinrich Alexander von). Recueil d'observations astronomiques, d'opérations trigonométriques et de mesures barométriques.
Fol. I: Paris, 1810, pp. lxxvi, 138, 52, 382; II: Paris, 1810, pp. 529, 1 plate. (Washington, Coast Survey.)

Hume (Joseph). "Report of Colonel Waugh on the extent and nature of the operations of the grand trigonometrical survey."* Presented to Parliament in April, 1851.

Humäus (Georg Christian Konrad). Die geometrischen Instrumente der gesammten practischen Geometrie; deren Theorie, Beschreibung und Gebrauch.
8°, Hannover, 1862-'64, pp. viii, 671. (British Museum.)

Hunt (E. B.). Proposal for a trigonometrical survey of New York.
A. A. A. S., Proc., 1851, 382-385.

Hunt (E. B.)—Continued.
——— Description of base-measuring apparatus as used in the Coast Survey.
U. S. C. and G. Survey, Rep., 1854, 103-108; 1873, 132-136.

Hutton (Charles). An account of the calculations made from the survey measures taken at Schehalien in order to ascertain the mean density of the earth.
Roy. Soc. London, Phil. Trans., LXVII, 1778, ii, 689-788.
Density = 4½.
——— Calculations to determine at what point in the side of a hill its attraction will be the greatest. Read at the Royal Society, Nov. 11, 1779.
Separate, 4°, London, 1780, pp. 16.
——— On the calculations for ascertaining the mean density of the earth.
Phil. Mag. (Tilloch), XXXVIII, 1811, 112-116.
——— On the mean density of the earth.
Roy. Soc. London, Phil. Trans., 1821, 276-292; Phil. Mag. (Tilloch), 1821, 3-13.

Hutton (James). Theory of the earth, with proofs and illustrations. In four parts, two volumes.
12°, I: Edinburgh, 1795, pp. viii, 620, 4 plates; II: Edinburgh, 1795, pp. viii, 567, 2 plates.

Huyghens (Christian) [Hugenius (Christianus)]. Horologium oscillatorium sive de motu pendulorum ad horologia aptato demonstrationes geometricæ.
Fol., Paris, 1673, pp. [xii], 161. (Oxford, Bodleian.)
——— De la cause de la pesanteur.
12°, Leyde, 1691.
Divers ouvrages de Math. et Phys. par MM. de l'Acad. Roy. d. Sci. Paris, 1693, 305-312. (British Museum.)
——— Opuscula posthuma. Dissertatio de causa gravitatis, auctore C. H. à Z.
4°, Amsterdam, 1728.
Figure of the earth, 117-119.
———: **Plana (G.).** La figure de la terre et la loi de la pesanteur à sa surface d'après l'hypothèse d' —.
Astron. Nachr., XXXV, 1853, 371-378.

Ibañez (Carlos) y Meneses (Frutos Saavedra). Experimencias hechas con el aparato de medir bases perteneciente á la comision del mapa de España.
8°, Madrid, 1859, pp. viii, 255, cxlvii, 7 plates. (Gore.)
——— Noticia de los resultados obtenidos en la medicion de la base central del mapa de España.
Revista Cien. Fís., Madrid, XIII, 1863, 513-519, 1 chart.
Leida á la Real Academia de ciencias, 30 de nov. de 1863.
——— Discurso sobre el orígen y progresos de los instrumentos de astronomía y geodesia.
Acad. Cien. Madrid, Mém., I, 1863, ii, 1-45.
——— Comparacion de la regla geodesica perteneciente al gobierno de S. A. el Virey de Egipto con la que sirvió para la medicion de la base central del mapa de España.
Acad. Cien. Madrid, Mém., I, 1863, ii, 47-170.
Published separately, 4°, Madrid, 1863, pp. 125, 1 plate.
——— Notice sur les résultats obtenus dans la mesure de la base centrale de la carte d'Espagne.
Astron. Nachr., LXI, 1864, 339-346.

Ibañez (Carlos)—Continued.
———: **Laussedat (A.).** Sur les opérations en cours d'exécution pour la carte d'Espagne par M. —.
Acad. d. Sci. Paris, Comp. Rend., LVIII, 1864, 70-72.
———, **Meneses (Frutos Saavedra), Monet (Fernando) y Quirogá (Cessareo).** Base centrale de la triangulation géogésique d'Espagne. Traduit de l'espagnol par A. Laussedat.
8°, Madrid, 1865, pp. viii, 300, cclxiv, 6 plates. (Gore.)
Appendice 10. Publications relatives aux travaux géodésiques exécutées dans différents pays.
——— Exposé de l'état des travaux géodésiques poursuivis en Espagne.
Int. Geod. Cong., Gen.-Ber., 1865, 57-58.
——— Exposé de l'état des travaux géodésiques poursuivis en Espagne.
Int. Geod. Cong., Gen.-Ber., 1869, 62-65.
——— A son excellence M. le général Baeyer.
Int. Geod. Cong., Gen.-Ber., 1870, 69-70.
Regarding the geodetic work in Spain during 1870.
——— Descripcion geodésica de las Islas Baleares.
8°, Madrid, 1871, pp. xii, 866, 8 plates, 1 chart. (Berlin, Royal.)
Publicada de real orden.
——— Un rapport sur les travaux géodésiques poursuivis par l'Institut géographique de l'Espagne pendant l'année 1870.
Int. Geod. Cong., Gen.-Ber., 1871, 65-66.
——— Rapport sur les travaux géodésiques exécutés par l'Institut géographique d'Espagne depuis septembre 1871.
Int. Geod. Cong., Gen.-Ber., 1872, 57-58.
——— Rapport sur les travaux géodésiques en Espagne pendant les années 1871-'74.
Int. Geod. Cong., Gen.-Ber., 1874, 83-85.
——— Rapport sur l'état des travaux géodésiques poursuivis par l'Institut géographique et statistique d'Espagne.
Int. Geod. Cong., Gen.-Ber., 1875, 219-222.
——— Rapport sur les travaux géodésiques en Espagne en 1876.
Int. Geod. Cong., Gen.-Ber., 1876, 125-128.
——— Rapport sur l'état des travaux géodésiques poursuivis par l'Institut géographique et statistique d'Espagne pendant l'année 1877.
Int. Geod. Cong., Gen.-Ber., 1877, 309-312.
——— Rapport sur les travaux géodésiques et astronomiques accomplis pendant l'année 1878 (Espagne).
Int. Geod. Cong., Gen.-Ber., 1878, 112-115.
——— Rapport sur les travaux géodésiques at astronomiques accomplis pendant l'année 1879.
Int. Geod. Cong., Gen.-Ber., 1879, 115-117.
———: **Koppe (C.).** Der Basisapparat des General — und die Aarberger Basismessung.
4°, Nordhausen, 1881, pp. 11. (Gore.)
——— Rapport sur les travaux géodésiques pendant l'année 1880 (Espagne).
Int. Geod. Cong., Gen.-Ber., 1880, 41-44.
——— *et* **Perrier (F.).** Jonction géodésique et astronomique de l'Algérie avec l'Espagne.
Int. Geod. Cong., Gen.-Ber., 1880, 44-47.

Ibañez (Carlos)—Continued.

—— Memorias del Instituto geográfico y estadístico.

Tomo 1. Madrid, 1875. Red geodésica de 1er órden de España. Parte primera. Meridianos de Salamanca y de Madrid, pp. 1–403.

Tomo 2. Madrid, 1878. Red geodésica de 1er órden de España. Parte segunda. Cadena de costa sur. Paralelo de Badajoz. Paralelo de Madrid. Cadena de Costa Norte. Paralelo de Palencia, pp. 559.

Tomo 3. Madrid, 1881. Red geodésica de 1er órden de España. Parte tercera. Meridiano de Pamplona. Meridiano de Lerida. Cadena de Costa Este. Descripcion y uso del aparato de Ibañez, para medir bases. Dilatacion lineal de la regla del aparato, y en longitud á una temperatura determinada. Base de arcos de la frontera. Base de Lugo. Base de Vich, pp. 1–482.

Tomo 4. Madrid, 1883. Red geodésica de 2er órden de España. Parte cuarta. Base de Olite, 99–172. Determinacion del coeficiente de dilatacion lineal de la regla de hierro laminado, perteneciente al aparato de Ibañez, 659–696.

Tomo 5. Madrid, 1884. Red geodésica de 1er órden de España. Parte quinta. Bases de Cartagena y de Madridejos.

Tome 6. Madrid, 1886. Red geodésica de 1er órden de España. Parte sexta. Compensación de los errores angulares de la red geodésica de 1er órden de España.

Tomo 7. Madrid, 1888. Enlace geodésico y astronómico de la Algeria con España, realizado en 1879, por orden de los gobiernos de España y de Francia. Compensación de los errores angulares de la red geodésia de 1er órden de España. (Gore.)

——: **Westphal (A.)**. Der Basisapparat —'s und sein Verhältniss zum älteren spanischen Apparat.
Zeits. f. Instrumentenkunde, I, 1881, 173–183.

—— *et* **Barraquer (J.-M.)**. Rapport de Monsieur le général Ibañez sur les travaux géodésiques de l'Institut géographique et statistique (Espagne).
Int. Geod. Cong., Gen.-Ber., 1881–'82, 134–141.

—— Rapport sur les travaux géodésiques de l'Institut géographique et statistique (en Espagne pendant l'année 1883).
Int. Geod. Cong., Gen.-Ber., 1883, 283–285.

—— *et* **Perrier**. Publication internationale. Jonction géodésique et astronomique de l'Algérie avec l'Espagne, exécutée en commun en 1879, par ordre des gouvernements d'Espagne et de France.
4°, Paris, 1886, pp. xix. 281, 6 plates, 6 etchings. (Washington, Coast Survey.)

—— [Rapport sur les travaux géodésiques en Espagne pendant les années 1884–'86.]
Int. Geod. Cong., Verhandl., 1884–'86, 124–127.

—— Espagne. Rapport sur les travaux géodésiques de premier ordre de l'Institut géographique et statistique.
Int. Geod. Cong., Verhandl., 1887, Annexe XIII, 1–3.

Ideler (Christian Ludwig). Ueber die Gradmessung der Alten.
Mon. Corr. (Zach), XXIII, 1811, 453–482.

Ideler (Christian Ludwig)—Continued.

—— Ueber die Längen- und Flächenmasse der Alten. Von den Wegemassen der alten Geographie. Ueber die von den Alten erwähnten Bestimmungen des Erdumfangs und die von den neueren daraus abgeleiteten Stadien.
K. Ak. d. Wiss., hist. Cl., Abhandl., 1825, 169–189; 1827, 111–128.

—— Ueber die von d'Anville in die alte Geographie eingeführten Stadien.
K. Ak. d. Wiss., phil. Cl., Abhandl., 1826, 1–18.

India, Trig. Survey *for*. Account of the operations of the Great Trigonometrical Survey of India.
4°, Dehra Dún, 1870–'83 (9 vols.).

INDIA.

Airy (G. B.). Investigations applying to the Indian geodesy.
India, Trig. Survey, II, 1879, i, 3–10.

Branfil (B. R.). Budhon meridional series.
India, Trig Survey, VII, 1882, i–xvi, 1–74 (J.); Gurwani meridional series, VIII, 1882, viii, 45 (N.); Gora meridional series, VIII, 1882, ix, 70 (O.); Chendowa meridional series, VIII, 1882, viii, 56 (Q.).

Cole (W. H.). Northwest quadrilateral.
India, Trig. Survey, II, 1879, xi, 255–282; Rahun series, IV, 1876, vi, 106, 80; Great arc series, IV, 1876, xi, 78, 104; Gurhagarh series, IV, 1876, x, 115, 61; Great arc series, VI, 1880, iii, 124; Calcutta series, VI, 1880, xiii, 226; East Coast series, VI, 1880, xxxix, 161; Jabalpur series, VI, 1880, vii, 101; Bider series, VI, 1880, xiv, 111; Bilaspur series, VI, 1880, xviii, 128; Southeast quadrilateral, VI, 1880, 164, 124; Budhon series, VII, 1882, i, 1–111; Eastern frontier series, VIII, 1882, x, 108; Brahmaputra series, VIII, 1882, xiv, 96; East Calcutta series, VIII, 1882, vii, 79.

Cunningham (A.). The Indian survey.
Nature, XXVII, 1882, 97–98.

Danvers (F. C.). The surveys of India.
Quart. Journ. Sci., VII, 1870, 448–458.

De Prée (G. C.). Synopses of the results of the Great Trigonometrical Survey of India.
Debra Dún, 1883–'85.

Everest (G.). An account of the measurement of an arc of meridian in India.
London, 1830; London, 1847.

—— Some accounts of the progress of the survey of India.
Roy. Astron. Soc., Month. Not., IV, 1836–'39, 206–210; Brit. A. A. S., Rep., XIV, 1844, 3–4.

—— Rectification of logarithmic errors in the measurement of two sections of the arc of India.
Roy. Soc. London, Proc., XX, 1858, 620–626.

Haig (C. T.). General description of the Jodhpore series.
India, Trig. Survey, IV, 1886, xv.

Jervis (T. B.). On the state and prospects of the surveys of India.
Brit. A. A. S., Geogr. Section, VIII, 1838, 98.

Lambton (W.). An account of a method for extending a geographical survey across India.
Asiatick Researches, VII, 1803, 312–335; X, 1811, 290–384.

—— An account of the measurement of an arc of the meridian on the coast of Coromandel.
Asiatick Researches, VIII, 1805, 137–194 . . . ; XII, 1818, 2–101, 294–359; XIII, 1820, 1–127.

Lindenau (B. A. von). Die trigonometrische Vermessung in Ostindien, 1816 und 1818.
Zeits. f. Astron. (Lindenau), II, 1816, 79–89, 359–375.

Markham (C. R.). Memoir on Indian surveys.
London, 1871, 1878.

Montgomerie (T. G.). Memorandum . . . on the progress of the Kashmir series.
Asiatic Soc., Journ., XXX, 1861, 99–110.

INDIA—Continued.

PRATT (J. H.). On the curvature of the Indian arc.
L., E., D. Phil. Mag., x, 1855, 340–345; xvi, 1858, 401–408; Asiatic Soc., Journ., xxvii, 1858, 201–213; xxviii, 1859, 22–27; Roy. Soc. London, Proc., x, 1859, 197–199, 648–650; Phil. Trans., 1861, 579–594.

RENNY (T.). Ueber die trigonometrische Vermessung von Indien.
Ann. d. Erdkunde (Berghaus), viii, 1833, 75–76; i, 1836, 353–359.

STRANGE (A.). Geodesy, especially relating to the Great Trigonometrical Survey of India.
United Service Journ., vi, 1863, 457–486.

THUILLIER (H. R.). A manual of surveying for India.
Calcutta, 1851, 1875.

——— Longitudinal series.
India, Trig. Survey, iii, 1876.

——— Synopses of the results of the Great Trigonometrical Survey of India.
Dehra Dún, 1879.

WALKER (J. T.). The great trigonometrical survey of India.
Calcutta Rev., iv, 1845, 63–95; xvi, 1851, 514–540; xxxviii, 1863, 26–62; Asiat. Soc., Journ., xxxi, 1862, 32–48; xxxii, 1863, 111–123; Indian Eng. (Medley), i, 1864, 180–210; Van Nostrand's Mag., xxxiv, 1887, 65–79.

——— Triangle series.
India, Trig. Survey, iii, 1873; iv, 1876; vii, 1882.

——— Synopses of the results of the Great Trigonometrical Survey of India.
Dehra Dún, 1874–'80.

WAUGH (A.). On the great trigonometrical survey of India.
Calcutta Rev., iv, 1842, 62–95; Indian Eng. (Medley), ii, 1865, 285–300, 398–407; iii, 1866, 94–108, 305–318, 402–413; iv, 1867, 303–316, 413–422.

WEBB. Trigonometrical survey of India.
Phil. Mag. (Tilloch), liii, 1819, 146.

WOOD (C.). Triangulation series.
India, Trig. Survey, vii, 1882; viii, 1882.

ZACH (F. X. VON). Ost-Indische Gradmessung der Länge und Breite.
Mon. Corr. (Zach), xii, 1805, 488–494.

ANON. Trigonometrical Survey—India: Return to an order of the honorable the House of Commons, dated 12th of February, 1850, for returns "of full and detailed reports of the extent and nature of the operations and expenditures connected with the grand trigonometrical survey of India, and the grand triangulation thereof, for the measurements of the arcs of the meridian, from the year the first base was measured to the latest date, etc., 1851.
Calcutta Rev., xvi, 1851, 514–540.

——— The Great Trigonometrical Survey of India.
Van Nostrand's Mag., iii, 1870, 299–306.

——— The Indian trigonometrical survey.
Nature, xii, 1875, 72–74; Van Nostrand's Mag., xiii, 1875, 367–371.
A review of the report of the survey for 1873–'74.

——— The Indian survey.
Nature, xxix, 1884, 360–362.

——— The Great Trigonometrical Survey of India.
Van Nostrand's Mag., iii, 1870, 299–306.

Indian Eng. (Medley), *for* Professional Papers on Indian Engineering.
8°, Roorkee, 1863–'68 (4 vols.). (British Museum.)

Inghirami (Giovanni). Di una base trigonometrica misurata in Toscana nell' autunno 1817.
8°, Firenze, 1818, pp. 192. (Cambridge University.)

——— [Triangolazione in Toscana.]
Corr. Astron. (Zach), i, 1818, 101–120, 227–243, 368–389.

Inghirami (Giovanni)—Continued.

——— [Lettera: Triangolazione della Lombardia e dello stato di Lucca e della Toscana.]
Corr. Astron. (Zach), iii, 1819, 135–155.

——— Riunione della triangolazione di Lombardia con quella della Toscana.
Opuscoli e Notizie d. Sci. (Inghirami), i, 1820, 101–107.

——— [Relativo alla vera distanza tra il centro del fanale di Portoferrajo e quello dell' opposta torre Populonia.]
Corr. Astron. (Zach), v, 1821, 251–276; Note, 271–282.

——— Delle operazioni trigonometriche, eseguite l' anno 1816 nella Costa occidentale della Toscana.
8°, Livorno, 1821, pp. 32. (Vienna, War Office).
(Fascicolo ix dell' Antologia.)

Inst. de France, Mém. Cl. Sci. Math. Phys., *for* Mémoires de la classe des sciences mathématiques et physiques de l'Institut royal de France.
4°, Paris, 1806–'15. (Washington, Observatory.)

Institution Civ. Eng., Proc., *for* Minutes of the Proceedings of the Institution of Civil Engineers.
8°, London, 1837. (Washington, Congress.)

INSTRUMENTS, GEODETIC. *See* **GEODETIC INSTRUMENTS.**

Int. Bur. Weights and Measures, Trav., *for* Travaux et mémoires du Bureau international des poids et mesures.
4°, Paris, 1881. (Washington, Observatory.)

Int. Geod. Cong., Gen.-Ber., *for* Generalbericht über die mittel-europäische Gradmessung. Bericht über die Verhandlungen der [ersten, zweiten, etc.] allgemeinen Conferenz der europäischen Gradmessungen.
4°, Berlin, 1863–'74. (Gore.)

INTERNATIONAL GEODETIC CONGRESS.

TITLES OF PUBLICATIONS.

Generalbericht über die mitteleuropäische Gradmessung.
Für 1863, Berlin, 1864.
Für 1864, Berlin, 1865.
Containing: Verhandlungen der ersten allgemeinen Conferenz der Bevollmächtigten zur mitteleuropäischen Gradmessung in Berlin vom 15. bis 22. Oktober 1864.
Für 1865, Berlin, 1866.
Für 1866, Berlin, 1867.
The title is changed to: Bericht über die Verhandlungen der vom 30. September bis 7. October 1867 zu Berlin abgehaltenen [zweiten] allgemeinen Conferenz der europäischen Gradmessungen. Zugleich als General-Bericht für 1867 herausgegeben vom Central-Bureau der europäischen Gradmessung. Berlin, 1868.

General-Bericht über die europäische Gradmessung für die Jahre 1868, 1869, 1870. 3 vols. Berlin, 1869, 1870, 1871.

Bericht über die Verhandlungen der vom 21. bis 30. September 1871 zu Wien abgehaltenen dritten allgemeinen Conferenz der europäischen Gradmessung. Zugleich als General-bericht über die europäische Gradmessung. Berlin, 1872.

General-Bericht über die europäische Gradmessung, 1872, 1873. 2 vols. Berlin, 1873, 1874.

Bericht über die Verhandlungen der vom 23. bis 28. September zu Dresden abgehaltenen vierten allgemeinen Conferenz der europäischen Gradmessung. Zugleich als General-Bericht für 1874. Berlin, 1875.
The title again changes: Verhandlungen der vereinigten permanenten Commission der europäischen Gradmessung, 1875, 1876. 2 vols. Berlin, 1876, 1877.

INTERNATIONAL GEODETIC CONGRESS—Continued.

TITLES OF PUBLICATIONS.

Verhandlungen der fünften allgemeinen Conferenz der europäischen Gradmessung. [Stuttgart, 1877.] Zugleich mit General-Bericht für das Jahr 1877. Berlin, 1878.

Verhandlungen der vereinigten permanenten Commission der europäischen Gradmessung. Zugleich mit dem Bericht für 1878, 1879. 2 vols. Berlin, 1879, 1880.

Verhandlungen der sechsten allgemeinen Conferenz der europäischen Gradmessung. [Munich.] Zugleich mit dem General-Bericht für das Jahr 1880. Berlin, 1881.

Verhandlungen der vereinigten permanenten Commission der europäischen Gradmessung. Zugleich mit dem Generalbericht für die Jahre 1881 und 1882. Berlin, 1883.

Verhandlungen der siebenten allgemeinen Conferenz der europäischen Gradmessung. Zugleich mit dem Generalbericht für das Jahr 1883. Berlin, 1884.

Verhandlungen der achten allgemeinen Conferenz der internationalen Erdmessung und deren permanenten Commission. Zugleich mit den Berichten der Vertreter der einzelnen Staaten über die Fortschritte der Erdmessung in ihren Ländern, von 1884–'86. Berlin, 1887.

Verhandlungen der Conferenz der permanenten Commission der internationalen Erdmessung. Zugleich mit den Berichten mehrerer Special-Referenten über die Haupt-Fächer, und den Berichten über die Fortschritte der Erdmessung in den einzelnen Ländern im letzten Jahre. Supplement. 2 vols. Berlin, 1888.

From 1874 up to the present time the transactions and reports appear in both French and German.

ADAN (E.-H.-J.). Notice sur l'Association internationale de géodésie.
Ixelles, 1876.

—— Conférence de Hambourg, 1878.
Acad. de Belgique, Bull., XI, 1878, 529–533.

—— Conférence de Geneve, 1879.
Acad. de Belgique, Bull., III, 1879, 658–655.

—— Conférence à Munich, 1880.
Bruxelles, 1880.

BAUERNFEIND (C. M.). Die dritte allgemeine Conferenz der europäischen Gradmessung.
Allg. Zeit., 1872, 3–4, 18–20, 34–35, 82–83.

—— Die sechste Generalversammlung der europäischen Gradmessung in München.
Zeits. f. Vermes., IX, 1880, 457–474.

—— Die Gradmessungsconferenz im Haag.
Allg. Zeit., 1882, 4179–4180.

—— Die siebente General-Conferenz der europäischen Gradmessung zu Rom, 1883.
Zeits. f. Vermes., XIII, 1884, 133–140.

ENGEL. Die mitteleuropäische Gradmessung, und die erste allgemeine Conferenz.
Berlin, 1864.

FAYE (H.-A.-E.-A.). Rapport sur le protocole de la Conférence géodésique tenue à Berlin en 1862.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 28–34.

HELMERT (F. R.). Kurzer Bericht über die Versammlung der International-Erdmessungs-Commission, 1887.
Zeits. f. Vermes., XVII, 1888, 129–140; 1888, Zeits. f. Vermes., XVIII, 1889, 65–84.

JORDAN (W.). Ueber den Verlauf . . . der allgemeinen Conferenz der internationalen Erdmessung in Berlin, 1886.
Zeits. f. Arch.- u. Ingen.-Vereins, 1887, 143.

KAISER (F.). Rapport omtrent de tweede algemeene bijeenkomst der gemagtigden voor de graadmeting in Europa.
Amsterdam, 1867.

PRITTWITZ (M. K. E. VON). Die Fortschritte und der jetzige Stand der mitteleuropäischen Gradmessung.
Zeits. allg. Erdkunde, XIX, 1865, 324–345.

SCHOTT (C. A.). International Geodetic Association of Europe.
Science, II, 1883, 656–658.

INTERNATIONAL GEODETIC CONGRESS—Continued.

ANON. Permanent Commission of the International Geodetic Association.
Nature, XII, 1875, 501–502.
Notice of meeting at Paris, September 20, 1875.

—— International Geodetic Association.
Nature, XIV, 1876, 560; XVI, 1877, 298.
Notice of meeting at Stuttgart, in 1877.

—— Permanent Commission of the International Geodetic Association.
Nature, XX, 1879, 433, 508, 535.
Notice of meeting at Geneva, September 16, 1879.

—— The Geodetic Congress.
Nature, XXVIII, 1883, 616–617; XXIX, 1883, 14.
Report of the meeting in Rome, in October, 1883.

—— Allgemeine Konferenz der internationalen Erdmessung in Berlin (27. October bis 2. November 1886).
Zeits. f. Vermes., XV, 1886, 545–558.

Int. Geod. Cong., Verhandl., *for* Verhandlungen der vereinigten permanenten Commission der europäischen Gradmessung. Verhandlungen der allgemeinen Conferenz der internationalen Erdmessung und deren permanenten Commission.
4°, Berlin, 1875+. (Gore.)

Ismail Effendi *y* **Ibañez (C.).** Comparacion de la regla geodésica perteneciente al gobierno de Egipto con la de la base centrale de España.
Madrid, 1863.
Title in full under IBAÑEZ (C.).

Ismail-Effendi-Moustapha. Recherches des coefficients de dilatation et étalonage de l'appareil à mesurer les bases géodésiques appartenant au gouvernement égyptien.
8°, Paris, 1864, pp. xx, 194, 169, 5 plates. (Brussels, Observatory.)

Issel (Arthur). Note sur un instrument destiné à mesurer l'intensité de la pesanteur.
Bull. d. Naturalistes de Moscou, 1882, 134–139.

Ist. di Bologna, Mem., *for* Memorie della reale Accademia delle scienze dell' Istituto di Bologna.
4°, Bologna, 1850+. (Washington, Congress.)

Ist. Lomb. Sci., Giorn., *for* Giornale dell' Istituto Lombardo di scienze e lettere.
8°, Milano, 1840+. (Washington, Congress.)

Ist. Lomb. Sci., Rendi., *for* Reale Istituto Lombardo di scienze e lettere, rendiconti, Classe di scienze matematiche e naturali.
8°, Milano, 1864+. (Washington, Congress.)

Ist. Veneto., Mem., *for* Memorie del reale Istituto Veneto di scienze, lettere ed arte.
4°, Venezia, 1843+. (Washington, Congress.)

ITALY.

ITALIA. Lavori eseguiti nell' anno 1875. Astronomici e geodetici.
Int. Geod. Cong., Gen.-Ber., 1875, 175–178.

ISTITUTO TOPOGRAFICO MILITARE. Elementi geodetici dei punti contenuti nel foglio 254 della carta d' Italia.
8 parts, 4°, Firenze, 1880–'82.

COMMISSIONE ITALIANA per la misura dei gradi. Processo verbale della seduta commissione geodetica italiana tenuta in Firenze, Milano, Napoli, Padova, Roma, Torino.
12 parts, 8°. 1865–'87.

ITALY—Continued.

COMMISSIONE ITALIANA per la misura de' gradi in Europa. Istituto topografico militare.

Parte I. Geodetica.

Fascicolo I. Descrizione dell' apparato di Bessel. Primi studi eseguiti. Misura delle basi di Foggia e Napoli. Napoli, 1875.

Fascicolo II. Nuovi studi sull' apparato di Bessel. Misura delle basi di Catania, Crati e Lecce, 1876.

Fascicolo III. Cenni preliminari sulla triangolazione di 1° ordine eseguita lungo la zona meridiana di Capo Passero a Lissa. Osservazioni della rete di Capitanata e suo collegamento con la triangolazione austriaca sulle coste dalmate. 1877–'78. Misura della base di Udine eseguita nel 1874. 1877.

Fascicolo IV. Osservazioni e calcolo della rete di Basilicata, del Crati e di Calabria. 4°, Napoli, 1875–'82, pp. 589, 16 plates.

Parte II. Geodetica.

Fascicolo I. 64 pp., 9 plates. Napoli, 1875.

Fascicolo II. 65–105 pp., 4 plates. Napoli, 1876. (Gore.)

ARAGO (D.-F.-J.). Sur les opérations géodésiques exécutées en Italie par les ingénieurs-géographes français.
Conn. d. Temps, 1827, 385–391.

BAULINA (J.). Rapport sur l'avancement des travaux géodésiques de la commission italienne.
Int. Geod. Cong., Gen.-Ber., 1881–'82, 85–88.

FERGOLA (F.). Relazione delle operazioni geodetiche eseguite nelle provincie di Napoli.
Napoli, 1838; 1851.

FERRERO (A.). Avancement des travaux géodésiques en Italie.
A. Franç. A. S., 1882, 86–91.

——— Rapport sur l'état actuel des travaux géodésiques en Italie.
Int. Geod. Cong., Gen.-Ber., 1883, 252–257; 1884–'86, 143–145; 1887, VI, 1–2.

INGHIRAMI (G.). Di una base trigonometrica misurata in Toscana.
Firenze, 1818.

——— Triangolazione in Toscana.
Corr. Astron. (Zach), I, 1818, 101–120, 227–243, 368–389; III, 1819, 135–155; Opuscoli e Notizie (Inghirami), I, 1820, 101–107; Livorno, 1821.

MAYO (E.). Relazione sui lavori geodetici [in Italy].
Int. Geod. Cong., Gen.-Ber., 1877, 287–292; 1878, 87–89; 1879, 96; 1880, 16–18.

PLANA (G. A. A.). Report on geodetic work in Italy.
Accad. Sci. Torino, Mem., XXVII, 1824, xxxiv–l.

RICCARDI (P.). Cenni sulla storia della geodesia in Italia.
Bologna, 1879.

RICCI (G.). Exposé de l'état actuel des travaux de géodésie en Italie.
Int. Geod. Cong., Gen.-Ber., 1864, 18–21.

SAIGEY (J.-F.). Sur les opérations géodésiques exécutées en Italie.
Bull. Sci. Math. (Saigey), III, 1825, 238–239.

SCHIAVONI (F.). Osservazioni geodetiche sul Vesuvio.
N. d.; Napoli, 1872.

——— Intorno a' lavori geodetici nella città di Napoli.
Napoli, 1863.

——— Relazione sui lavori geodetici.
Int. Geod. Cong., Gen.-Ber., 1871, 25–31; 1872, 4–6.

SECCHI (A.). Regarding the geodetic work in Italy.
Int. Geod. Cong., Gen.-Ber., 1869, 18–19; Accad. d. Lincei, Atti, XXIV, 1871, 232–258.

VECCHI (E.). Relazione annuale sui lavori geodetici.
Int. Geod. Cong., Gen.-Ber., 1873, 5; 1874, 26–30; 1876, 100–105.

ZACH (F. X. VON). Astronomische und geodätische Bestimmungen in Golfo della Spezzia.
Mon. Corr. (Zach), XVIII, 1808, 362–363.

——— Notices sur les opérations géodésiques en Italie de Riccioli et Grimaldi, de Manfredi et Stancari.
Corr. Astron. (Zach), II, 1819, 115–126.

ITALY—Continued.

ANON. Cenno storico dei lavori geodetici e topografici eseguiti nel reale officio topografico di Napoli e metodi in essi adoperati.
8°, Napoli, 1860, pp. 17.

——— Sguardo storico intorno alla cartografia italiana.
Revista Militare Italiana, III, 1875, 288–342; Lavori geodetici, 293–298, 308–315, 332–336.

——— Geodetic surveys of Italy.
Railroad and Engineering News, LXII, 1888, 496–498.

——— Istruzioni sull' eseguimento delle stazioni trigonometriche. Istituto topografico militare. *
Napoli, 1877.

——— Istruzioni sulle riconoscenze trigonometriche. Istituto topografico militare.
8°, Firenze, 1877, pp. 34, 10 plates.

Ivory (James). On the rolling pendulum.
Phil. Mag. (Tilloch), LVIII, 1821, 417–421.

——— Calculation of the horizontal refraction in an atmosphere of uniform temperature.
Phil. Mag. (Tilloch), LIX, 1822, 90–93.

——— On the figure requisite to maintain the equilibrium of a homogeneous fluid mass that revolves upon an axis.
Roy. Soc. London, Phil. Trans., CXIV, 1824, 85–150.

——— Remarks on the theory of the figure of the earth.
Phil. Mag. (Tilloch), LXIII, 1824, 339–348.
An historic review of the Newtonian theory.

———: Francœur (L.-B.). Solution d'un problème de géodésie par —.
Bull. Sci. Math. (Saigey), II, 1824, 279–280.

——— Solution of a geodetical problem. (Corrections are given in vol. LXV, 249–250.)
Phil. Mag. (Tilloch), LXIV, 1824, 35–39.
The problem is: The length of a geodetical line on the earth's surface, together with the latitude, the longitude, and the azimuth, of one of its extremities being given; it is required to determine the latitude, the longitude, and the azimuth of the other extremity.

——— On the theory of the figure of the earth.
Phil. Mag. (Tilloch), LXV, 1825, 241–249.
Revd. by S[AIGEY], Bull. Sci. Math. (Saigey), V, 1826, 87–97.
Contains a demonstration of: If a homogeneous mass of fluid revolves about its axis and be in equilibro by the attraction of its particles in the inverse proportion of the square of the distance, all the level surfaces will be similar to the outer one; and any stratum of the fluid contained between two level surfaces will attract particles in the inside with equal force in opposite directions.

——— On the properties of a line of shortest distance traced on the surface of an oblate spheroid.
Phil. Mag. (Tilloch), LXVII, 1826, 241–249, 340–352.

——— On the ellipticity of the earth as deduced from experiments made with the pendulum.
Phil. Mag. (Taylor), LXVIII, 1826, 3–10, 92–101.
Revd. by S[AIGEY], Bull. Sci. Math. (Saigey), VI, 1826, 269–270.
Concludes, that supposing an attraction according to the law of nature, and a centrifugal force, there is no other figure known which is competent to maintain the equilibrium of a homogeneous fluid, except the elliptical spheroid of revolution.

——— On the method of least squares.
Phil. Mag. (Tilloch), LXVIII, 1826, 161–165.

Ivory (James)—Continued.

——— On the methods proper to be used for deducing a general formula for the length of the seconds pendulum, from a number of experiments made at different latitudes.
Phil. Mag. (Tilloch), LXVIII, 1826, 241–245.

——— Disquisitions concerning the length of the seconds pendulum, and the ellipticity of the earth.
Phil. Mag. (Taylor), LXVIII, 1826, 246–251.
Investigating a general formula for the length of the seconds pendulum in all latitudes and comparing it with all the tolerably exact experiments that have presented themselves.

——— On the grounds for adopting the ellipticity of the earth deduced by Captain Sabine from his experiments with the pendulum in his work lately published.
Phil. Mag. (Tilloch), LXVIII, 1826, 321–326.

——— Short abstract of M. de Freycinet's experiments for determining the length of the pendulum.
Phil. Mag. (Tilloch), LXVIII, 1826, 350–353.

———: **Anonymous.** Ivory's mode of finding the length of the geodetic curve.
Quart. Journ. Sci., XXI, 1826, 361–363.

———: **Bessel (F. W.).** Betreffend beide Methoden geodätischer Berechnung.
Astron. Nachr., V, 1827, 177–180.

——— Notice relating to the seconds pendulum at Port Bowen.
Phil. Mag. (Taylor), I, 1827, 170–171.

——— On the ellipticity of the earth as deduced from experiments with the pendulum.
Phil. Mag. (Taylor), III, 1828, 165–173.
It is remarkable that the pendulum experiments within 30° of the equator are very irregular. This may be that gravity is unequally distributed in that quarter of the globe, or the observations were erroneous.

——— Additional discussion respecting the ellipticity of the earth as determined by experiments made with the pendulum.
Phil. Mag. (Taylor), III, 1828, 206–210.
In deducing the figure of the earth from the observed length of the pendulum, I have always thought it necessary to leave out a few of the experiments that were inconsistent with the rest. The inconsistency is proved by comparing the pendulum on the same parallel, or nearly on the same, when a correction must be applied. If they are excessively irregular, I always rejected such as were irreconcilable with the rest.

——— A letter to the editors, relating to the ellipticity of the earth as deduced from experiments with the pendulum.
Phil. Mag. (Taylor), III, 1828, 241–243.
It is also stated that it is useless to involve terms of the second order.

——— On the figure of the earth, as deduced from measurements of different portions of the meridian.
Phil. Mag. (Taylor), III, 1828, 343–349, 431–436.
From the Peru, India, France, and England arcs an ellipticity of $\frac{1}{300}$ was found.

——— On the latitudes and differences of longitude of Beachy Head and Dunnose, in the Isle of Wight, as laid down in the trigonometrical survey of England;

Ivory (James)—Continued.

and the length of a degree perpendicular to the meridian at the latitude of Beachy Head.
Phil. Mag. (Taylor), IV, 1828, 6–11.
Criticises the formula used by the trigonometric survey for finding difference of longitude. Segments of the above arc showed a decrease in the length of a degree in going north. Ivory found an error of 18″ in the amplitude, which, when applied, gave increasing degrees towards the north.

——— On measurements on the earth's surface perpendicular to the meridian.
Phil. Mag. (Taylor), IV, 1828, 189–194.
States that the measurements in England and India belong to the same spheroid, but disagree with the French, while a measured arc perpendicular to the meridian in France agrees with the trigonometric degree, which tends to throw doubt upon the English methods of computing difference of longitude.

——— On the method employed in the trigonometrical survey for finding the length of a degree perpendicular to the meridian.
Phil. Mag. (Taylor), IV, 1828, 241–245.
Stating that the azimuth between two points on a spheroid is not the same as on a sphere when the latitude and difference of longitude are the same; hence the error in the formula used by the trigonometric survey for computing difference of longitude.

——— On the method in the trigonometrical survey for finding the difference of longitude of two stations very little different in latitude.
Phil. Mag. (Taylor), IV, 1828, 432–435.
Referring to the methods of the trigonometrical survey, says: "It is just to characterize the method of calculation in the survey as the greatest delusion that has ever prevailed in practical mathematics."

——— On the method of deducing the difference of longitude from the latitudes and azimuths of two stations on the earth's surface.
Phil. Mag. (Taylor), V, 1829, 24–28, 106–109.
Showing what he calls an error in the method of computing difference of longitude used by the trigonometrical survey of Great Britain.

——— Some arguments tending to prove that the earth is a solid of revolution.
Phil. Mag. (Taylor), V, 1829, 205–209.
The most probable inference that we can at present draw from the best measurements that have been made is that the meridians are equal and similar ellipses.

——— Letter relating to the figure of the earth.
Phil. Mag. (Taylor), VII, 1830, 241–244, 412–416.
Stating the insufficiency of Clairaut's theory, as it is universally taught and applied, for finding the figure of equilibrium of a homogeneous planet, supposed fluid.

——— On the figure of the earth.
Phil. Mag. (Taylor), VII, 1830, 412–416.
A discussion of the theory advanced by Biot and published in Mémoires de l'Académie des sciences, VIII, 1829.

——— A direct method of finding the shortest distance between two points on the earth's surface when their geographical position is given.
Phil. Mag. (Taylor), VIII, 1830, 30–34.

J. Survey of the coast of the United States.
Merchant's Mag. (Hunt), 1849, 131–149.

Jackson (Rowland). A new theory of the figure of the earth, wherein are demonstrated the mechanical causes of its figure as it is determined by the observations of —.*
8°, London, 1748.
LALANDE, 1748.

Jackwitz (Ernst). Ueber die unendlich kleinen Schwingungen eines Pendels A, B, C, welches nur aus zwei festen Massenpunkten B und C besteht, die um die Gleichgewichtslage A D oscillieren.
4°, Posen, 1881, pp. 17. (Berlin, Royal.)

Jacob (W. S.). On the causes of the great variation among the different measures of the earth's mean density.
Roy. Soc. London, Proc., VIII, 1857, 295–299.

Jacobi (Karl Gustav Jacob). Ueber die Figur des Gleichgewichts.
Ann. d. Phys. (Poggendorff), XXXIII, 1834, 229–232.

——— Note von der geodätischen Linie auf einem Ellipsoid und den verschiedenen Anwendungen einer merkwürdigen analytischen Substitution.
Journ. f. Math. (Crelle), XIX, 1839, 309–313; Journ. de Math. (Liouville), VI, 1841, 267–272; K. Ak. d. Wiss., Ber., 1839, 8(–91.

———: **Bessel (F. W.).** Neue Formel von — für die Anwendung der Methode der kleinsten Quadrate.
Astron. Nachr., XVII, 1840, 305–308.

——— Ueber eine neue Auflösungsart der bei der Methode der kleinsten Quadrate vorkommenden lineären Gleichungen.
Astron. Nachr., XXII, 1844, 297–306.

——— Bestimmung der geodätischen Linie auf einem dreiaxigen Ellipsoid mittelst blosser Quadraturen, als Beispiel zu dieser neuen Methode.
K. Ak. d. Wiss., Ber., 1846, 351–355.

——— Nouvelles formules de géodésie communiquées par M. le professeur E. Luther à Kœnigsberg.
Astron. Nachr., XLI, 1855, 209–215.

———: **Luther (E.).** —'s Ableitung der in seinem Aufsatze "Solution nouvelle d'un problème de géodésie" enthaltenen Formeln.
Astron. Nachr., XLII, 1856, 337–358.

——— Solution nouvelle d'un problème fondamental de géodésie.
Journ. f. Math. (Crelle), LIII, 1857, 335–341; Gesammelte Werke, II, 1882, 417–424.
Knowing the length of a geodetic arc and the latitude of one extremity and the azimuth, to find the latitude of the other extremity.

———: **Cayley (A.).** Geodesic lines on an ellipsoid. Method of —.
Astron. Ges., Vierteljahrs., IX, 1874, 47–51.

Jacobi (H.). Note sur la fabrication des étalons de longueur par la galvanoplastie.
Acad. de St.-Pétersbourg, Mél. Phys. Chim., VIII, 1872, 582–589.

Jacquin (E.). Théorie du pendule.*
Annales Conduct. Ponts et Chauss., V, 1861, 68–70.

Jadanza (Nicodemo). Alcuni problemi di geodesia.*
Accad. Sci. Torino, Atti, XVII, 742+.

——— Sulla latitudine, longitudine ed azimut dei punti di una rete trigonometrica.
Giorn. Mat. (Battaglini), XVIII, 1880, 137–139.

Jadanza (Nicodemo)—Continued.

——— Sulla misura di un arco di parallelo terrestre.
Accad. Sci. Torino, Atti, XIX, 1886, 991–1004; XX, 326–330.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XVI, 1884, 1085, by B[RUNS].

——— Sul calcolo della distanza di due punti le cui posizioni geografiche son note.*
Accad. Sci. Torino, Atti, XIX, 1886.

——— Sulla forma del triangolo geodetico e sulla esattezza di una rete trigonometrica.* Torino, n. d.

Jäderin (Edv.). Geodätische Längenmessungen mit Stahlbändern und Metalldrähten.
K. Svenska Veten. Ak., Handl., Bihang, IX, 1885, XV, pp. 57, 2 plates.

Jahn (Gustav Adolph). Aufgaben auf die Geometrie, Stereometrie, Trigonometrie, Geodäsie, Astronomie und Physik zu Uebungen im numerischen Rechnen, besonders mit Logarithmen. Nebst einem Anhange, enthaltend einige schwere, allgemeine und besondere geometrische Aufgaben.
8°, Leipzig, 1842, pp. xiv, 287. (British Museum.)

——— Geschichte der Astronomie vom Anfange des neunzehnten Jahrhunderts bis zu ende des Jahres 1842.
8°, Leipzig, 1844, pp. x, 308; 2(2. (British Museum.)
Gradmessungen, II, 151–200.

——— *und* **Vogel (Emil Ferdinand).** Praktische Anleitung zum gründlichen Studium der Erdkunde nach ihrer mathematischen, physikalischen und politischen Bedeutung. Ein Handbuch für denkende Freunde dieser Wissenschaft.
8°, Leipzig, 1847, pp. 418. (British Museum.)
Die Gestalt der Erde, 42–44, 93–101.

———: **Bohnenberger (J. G. von).** Anleitung zu geographische Ortsbestimmung.
Göttingen, 1852.
Title in full under BOHNENBERGER (J. G. VON), 1795.

James (Henry). On the geodetic operations of the Ordnance Survey.
Roy. Inst., Proc., II, 1854, 516–521.

——— On the deflection of the plumb-line at Arthur's Seat, and on the mean specific gravity of the earth.
Roy. Soc. London, Phil. Trans., CXLVI, 1856, 591–606; Roy. Soc. Edinb., Proc., III, 1857, 364–366.
Revd. in Roy. Astron. Soc., Month. Not., XVIII, 1858, 220.

——— Geodetical tables based on the elements of the figure of the earth given in the "Account of the principal triangulation."
4°, London, 1858, pp. 13. (Southampton, Ordnance Survey.)

——— On the figure, dimensions, and mean specific gravity of the earth as derived from the Ordnance Trigonometrical Survey of Great Britain and Ireland.
Roy. Soc. London, Phil. Trans., CXLVI, 1856, ii, 607–626.
Revd. in Geogr. Mittheil. (Petermann), 1857, 285; Roy. Astron. Soc., Month. Not., XVIII, 1858, 220–221.

——— *and* **Clarke (A. R.).** Ordnance Trigonometrical Survey of Great Britain and Ireland. Account of the observations and calculations of the principal tri-

James (Henry)—Continued.
angulation, and of the figure, dimensions, and mean specific gravity of the earth as derived therefrom.
4°, London, 1858, pp. xvii, 728, 28 plates. (Gore.)
Revd. in Roy. Astron. Soc., Month. Not., XVIII, 1858, 194-199.

——— Extension of the triangulation of the Ordnance Survey into France and Belgium with the measurement of an arc of parallel in latitude 52° N. from Valentia, in Ireland, to Mount Kemmel, in Belgium.
4°, London, 1863, pp. vi, 62, 7 plates. (Gore.)

——— Sketches of scaffolds erected over the trigonometrical stations of the Ordnance Survey of Great Britain and Ireland.
Fol., Southampton, 1865, 27 plates. (Southampton, Ordnance Survey.)

———: **Clarke (A. R.)**. Comparisons of standards of length under the direction of —.
London, 1866.
Title in full under CLARKE (A. R.).

——— Account of the methods and processes adopted for the production of the maps of the Ordnance Survey of the United Kingdom.
4°, London, 1875, pp. vi, 215. (Southampton, Ordnance Survey.)

Jeffrey (Henry M.). On the duals of geodesics and lines of curvature on an ellipsoid and on its pedal surfaces.
Quart. Journ. Math., XII, 1873, 322-345.

Jervis (Thomas Best). Records of ancient science, exemplified and authenticated in the primitive universal standard of weights and measures. Communicated in an essay transmitted to Capt. Henry Kater.
8°, Calcutta, XIV, 1835, pp. 29. (British Meseum.)

——— On the state and prospects of the surveys of India.
Brit. A. A. S., Geogr. Section, VIII, 1838, 98.

Jerwood (James). On the application of weight to test the figure of the earth.
Devonshire A. A. Sci., Lit. and Art, Trans., III, 1869, 166-178.

Jimenez (F.) y Fernandez (L.). Determinacion de la longitud del péndulo de segundos, y de la gravidad en México á 2283 M. sobre el nivel del mar. Observatorio astronómico central.
8°, México, 1878-'79, pp. 61.

Johnson (William Woolsey). Note the catenary.
Analyst, VI, 1879, 119-120.
A discussion of formulæ which may arise in the measurement of a base-line by means of a steel tape.

Johnston (Alexander Keith). Historical notice of the progress of the Ordnance Survey in Scotland.
Roy. Soc. Edinb., Proc., III, 1857, 31-41.

Jomard (Edmond-François). Mémoire sur le système métrique des anciens Égyptiens, contenant des recherches sur leurs connoissances géométriques et sur les mesures des autres peuples de l'antiquité.
Fol., Paris, 1817, pp. 300. (Oxford, Bodleian.)
Valeur du degré terrestre; étendue de l'Égypte; échelle du système, 7-9.

——— Description d'un étalon métrique orné d'hiéroglyphes découvert dans les ruines de Memphis par les soins de M. le chevalier Drovetti.
4°, Paris, 1822, pp. 17, 1 plate. (Oxford, Bodleian.)

Jomard (Edmond-François)—Continued.

——— Lettre à M. Abel Remusat, sur une nouvelle mesure de coudée trouvé à Memphis par M. le chev. Drovetti, et sa comparaison avec les autres mesures semblables connues jusqu'à présent.
8°, Paris, 1827, pp. 27. (British Museum.)
Bound with Étalon métrique.

——— Étalon métrique trouvé à Memphis orné d'hiéroglyphes, découvert dans les ruines de Memphis.
8°, Paris, 1827, pp. 19, 1 plate.
Bound with Lettre à M. Abel Remusat.

Jordan (Wilhelm). Bericht über die von der grossherzoglich badischen Regierung für die Zwecke der europäischen Gradmessung begonnenen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1868, 3-4.

——— Bericht über den Stand der für die Zwecke der europäischen Gradmessung im Grossherzogthum Baden unternommenen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1869, 3.

——— Ueber die Bestimmung der Genauigkeit mehrfach wiederholter Beobachtungen einer Unbekannten.
Astron. Nachr., LXXIV, 1869, 209-226.

——— Bericht über den Stand der im Grossherzogthum Baden unternommenen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1870, 3.

——— Ueber die Genauigkeit der süddeutschen Landestriangulirung.
Astron. Nachr., LXXV, 1870, 289-306.

——— Bemerkungen zu der 2ten Gauss'schen Auflösung der Hauptaufgabe der höheren Geodäsie.
Astron. Nachr., LXXVI, 1870, 305-312.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869-'70, 839, by BRUNS.

——— Ueber das Einschalten eines trigonometrischen Punktes in ein gegebenes Dreiecksnetz nach der Methode der kleinsten Quadrate.
Zeits. f. Math. (Schlömilch), XVI, 1871, 164-167.
Revd. in Jahrb. üb. d. Fortschr. d. Math., III, 1871, 548, by B[RUNS].

——— Ueber die Genauigkeit einfacher geodätischer Operationen.
Zeits. f. Math. (Schlömilch), XVI, 1871, 397-427.
Revd. in Jahrb. üb. d. Fortschr. d. Math., III, 1871, 549, by B[RUNS].

——— Bericht über die geodätischen Arbeiten in Baden für das Jahr 1872.
Int. Geod. Cong., Gen.-Ber., 1872, 1.

——— Ueber die Bestimmung des mittleren Fehlers durch Wiederholung der Beobachtungen.
Astron. Nachr., LXXIX, 1872, 219-222.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869-'70, 841-842, by BRUNS.

——— Vergleichung der Genauigkeit verschiedener Gradmessungen.
Astron. Nachr., LXXX, 1873, 17-22, 67-70.

——— Ueber die Genauigkeit der Längenmessung mit Kette und Latten.
Zeits. f. Vermes., I, 1872, 17-36, 199-200.

——— Ueber den mittleren Fehler der Latten- und Kettenmessung.
Zeits. f. Vermes., I, 1872, 221-225.

Jordan (**Wilhelm**)—Continued.

——— Ueber die Bestimmung des Gewichtes einer durch die Methode der kleinsten Quadrate bestimmten Unbekannten.
Zeits. f. Math. (Schlömilch), XVII, 1872, 350–352.

———: **Klose** *und* **Rheiner**. Triangulirung des Grossherzogthums Baden. Revisionsberechnung von —. Carlsruhe, 1873.
Title in full under KLOSE.

——— Ueber die Berechnung des mittleren Fehlers einer Basismessung.
Astron. Nachr., LXXX, 1873, 189–190; LXXXI, 1873, 51–56.
Referring partly to Zachariæ, "Note betreffend, etc."

——— Ueber die Methoden und Ziele der europäischen Gradmessung. Vortrag, gehalten im naturwissenschaftlichen Verein zu Carlsruhe.*
8°, Carlsruhe, 1873, pp. 42.
Title communicated by the author.

——— Verallgemeinerung eines Satzes der Methode der kleinsten Quadrate.
Zeits. f. Math. (Schlömilch), XVIII, 1873, 116–120.
Solution of normal equations.

——— Mittheilungen über die Haupttriangulation des Grossherzogthums Baden.
Zeits. f. Vermes., II, 1873, 117–125.

——— Kalender für Vermessungskunde mit astronomischen Ephemeriden für die Jahre 1874+.
Stuttgart, 1874+.

——— Taschenbuch der praktischen Geometrie. Eine Sammlung von Resultaten der höheren und niederen Vermessungskunde.
8°, *Stuttgart, 1874, pp. xi, 416.*
Revd. in Lit. Zeit. (Schlömilch), XVIII, 1874, 33–40; Jahrb. üb. d. Fortschr. d. Math., V, 1873, 593, by O[HRTMANNS].
This formed a part of Elemente der Vermessungskunde.—MERRIMAN, p. 222.

——— Eine Inconsequenz in manchen Dreiecksnetzausgleichungen.
Astron. Nachr., LXXXV, 1875, 69–72.

———: **Abbadie (A. d')**. Géodésie d'Éthiopie, ou triangulation d'une partie de la haute Éthiopie. Revd. by —.
Astron. Ges., Vierteljahrs., X, 1875, 39–50.

——— Zur Vergleichung des Soldner'schen rechtwinkligen sphärischen Coordinaten mit der Gauss'schen conformen Abbildung des Ellipsoids auf die Ebene.
Zeits. f. Vermes., IV, 1875, 27–32.

——— Ein Beitrag zur Theorie der terrestrischen Strahlenbrechung.
Astron. Nachr., LXXXVIII, 1876, 99–110.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VIII, 1876, 733–734, by B[RUNS].

——— Ueber die Bestimmung des mittleren Winkelmessungsfehlers einer nach der Bessel'schen Methode ausgeglichenen Triangulirung.
Astron. Nachr., LXXXIX, 1876, 27–30.

——— Ueber Coordinatengewichte für Triangulirung.
Zeits. f. Vermes., V, 1876, 107–115.

——— Einige allgemeine Betrachtungen über die Fehler in Polygonzügen.
Zeits. f. Vermes., V, 1876, 175–179.

Jordan (**Wilhelm**)—Continued.

——— Die Beziehung zwischen den wahrscheinlichsten Verbesserungen und den mittleren Fehler von Beobachtungen.
Zeits. f. Vermes., V, 1876, 479–481.

——— Ueber Seitenrefraction bei Triangulirungen.
Zeits. f. Vermes., VI, 1877, 192–195.

——— Trigonometrische Punkteinschaltung nach der Methode der kleinsten Quadrate.
Zeits. f. Vermes., VI, 1877, 328–333.

——— Handbuch der Vermessungs-Kunde. Zweite umgearbeitete und vermehrte Auflage des Taschenbuchs der praktischen Geometrie. 8°.
I. Stuttgart, 1877, pp. xiv, 717. *Metzler.* Methode der kleinsten Quadrate und niedere Geodäsie.
Revd. by J. REBSTEIN, Zeits. f. Vermes., VII, 1878, 194–199; VIII, 1879, 508–512.
II. Stuttgart, 1878, pp. ix, 492. Höhere Geodäsie. (Gore.)
Revd. by B[RUNS], Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 771–773.

——— Ausgleichung eines Triangulirungsnetzes mit Repetitionswinkelmessung.
Zeits. f. Vermes., VII, 1878, 18–34, 120.

——— Uebersicht der Literatur für Vermessungswesen vom Jahr 1877.
Zeits. f. Vermes., VII, 1878 (1)–(66).
Methode der kleinsten Quadrate, 27–31; Höhere Geodäsie, 31–34.

———, **Lindemann, Müller, Ruckdeschel** *und* **Schüle.** Bericht der Commission für geometrische Genauigkeitsbestimmungen.
Zeits. f. Vermes., VIII, 1879, 352–374.

——— Uebersicht der Literatur für Vermessungswesen vom Jahr 1878. Bearbeitet von Professor Jordan.
Zeits. f. Vermes., VIII, 1879 (117)–(150).
Methode der kleinsten Quadrate (141); Höhere Geodäsie und Gradmessung (141)–(146).

——— Elementare Begründung des Fundamentalsatzes über die geodätische Linie auf einer Umdrehungsfläche.
Zeits. f. Vermes., IX, 1880, 297–298.
See WIERNER, Zusatz, etc.
See HELMERT, Nochmals, etc.

——— Ueber die günstigste Seitengleichung im Viereck.
Zeits. f. Vermes., IX, 1880, 65–73.

——— Die Basismessung der preussischen Landesaufnahme bei Göttingen im August 1880.
Zeits. f. Vermes., IX, 1880, 377–403.

———: **Helmert (F. R.)**. Die mathematischen und physikalischen Theorieen der höheren Geodäsie, I. Revd. by —.
Astron. Ges. Vierteljahrs., XVI, 1881, 170–180.

——— *und* **Steppes (K.)**. Das deutsche Vermessungswesen, historisch-kritische Darstellung auf Veranlassung des deutschen Geometer-Vereins, unter Mitwirkung von Fachgenossen herausgegeben.
I. Höhere Geodäsie und Topographie. Herausgegeben von Jordan.
8°, Stuttgart, 1882, pp. 287.
II. Das Vermessungwesen im engeren Dienste der Staatsverwaltung. Herausgegeben von Steppes (K.).
Stuttgart, 1882, pp. iii, 482. (Vienna, Geographic Institute.)

Jordan (**Wilhelm**)—Continued.

——— Das schweizerische Dreiecksnetz. Zürich, 1881. Revd. by —.
Zeits. f. Vermes., XI, 1882, 456–457.

——— Bemerkung zur Rectification eines Meridianbogens.
Zeits. f. Vermes., XI, 1882, 622–625.

——— Neue Auflösung der geodätischen Hauptaufgabe und ihrer Umkehrung.
Zeits. f. Vermes., XII, 1883, 65–82.

——— Elementare Begründung der Beziehung zwischen der geodätischen Linie und den Normalschnitten.
Zeits. f. Vermes., XII, 1883, 238–241.

——— Basis-Messung der preussischen Landesaufnahme bei Meppen, ausgeführt im Juli 1883 unter der Leitung des Chefs der trigonometrischen Abtheilung der preussischen Landesaufnahme, Oberstlieutenant Schreiber.
Zeits. f. Vermes., XII, 1883, 577–584.

——— Die Bessel'schen Erddimensionen.
Zeits. f. Vermes., XIV, 1885, 22–28.

——— Zur Theorie der Polygonzüge.
Zeits. f. Vermes., XIII, 1884, 197–203, 229–238; XV, 1886, 332–335.

——— Möglichkeit oder Unmöglichkeit einer Pothenotischen Bestimmung.
Zeits. f. Vermes., XV, 1886, 140–145.

——— Ueber den Verlauf und die Verhandlungen der allgemeinen Conferenz der internationalen Erdmessung in Berlin in der Zeit vom 27. October bis 2. November 1886.*
Zeits. d. Arch.- u. Ingenieur-Vereins zu Hannover, 1887, 143+.

——— Genauigkeits-Verhältnisse der Polygonzug-Messung.
Zeits. f. Vermes., XVII, 1888, 1–18.

——— Die deutschen Landesvermessungen. Vortrag, gehalten auf dem siebenten deutschen Geographentage zu Karlsruhe (14. April 1887).
Zeits. f. Vermes., XVII, 1888, 310–325.

——— Die Fechner'sche Formel für den wahrscheinlichen Fehler.
Zeits. f. Vermes., XVII, 1888, 374–375.

——— Ueber günstigste Gewichtsvertheilung. Der Schreiber'sche Satz.
Zeits. f. Vermes., XVII, 1888, 641–649.

——— Bestimmung eines Folgepunktes bei der trigonometrischen Abtheilung der Landes-Aufnahme.
Zeits. f. Vermes., XVIII, 1889, 1–4.

——— Die Gradmessung der Araber, 827 nach Chr.
Zeits. f. Vermes., XVIII, 1889, 100–109, 159.

——— Die Grundformeln der terrestrischen Refraction.
Zeits. f. Vermes., XVIII, 1889, 176–183.

Journ. du Génie Civil, *for* Journal du génie civil des sciences et des arts.
8°, Paris, 1828–'48. (Oxford, Bodleian.)

Journ. de Math. (**Liouville**), *for* Journal de mathématiques pures et appliquées (Liouville).
4°, Paris, 1836+. (Washington, Observatory.)

Journ. d. Mines, *for* Journal des mines.
8°, Paris, 1795–1815. (Washington, Patent Office.)

Journ. d. Phys., *for* Journal der Physik.
8°, Halle und Leipzig, 1790–'94.
Neues Journal des Physik, 1794–'98.

Journ. d. Sav., *for* Journal des Sçavans.
4°, Paris, 1665–1792.
Journal des Savants. 8°, Paris, 1797-1816+. (Washington, Congress.)

Journ. f. Math. (**Crelle**), *for* Journal für die reine und angewandte Mathematik (Crelle).
4°, Berlin, 1826+. (Washington, Observatory.)

Journ. Frank. Inst., *for* Journal of the Franklin Institute of the State of Pennsylvania.
8°, Philadelphia, 1826+. (Washington, Patent Office.)

Journ. Nat. Phil. (**Nicholson**), *for* Journal of Natural Philosophy, Chemistry and the Arts (Nicholson).
4°, London, 1798-1801 (5 vols.). (Washington, Patent Office.)

Juan y Santacilia (**Jorge**) *y* **Ulloa** (**Antonio**). Relacion histórica del viage á la América meridional hecho de órden de S. Mag. para medir algunos grados de meridiano terrestre, y venir por ellos en conocimiento de la verdadera figura y magnitud de la tierra, con otras varias observaciones astronómicas, y phísicas.
4°, Madrid, 1748, I, pp. [xix], 404; II, pp. 405–682; III, pp. [VII], 379; IV, pp. 380–603, [cxcv.] (Washington, Congress).
Sometimes bound in two volumes, as the pagination indicates.

——— ——— Allgemeine Historie der Reisen zu Wasser und zu Lande; oder Sammlung aller Reisebeschreibungen, welche bis itzo in verschiedenen Sprachen von allen Völkern herausgegeben worden, und einen vollständigen Begriff von der neuern Erdbeschreibung und Geschichte machen; worinnen der wirkliche Zustand aller Nationen vorgestellt, und das merkwürdigste, nützlichste und wahrhaftigste in Europa, Asia, Africa, und America, in Ansehung ihrer verschiedenen Reiche und Länder; deren Lage, Grösse, Gränzen, Eintheilung, Himmelsgegenden, Erdreich, Früchte, Thiere, Flüsse, Seen, Gebirge, grossen und kleinen Städte, Häfen, Gebäude u. s. w., wie auch der Sitten und Gebräuche der Einwohner, ihrer Religion, Regierungsart, Künste und Wissenschaften, Handlung und Manufacturen, enthalten ist; mit nöthigen Landkarten nach den neuesten und richtigsten Wahrnehmungen, und mancherley Abbildungen der Städte, Küsten, Aussichten, Thiere, Gewächse, Kleidungen und anderer dergleichen Merkwürdigkeiten versehen. Neunter Band, welcher des Don Georg Juan und des Don Antonio de Ulloa Reise nach süd-America aus dem Spanischen übersetzt, in sich fasset.
4°, Leipzig, 1751, pp. xvii, 656. (Washington, Congress.)

——— ——— Voyage historique de l'Amériqué méridionale, par —, contenant l'histoire des Incas et les observations astronomiques faites pour déterminer la figure et la grandeur de la terre; traduit de l'espagnol par de Monvillon.*
4°, Paris, 1752.

Juan y Santacilia (Jorge) y Ulloa (A.)—Continued.

——— ——— A voyage to South America. Trans. from the original Spanish by John Adams.*
London, 1760–'72, 1806–'07.

——— ——— Observaciones astronómicas y phísicas hechas de órden de S. M. en los reynos del Perú. Por D. Jorge Juan y Santacilia y D. Antonio de Ulloa. De las quales se deduce la figura y magnitud de la tierra, y se aplica á la navegacion.
Fol., Madrid, 1773, pp. 396, 1 plate. (British Museum.)

——— ——— Historische reisbeschrijving van geheel Zuid-America; gedaan op bevel des konings.
4°, Goes, 1771, I, pp. 428, 5 maps, 2 pl.; II, pp. viii–iv, 406, 9 maps, 4 pl.

Jürgensen (Chr.). Om den Formel der Tjener til at bestemme Jordklodens Figur ved Jagttagelser over Pendulets Svingninger.
K. danske Viden., Forhandl., 1843, 65–72.

Jütner (Joseph). Trigonometrische Vermessung der K. Haupstadt Prag und ihre Umgebungen von 1804–'12.
8°, Prag, pp. 120, 1 chart.
Bound also in K. böhmische, Ges. d. Wiss., Abhandl., VIII, 1824.

——— Trigonometrische Vermessung von Wien.
K. k. Sternwarte, Ann., XX, 1840, 1–2.

Jullien (M.). Mémoire sur la probabilité des erreurs dans la somme ou dans la moyenne de plusieurs observations.*
Ann. de Mat. (Tortolini), I, 1858, 76–88, 149–156, 227–237.

Jung (Johann). De structura globi terraquei exteriori, et quomodo corpora marina petrefacta in montis terræque strata pervenerint.*
Moguntinæ, 1767.
POGGENDORFF, I, 1212.

Kämtz (Ludwig Friedrich). Ueber die Länge des Secundenpendels, nach den neueren Untersuchungen.
Hertha, IX, 1827, 71–122, 197–208, 417–442; X, 1827, 376–386.

——— Die Erde; Gradmessung.
Encycl., Ersch u. Gruber, XVIII, Theil XXXVI, Leipzig, 1842, 282–291.
Pendelmessungen, 291–299; Theoretische Bestimmung der Figur, 299–319; Dichtigkeit, 319–327.

Kästner (A. G.): Lulofs (J.). Anleitung zu der mathematischen und physikalischen Kenntniss der Erdkugel. Translated by —.
Göttingen, 1775.
Title in full under LULOFS (J.).

——— Quanta incertitudine designentur vertices angulorum acutiorum.
Acad. Mogunt., Acta, 1778, 177–190.

——— De objecti e duobus locis dissitis visi invenienda distantia a superficie terræ.
Acad. Mogunt., Acta, 1782–'83, VI, 1–11.

——— Weitere Ausführung der mathematischen Geographie besonders in Absicht auf die sphäroidische Gestalt der Erde.
8°, Göttingen, 1795, pp. xxxii, 526, 5 plates. (British Museum.)
Ueber die Erde als ein Sphäroid betrachtet, 32–134; Schwungkraft auf der Erde, 137–206.

K. Ak. Weten. Amsterdam, Versl., *for* Verslagen en mededeelingen der Koninklijke Akademie van Wetenschappen, Afdeling Natuurkunde.
8°, Amsterdam, 1853+. (Washington, Congress.)

K. Ak. d. Wiss. Monatsber., *for* Monatsbericht der kön. (preussischen) Akademie der Wissenschaften.
8°, Berlin, 1856+. (Washington, Observatory.)

K. Ak. d. Wiss., Ber., *for* Bericht über die zur Bekanntmachung geeigneten Verhandlungen, Königl. (preussische) Academie der Wissenschaften.
8°, Berlin, 1836–'55 (20 vols.). (Washington, Observatory.)

K. Ak. d. Wiss., math. Cl., Abhandl., *for* Königl. (preussische) Akademie der Wissenschaften, Abhandlungen (mathematische Classe).
4°, Berlin, 1804+. (Washington, Observatory.)

K. bayer. Ak. d. Wiss., Denkschr., *for* Denkschriften der königl. bayerischen Akademie der Wissenschaften, München.
4°, München, 1808–'24 (90 vols.). (Washington, Congress.)

K. bayer. Ak. d. Wiss., Sitzber., *for* Sitzungsbericht der kön. bayerischen Akademie der Wissenschaften.
8°, München, 1860+; Mathematisch-physikalische Classe, 1868+. (Washington, Observatory.)

K. bayer. Ak. d. Wiss., math.-phys. Cl., Abhandl., *for* Abhandlungen der mathematisch-physikalischen Classe der kön. bayerischen Akademie der Wissenschaften.
4°, München, 1829+ (published in 1832). (Washington, Observatory.)

K. böhm. Ges. d. Wiss., Abhandl., *for* Abhandlungen der königl. böhmischen Gesellschaft der Wissenschaften.
4°, Prag, 1785+. (Washington, Congress).

K. danske Videns., Forhandl., *for* Oversigt over det kong. danske Videnskabernes Selskabs Forhandlinger, og dets Medlemmers Arbeider.
8°, Kjøbenhavn, 1806+. (Washington, Congress.)

K. Ges. d. Wiss. Göttingen, Abhandl., *for* Abhandlungen der königl. Gesellschaft der Wissenschaften zu Göttingen.
4°, Göttingen, 1838+. (Washington, Congress.)

Kahler (Johann). De terra ejusque figura, magnitudine, motu et loco in universo, interiori structura, etc.*
Rintuli, 1682.
POGGENDORFF, I, 1219.

Kaiser (Franz) en Stuart (Cohen). De eischen der medewerking aan de ontworpen graadmeting in midden Europa.*
Amsterdam, 1864.

——— Schreiben über die holländische Gradmessungs-Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1864, 16–18.

——— Nachrichten über die Theilnahme des Königreichs der Niederlande an der mitteleuropäischen Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1865, 11–12.

Kaiser (**Franz**)—Continued.

—— Rapport omtrent de tweede algemeene bijeenkomst der gemagtigden voor de graadmeting in Europa.
8°, Amsterdam, 1867 [excerpt], pp. 83.

—— Bericht über die Theilnahme des Königreichs der Niederlande an der mitteleuropäischen Gradmessung im Jahre 1866.
Int. Geod. Cong., Gen.-Ber., 1866, 13–15.

—— Bericht über die für die europäische Gradmessung im Jahre 1868 von Seiten des Königreichs der Niederlande ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1868, 16–24.

—— Ueber einen neuen Apparat zur absoluten Bestimmung von persönlichen Fehlern.
K. Ak. Weten. Amsterdam, Versl., II, 1868, ii, 216–236.

—— *und* **Stamkart** (**F. J.**). Bericht über die für die ropäische Gradmessung im Jahre 1869 von Seiten des Königreichs der Niederlande ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1869, 12–18.

Kalmár (**Alexander von**). Bericht über die von der Triangulirungs-Calcul-Abtheilung des k. k. militär-geographischen Institutes im Jahre 1879 für Zwecke der europäischen Gradmessung ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1879, 98–101.

—— Bericht über die von der triangulirungs-Calcul-Abtheilung des k. k. militär-geographischen Institutes im Jahre 1880 für die Zwecke der europäischen Gradmessung ausgeführten Arbeiten. (Oesterreich.)
Int. Geod. Cong., Gen.-Ber., 1880, 23–29.

—— Bericht über die Leistungen der astronomisch-geodätischen Abtheilung des k. k. militär-geographischen Institutes für die Jahre 1881 und 1882. (Oesterreich.)
Int. Geod. Cong., Gen.-Ber., 1881–'82, 91–111.

—— Bericht über die Leistungen der astronomisch-geodätischen Abtheilung des k. k. militär-geographischen Institutes im Jahre 1883. (Wien.)
Int. Geod. Cong., Gen.-Ber., 1883, 261–269.

—— *und* **Hartl** (**H.**). Bericht über die Leistung der geodätischen Gruppe des militär-geographischen Institutes.
Int. Geod. Cong., Verhandl., 1884–'86, 154–177.

——, **Sterneck** (**R. von**), **Hartl** (**H.**), *und* **Tinter** (**W.**). Bericht über die Gradmessungs-Arbeiten der astronomisch-geodätischen Gruppe des k. k. militär-geographischen Institutes im Jahre 1887.
Int. Geod. Cong., Verhandl., 1887, vii, 1–18.

Kampf (**F.**) *and* **Tillman** (**S. E.**). Geodetic computation.
U. S. Eng. Rep., 1878., Ap. NN., 28–37.

Kane (**J. K.**). Report on the history and progress of the American Coast Survey.
A. A. A. S., Proc., 1859, 27–150.

Kater (**Henry**). Description of a new compensation pendulum. (H.)
Journ. Nat. Phil. (Nicholson), XX, 1808, 214–220.

—— An account of experiments for determining the length of the pendulum vibrating seconds in the latitude of London.
Roy. Soc. London, Phil. Trans., 1818, 32–109.

Kater (**Henry**)—Continued.

—— On the length of the French metre estimated in parts of the English standard.
Roy. Soc. London, Phil. Trans., 1818, 110–117; Ann. de Chim., VIII, 1818, 376–382.

——: **Young** (**T.**). Appendix to —'s account of experiments for determining the length of the pendulum vibrating seconds in the latitude of London.
Roy. Soc. London, Phil. Trans., 1818, 95–109; Miscel. Works of Thomas Young, II, London, 1855, 1–7.

—— An account of experiments for determining the variations in the length of the pendulum vibrating seconds, at the principal stations of the trigonometrical survey of Great Britain.
Roy. Soc. London, Phil. Trans., CIX, 1819, 337–508; Edinb. Phil. Journ., II, 1820, 319–325.

——: **Watts** (**W.**). Remarks on —'s paper, containing experiments for determining the length of the seconds pendulum in the latitude of London.
Edinb. Phil., Journ., I, 1819, 325–337.

—— An account of the comparisons of various British standards of linear measure.
Roy. Soc. London, Phil. Trans., CXI, 1821, 75–94.

—— An account of experiments made with an invariable pendulum at New South Wales, by Major-General Thomas Brisbane.
Roy. Soc. London, Phil. Trans., CXIII, 1823, 308–325.

——: **Young** (**T.**). The resistance of the air determined from —'s experiments on the pendulum.
Quart. Jour. Sci., XV, 1823, 351–356; Miscel. Works of Thomas Young, II, London, 1855, 93–98.

——: **Walbeck** (**H. J.**). Vergleichung der Secundenpendel-Beobachtungen —'s unter sich selbst nach der Methode der kleinsten Quadrate.
Astron. Nachr., I, 1823, 253–256.

——: **Galbraith** (**W.**). Remarks on the experiments of the pendulum made by —.
Phil. Mag. (Tilloch), LXIV, 1824, 161–170.

—— An account of the construction and adjustment of the new standard of weights of the United Kingdom. (H.)
Roy. Soc. London, Phil. Trans., 1826, ii, 551–552.

——: **Saigey**. Comparaison des observations du pendule à diverses latitudes; faites par —.
Bull. Sci. Math. (Saigey), VII, 1827, 31–43, 171–184; Hertha, XIII, 1829, 287–290.

—— An account of trigonometrical operations in the years 1821, 1822, 1823 for determining the difference of longitude between the royal observatories of Paris and Greenwich.
Roy. Soc. London, Phil. Trans., CXVIII, 1828, 153–239.

——: **Sabine** (**E.**). On the reduction to a vacuum of —'s convertible pendulum.
Roy. Soc. London, Phil. Trans., 1829, 331–338.

—— On the error in standards of linear measure arising from the thickness of the bar on which they are traced.
Roy. Soc. London, Phil. Trans., CXX, 1830, 359–382.

—— An account of the construction and verification of a copy of the imperial standard yard made for the Royal Society. (H.)
Roy. Soc. London, Phil. Trans., 1831, 345–347.

Kater (Henry)—Continued.

——— An account of the construction and verification of certain standards for the Russian Government. (H.)
4°, London, 1832, pp. 27.

———: **Jervis (T. B.)**. Records of ancient science exemplified in the primitive universal standard of weights and measures. An essay transmitted to —.
Calcutta, 1835.
Title in full under JERVIS (T. B.).

——— Contributions to astronomy and geodesy from the Cape of Good Hope.*
London, 1851.

———: **Finger (J.)**. Ueber ein Analogon des — Pendules.
K. k. Ak. d. Wiss. Sitz.-Ber., LXXXIV, 1881, ii, 168–193.

Kaupert *und* **Börsch (O.)**. Bericht über die geodätischen Arbeiten in Hessen, 1864, 1865, 1866.
Title in full under BÖRSCH (O.).

K[ay] (D[avid]). Trigonometrical survey.
Encycl. Brit., 8th ed., XXI, 1860, 330–337.

Kayser (E.). Das Niveau in neuer und erweiterter Anwendung für geodätische und astronomische Zwecke.
Astron. Nachr., LXXXIII, 1874, 241–264.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VI, 1824, 729–730, by B[RU\S].

Keelan (H.) *and* **Hennessey (J. B. N.)**. Sutlej series.
India, Trig. Survey, IV, 1876, VIII, 60.

Keller (Filippo). Sull' attrazione delle montagne. (H.)
Com. Geol. Ital., Firenze, III, 1872, 99–110, 241–242.

——— Ricerche sull' attrazione delle montagne, con applicazione numeriche. (H.)
8°, Roma, 1873.

Kelly (P.). Metrology; or an exposition of weights and measures, chiefly those of Great Britain and France, comprising tables of comparison, and views of various standards; with an account of laws and local customs, parliamentary reports, and other important documents.
8°, London, 1816, pp. vi, 112, 20. (Oxford, Bodleian.)
Revd. by J. HERSCHEL, Nature, XXIV, 1881, 237–238.
Length of seconds pendulum at different latitudes, 8; Length of a degree of the meridian in different latitudes, 9.

Kerschbaum (G.). Ueber Winkelausgleichung.
Zeits. f. Vermes., III, 1874, 85–89.

——— Ueber Winkel Centrirung.
Zeits. f. Vermes., V, 1876, 115–119.

——— Ueber die neue Vermessung im Staate New York.
Zeits. f. Vermes., X, 1881, 269–280.

———: **Comstock (C. B.)**. Notes on European surveys. Revd. by —.
Zeits. f. Vermes., XII, 1883, 156–164, 197–226, 241–250, 337–353.

——— Ueber die Fortschritte der Arbeiten der Küstenvermessung der Vereinigten Staaten von Nord Amerika.
Zeits. f. Vermes., XIII, 1884, 497–499.
Review of U. S. C. and G. Survey Rep., for 1882.

Kerschbaum (G.)—Continued.

——— Die nord-amerikanische Basismessung von Chicago.
Zeits. f. Vermes., XIII, 1884, 533–547.

——— Basis-Apparat mit Eis-Temperatur.
Zeits. f. Vermes., XIV, 1885, 251.

Kerwijk. Geodesie, voor de Kon. Militaire Akademie.
Communicated by Prof. VAN DEN BERG.

Kexler (Simon). Arithmetica geodætica denaria.*
12°, Aboæ, 1649.
POGGENDORFF, I, 1251.

K. k. Ak. d. Wiss., math.-naturwiss. Cl., Denkschr., *for* Denkschriften der kaiserlich königlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Classe.
4°, Wien, 1850+. (Washington, Observatory.)

K. k. Ak. d. Wiss., math.-phys. Cl., Sitz.-Ber., *for* Sitzungsbericht der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Classe.
8°, Wien, 1848+. (Washington, Observatory.)

K. k. geogr. Ges., Mittheil. *for* Mittheilungen der kaiserlichen und königlichen geographischen Gesellschaft in Wien.
8°, Wien, 1857+. (Washington, Congress.)

K. k. mil.-geogr. Inst. Mittheil., *for* Mittheilungen, k. k. militär-geographisches Institut.
8°, Wien. (Gore.)

K. k. polytech. Inst., Jahrb., *for* Jahrbuch k. k. polytechnisches Institut.
8°, Wien, 1819–'39 (20 vols.). (Washington, Patent Office.)

K. k. Sternwarte, Ann., *for* Annalen der kais. kön. Sternwarte.
Fol. and 4°, Wien, 1821+. (Washington, Congress.)

Klein (Franz). Die wissenschaftlichen Instrumente auf der niederösterreichischen Gewerbeausstellung 1880.
Centralzeitung f. Optik u. Mech., 1880, 186–187.

——— Zweck und Aufgabe der europäischen Gradmessung.
4°, Wien, 1882, pp. 41.
Separat-Abdruck aus Nr. 8 der "Monatsblätter des wissenschaftlichen Club" vom 15. März 1882.

——— Die Figur der Erde.
K. k. geogr. Ges., Mittheil., XXVI, 1883, 161–173, 217–241.

Klein (J.). Ueber die Grösse und Gestalt der Erde.
Geogr. Mittheil. (Petermann), XV, 1869, 114–116.

Kleyer (A.). Vollständig gelöste Aufgabensammlung, nebst ungelösten Aufgaben aus allen Zweigen der Rechenkunst, der niederen und höheren Mathematik, Physik, Mechanik, Chemie, Geodäsie, etc.*
8°, Stuttgart, 1881–'84.

Klimmen (Albrecht Johann): **Cassini (J.)**. Abhandlung von der Figur und Grösse der Erde. Translated by —.
Zürich, 1741.
Title in full under CASSINI (J.).

Klingenstierna (S.). Von Erfindung der Grösse und Gestalt der Erde aus Vergleichung von 2 Meridiangraden.*
Stockholm, 1744.

Klöden (Karl Friedrich). Ueber die Gestalt und die Urgeschichte der Erde, nebst den davon abhängenden Erscheinungen in astronomischer, geognostischer, geographischer und physikalischer Hinsicht. Zweite vermehrte Auflage der Grundlinien zu einer neuen Theorie der Erdgestaltung.
8°, Berlin, 1829, pp. xxviii, 384, 6 plates. (Gore.)

Klose *und* **Rheiner.** Triangulirung des Grossherzogthums Baden, in der Zeit von 1823–'52. Im Auftrage des gr. Ministeriums des Innern, auf Grund der Acten des gr. Katasterbüreaus beschrieben und durch Revisionsberechnungen nach der Methode der kleinsten Quadrate erläutert.
Fol., Carlsruhe, 1873, pp. 68, 5 plates. (Lithographed.) (Berlin, Geodetic Institute.)

Klostermann. [Die Ursachen der Anomalie in den Graden der Mittags-Kreise und der Verschiedenheit in der Ellipticität des Erdballs.]
Gött. Anzeigen, LXXVII, 1785, 1169–1175.

——— Recherches sur le degré du méridien entre Paris et Amiens et sur la jonction de l'observatoire de Greenwich à celui de Paris.
4°, St.-Pétersbourg, 1789, pp. 35, 1 plate. (Berlin, Observatory.)

Klüver. Ueber die Abweichung der Abplattung unserer Erde, welche aus ihrer jetzigen Rotationsgeschwindigkeit gefolgert werden muss und derjenigen, welche die wirkliche Beobachtung ergeben.
Deutsche Naturf.-Versaml., Ber., 1844, ii, 38–41.

Klügel (G. S.). Ueber die Figur der Erde.
Astron. Jahrb. (Bode), 1787, 165–172; 1788, 208–213.
From the arcs of Peru, France, and Lapland.

——— Parallaxenrechnung, mit Rücksicht auf die sphäroidische Gestalt der Erde.
Astron. Jahrb. (Bode), 1800, 132–144.

——— Aufgabe zur Meteorologie und Erdmesskunst.
Ann. d. Phys. (Gilbert), XIX, 1805, 115–117.

K. Nederl. Inst. Weten., Verhandel., *for* Nieuwe Verhandelingen, Kon. Nederlandsch Instituut van Wetenschappen, Letterkunde en Schoone Kunsten.
4°, Amsterdam, 1827–'52. (Washington, Congress.)

Knoch (August Wilhelm von). Ueber Pendelschwingungen von Körpern, die an einem Faden mit der Hand gehalten werden.
Ann. d. Phys. (Gilbert), LVII, 1817, 360–388.

———: **Wagner.** Ueber die sogenannte Pendel-Versuche des Prof. — in Braunschweig.
Ann. d. Phys. (Gilbert), LIX, 1818, 328–332.

Knogler (Gabriel). Nachricht von astronomischen Beobachtungen in Deutschland und China, und von einer chinesischen Grad-Messung.
Mon. Corr. (Zach), I, 1800, 241–251.

——— Nachricht von einer merkwürdigen neu aufgefundenen chinesischen Grad-Messung.
Mon. Corr. (Zach), I, 1800, 589–593.

K. Norske Videns., Saml., *for* Nye Samling af det kongelige norske Videnskabers Selskabs Skrifter.
4°, Kjøbenhavn, 1784–'88 (2 vols.). (Washington, Congress.)

Köcher (Franz Adrian). Darstellung der mathematischen Geographie, für die oberen Gymnasialklassen und höheren Bürgerschulen.
8°, Breslau, 1839, pp. 43, 2 plates. (Berlin, Royal.)
Gestalt und Grösse der Erde, 16–19.

Köhler (Conrad). Die Landesvermessung des Königreichs Württemberg. In wissenschaftlicher, technischer und geschichtlicher Beziehung auf Befehl der k. Regierung bearbeitet und mit deren Genehmigung herausgegeben von —.
4°, Stuttgart, 1858, pp. xii, 428, 3 charts. (Gore.)

——— *und* **Kundt.** Bericht der mecklenburgischen Landes-Vermessungs-Commission über die 1873 ausgeführten Arbeiten und Berechnungen.
Int. Geod. Cong., Gen.-Ber., 1873, 6–7.

——— *und* **Paschen (P.).** Grossherzoglich mecklenburgische Landesvermessung.
Schwerin, 1882.
Title in full under PASCHEN (P.).

Koelher (J.). Dissertationes geographicæ de terrâ ejusque magnitudine, figurâ, motu, loco.*
Rentuli, 1682.
LALANDE, 305.

König (Arthur): Richarz (F.). Eine neue Methode zur Bestimmung der Gravitationsconstante.
K. Ak. d. Wiss., Sitz.-Ber., 1884, 1203–1205; Nature, XXXI, 1885, 260, 484.

Köpen (Müller). On the triangulation of the royal Russian survey.
Inst. Civil Eng., Proc., XLII, 1875, 391–392. Translated by W. R. B.
From Zeits. des Vereins deutscher Ingenieure, 1875, 224–228.

Koll (A.) *und* **Weltmann.** Formeln der Mathematik. Theorie der Beobachtungsfehler.
Bonn, 1886.
Title in full under WELTMANN.

Koll (Otto). Einige Formulare für trigonometrische und polygonometrische Rechnungen.
Zeits. f. Vermes., VI, 1877, 305–327.

——— Geodätische Reiseskizzen aus Süddeutschland.
Zeits. rheinisch-westphäl. Landmesser-Vereins, VI, 1886, 22–25.

Koppe (Karl). Die mathematische Geographie und die Lehre vom Weltgebäude für den Unterricht in höheren Schulen sowie auch zur Selbstbelehrung.
8°, Essen (Esslingen), 1872, pp. vii, 119, 1 chart. (Berlin, Royal.)
Die Gestalt der Erde, 6–10.

——— Bestimmung der Achse des Gotthardtunnels (1874–'75).
Zeits. f. Vermes., IV, 1875, 369–444; V, 1876, 129–145, 353–382.

———: **Helmert (F. R.).** Discussion der Beobachtungsfehler in —'s Vermessung für die Gotthardtunnelachse.
Zeits. f. Vermes., V, 1876, 146–155.

Koppe (Karl)—Continued.

——— Der Basisapparat des General Ibañez und die Aarberger Basismessung.

4°, Nordhausen, 1881, pp. 11. *Eggendorff.*

Revd. by SCHLEBACH, in Zeits. f. Vermes., XI, 1882, 95–98.

——— Die Ausgleichungsrechnung nach der Methode der kleinsten Quadrate in der praktischen Geometrie.

8°, Nordhausen, 1885, pp. viii, 222. (British Museum.)

Kořistka (Karl F. E.). Bericht über die wichtigsten Werkstätten für geodätische Instrumente in Deutschland und Frankreich.*

Prag, 1854.

POGGENDORFF, I, 1306.

——— [Results of the measurements of the earth's magnitude.]

Ziva; Casopis přuodnicky, XI, 1863, 141–154.

Kosmos, *for Kόσμος.* Les Mondes. (Moigno.)

8°, Paris, 1874+. (Washington, Patent Office.)

Kotzebue: Lenz (A. F. E.). Physikalische Beobachtungen angestellt unter dem Commando des Capitains —.

Acad. de St.-Pétersbourg, Mém., I, 1831, 226–228.

Krafft (Georg Wolfgang). De figura terræ.

Acad. de St.-Pétersbourg, Com., VIII, 1736, 220–252.

——— De gravitate terrestri.*

4°, St. Petersburg, 1749.

——— De figura terræ.

Accad. Sci. Bologna, Com., VIII, 1785, 199–228.

Krafft (Wolfgang Louis). Sur la mesure universelle décrétée, le 8 mai 1790, par l'Assemblée nationale, et sur le projet de mesurer la méridienne de France.

Journ. d. Savans, 1791, 154–155.

——— Analyse des expériences faites en Russie sur la longueur du pendule à secondes, ou le rapport de la pesanteur en différentes latitudes.

Acad. de St.-Pétersbourg, Acta, VII, 1793, 215–228.

——— De tempore oscillationis pendulorum, dun arcus datæ amplitudines cujuscumque describunt.

Acad. de St.-Pétersbourg, Acta, IX, 1794, 225–242.

Kramer (Johann Hermann). Ueber den Gebrauch einer Normal-Linie bei geodätischen Arbeiten, ein Beitrag zur Geometrie.*

Hamm und Münster, 1822.

POGGENDORFF, I, 1312.

Krayenhoff (Cornelius Rudolph Theodor von). Ueber die neue astronomisch-trigonometrische Landes-Vermessung der batavischen Republik.

Mon. Corr. (Zach), VIII, 1803, 501–506; IX, 1804, 168–186, 264–268.

——— Précis historique des opérations géodésiques et astronomiques faites en Hollande; pour servir de base à la topographie de cet État.

Square 8°, La Haye, 1815, pp. xvi, 180. (Gore.)

——— Précis historique des opérations géodésiques et astronomiques faites en Hollande; pour servir de base à la topographie de cet État.

4°, à La Haye, 1827, pp. xxx, 202, 1 chart. (Brussels, Cartographic Institute.)

Kriel (Karl). Observations géodésiqes et magnétiques faites en Autriche pendant l'année 1846.

Acad. de Belgique, Bull., XIV, 1847, 286–291.

——— Observations géodésiques et magnétiques faites dans les États autrichiens pendant les années 1847 et 1848.

Acad. de Belgique, Bull., XVI, 1849, i, 329–333.

Kries (J.). Die Principien der Wahrscheinlichkeitsrechnung.*

Freiburg, 1886.

Kreplin (Heinrich). Ueber die Construction von geodätischen Instrumenten für den Gebrauch des Ingenieurs und des Topographen.

Zeits. f. Vermes., X, 1881, 122–126.

Kretschner. Zur Theorie der geodätischen Linien auf den Rotationsflächen.*

4°, Berlin, 1864.

Krüger (Louis). Die geodätische Linie des Sphäroids und Untersuchung darüber, wann dieselbe aufhört, kürzeste Linie zu sein.

8°, Berlin, 1883, pp. 28. (Munich, Royal.)

Krüger (Paul). Rotations- und Pendelbewegung eines Körpers in einer Flussigkeit.

8°, Danzig, 1882, pp. 42. (Oxford, Bodleian.)

Kruspér (S. von). Ueber die Vergleichung von Strickmaassen in Flüssigkeiten.*

Budapest, 1873.

——— Handbuch der Geodäsie.*

Budapest, 1885.

K. sächs. Ges. d. Wiss., math.-phys. Cl., Abhandl., *for* Abhandlungen der mathematisch-physischen Classe, königl.-sächsische Gesellschaft der Wissenschaften.

8°, Leipzig, 1850+. (Washington, Observatory.)

K. sächs. Ges. Wiss., math.-phys. Cl., Ber., *for* Bericht über die Verhandlungen der königl.-sächsischen Gesellschaft der Wissenschaften, mathematisch-physische Classe.

8°, Leipzig, 1849. (Washington, Observatory.)

K. Svenska Veten. Ak., Handl., *for* Handlingen, Königl.-Svenska Vetenskaps Akademien.

8°, Stockholm, 1739+. (Washington, Congress.)

K. Svenska Vetens. Ak., Öfvers., *for* Öfversigt af (Königl.Svenska) Vetenskaps Akademien Förhandlingen.

8°, Stockholm, 1844+. (Washington, Congress.)

Küttner (W.). Einführüng unvollständiger Beobachtungen in die Wahrscheinlichkeitsrechnung.

Zeits. f. Math. (Schlömilch), XXIX, 1884, 193–211.

Revd. in Jahrb. üb. d. Fortschr. d. Math., XVI, 1884, 186–187, by Ls. [LAZARUS].

Kuhlberg (P.). Resultate aus Pendelbeobachtungen im Kaukasus.

Astron. Nachr., XCIX, 1881, 282–288.

——— Untersuchungen über den Einfluss des Mitschwingens des zum russischen akademischen Revision-Pendel-Apparate gehörigen Stativs auf die Länge des Secundenpendels.

Astron. Nachr., CI, 1882, 243–246.

——— Ueber die Anwendung eines leichten Pendels zur Bestimmung der Correction für das Mitschwingen des Stativs der russischen Akademischen Reversionspendels.

Astron. Nachr., CXIII, 1886, 1–4.

Kummell (Charles Hugo). New investigation of the law of errors of observation.
Analyst, III, 1877, 133–140, 165–171.

——— To find the least distance between two places given by latitude and longitude, taking into account the polar compression.
Analyst, IV, 1877, 117–120.

——— Strenge Gleichungen zwischen den Seiten eines Dreiecksnetzes auf irgend einer Oberfläche, insbesondere auf Bessels mittlerem Erdsphäroid.
Astron. Nachr., LXXXIX, 1877, 49–58.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 777, by B[RUNS].

——— Revision of proof of the formula for the error of observation.
Analyst, VI, 1879, 80–81.

——— Reduction of observation equations which contain more than one observed quantity.
Analyst, VI, 1879, 97–105.

——— Proof of some remarkable relations in the method of least squares.
Analyst, VII, 1880, 84–88.

——— Alignment curves on any surface, with special application to the ellipsoid.
Phil. Soc. Wash., Bull., VI, 1884, 123–132.

——— On the determination of the shortest distance between two points on a spheroid.
Astron. Nachr., CXII, 1885, 97–108.
Read before the Mathematical section of the Philosophical Society of Washington [April 15, 1885].

Kundt *und* Koehler. Bericht der mecklenburgischen Landes-Vermessungs-Commission.
Int. Geod. Cong., Gen.-Ber., 1873, 6–7.

Kupffer (A. T.). Travaux pour fixer les mesures et les poids de l'empire de Russie. (H.)
2 vols., 4°, St.-Pétersbourg, 1841, 15 plates.

——— Sur une nouvelle méthode pour déterminer la figure de la terre.
Acad. de St.-Pétersbourg, Cl. phys. math., Bull., XVII, 1859, 237–240; Mél. phys. chim., III, 1859, 493–497.

——— L'association internationale pour l'uniformité des poids, des mesures et des monnaies dans tout le monde.*
St. Pétersbourg, 1860.

Kupka (P. F.). Geodätische Instrumente. Bericht über die Weltausstellung in Philadelphia.
8°, Wien, 1877, p. 18.

Kurz (A.). Ueber die Methode der kleinsten Quadrate.
Naturf. Ges. Zürich, Vierteljahrs., VIII, 1863, 225–240.
On the various methods of forming and solving normal equations, etc.

Kutscher (G.). Beitrag zur Geschichte der Gradmessungen.
Zeits. f. Vermes., XIII, 1884, 282–285.
Mechain's work.

K. Vetens. Ak. Handl., Ueb. Holzbecher u. Kästner, *for* Abhandlungen der königl. schwedischen Akademie der Wissenschaften. Uebersetzt von Holzbecher und Kästner.
8°, Hamburg, 1739–'79 (41 vols.). (Washington, Congress.)

L. (Fr.): Sabine (E.). Nouvelles expériences sur le pendule. [Corr. Math. (Quelteiet).] Revd. by —.
Bull. Sci. Math. (Saigey), XII, 1829, 236–239.

Lacaille (Nicolas-Louis de). Mesure du trente-quatrième degré de latitude australe.
Acad. d. Sci. Paris, Mém., 1751, 425–436; Hist., 158–169.

——— Mesure de la longueur du pendule à 33° 51′ de latitude australe.
Acad. d. Sci. Paris, Mém., 1751, 436–438; Hist., 158–169.

——— Observations pour la longueur du pendule simple à secondes à l'Isle de France.
Acad. d. Sci. Paris, Mém., 1754, 54–56.

——— Éclaircissemens sur les erreurs qu'on peut attribuer à la mesure du degré en France, entre Paris et Amiens.
Acad. d. Sci. Berlin, Hist., x, 1754, 337–346.

——— Diverses observations faites pendant le cours [de trois voyages], etc. Observations [à Rio de Janeiro] pour la longueur du pendule. (H.)
Acad. d. Sci. Paris, Mém., 1754, 108.

——— Sur la précision des mesures géodésiques faites en 1740, pour déterminer la distance de Paris à Amiens; à l'occasion d'un mémoire de M. Euler, inséré dans le neuvième tome de l'Académie de Berlin.
Acad. d. Sci. Paris, Mém., 1755, 53–59.

———: **Condamine (C. M. de la).** Letter to Dr. Matty regarding the mesure of —.
Roy. Soc. London, Phil. Trans., XLIX, 1756, ii, 623–624.

——— Mémoire sur la vraie longueur des degrés du méridien en France.
Acad. d. Sci. Paris, Mém., 1758, 237–244.

——— Journal historique du voyage fait au Cap de Bonne-Espérance par M. l'abbé —. Précédé d'un discours sur la vie de l'auteur, suivi de remarques et de réflexions sur les coutumes des Hottentots et des habitans du Cap.
16°, Paris, 1776, pp. xxxvi, 380. (Washington, Congress.)
Discours à M. le gouverneur du Cap sur la mesure du 34e degré de latitude australe, 187–216.

———: **Maclear (T.).** Observations made for the verification of the amplitude of —'s arc of the meridian.
Roy. Soc. London, Proc. IV, 1839, 192–193; Roy. Astron. Soc., Month. Not., v, 1839–'43, 45–50.

———: **Maclear (T.).** On the measurement of —'s arc, position of stations, and length of base line.
Roy. Astron. Soc., Mem., XI, 1840, 91–137; XX, 1851, 7–29; Month. Not., VII, 1845–'47, 57–58; XVIII, 1858, 107–108; Astron. Nachr., XXIV, 1846, 359–364.

La Casa (Vittorio de). *See* **Casa (Vittorio de la).**

Lagrange: Borda (J.-C.). Rapport sur le choix d'une unité de mesures.
Acad. d. Sci. Paris, Mém., 1791, 7–16. (Hist.)
Title in full under BORDA (J.-C.).

Lagrange (Joseph-Louis). Éclaircissement d'une difficulté singulière qui se rencontre dans le calcul de l'attraction des sphéroïdes tres-peu différens de la sphère.
École Polytech. Journ., VIII, 1809, 57–67.

Laguerre. Sur un genre particulier de surface dont on peut intéger les lignes géodésiques.*
Soc. Math. de France, Bull., I.

La Hire (Philippe de). Comparaison du pied antique romain à celui du châtelet de Paris, avec quelques remarques sur d'autres mesures.
Acad. d. Sci. Paris, Mém., 1714, 394–400.

——— Sur les pendules à seconde.
Acad. d. Sci. Paris, Mém., 1715, 130–132.

Lais (C. G.): Sawitsch (A. N.). Die Anwendung der Wahrscheinlichkeitstheorie auf die Berechnung der astronomischen Beobachtungen und geodätischen Messungen. Translated by —.
Leipzig, 1863.
Title in full under SAWITSCH (A. N.).

La Lande (J.-J.). Mémoire sur la détermination de la parallaxe de la lune et de la courbure de la terre entreprise au Cap de Bonne-Espérance et à Berlin par ordre de S. M. T. Chrét. Avec les observations, faites depuis le 25 nov. 1751, jusqu'au 20 avril 1752 à l'observatoire royal de Berlin.
Acad. d. Sci. Berlin, Hist., VI, 1750, 236–279, 379–411.

——— *Premier mémoire sur la parallaxe de la lune.*
Acad. d. Sci. Paris, Mém., 1752, 78–114; Hist., 103–110.
In which the ellipticity of the earth is determined.

——— Sur la quantité de l'aplatissement de la terre.
Acad. d. Sci. Paris, Mém., 1785, 1–8.

——— Sur la mesure de la terre, que Fernel publia en 1528.
Acad. d. Sci. Paris, Mém., 1787, 216–225.

Lalande *for* Bibliographie d'Astronomie par Lalande (J. Le F. de).
Paris, 1804.

Lalande (Jérôme le François de). Mesure de la méridienne.
Soc. Philom., Bull., I, 1791, 47.

——— *Astronomie. Troisième édition, revue et augmentée.*
8°, Paris, 1792, I: pp. lxvi, 478, 378, 1 plate; II: pp. 720, iii, 737. (Washington, Congress.)
De la grandeur et de la figure de la terre, iii, 1–47.

——— [Bericht über die französischen Gradmessungs-Arbeiten.]
Allg. geogr. Eph., I, 1798, 127–131.

———: **Montucla (J.-E.).** Histoire des mathématiques. Achevée et publiée par —.
Paris, 1799–1802.
Title in full under MONTUCLA (J.-F.).

——— Sur les degrés de la terre et sur les nouvelles mesures. (H.)
Conn. d. Temps, 1801, x, 455–474.

——— Sur la mesure d'un degré de la terre en Laponie.
Journ. d. Phys., LVI, 1802, 400–401.

——— [Bericht über Gradmessungsarbeiten.]
Mon. Corr. (Zach), v, 1802, 55–56.

——— [Dimensions de l'ellipsoïde terrestre.]
Mon. Corr. (Zach), II, 1800, 82; Astron. Jahrb. (Bode), 1803, 238.

——— Du milieu qu'il faut choisir entre les résultats d'un grand nombre d'observations.
Conn. d. Temps, 1813, 213–223.

Lalmand (A.-A.). Géodésie, ou l'art de partager les champs, à l'usage des arpenteurs et des personnes qui, avec les premiers connoissances de la géométrie, voudroient procéder à la division des terrains.
8°, Paris, 1793, pp. 193, 4 plates.
Simple surveying.

Lamarche: Siraped (W. S. de). De la forme de la terre. Translated by —.
Paris, 1828.
Title in full under SIRAPED (W. S. DE).

La Marmora (Albert Ferrero le *Comte* de). Notice sur les opérations géodésiques faites en Sardaigne pour la construction de la carte de cette île.
8°, Paris, 1839, pp. 33. (Paris, National.)
Also in Voyage en Sardaigne, 2d ed., 481–514.
Written LAMARMORA by FERRERO.

Lamb (Martha J.). The Coast Survey.
Harper's Mag., LVIII, 1878, 506–520.

Lambton (William). An account of a method for extending a geographical survey across the peninsula of India.
Asiatick Researches, VII, 1803, 312–335.

——— An account of the measurement of an arc of the meridian on the coast of Coromandel, and the length of a degree deduced therefrom in latitude 12° 32′.
Asiatick Researches, VIII, 1805, 137–194; Bibl. Brit. Genève, XXXVI, 1808, 165–245; Journ. Nat. Phil. (Nicholson), XIX, 1808, 309–317; XX, 1808, 40–50; Conn. d. Temps., 1810, 383–386; Edinb. Rev., XXI, 1813, 310–328.
Containing a comparison of an arc of meridian with an arc of parallel:
1° meridian = 60,495 fathoms.
1° parallel = 61,061 fathoms.

——— An account of the trigonometrical operations in crossing the peninsula of India, and connecting Fort St. George with Mangalore.
Asiatick Researches, x, 1811, 290–384.

——— An account of the measurement of an arc on the meridian comprehended between the latitudes 8° 9′ 38″.39 and 10° 59′ 48″.93 north, being a continuation of the great meridional arc commenced in 1804 and extending to 14° 6′ 19″ north.
Asiatick Researches, XII, 1818, 2–101; Roy. Soc. London, Phil. Trans., CVIII, 1818, 486–517.
Revd. by DELAMBRE, Conn. d. Temps., 1819, 292–302.

——— An account of the measurement of an arc on the meridian, extending from latitude 10° 59′ 49″ to 15° 6′ 0″.65 north.
Asiatick Researches, XII, 1818, 294–359.

——— Account of the measurement of an arc on the meridian, extending from latitude 15° 6′ 0″.2 to latitude 18° 3′ 45″, being a further continuation of the former arc, commencing in latitude 8° 9′ 38″.
Asiatick Researches, XIII, 1820, 1–127.

——— [Extrait des résultats obtenus de la mesure d'un arc du méridien en Inde.]
Conn. d. Temps., 1821, 331–336.

——— Correction to the (Indian) meridional arc to reduce it to parliamentary standard.
Roy. Soc. London, Phil. Trans., CXIII, 1823, 27–33.

——— Sur le nouveau système des poids et mesures adopté en France.
Ann. de Chim., XXII, 1823, 407–410.

Lambton (William)—Continued.

——— : **Everest (G.)**. An account of the measurement of an arc of the meridian, as detailed by —.
London, 1830.
Title in full under EVEREST (G.).

La Métherie (Jean-Claude de). Théorie de la terre.
3 vols., Paris, 1795; 2e éd., 5 vols., Paris, 1797.
Purely geological and mineralogical.

Lamont (Johann von). Astronomische Bestimmung der Lage des bayerischen Dreiecksnetzes auf dem Erdsphäroid.
K. bayer. Ak. d. Wiss., math.-phys. Cl., Sitz.-Ber., I, 1865, 28–66.

——— Astronomisch-geodätische Bestimmungen, ausgeführt an einigen Hauptpunkten des bayerischen Dreiecksnetzes.
8°, München, 1871, pp. lxxx, 178; Münchener Sternwarte, Ann., x.

——— *und* **Orff (von)**. Astronom.-geodätische Ortsbestimmungen in Bayern.*
4°, München, 1880.
Revd. by SCHUR (W.), Astron. Ges., Vierteljahrs., XVI, 1881, 135–145.

Lamp (Ernst August): **Zachariae (G.)**. Die geodätischen Hauptpunkte und ihre Coordinate. Translated by —.
Berlin, 1878.
Title in full under ZACHARIAE (G.).

Lancaster (A.) *et* **Houzeau (J.-C.)**. Bibliographie générale de l'astronomie.
Bruxelles, 1882.
Title in full under HOUZEAU (J.-C.).

Landreth (Olin H.). Instruction for transmitting communications by heliotrope signaling. Arranged for use on the New York State Survey, by Olin H. Landreth, pp. [3], —, 1882.

Lane (J. Homer). On the coefficient of expansion of the British standard yard bar.
U. S. C. and G. Survey, Rep., 1877, 148–181.

Lange (G. A. de). Verslag van de geodesische triangulatie der residentie Banjoemas.
Natuurk. Ver. Neder. Indië, Verhandel., II, 1857–'58, 1–30.

——— Verslag van de geodesische triangulatie van de residentien Bagelen en Kadoe.
Natuurk. Ver. Neder. Indië, Verhandel., II, 1857–'58, i, 1–32.

Langenbeck (R.). Ueber diejenigen geodätischen Linien auf dem dreiaxigen Ellipsoid, welche durch einen der Nabelpunkte desselben gehen.
8°, Göttingen, 1877, pp. 39. (Gore.)

Langhansen (Christophorus [Christoph]). De figurâ telluris ad sensum sphæricâ.
4°, Regiomonti, 1724, pp. [v], 26. (Munich, Royal.)

Langsdorff (G. W. von). Grundriss der Geodäsie für Unterricht und zur Selbstbelehrung.
18°, Mannheim, 1843, pp. iv, 143, 8 plates; 3d ed., Mannheim, 1846. (Gore.)

——— Ueber den Distanzmesser mit Parallelfäden.
Arch. d. Math. (Grunert), VIII, 1846, 250–254.

Laplace (Pierre-Simon de). Mémoire sur l'inclinaison moyenne des orbites; des comètes; sur la figure de la terre, et sur la fonctions.
Mém. de Math. Phys., VII, 1773, 503–540; Mém. Sav. Étrang., VII, 1776.

Laplace (Pierre-Simon de)—Continued.

——— Mémoire sur la figure de la terre.
Acad. d. Sci. Paris, Mém., 1783, 17–48.

——— Sur les degrés mesurés des méridiens, et sur les longueurs observées du pendule.
Acad. d. Sci. Paris, Mém., 1789, 18–43.
"The matter of this memoir is mostly reproduced in sections 39-42 of Chap. v, Book III, of Traité mécanique céleste."—MERRIMAN, 160.

——— : **Borda (J.-C.)**. Rapport sur le choix d'une unité de mesures.
Acad. d. Sci. Paris, Mém., 1791, 7–16 (Hist.).
Title in full under BORDA (J.-C.).

——— Exposition du système du monde.
3e éd., Paris, 1808.
De la figure de la terre, de la variation de la pesanteur à sa surface, et du système décimal des poids et mesures, 57–78.

——— : **Delambre (J.-B.-J.)** Méthode sur les intégrales définies et leur application aux probabilités, par —.
Inst. de France, Cl. Math. Phys., Mém., II, 1811, 1–18 (Hist.).

——— Ueber die Bestimmung des wahrscheinlichsten Resultats aus den Resultaten einer grossen Menge von Beobachtungen.
Mon. Corr. (Zach), XXV, 1812, 105–120.

——— Essai philosophique sur les probabilités.
12°, Paris, 1816, pp. 232; 6e éd., Paris, 1840; 7e éd., Bruxelles, 1840. (Brussels, Royal.)

——— Sur l'action réciproque des pendules; la vitesse du son dans les diverses substances.
Ann. de Chim., III, 1816, 162–166.

——— Sur la longueur du pendule à secondes.
Ann. de Chim., III, 1816, 92–95; Conn. d. Temps, 1820, 265–280, 441–442; Ann. d. Phys. (Gilbert), LIII, 1817, 225–229; Soc. Philom., Bull., 170–172; Phil. Mag. (Tilloch), XXIX, 1817, 256–258.

——— : **Prony (G.-C.-F.-M.-R. de)**. Note relative à l'article de — sur la longueur du pendule à secondes.
Soc. Philom., Bull., 1816, 172–174; 1817, 193–194.

——— Application du calcul des probabilités aux opérations géodésiques.
Journ. de Phys., LXXXV, 1817, 145–148; Soc. Philom., Bull., V, 1817, 143–146; Ann. de Chim. V, 1817, 351–356; Conn. d. Temps., 1820, 422–440.
Revd., Acad. d. Sci. Paris, Hist., 1819, pp. i–iii, by DELAMBRE (J.-B.-J.).

——— Mémoire de la figure de la terre.
Acad. d. Sci. Paris, Mém., III, 1817, 137–184; III, 1818, 489–502; 1819, iii–v (Hist.); Ann. de Chim., XI, 1819, 31–39; Conn. d. Temps, 1822, 284–293; Journ. de Phys., XC, 1820, 303–307; Soc. Philom., Bull., 1819, 97–100; Quart. Journ. Sci., VIII, 1820, 108–114; Ann. Nat. Phil. (Thomson), XIV, 1819, 401–406; Phil. Mag. (Tilloch), 1819, 371–376.
This contains the theorem: "If the length of the seconds pendulum at the equator be taken as unity, and if to the length of this pendulum, observed at any point on the surface of the terrestrial spheroid, be added, half the height of this point above the level of the ocean, divided by half the polar axis, a height which is given by barometrical observation, the increase of the length, thus corrected, will be, on the hypothesis of a constant density below a small depth, equal to the product of the square of the sine of the latitude by five-fourths of the centrifugal force to the gravity, or by forty-three ten-thousandths."

Laplace (Pierre-Simon de)—Continued.

——— Sur la figure de la terre et la loi de la pesanteur à sa surface.

Ann. de Chim., VIII, 1818, 312–318; Journ. de Phys., LXXVII, 1818, 136–140; Oken, Isis, 1818, 1759–1762; Soc. Philom., Bull., 1818, 122–125; Conn. d. Temps, 1821, 326–331.

——— Application du calcul du probabilités aux opérations géodésiques de la méridienne de France.

Ann. de Chim., XII, 1819, 37–41; Soc. Philom., Bull., VI, 1819, 137–139; Conn. d. Temps, 1822, 346–348; Phil. Mag. (Tilloch), LVIII, 1821, 133–136.

In a chain of 107 triangles the sum of the squares of the error was 108.13, while the theory of probability gave 107.78. Comparing the work of Condamine and Cassini he concludes to give a great preference to repeating theodolites.

——— Sur la densité moyenne de la terre.

Ann. de Chim., XIV, 1820, 410–417; Conn. d. Temps, 1823, 328–331; Journ. d. Phys., XCI, 1820, 146–150; Soc. Philom., Bull., 1820, 124–127; Phil. Mag. (Tilloch), LVI, 1820, 322–326.

———: **Young (T.)**. Remarks on —'s latest computation of the density and figure of the earth.

Quart. Journ. Sci., IX, 1820, 32–35.

———: **L. (S.-B.)**. Remarques sur les derniers calculs de M. —. Sur la figure et la densité de la terre.

Journ. de Phys., XC, 1820, 463–465.

——— Sulla interna constituzione della terra, e sulla di lei temperatura.

Giorn. di Fis. (Brugnatelli), III, 1820, 128–132; Ann. de Chim., XI, 1819, 31.

——— Sulla diminuzione della durata del giorno per il raffreddamento della terra.

Giorn. Fis. (Brugnatelli), III, 1820, 343–346.

——— Théorie analytique des probabilités; par M. le marquis de Laplace, Paris, 1812.

3e éd., revue et augmentée par l'auteur, 4°, Paris, 1820, pp. cxlii, 506, 34, 50, 36, 28.

Deuxième supplément. Application du calcul des probabilités aux opérations géodésiques, pp. 50.

Troisième supplément. Application des formules géodésiques de probabilité à la méridienne de France, pp. 36.

4e éd. (vol. VII of Œuvres de Laplace), 4°, Paris, 1847+, pp. cxcv, 691. (Gore.)

The second supplement was first published in part in Conn. des Temps, 1820, 422–440; Ann. de Chim. v, 1817, 351–356; Zeits. für Astron., v, 1–9.—MERRIMAN.

——— Sur la loi de la pesanteur en supposant le sphéroïde terrestre homogène et de même densité que la mer.

Conn. d. Temps, 1821, 284–290.

——— Sur la réduction de la longueur du pendule au niveau de la mer.

Ann. de Chim., XXX, 1825, 381–387.

Revd. by FRANCŒUR, Bull. Sci. Math. (Saigey).

——— Mécanique céleste, by the Marquis de Laplace. Translated with a commentary by Nathaniel Bowditch.

4°, Boston, 1829–'39. (Gore.)

On the figure of a spheroid, differing but little from a sphere, II, 241–357; Comparison of the preceding theory with observation, II, 358–491.

LAPLAND.

HANSEN (P. A.). . . . über die Maupertuis'sche Gradmessung.
Astron. Nachr., IX, 1821, 189–219, 237–262.

LINDHAGEN (D. G.). Bericht über die in Angelegenheiten der Gradmessung unternommenen Reise nach Lappland.
Acad. de St.-Pétersbourg, Mél. Math. Astron., I, 1852, 449–476; Cl. Math., Bull., X, 1852, 241–261.

MELANDERHJELM (D.). Ueber die Gradmessung in Lappland.
Mon. Corr. (Zach), I, 1800, 139–145, 372–380; II, 1800, 250–257; V, 1802, 156–169; VII, 1803, 561–568; IX, 1804, 491–495; Astron. Jahrb. (Bode), 1806, 219–223.

OUTHIER (R.). Journal d'un voyage au nord en 1736–'37.
Paris, 1744.

PROSPERIN (E.). Ueber die geographische Lage des 1736–'37 in Lappland gemessenen Breitengrades.
Geogr. Ephem. (Zach), IV, 1799, 97–104; Astron. Jahrb. (Bode), 1806, 193–195.

ROSENBERGER (O. A.). Ueber die . . . französischen in Schweden vorgenomene Gradmessung.
Astron. Nachr., VI, 1828, 1–32.

SELANDER (N. H.). Gradmätning och nivelliring i Lappland.
K. Svenska Videns., Öfversigt, VII, 1850, 250–252.

SVANBERG (J.). Ueber die alte nordische Gradmessung.
Mon. Corr. (Zach), II, 1800, 257–261; V, 1802, 161–169.

——— Berättelse öfver . . . den Franska gradmätning en omkring Tornea.
K. Vetens. Acad., Handl., XX, 1799, 279–291.

——— Exposition des opérations faites en Lapponie pour la détermination d'un arc du méridien.
Stockholm, 1805.

Lapparent (Albert de). Sur les rapports de la géodésie avec la géologie; réponse aux observations de M. Faye.

Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 772–774.

——— Sur les conditions de forme et de densité de l'écorce terrestre.

Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 1040–1042.

———: **Faye (H.-A.-E.-A.)**. Réponse à une note de M.— sur les conditions de forme de l'écorce terrestre.

Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 1093–1101, 1221–1224.

Largeteau (Charles-Louis). Rapport fait au bureau des longitudes sur la détermination de la longueur de l'arc du méridien compris entre les parallèles de Dunkerque et de Formentera.

Conn. d. Temps, 1844, 123–131.

Laugier *et* **Delaunay (C.-E.)**. Rapport sur l'état actuel de la géodésie et sur les travaux à entreprendre par le bureau des longitudes.

Conn. d. Temps, 1864, 1–20.

Laugner (Hugo). Ueber eine Methode zur Messung kleiner Winkel-Differenzen.

Zeits. f. Instrumentenkunde, VI, 1886, 299–304.

Laur (J. A.). Ueber die Unveränderlichkeit der Erdmasse.*

——— Géodésie pratique, simplifiée et perfectionnée, à l'usage du génie civil et militaire, des ponts et chaussées et des mines, des géomètres du cadastre, des experts et géomètres, et de toutes les personnes qui s'occupent de plans géométriques, de drainages, de partages et de bornages des terres.

8°, 6e éd., Bruxelles, 1855, pp. xiv, 315, 9 pl.; pp. xvi, 220, 6 pl. (Paris, National.)

Simple surveying.

Laur (J. A.)—Continued.

——— Vereinfachte und vervollkommnete praktische Geodäsie zum Gebrauche der Civil- und Militär-Ingenieurs- und Wege-Baues, des Bergwerkswesens, der Geometer des Katasters, der vereideten Experten und Geometer, und aller Personen, welche sich mit Plänen und geographischen Karten, mit der Drainage, dem Theilen und Begränzen der Aecker beschäftigen. Aus dem Französischen übertragen von Strubberg (O.).

8°, Leipzig, 1857, I: pp. xvi, 291, 8 plates; II: pp. xiv, 308, 9 plates.

Laurent (H.). Sur la méthode des moindres carrés.

Journ. de Math. (Liouville), I, 1875, 75–80.

Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 112, by B[RUNS].

Laussedat (A.). Note sur les travaux géodésiques de la carte d'Espagne.

Acad. d. Sci. Paris, Comp. Rend., XLVIII, 1859, 473–475.

——— Expériences faites avec l'appareil à mesurer les bases appartenant à la commission de la carte d'Espagne. Ouvrage publié par ordre de la reine. Traduit de l'espagnol par —.

8°, Paris, 1860, pp. [vii], 235, cxlvii, 7 plates.

Appendix 6, pp. cxxxiii–cxxxvii, contains a list of publications "relatives aux bases géodésiques mesurées dans différents pays."

——— Sur les opérations en cours d'exécution pour la carte d'Espagne, d'après les renseignements donnés à l'Académie de Madrid par M. le colonel Ibañez.

Acad. d. Sci. Paris, Comp. Rend., LVIII, 1864, 70–72.

———: **Ibañez (C.)**. Base centrale de la triangulation géodésique d'Espagne. Translated by —.

Madrid, 1865.

Title in full under IBAÑEZ (C.).

——— Sur les travaux géodésiques exécutés en Espagne, à propos de la publication d'une traduction de l'ouvrage intitulé: Base centrale de la triangulation géodésique de l'Espagne.

Acad. d. Sci. Paris, Comp. Rend., LXII, 1866, 1007–1010.

——— Note relative au prolongement de la méridienne de France et d' Espagne en Algérie.

Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1492–1500.

———: **Perrier (F.)**. Réponse à la note de M. — sur le prolongement de la méridienne d'Espagne en Algérie.

Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1696–1699.

——— Sur l'emploi des signaux lumineux dans les opérations géodésiques. Lettre de M. Laussedat à M. le secrétaire perpétuel.

Acad. d. Sci. Paris, Comp. Rend., LXXVIII, 1874, 898–901.

——— Sur la méthode employée par d'Aubuisson, en 1810, pour la mesure des bases géodésiques. Lettre de M. Laussedat à M. le secrétaire perpétuel.

Acad. d. Sci. Paris, Comp. Rend., XCI, 1880, 922–923; Ann. d. Mines, IX, 1881+.

Lazarus (W.). Die Bestimmung und Ausgleichung der aus Beobachtungen abgeleiteten Wahrscheinlichkeiten.

Math. Ges. Hamburg, Mittheil., 1878, 7–27.

Revd. in Jahrb. üb. d. Fortschr. d. Math., X, 1878, 164–165, by B[RUNS].

Leake (W. Martin). On the stade, as a linear measure.

Roy. Geogr. Soc. London, Journ., IX, 1839, 1–25.

LEAST SQUARES.

ABBE (C.). A historical note on the method of least squares.
Am. Journ. Sci., I, 1871, 411–415.

ARGELANDER (F. W. A.). Die Anwendung der Methode der kleinsten Quadrate auf einen besondern Fall.
Astron. Nachr., XXI, 1843, 163–168.

BACHE (A. D.). Comparison of the results obtained in geodesy by the application of the theory of least squares.
A. A. A. S., Proc., 1849, 102–105.

——— Reduction of horizontal angles by the method of dependent directions and of dependent angular quantities by the method of least squares.
U. S. C. and G. Survey, Rep., 1854, 63–95.

BERTRAND (J.). Méthodes des moindres carrés.
Paris, 1855.

BESSEL (F. W.). Ein Hülfsmittel zur Erleichterung der Anwendung der Methode der kleinsten Quadrate.
Astron. Nachr., XVII, 1840, 225–230.

——— Neue Formel von Jacobi für die Anwendung der Methode der kleinsten Quadrate.
Astron. Nachr., XVII, 1840, 305–308.

BOND (G. P.). On the use of equivalent factors in the method of least squares.
Am. Acad., Mem., VI, 1857, 179–212.

CASORATI (F.). Intorno ad alcuni punti della teoria dei minimi quadrati.
Roma, 1858.

CHAUVENET (W.). Method of least squares.
Philadelphia, n. d.

CLEMENS (F. A.). Ueber die Methode der kleinsten Quadrate.
Tilsit, 1848.

DADDI (G. B.). Della combinazione degli errori nel metodo dei minimi quadrati.
Torino, 1879.

DENZLER (W.). Ueber den Fundamentalsatz der Methode der kleinsten Quadrate.
Naturf. Ges. Zürich, Mittheil., II, 1850–'52, 110–112.

DIENGER (J.). Ueber die Bestimmung des Gewichts der nach der Methode der kleinsten Quadrate erhaltenen wahrscheinlichsten Werthe der Unbekannten.
Arch. d. Math. (Grunert), XIX, 1852, 197–202.

——— Ausgleichung der Beobachtungsfehler nach der Methode der kleinsten Quadrate.
Braunschweig, 1857.

DONKIN (W. F.). On an analogy relating to the theory of probabilities and on the principle of the method of least squares.
Quart. Journ. Math., I, 1857, 152–162.

ELLIS (R. L.). On the method of least squares.
Phil. Soc. Camb., Trans., VIII, 1844, ii, 204–219.

ENCKE (J. F.). Ueber die Begründung der Methode der kleinsten Quadrate.
K. Ak. d. Wiss., math.-phys. Cl., 1831, 73–78; Ber., 1850, 211–214; Berlin, 1888.

FARQUHAR (H.). Form of least square computation.
Phil. Soc. Wash., Bull., VI, 1883, 150–152.

FAYE (H.-A.-E.-A.). Note . . . sur la méthode des moindres carrés.
Acad. d. Sci. Paris, Comp. Rend , LXXX, 1875, 352–357.

FERRERO (A.). Esposizione del metodo dei minimi quadrati, Firenze, 1876.
Am. Journ. Math., I, 1878, 59–63.

FORTI (A. O.). La teorica degli errori, ed il metodo dei minimi quadrati.
Milano, 1880.

FRIEDEN (W. VON). Die Praxis der Methode der kleinsten Quadrate.
Braunschweig, 1863.

LEAST SQUARES—Continued.

FRISANI. Sulle più vantaggiosa combinazione delle osservazioni.
Ist. Lomb., Mem., II, 1870, 1–21.

GALBRAITH (W.). On the method of least squares as employed in determining the figure of the earth.
Phil. Mag. (Taylor), II, 1827, 48–54.

GALLOWAY (T.). On the application of the method of least squares to the determination of the probable error in the Ordnance Survey.
Roy. Astron. Soc., Mem., XV, 1846, 23–69.

GAUSS (C. F.). Ueber die vortheilhafte Anwendung der Methode der kleinsten Quadrate.
Zeits. f. Astron. (Lindenau), V, 1827, 230.

—— Abhandlungen zur Methode der kleinsten Quadrate.
Berlin, 1887.

GEER (P. VAN). Over het gebruik van determinanten bij de methode der kleinste kwadraten.
Arch. voor Wisk., I, 1875, 177–188; Arch. Néer., XVIII, 1883, 127–137.

GERLING (C. L.). Die Ausgleichungsrechnungen der praktischen Geometrie.
Hamburg, 1843; Arch. d. Math. (Grunert), VI, 1845, 141–146, 375–378.

GILETTA (L.). Intorno ai fondamenti dei minimi quadrati.
Giorn. Mat. (Battaglini), XVIII, 1880, 159–174.

GLAISHER (J. W. L.). On the solution of the equations in the method of least squares.
Roy. Astron. Soc., Month. Not., XXXII, 1874, 241–242; XXXIV, 1874, 311–314; XL, 1880, 600–614; XLI, 1881, 18–83; Mem., XXXIX, 1872, 75–124; Nature, VI, 1872, 140–141.

—— Note on a point in the method of least squares.
Mess. Math., 1880, 132.

GOSS (J. W.). Begründung der Methode der kleinsten Quadrate.
1871.

GRAVELAAR (N. L. W. A.). Het gebruik van determinanten bij de methode der kleinste quadraten.
Arch. voor Wis., Amsterdam, X, 1885, 107–112.

HANSEN (P. A.). Von der Methode der kleinsten Quadrate . . . und ihrer Anwendung auf die Geodäsie.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Abhandl., VIII, 1865, 573–806; Leipzig, 1867.

IVORY (J.). On the method of least squares.
Phil. Mag. (Tilloch), LXVIII, 1826, 161–165.

JACOBI (C. G. J.). Ueber eine neue Auflösungsart der bei der Methode der kleinsten Quadrate vorkommenden linearen Gleichungen.
Astron. Nachr., XXII, 1844, 297–306.

JORDAN (W.). Verallgemeinerung eines Satzes der Methode der kleinsten Quadrate.
Zeits. f. Math. (Schlömilch), XVIII, 1873, 116–120.

KOPPE (C.). Die Ausgleichungsrechnung nach der Methode der kleinsten Quadrate in der praktischen Geometrie.
Nordhausen, 1885.

KUMMELL (C. H.). Proof of some remarkable relations in the method of least squares.
Analyst, VII, 1880, 84–88.

KURZ (A.). Ueber die Methode der kleinsten Quadrate.
Naturf. Ges. Zürich, Vierteljahrs., VIII, 1863, 225–240.

LAURENT (A.). Sur la méthode des moindres carrés.
Journ. de Math. (Liouville), I, 1875, 75–80.

LEGENDRE (A. M.). Méthode des moindres carrés.
Inst. de France, Mém., 1810, ii, 149–154.

LÜDECKE (C.). Die Anwendung der Methode der kleinsten Quadrate in der niederen Geodäsie.
Zeits. f. Vermes., VIII, 1879, 438–456.

MATZKA (W.). Beweis des obersten Grundsatzes der Methode der kleinsten Quadrate.
Arch. d. Math. (Grunert), XI, 1848, 369–377.

LEAST SQUARES—Continued.

MERRIMAN (M.). Elementary discussion of the principles of least squares.
Journ. Frank. Inst., LXXIV, 1877, 173–187.

—— Elements of the method of least squares.
London, 1877.

—— On the history of the method of least squares.
Analyst, IV, 1877, 33–36, 140–143.

—— List of writings relating to the method of least squares.
Connecticut Acad., Trans., IV, 1877, i, 151–232.

—— A text-book on the method of least squares.
New York, 1884.

MILLER (A. R. VON). Ueber die Methode der kleinsten Quadrate.
Oesterreich. Zeits. f. Bergwes., XV, 1867, 181–194.

MINDING (E. F. A.). Zur Methode der kleinsten Quadrate.
Acad. de St.-Pétersbourg, Bull., XVI, 1871, 305–308.

NATANI (L.). Methode der kleinsten Quadrate.
Berlin, 1875.

NELL (A. M.). Ueber einige Vereinfachungen, welche bei der Anwendung der Methode der kleinsten Quadrate gemacht werden können.
Zeits. f. Vermes., XVI, 1887, 454–467.

PAUCKER (E. G. VON). Ueber die Anwendung der Methode der kleinsten Quadratsumme auf physikalische Beobachtungen.
Mitau, 1819.

—— Zur Theorie der kleinsten Quadrate.
Acad. de St.-Pétersbourg, Bull. Phys.-Math., IX, 1851, 113–125; X, 1852, 33–43, 233–238; Mél. Math., I, 1853, 188–204, 333–346, 433–439.

RITTER (E.). Manuel . . . de la méthode des moindres carrés.
Paris, 1853–'58.

RÜDIGER (W. VON). Die Methode der kleinsten Quadrate . . .
Berlin, 1877.

SAFFORD (T. H.). On the method of least squares.
Am. Acad., Proc., XI, 1876, 193–201.

SAWITSCH (A. N.). Die Methode der kleinsten Quadrate.
Leipzig, 1863.

SCHOTT (C. A.). Solution of normal equations by indirect elimination.
U. S. C. and G. Survey, Rep., 1855, 255–264.

SEELIGER (H.). Ueber die Vertheilung der Vorzeichen der nach einer Ausgleichung übrig bleibenden Fehler.
Astron. Nachr., XCVI, 1879, 49–62; XCVII, 1880, 289–304.

SEIDEL (L.). Ueber ein Verfahren die Gleichungen, auf welche die Methode der kleinsten Quadrate führt, sowie lineare Gleichungen überhaupt durch successive Annäherung aufzulösen.
K. bayer. Ak. d. Wiss., Abhandl., XI, 1874, iii, 81–108.

STEINTHAL (A. E.). The method of least squares applied to conditioned observations.
Messenger Math., X, 1881, 186–190.

THIELE (T.-N.). Sur la compensation de quelques erreurs quasi-systématiques par la méthode des moindres carrés.
Copenhagen, 1880.

TODHUNTER (I.). On the method of least squares.
L., E., D. Phil. Mag., XXX, 1865, 378; Phil. Soc. Camb., Trans., XI, 1869, ii, 219–238.

VERDAM (G. J.). Verhandeling over de methode der kleinste quadraten.
Groningen, 1850–'52.

VOGLER. Die Methode der kleinsten Quadratsummen als Bildnerin bestgewählter Mittelgrossen.
Zeits. f. Vermes., XVI, 1887, 142–147.

WATSON. Theoretical astronomy.
Philadelphia, 1869.

WITTSTEIN (T. L.). Die Methode der kleinsten Quadrate.
Hannover, 1875; Astron. Nachr., CII, 1882, 339–342; Zeits. f. Math. (Schlömilch), XXVII, 1882, 315–317.

LEAST SQUARES—Continued.

WOLF (R.). Note zur Methode der kleinsten Quadrate.
Naturf. Ges. Bern, Mittheil., 1849, 140–144.

WRIGHT (T. W.). On the application of the method of least squares.
Analyst, x, 1883, 33–41.

——— On the adjustment of observations in the method of least squares.
Van Nostrand's Mag., XXVIII, 1883, 419–436, 473–505; New York, 1884.

ZACHARIAE (G.). De mindste qvadraters methode.
Nyborg, 1871; Kjøbenhavn, 1887.

ZECH (J.). Zur Methode der kleinsten Quadrate.
Tübingen, 1857.

Lecoq (**von**). Trigonometrische Vermessungen und Orts-Bestimmung in Westphalen.
Mon. Corr. (Zach), II, 1800, 203–207.

——— Ueber die trigonometrische Aufnahme in Westphalen.
Mon. Corr. (Zach), VIII, 1803, 68–81, 136–158, 197–207, 321–331; IX, 1804, 81–86.

L., E., D. Phil. Mag., *for* London and Edinburgh Philosophical Magazine and Journal of Science.
8°, London, 1832+. (Washington, Patent Office.)

Lee (**Thomas Jefferson**). Tables and formulæ useful in surveying, geodesy, and practical astronomy, including elements for the projection of maps, and instructions for field magnetic observations.
8°, Washington, 1853.
3d ed., revised and enlarged. Washington, 1873, pp. ix, 310.
Professional Papers of the Corps of Engineers, U. S. Army, No. 12, Geodesy, 81–182.

Lefèvre (**A.**). Manuel du trigonométrie; servant de guide aux jeunes ingénieurs qui se destinent aux opérations géodésiques; suivi de divers solutions de géométrie pratique et plusieurs tables.
8°, Paris, 1819, pp. 284, 2 plates. (Washington, Coast Survey.)

——— Nouveau traité géométrique de l'arpentage, à l'usage des personnes qui se destinent à l'état d'arpenteur, au lever des plans et aux opérations de nivellement. 4e édition. Entièrement refondue et augmentée d'un traité de géodésie pratique; ouvrage contenant tout ce qui est relatif à l'arpentage, à l'aménagement des bois et à la division des propriétés; ce qui faut connaître pour les grandes opérations géodésiques et le nivellement.
8°, Paris, 1826, I: pp. xi, 509, 1 plate; II: pp. 440, 28 plates. (British Museum.)

——— Application de la géométrie à la mesure des lignes inaccessibles et des surfaces planes, etc., ou longi-planimétrie pratique.
8°, Paris, 1827, pp. xvi, 246, 5 plates. (British Museum.)

——— Développement d'un nouveau mode d'observer les angles d'une triangulation.
12°, Paris, 1837, pp. iv, 188.
Surveying.
The inner title is: Connaissances du géodésiste, ou traité spécial de la division des propriétés rurales, suivi d'un article sur leur abornement et leurs clôtures.

Legendre (**Adrien-Marie**). Recherches sur la fiurge des planètes.
Acad. d. Sci. Paris, Mém., 1784, 370–389.

Legendre (**Adrien-Marie**)—Continued.

——— Mémoire sur les opérations trigonométriques dont les résultats dépendent de la figure de la terre.
Acad. d. Sci. Paris, Mém., 1787, 352–383.

——— Suite du calcul des triangles qui servent à déterminer la différence de longitude entre l'Observatoire de Paris et celui de Greenwich.
Acad. d. Sci. Paris, Mém., 1788, 747–754.

——— Recherches sur la figure des planètes.
Hist. Acad. Sci., avec Mém. de mathém. et phys., 1789, 372–454.
Figure de la terre par les degrés du Pérou et de France, 422.

——— *et* **Delambre** (**J.-B.-J.**). Méthodes pour la détermination d'un arc du méridien.
Paris, 1799.
Title in full under DELAMBRE (J.-B.-J.).

——— *et* **Cassini** (**J.-D.**). La jonction des observatoires de Paris et de Greenwich.
Paris, 1790.
Title in full under CASSINI (J.-D.).

——— Méthode pour déterminer la longueur exacte du quart du méridien, d'après les observations faites pour la mesure de l'arc compris entre Dunkerque et Barcelonne.
Inst. de France, Mém., 1799–1819, iv, 1–16.

——— Analyse des triangles tracés sur la surface d'un sphéroïde.
Inst. de France, Mém., 1806, 130–161.

——— Méthode des moindres carrés, pour trouver le milieu le plus probable entre les résultats de différentes observations.
Inst. de France, Mém., 1810, ii, 149–154.

——— Mémoire sur l'attraction des ellipsoïdes homogènes.
Inst. de France, Mém. Cl. Math. Phys., 1810, ii, 155–183; 1812, ii, 1–5 (Hist.).

Legentil de la Galaisière (**Guillaume-Hyacinthe-Joseph-Jean-Baptiste**). Voyage dans les mers de l'Inde, fait par ordre du roi, à l'occasion du passage de Vénus en 1761 et 1769.*
4°, Paris, II, 1779–'81.
It is said to contain results of pendulum observations.—POGGENDORFF, I, 1407.

Legnazzi (**E. N.**). Del catasto romano e di alcuni strumenti antichi di geodesia.
8°, Verona e Padova, 1887, pp. 311, 42 plates. (Oxford, Bodleian.)

Lehargre (**A.**). École d'application de l'artillerie et du génie. Cours de topographie. Première partie: Instruments de lever. 4°, Paris, 1876, pp. xv, 354, 14 plates.
Deuxième partie: Méthodes de levers, levers à grande échelle, levers d'une grand étendue. Levers de reconnaissance. Paris, 1878, pp. xiii, 436, 22 plates.
Troisième partie: Opérations trigonométriques. Lever de la triangulation. Développement et calculs de la triangulation. Nivellement. Paris, 1880, pp. xv, 276, 12 plates. (Paris, National.)

Lehmann-Filhes (**R.**). Beitrag zur Methode der kleinsten Quadrate.
Astron. Nachr., CX, 1885, 81–95.

Lehmann-Filhes (R.)—Continued.

——— Bemerkungen zu dem Atikel des Herrn Prof. Thiele "Ueber Ausgleichung abgegrundeter Beobachtungen."
Astron. Nachr., CX, 1885, 369–372.

Leibnitz (Gottfried Wilhelm). Ars combinatoria.*
4°, Lipsiæ, 1668; Francofurti, 1690.
POGGENDORFF, I, 1413.

Lejonmark (Gustav Adolph). Om pendlars svängningstider.
K. Svenska Veten. Ak., Handl., XXIII, 1802, 165–176.

Lelewel (Joach.). Pytheas und die Geographie seiner Zeit, herausgegeben von J. Straszéwicz. Nebst A. J. Letronne's Untersuchung über die Erdmessungen der Alten und über Hipparch's Ansicht der Verbindung Afrika's mit Asien, übersetzt und mit Anmerkungen von F. W. Hoffmann.*
4°, Leipzig, 1838.

Le Maire. Rapport sur les opérations géodésiques exécutées en Belgique pendant 1872.
Int. Geod. Cong., Gen.-Ber., 1872, 2–3.

Le Monnier (Pierre): Maupertuis (P. L.-M. de). La figure de la terre, déterminée par les observations de . . . —. . . .
Paris, 1738–'39.
English translation, London, 1738; German translation, Zürich, 1741; Latin translation, Lipsiæ, 1742.
Title in full under MAUPERTUIS (P.-L.-M. DE).

——— *et* **Picard (J.).** Degré du méridien entre Paris et Amiens.
Paris, 1740; German translation, Zürich, 1742.
Title in full under PICARD (J.).

[———] Premières observations faites par ordre du roi, pour connoître la distance entre Paris et Amiens avec les mêmes mesures qui ont servi aur Nord et au Pérou, où l'on déduit succinctement divers détails préliminaires pour constater la grandeur du degré de France, et pour décider de la courbure des méridiens.
8°, Paris, 1757, pp. ii, 29. (Paris, National.)
This contains: Remarques proposées à l'Acad. d. Sci. sur le degré de M. Picard compris entre Paris et Amiens au 16 juin 1756.

——— Observations faites au secteur, au sujet de la nutation de l'axe terrestre, causée par l'action de la lune sur le sphéroïde applati.
Acad. d. Sci. Paris, Mém., 1745, 512–528, 577–587.

Lenoir (Paul-Étienne Marie): Prony (G.-C.-F.-M.-R. de). Description du comparateur de — employé pour faire des expériences sur la dilatation des métaux.
Bibl. Brit. Genève, XIX, 1802, 301–315; Ann. de Phys. (Gilbert), LII, 1816, 329–338; Phil. Mag. (Tilloch), XLVII, 1816, 125–130.

——— Sur les instruments d'astronomie et de géodésie.*
8°, Paris, 1827.
POGGENDORFF, I, 1422.

Lenoir (T.-F.). Principes élémentaires et pratiques de géodésie, ou traité complet de la division des champs par des méthodes nouvelles, simples et exactes basées sur la proportionnalité pour partager toutes les figures quelles que soient leurs irrégularités; suivis d'une table des racines et de leurs carrés et des tables

Lenoir (T.-F.)—Continued.
de comparaison d'anciennes mesures agraires avec les nouvelles, à l'usage des géomètres, arpenteurs, et de toute personne qui se destine à l'enseignement et à la pratique de la division des terres.
8°, Clermont (Oise), 1853, pp. xiv, 211, 6 plates. (Paris, National.)
Simple surveying.

Lenz (Heinrich Friedrich Emil). Physikalische Beobachtungen, angestellt auf einer Reise um die Welt unter dem Commando des Capitains von Kotzebue in den Jahren 1823–'26.
Acad. de St.-Pétersbourg, Mém., I, 1831, 221–344.
Pendelbeobachtungen, 226–228.

Leonhardi (F. G.). Anleitung zum Unterricht für geodäten bei der Landesvermessung.
8°, Dresden, 1852, pp. 156, 2 plates. (Vienna, Geographic Institute.)

Leopoldina.
4°, Jena (later Leipzig), 1859+. (Washington, Congress.)

Lepsius (R.). Die Längenmasse der Alten.
8°, Berlin, 1884, pp. 110. (Oxford, Bodleian.)
Of value as a discussion of the lengths of units referred to by Eratosthenes, Herodotus, and Strabo.

Lesage. Lettre sur la fausseté de deux suites d'expériences, par lesquelles on a voulu infirmer la diminution que subit la pesanteur quand la distance au centre de la terre est augmentée, mais encore prouver qu'alors la pesanteur va en augmentant.*
Journ. de Phys. (Rozier), II, 1773, 249.
Regarding the experiments of Bertier and Roiffé.

——— Réflexion sur une nouvelle expérience du R. P. Bertier, qui prouverait que la pesanteur augmente à mesure qu'on s'éloigne de la terre, et même suivant une progression fort rapide.*
Journ. de Phys. (Rozier), II, 1773, 378.

——— Expériences et vues sur l'intensité de la pesanteur dans l'intérieur de la terre.*
Journ. de Phys. (Rozier), VI, 1775.

Leslie (R.). On a method of ascertaining an universal and invariable standard of measure.
Report of Arts and Manufactures, I, 1794, 170–174.

Létronne (Jean-Antoine). Recherches géographiques et critiques sur le livre: De mensura orbis terræ, composé en Irlande au commencement du XIXme siècle par Dicuil, suivies du texte restitué.
8°, Paris, 1814, pp. vi, 249. (Oxford, Bodleian.)

——— Mémoire sur cette question: Les Anciens ont ils exécuté une mesure de la terre postérieurement à l'établissement de l'École d'Alexandrie?
Acad. d. Insc., Mém., VI, 1822, 261–323.

——— Recherches critiques, historiques et géographiques sur les fragments d'Héron d'Alexandrie, ou du système métrique égyptien, considéré dans ses bases, dans ses rapports avec les mesures itinéraires des Grecs et des Romains et dans les modifications qu'il a subies depuis le règne des Pharaons jusqu'a l'invasion des Arabes. (Ouvrage posthume mis en rapport par A.-J.-H. Vincent.)
4°, Paris, 1851, pp. xiii, 249. (Oxford, Bodleian.)

Létronne (Jean-Antoine)—Continued.

——: **Martin (T. M.)**. Examen d'un mémoire posthume de M. —.
Revue Archéol., x, 1853. 679–696, 720–743; xi, 1854, 25–54, 89–114, 129–164.

Levret (H.). Détermination des positions géographiques sur un ellipsoïde quelconque.
Acad. d. Sci. Paris, Comp. Rend., LXXVI, 1873, 410–413.
Revd. in Jahrb. üb. d. Fortschr. d. Math., v., 1873, 594, by B[RUNS].

—— Influence sur les résultats des opérations géodésiques, de la substitution des arcs de plus courte distance aux sections planes de l'ellipsoïde; expression de la correction qui doit être faite à toutes les valeurs des mesures d'angles.
Acad. d. Sci. Paris, Comp. Rend., LXXVI, 1873, 540–542.
Revd. in Jahrb. üb. d. Fortschr. d. Math., v, 1873, 594, by B[RUNS].

Lévy (Albert): **Delaunay (C.-E.)**. Cours élémentaire d'astronomie.
Sixième édition par —, Paris, 1876.
Title in full under DELAUNAY (C.-E.).

Levy (Maurice). Sur les intégrales rationnelles du problème des lignes géodésiques.
Acad. d. Sci. Paris, Comp. Rend., LXXXV, 1877, 1065–1068.

Liagre (J.-B.-J.). Sur la valeur la plus probable d'un côté géodésique commun à deux triangulations.
Acad. de Belgique, Bull., 1854, i, 313–334.

—— Sur la probabilité de l'existence d'une cause d'erreurs régulière dans une série d'observations.
Acad. de Belgique, XXII, 1855, ii, 9–13, 15–54.

—— Calcul des probabilités et la théorie des erreurs avec des applications aux sciences d'observation en général et à la géodésie en particulier.
12°, Bruxelles, 1852, pp. 416; Bruxelles, 1879, pp. 592. (Washington, Coast Survey.)
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1879, 157–158, by Mx. [MANSION].

——: **Folie (F.)**. Sur le calcul de la densité de la terre. Rapport de —.
Acad. de Belgique, Bull., XXXIII, 1872, 369–371.

——, **Quetelet (E.)** *et* **Folie (F.)**. Rapport présenté au nom du dépôt de la guerre de Belgique à la commission permanente de l'Association géodésique internationale.
Acad. de Belgique, Bull., XLI, 1876, 397–407.

—— Sur la compensation d'un réseau trigonométrique.
Int. Geod. Cong., Gen.-Ber., 1877, 224–226.

—— *et* **Houzeau (J.-C.)**. Sur la triangulation du royaume.
Acad. de Belgique, Bull., I, 1881, 867–872.

Liais (Emmanuel). Traité d'astronomie appliquée et de géodésie pratique comprenant l'exposé des méthodes suivies dans l'exploration du Rio de S. Francisco et précédé d'un rapport au gouvernement impérial du Brésil. [Explorations scientifiques au Brésil.]
8°, Paris, 1867, pp. xxiv, 584.

——: **Cruls (Louis)**. Les travaux de la mesure d'un arc du méridien au Brésil sous la direction de —.
8°, Rio de Janeiro, 1876, pp. 6.

Lie (Sophus). Classification der Flächen nach der Transformationsgruppe ihres geodätischen Curven.
4°, Kristiania, 1879, pp. 45. (Dresden, Royal.)

—— Untersuchungen über geodätische Curven.
Math. Ann., XX, 1882, 357–454.

—— Zur Theorie der geodätischen Curven der Minimalflächen.
Arch. f. Math. og Naturvid., VIII, 1882, 490–501.

—— Ueber die allgemeinste geodätische Abbildung der geodätischen Kreise einer Fläche*.
Arch. f. Math. og. Naturvid.

—— Bestimmung des Bogenelements aller Flächen, deren geodätische Kreise eine infinitesimale Berührungs transformation gestatten*.
Arch. f. Math. og Naturvid.

Liebknecht (Johann Georg). Desideria mathematica nov-antiqua ad mensuras speciatim geographicas et geodeticas.*
4°, Giessen, 1721.
POGGENDORFF, I, 1460.

Liechenstein (Joseph Marx von). Vorschriften zu den practischen Verfahren bey der trigonometrisch-geometrischen Aufnahme eines Landes; mit einer Einleitung dienenden kurzen Geschichte der österreichischen Mappirungen.
8°, Dresden, 1821, pp. 188, 4 plates. (Berlin, Royal.)

Liedbeck. De necessitate sphæroidis telluris. De dimensione graduum longitudinum telluris. De dimensione graduum latitudinum telluris. (H.)
London, 1748.

Liesganig (Josephus). Extract of a letter, dated Vienna, April 4, 1867, from Father Joseph Liesganig, Jesuit, to Dr. Bevis, containing a short account of the measurement of three degrees of latitude under the meridian of Vienna. From the Latin.
Roy. Soc. London, Phil. Trans., LVIII, 1768, 15–17.

—— Dimensio graduum meridiani Viennensis et Hungarici.
4°, Vindobonæ, 1770, pp. [xx] 262, 10 charts.

——: **Zach (F. X. von)**. Beweis, dass die österreichische Gradmessung —'s sehr fehlerhaft und zur Bestimmung der Gestalt der Erde ganz untauglich sey.
Mon. Corr. (Zach), VIII, 1803, 507–527; IX, 1804, 32–38, 120–130.

Limpo (F. A. de Brito). *See* **Brito-Limpo (F. A. de)**.

Lindelöf (Laurent Léonard). Om gradmatningen emellan Svartahafvet och Ishafvet.
Finsk. Veten. Helsingfors, Öfvers., v, 1863, 170–173.

Lindemann (F.). Das Vermessungswesen im preussischen Staate.
Zeits. f. Vermes., IV, 1875, 147–152, 161–175.

—— Einige Berechnungsarten für die Pothenot'sche Aufgabe und die Aufgabe der unzugänglichen Entfernung.
Zeits. f. Vermes., VII, 1878, 369–387.

Lindenau (Bernhard August von). [Ueber die Benutzung der Beobachtungen des Mondes zur Bestimmung der Abplattung der Erde.]
Mon. Corr. (Zach), XIV, 1806, 310.

Lindenau (Bernhard August von)—Continued.

——— Ueber den Gebrauch der Gradmessungen zur Bestimmung der Gestalt der Erde.
Mon. Corr. (Zach), XIV, 1806, 113–158, 309–326, 374–376.

——— Ueber die Bestimmung des Radius einer Kugel, deren Oberfläche der eines Ellipsoids von gegebenen Dimensionen am nächsten kommt.
Mon. Corr. (Zach), XVI, 1807, 424–433.

——— Die trigonometrische Vermessung in Ostindien, 1816 und 1818.
Zeits. f. Astron. (Lindenau), II, 1816, 79–80, 359–375.

——— Beobachtungen über terrestrische Strahlenbrechung in Ostindien.
Zeits. f. Astron. (Lindenau), III, 1817, 190–198.

——— [Causes qui peuvent occasionner les différences entre les résultats astronomiques et géodésiques.]
Corr. Astron. (Zach), I, 1818, 121–132, 133–137.

——— [Abplattung der Erde aus Bessel's Præcessionsbestimmung.
Astron. Jahrb. (Bode), 1820, 212.
e = 1: 315. 82.

——— Lettre: Nouvelles recherches sur le degré moyen et sur l'aplatissement de la terre.
Corr. Astron. (Zach), I, 1825, 125–139.

——— Kann die Erdmasse als unveränderlich betrachtet werden?
Astron. Nachr., XXXI, 1851, 157–164.

Lindenkohl (A.). Solution of the three-point problem, by determining the point of intersection of a side of the given triangle with a line from the opposite point to the unknown point.
U. S. C. and G. Survey, Rep., 1869, 235.

Lindhagen (Daniel Georg). Bericht an den Herrn Director der Hauptsternwarte, über die im Sommer 1850 ausgeführte Expedition nach dem norwegischen Finnmarken.
Acad. de St.-Pétersbourg, Cl. Phys. Math., Bull., IX, 1851, 265–288.

——— Bericht an den Herrn Director der Haupt-Sternwarte über die Ergebnisse der im Sommer 1851 in Angelegenheiten der Gradmessung unternommenen Reise nach Lappland.
Acad. de St.-Pétersbourg, Mél. Math. et Astron., I, 1852, 449–476; Cl. Phys. Math., Bull., X, 1852, 241–261.

———: **Struve (F. G. W. von).** Exposé historique des travaux exécutés jusqu'à 1851, pour la mesure de l'arc du méridien. Suivi de deux rapports de —.
St.-Pétersbourg, 1852.
Title in full under STRUVE (F. G. W. VON).

——— Om terrestra refractions theorie.
K. Svenska Veten., Handl., I, 1855–'56, 395–439.

——— Bericht über die im Jahre 1863 ausgeführten Arbeiten in Schweden und Norwegen.
Int. Geod. Cong., Gen.-Ber., 1863, 28–29.

——— Bericht über den Standpunkt der Gradmessungsoperationen in Schweden am Ende des Jahres 1864.
Int. Geod. Cong., Gen.-Ber., 1864, 43–48.

——— Komparationer mellan Struve's dubbel-toise och den Svenska Vetenskaps-Akademiens räkning förfärdigade Kopian af densamma.
K. Svensk. Veten., Handl., IV, 1864, v.

Lindhagen (Daniel Georg)—Continued.

——— Bericht über den Fortschritt der Gradmessungsarbeiten in Schweden im Jahre 1865.
Int. Geod. Cong., Gen.-Ber., 1865, 37–38.

——— Schreiben an den Generallieutenant z. D. Baeyer.
Int. Geod. Cong., Gen.-Ber., 1866, 46–47.
Regarding the geodetic work in Sweden and Norway during 1866.

——— Schreiben an den Präsidenten des Centralbüreaus.
Int. Geod. Cong., Gen.-Ber., 1869, 61.
Regarding the geodetic work in Sweden and Norway in 1869.

——— Bericht über die geodätischen Arbeiten in Schweden pro 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 216–217.

Lindmann (Christian Frederik). Om jordens afplattning och massa.
K. Vetensk. Acad., Förhandl., X, 1853, 85–98.

Lindquist (Joannes Henricus). Diss. observationes quasdam circa reductionem angulorum ad horizontum continens.*
Aboæ, 1786.
POGGENDORFF, I, 1468.

LINES, GEODETIC. *See* **GEODETIC LINES.**

Liouville (Joseph). Sur la loi de la pesanteur à la surface ellipsoïdale d'équilibre d'une masse liquide homogène douée d'un mouvement de rotation.
Journ. de Math. (Liouville), VIII, 1844, 360–378.

——— De la ligne géodésique sur un ellipsoïde quelconque.
Journ. de Math. (Liouville), IX, 1844, 401–408.

——— Démonstration géométrique relative à l'équation des lignes géodésiques sur les surfaces du second degré.
Journ. de Math. (Liouville), II, 1846, 21–24.

——— Démonstration géométrique relative à l'équation *des lignes géodésiques sur un ellipsoïde quelconque.*
Acad. d. Sci. Paris, Comp. Rend., XXII, 1846, 111–113.

——— Sur les figures ellipsoïdales à trois axes inégaux, qui peuvent convenir à l'équilibre d'une masse liquide homogène, douée d'un mouvement de rotation.
Journ. de Math. (Liouville), XVI, 1851, 241–254.

——— Expression simple du rayon de courbure géodésique d'une ligne tracée sur un ellipsoïde.
Journ. de Math. (Liouville), XIX, 1854, 368.

——— Note au sujet d'un mémoire de M. Chasles sur les lignes géodésiques des surfaces.
Journ. de Math. (Liouville), XII, 1874, 225.

Lipschitz (Rudolph Otto Sigismund). Gesetz der Dichtigkeitsänderung der Schichten im Innern der Erde.
K. Ak. d. Wiss., Monatsber., 1862, 601–607.

——— Ergebnisse einer Untersuchung über die Gestalt unserer Erde.
Niederrhein. Ges., Sitz.-Ber., 1864, 59–61; Zeits. gesammt. Naturw. (Halle), XXVI, 1865, 451–453.

——— Untersuchungen über die Bestimmungen von Oberflächen mit vorgeschriebenen, die Krümmungsverhältnisse betreffenden Eigenschaften.
K. Ak. d. Wiss., Sitz.-Ber., 1882, 1077–1087; 1883, 169–188, 546–560.

Listing (**Johann Benedict**). Ueber unsere jetzige Kenntniss der Gestalt und Grösse der Erde.
Nach. d. k. Ges. d. Wiss. (Göttingen), 1873, 33–98; Bull. d. Sci. Math. et Astron. (Darboux et Hoüel), IX, 1873, 241.
Revd. by BERTRAND, Journ. d. Savants, 1874, 697–719.

——— Neue geometrische und dynamische Constanten des Erd-Körpers.
Astron. Nachr., 1878, XLIII, 317–318.
Extract from book of same title.

——— Neue geometrische und dynamische Constanten des Erd-Körpers. Eine Fortsetzung der Untersuchung über unsere jetzige Kenntniss der Gestalt und Grösse der Erde, von Johann Benedikt Listing.*
8°, Göttingen, 1878, pp. 67. (*Dietrisch.*)
Title from Zeits. f. Vermess., VIII, 1879, 144.

——— Neue geometrische und dynamische Constanten des Erdkörpers.
K. Ges. d. Wiss. Göttingen, Nachr., 1877, 749–815.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, by B[runs].

Littrow (**Joseph Johann**). Theoretische und practische Astronomie, von J. J. Littrow. (Washington Observatory.)
3 vols., 8°, Wien, 1821–'27.
Terrestrische Messungen, I, 270–341.

——— Abriss einer Geschichte der Astronomie.
Wien, 1835.
Title in full under AIRY (G. B.).

——— Beobachtungen an zwei unveränderlichen Reversionspendeln. (H.)
Zeits. f. Phys. u. Math. (Baumgärtner), V, 1837, 97–116.

Littrow (**Karl Ludwig von**). Bericht über die in den Jahren 1847–'51 ausgeführte österreichisch-russische Verbindungs-Triangulation.
K. k. Ak. d. Wiss., math., naturwiss, Cl., Sitz.-Ber., IX, 1852, 912–915; Denkschrift, V, 1853, 111–128.
Also published separately, 4°, Wien, 1853, pp. 20, 3 plates.

Livet. Cours de géodésie et gnomonique.
4°, Metz, 1843, pp. 218, 5 plates. (Brussels, Dépôt de la Guerre.)
Lithographed.

Löw. Bericht über die geodätischen Arbeiten, 1883.
Title in full under BAEYER (J. J.).

Löw (**Moritz**). Astronomisch-geodätische Ortsbestimmung im Harz. Bestimmung der Polhöhen und der geodätischen Lage der Stationen Blankenburg, Hüttenrode, Hasselfelde, und der Polhöhe von Nordhausen.
4°, Berlin, 1882, pp. 32. Published by K. preuss. geodätisches Institut.

Loewenberg (**L.**). Bericht über die wissenschaftlichen Instrumente auf der Berliner Gewerbe-Ausstellung im Jahre 1879.
8°, Berlin, 1880, pp. viii, 335.
Geodätische Instrumente, 51–129.

Loewy (**B.**) *and* **Stewart** (**B.**). Account of the base observations made at the Kew Observatory with the pendulums to be used in the Indian survey.
Roy. Soc. London, Proc., XIV, 1865, 425–435.

Loewy (**B.**) *and* **Stewart** (**B.**)—Continued.

——— ——— Account of experiments made at the Kew Observatory for determining the true vacuum and temperature corrections to pendulum observations.
Roy. Soc. London, Proc., XVII, 1869, 488–499.

Loewy (**M.**). Nouvelles méthodes pour la détermination complète de la réfraction.
Inst. de France, Comp. Rend., CII, 1886, 1–47. (Separate.)

Lorber (**Franz**). Ueber die Winkelsumme in Polygonen mit Seitendurchschneidungen.
Zeits. f. Vermes., XVII, 1888, 593–599.

Lorentzen (**Gerhard Wolfgang Friedrich Karl**). Theorie des Gaussischen Pendels.
4°, Kiel, 1886, pp. 24. (Oxford, Bodleian.)

Lorenzoni (**G.**). Intorno alle principali ricerche sulla lunghezza del pendolo a secondi eseguite nell' ultimo ventennio (1860–1880). (H.)
Commissione Italiana per la Misura d. gradi., Proc. Verb., 1880, pp. 11.

——— Sulla figura della terra.*
La Natura, III, 1883.

Loupot (**C.**). Elémens d'astronomie à l'usage des personnes du monde peu versées dans les mathématiques: Par C. Loupot.
8°, Paris, 1842, pp. xvii, 353, 4 plates. (Washington, Observatory.)
De la terre [figure, etc.], 51–105.

Love (**John**). Geodæsia; or the art of surveying and measuring land made easy, showing by plain and practical rules to survey, protract, cast up, reduce or divide any piece of land whatsoever; with new tables for the ease of the surveyor in reducing the measure of land. Moreover a more facile and sure way of surveying by the chain than has been hitherto taught. As also to lay out new lands in America or elsewhere, and how to make a perfect map of a river's mouth or harbor; with several other things never before published in our language. The ninth edition, corrected and improved by Samuel Clark.
9th ed., 8°, London, 1768, pp. [xviii], 196, Appendix, pp. 7; London, 1771; New York, 1793, pp. x, 189, tables. (Washington, Congress.)

Lubbock (**John William**). Expression for the time of vibration of a pendulum in a circular arc.
L., E., D. Phil. Mag., IV, 1828, 338–339.

——— On the pendulum.
Roy. Soc. London, Phil. Trans., CXX, 1830, 201–208.

Lübeck (**G.**). Notiz zu den Bessel'schen Pendelversuchen.
Ann. d. Phys. (Poggendorff), CL, 1873, 476–483.

——— Ueber den Einfluss, welchen auf die Bewegung eines Pendels mit einem kugelförmigen Hohlraume eine in ihm enthaltene reibende Flüssigkeit ausübt.
Journ. f. Math. (Crelle), LXXVII, 1874, 1–37.

Lückenhof (**J. C.**). Lehrbuch der mathematischen Geographie für Gymnasien.
8°, Münster, 1833, pp. viii, 224, 4 plates. (Berlin, Royal.)
Gestalt der Erde, 11–26.

Lüdecke (C.). Die Anwendung der Methode der kleinsten Quadrate in der niederen Geodäsie.
Zeits. f. Vermes., VIII, 1879, 438-456.

Lüroth (J.). Bemerkungen über die Bestimmung des wahrscheinlichen Fehlers.
Astron. Nachr., LXXIII, 1869, 187-190.

——— Vergleichung von zwei Werthen des wahrscheinlichen Fehlers.
Astron. Nachr., LXXXVII, 1876, 209-220.

——— Notiz über die Rectification eines Ellipsenbogens.
Zeits. f. Vermes., x, 1881, 225-226.

——— Eine Gleichung zwischen den Längen, Breiten und Azimuten dreier Erdorte.
Zeits. f. Vermes., XV, 1886, 529-535.

Luetke (Friedrich Benjamin von). [Les observations au pendule invariable.]
Acad. de St.-Pétersbourg, Mém., Bull. Sci., I, 1831, xi-xv; L., E., D. Phil. Mag., I, 1832, 420-424; Roy. Inst., Journ., I, 1831, 602-604.

——— Observations du pendule invariable exécutées dans un voyage autour du monde, 1826-'29.
St.-Pétersbourg, Mém. Savans Étrang., III, 1837, 1-242.

Lulops (Jan). Anleitung zu der mathematischen und physikalischen Kenntniss der Erdkugel. Aus dem Holländischen übersetzet von Abraham Gotthelf Kästner.
4°, Göttingen und Leipzig, 1755, pp. [x], 430, 174. (British Museum.)
Die Gestalt der Erdkugel, 1 90.

——— Over de langte van den enkelen slinger te Leiden. (H.)
Acad. d. Sci. Haarlem, Verhandel., 1757.

Luther (E.): Jacobi (C. G. J.). Nouvelles formules de géodésie communiquées, par —.
Astron. Nachr., XLI, 1855, 209-215.

——— Jacobi's Ableitung der in seinem Aufsatze: "Solution nouvelle d'un problème de géodésie fondamental," enthaltenen formeln.
Astron. Nachr., XLII, 1856, 337-358.

Luvini (G.). Sette studj sopra la refrazione laterale.*
Torino, n. d.

M. Mode of tracing a curve of very large radius, adopted in the survey of the northern boundary of the State of Delaware in 1701.
Journ. Frank. Inst., IV, 1842, 11-15.

M. (M.). The United States Coast Survey.
Christian Examiner and Religious Miscellany, LII, 1852, 77-96.

Maccullagh (James). On a difficulty in the theory of the attraction of spheroids.
Roy. Irish Acad., Trans., XVII, 1837, 237-240; Phil. Mag. (Taylor), III, 1833, 282-285.

——— On the attraction of ellipsoids.
Roy. Irish Acad., Proc., III, 1845-'47, 367-369.

——— On the attraction of ellipsoids, with a new demonstration of Clairaut's theorem.
Roy. Irish Acad., Trans., XXII, 1855, 379-395.

MacLaurin (Colin). A rule for finding the meridional parts to any spheroid with the same exactness as in a sphere.
Roy. Soc. London, Phil. Trans., XLI, 1741, ii, 808-809.

Maclear (Thomas). Observations made at the Cape of Good Hope, in the year 1838, with Bradley's zenith sector, for the verification of the amplitude of the Abbé de Lacaille's arc of the meridian. Communicated by Sir John Barrow.
Roy. Soc. London, Proc., IV, 1839, 192-193; Roy. Astron. Soc., Month. Not., v, 1839-'43, 45-50.

——— An account of some experiments made with an invariable pendulum at the Cape of Good Hope.
Roy. Astron. Soc., Month. Not., v, 1839-'43, 57-58.

——— On the position of Lacaille's stations at the Cape of Good Hope.
Roy. Astron. Soc., Mem., II, 1840, 91-137.

——— Report of the council of the Royal Astronomical Society on the measurement of Lacaille's arc.
Roy. Astron. Soc., Month. Not., VII, 1845-'47, 57-58.

——— [Remeasurement of Lacaille's arc.]
Astron. Nachr., XXIV, 1846, 359-364.

——— Arc of the meridian at Cape of Good Hope.
Roy. Astron. Soc., Mem., XX, 1851, 7-29.

——— Contributions to astronomy and geodesy.
4°, London, 1851, pp. 114. (Washington, Observatory.)

——— "Measurement and extension of Lacaille's arc of the meridian." Notice of —.
Roy. Astron. Soc., Month. Not., XVIII, 1858, 107-108.

——— Account of the results of the trigonometrical survey in the Cape Colony.
Roy. Astron. Soc., Month. Not., XVIII, 1858, 313-316; XIX, 1859, 137.

——— Verification and extension of Lacaille's arc of meridian at the Cape of Good Hope.
4°, London, 1866, I: pp. [7], 609, 2 maps; II: pp. 44. Edited by G. B. Airy. (Gore.)
Pp. 611-625, consisting of corrections and addenda, are inserted in vol. 2.
Revd. by WINNECKE (A.), Astron. Ges., Vierteljahrs., v, 1870, 44-87.

Mädler (Johann Heinrich). Leitfaden der mathematischen und allgemeinen physischen Geographie.
8°, Stuttgart, 1843, pp. vi, 221. (British Museum.)
Gestalt der Erde, 12-14; Gradmessungen, 37-51; Dichtigkeit der Erde, 52-60; Geodätische Linie, 60-61.

Maedler (T. F.). Essai d'une détermination de la figure de la terre. Revd. by —.
Wochenschr. f. Astr. Meteor. u. Geogr. (Heis), 1859; Am. Journ. Sci., XXX, 1860, 46-52.

Mag. f. Naturvid., *for* Nyt Magazin for Naturvidenskaberne.
8°, Christiania, 1823+. (Washington, Congress.)

Maggi (Gian Antonio). Intorno ad alcune formole relative al calculo degli errori d' osservazione. Nota del dott. Gian Antonio Maggi, presenta dal M. E. Prof. E. Beltami.
Ist. Lombardo, Rend., XV, 1882, ii, 351-358.

Mahmoud-Bey. Le système métrique actuel d'Égypte, comparé au système français, les nilomètres tant anciens que modernes et les antiques coudées de l'Égypte.
8°, Copenhague, 1872, pp. 44. (British Museum.)

Main (Robert). Practical and spherical astronomy, for the use chiefly of students in the universities.
8°, Cambridge, 1863, pp. xvi, 392. (Washington, Observatory.)
Determination of the magnitude and figure of the earth, 164–171.

Mairan (Jean-Jacques d'Ortoris de). Sur la diminution des degrés terrestres en allant de l'équateur vers les pôles.
Acad. d. Sci. Paris, Mém., 1720, 231–277; Hist., 65–79.

——— Expériences sur la longueur du pendule à secondes à Paris; avec des remarques sur cette matière, et sur quelques autres qui s'y rapportent.
Acad. d. Sci. Paris, Mém., 1735, 153–221, 505–544 (Hist.), 81–92.

——— Sur la figure de la terre. (H.)
Acad. d. Sci. Paris, Hist., 1742, 86–104

Maire (Christoph) *et* **Boscovich (R. J.).** De litterariâ expeditione per pontificiam ditionem ad dimetiendos duos meridiani gradus et corrigendam mappam geographicam jusu, et auspiciis Benedicti XVI Pont. Max. suscepta a patribus Societ. Jesu.
4°, Romæ, 1755, pp. xxi, 516, 4 plates. (Washington, Congress.)
An elaborate description of this work is given by TODHUNTER in History of the theories of attraction, I, 305–321, 332–334.

——— ———: **Condamine (C.-M. de la).** Letter to Dr. Matty regarding the measure of —.
Roy. Soc. London, Phil. Trans., XLIX, 1756, ii, 623–624.

——— ——— Voyage astronomique et géographique dans l'État de l'Église, entrepris par ordre et sous les auspices du Pape Benoît XIV, pour mesurer deux degrés du méridien et corriger la carte de l'État ecclésiastique. Traduit du latin, augmenté de notes et d'extraits de nouvelles mesures de degrés faites en Italie, en Allemagne, en Hongrie et en Amérique par [Hugon].
8°, Paris, 1770, pp. xvi, 526. (Washington, Congress.)

Mako von Kerek Gede (Paul). Dissertatio de figura telluris.*
4°, Olomut., 1767.
POGGENDORFF, II, 21.

Mallet (Fredrik). De figura et magnitudine telluris.
4°, Upsal., 1750, pp. 32. (Berlin, Observatory.)

——— Vom Widerstande der Luft gegen Pendel. (H.)
Ak. d. Wiss. Stockholm, Handl., 1762.

——— Genaueste Berechnung der eigentlichen Gestalt der Erde durch Vergleichung der Längen der Pendel.
K. Veten. Ak., Abhandl., üb. Holzbecher u. Kästner, XXIX, 1767, 168–174, 206–222.

Mallet (Jacques-André). Observationes variæ in Lapponia ad Ponoi institutæ. Observationes Petropoli et Poni institutæ ad longitudinem penduli minuta seconda indicantis determinandam.
Acad. de St.-Pétersbourg, Com., XIV, 1769, ii, 14–15, 24–33.

Mallet (Jacob). [On the transit of Venus, the lengths of pendulums, also the inclination and declination of the magnetic needle.]
Roy. Soc. London, Phil. Trans., 1770, 363–367; Russ. Bibl. (Bacmeister), I, 1770, 160–164.

Manfredi (Eustachio). Méthode de vérifier la figure de la terre par la parallaxe de la lune.
Acad Roy. d. Sc. Paris, Mém., 1734, 1–20; Hist., 59–63.

———: **Zach (F. X. von).** Notice sur les opérations géodésiques de —.
Mon. Corr. (Zach), II, 1819, 115–126.

Mangold (H. von). Ueber diejenigen Punkte auf positiv gekrümmten Flächen, welche die Eigenschaft haben, dass die von ihnen ausgehenden geodätischen Linien nie aufhören kürzeste Linien zu sein.
Journ. f. Math. (Crelle), XCI, 1881, 23–53.

Manning (Robert). A method of correcting errors in the observation of the angles of plane triangles, and of calculating the linear and surface dimensions of a trigonometrical survey.
Inst. Civil Eng., Proc., LXXIII, 1883, 289–310.

Mansfield (Jared). On the figure of the earth.
Connecticut Acad., Mem., I, 1810, 111–118.

Marcus (J. F.): **Bugge (T.).** Beschreibung der dänischen Ausmessungsmethode. Translated by —.
Dresden, 1787.
Title in full under BUGGE (T.).

Maréchal (*l'abbé*). Mémoire sur la théorie mathématique de la terre.
Acad. d. Sci. Metz., Mém., XXXIV, 1853, i, 156–241.

Marie (Maximilien). Histoire des sciences mathématiques et physiques.
8°, Paris, 1883–'87, 9 vols.

Marek (Johann). Ueber die Ausgleichung trigonometrischer Anschlussnetze.
Zeits. f. Vermes., III, 1874, 159–176.

——— Technische Anleitung zur Ausführung der trigonometrischen Operationen des Katasters. Im Auftrage des kön. ung. Finanzministeriums für den Gebrauch des kön. ung. Triangulirungs-Calcul-Bureau.
4°, Budapest, 1875, pp. xiv, 397, 1 plate. (Vienna, Geographic Institute.)

Marieni (Johann). Trigonometrische Vermessungen im Kirchenstaate und in Toscana, ausgeführt von dem Ingenieur — unter der Direction des k. k. militärischen geographischen Institutes in den Jahren 1841, 1842 und 1843.
4°, Wien, 1846, pp. x, 100, 1 chart.
Fortsetzung und Schluss, VI, 92. (Vienna, Geographic Institute.)

Marignac: **Dufour (W. H.).** Sur les déviations apparentes du plan d'oscillations du pendule. De concert avec —.
Acad. d. Sci. Paris, Comp. Rend., XXXIII, 1851, 13–15.

Markham (Clements R.). Memoir on the Indian surveys.
8°, London, 1871; 2d ed., London, 1878, pp. xxix, 481. (Gore.)

Marne (Jean-Baptiste de). Des instruments pour la mesure des distances.*
Paris, 1880.

Marmora (Albert de la). *See* **La Marmora (Albert de).**

Marriotte. Œuvres, 1668.
New ed., La Haye, 1740. (H.)
See Traité du mouvement des pendules.

Martens (A.). Die wissenschaftlichen Instrumente auf der deutschen Patent- und Musterschutz-Ausstellung in Frankfurt a. M., 1881.
Central-Zeit. f. Optik und Mech., II, 1881, 160–161, 208–211, 221–223, 230–233, 267–269, 277–280.

Martin (Thomas-Henri). Examen d'un mémoire posthume de M. Letronne.
Revue Archéologique, X, 1853, 679–696, 720–743; XI, 1854, 25–54, 89–114, 129–164.

——— Histoire des hypothèses astronomiques grecques qui admettent la sphéricité de la terre.
Acad. d. Inscr., Mém., XXIX, 1879, ii, 305–318.

Martins (Charles). Une station géodésique au sommet du Canigou dans les Pyrénées-Orientales.
8°, Paris, 1872, pp. 24.
Reprinted from Revue des Deux Mondes, December 15, 1872.

Martus (H. C. E.). Astronomische Geographie. Ein Lehrbuch angewandter Mathematik.
8°, Leipzig, 1880, pp. viii, 348. (British Museum.)
Gestalt und Grösse der Erde, 98–164.

Mascart (É.) *et* **Deville (H. St.-C.).** Sur la construction de la règle géodésique internationale.
École Norm. Supér., Ann. Sci., VIII, 1879, 9–54; IX, 1880, 9–20.

——— ——— Sur la construction de la règle géodésique internationale.
Int. Geod. Cong., Gen.-Ber., 1878, 1–50; 1879, 1–12.
Separately, Paris, 1879, pp. 50.

Mascow (Otto). Ueber die geodätische Linie auf dem abgeplatteten Rotationsellipsoid.
8°, Greifswald, 1873, pp. 26. (Gore.)

Maskelyne (Nevil). An account of observations made on the mountain Schehallien for finding its attraction.
Roy. Soc. London, Phil. Trans., LXV, 1775, 500–542.

——— A proposal for measuring the attraction of some hill in this kingdom by astronomical observations.
Roy. Soc. London, Phil. Trans., LXV, 1875, 495–499.

Mason (Charles) *and* **Dixon (J.): Maskelyne (N.).** Introduction to the observations made for determining the length of a degree of latitude in North America, by — —.
Roy. Soc. London, Phil. Trans., LVIII, 1768, 270–274.

——— ——— Astronomic observations made in the forks of the river Brandywine, in Pennsylvania, for determining the going of a clock in order to find the difference of gravity between the Royal Observatory at Greenwich and the place where the clock was set up in Pennsylvania.
Roy. Soc. London, Phil. Trans., LVIII, 1768, 326–336.

——— Observations for determining the length of a degree of latitude in the provinces of Maryland and Pennsylvania, in North America, with a postscript by the astronomer royal.
Roy. Soc. London, Phil. Trans., LVIII, 1768, 274–328.

MASON AND DIXON'S LINE.

Southern Literary Messenger, XXVII, 1858, 446–455; Princeton Rev., XXXVII, 1865, 88–110; Harper's Mag., LIII, 1876, 549–551.

Bliss (P. C.). Mason and Dixon's Line.
Hist. Mag., V, 1861, 199–202.

MASON AND DIXON'S LINE—Continued.

Darlington (W.). Mason and Dixon's Line.
Historical Mag., II, 1858, 37–42.

Gore (J. H.). Mason and Dixon.
Railroad and Eng. Journ., LXI, 1887, 104–106; Zeits. f. Vermes., XVII, 1888, 33–39.

• Graham (J. D.). Messages . . . ; being a portion of Mason and Dixon's Line.
Chicago, 1862.

Veech (J.). Mason and Dixon's line.
Pittsburg, 1857.

Matern. Ueber Winkelmessung mittels des Ocularmikrometers, im astronomischen Fernrohr.
Ann. d. Phys. (Poggendorff.), CLIV, 1875, 91–112.

Math. Ann. (Clebsch), *for* Mathematische Annalen (Clebsch und Neumann).
8°, Leipzig, 1868+. (Washington, Observatory.)

Mathieu (Claude-Louis). Sur les expériences du pendule faites par les navigateurs espagnols en différents points du globe.
Conn. d. Temps, 1816, 314–332.

——— Résultats des expériences faites avec des pendules de comparaison aux îles Malouines et à la Nouvelle-Hollande.
Conn. d. Temps, 1826, 280–307.

——— Sur un mémoire de M. Puissant sur la détermination de la figure de la terre par les mesures géodésiques et astronomiques.
Conn. d. Temps, 1829, 229–235.
The ellipticity as deduced from the French and Indian arcs.

Mathes (C. J.). Elementarer Beweis des vollständigen Ausdrucks für die Dauer der Pendelschwingungen.
Archiv d. Math. (Grunert), XLIX, 1869, 358–364.

Math. Soc. London, Proc., *for* Proceedings of the London Mathematical Society.
8°, London, 1865+. (Washington, Observatory.)

Matthias. Ueber eine Berechnungsmethode der Rotationszeiten, Abplattung und Dichtigkeiten der Planeten.
Astron. Jahrb. (Bode), 1797, 210+.

Matthewson (R. C.). The earth considered as a spheroid of revolution. Geodetic formulas.
Math. Month., III, 1861, 71–78.

Matthiessen (Ludwig). Ueber den Einfluss der Gestalt und täglichen Bewegung des Erdballs auf Gleichgewicht und scheinbare Bewegung irdischer Gegenstände in der Nähe der Oberfläche.
Zeits. f. Math. (Schlömilch), X, 1865, 402–416.

Matty: Condamine (C. M. de la). Letter to —, regarding the measures of Lacaille, Marie, and Boscovich.
Roy. Soc. London, Phil. Trans., II, 1756, 623–624.

Matzka (Wilhelm). Beweis des obersten Grundsatzes der Methode der kleinsten Quadrate.
Arch. d. Math. (Grunert), XI, 1848, 369–377.

Mauck (Karl). Trigonometrische Punkteinschaltung nach der Methode der kleinsten Quadrate.
Zeits. f. Vermes., VII, 1878, 292–297.

Maupertuis (Pierre-Louis-Moreau de). Discours sur les différentes figures des astres, d'où l'on tire des conjectures sur les étoiles qui paroissent changer de grandeur, et sur l'anneau de Saturne, avec une expo-

Maupertuis (Pierre-Louis-Moreau de)—Continued.
sition abrégée des sistèmes de M. Descartes et de M. Newton.
Acad. d. Sci. Paris, Mém., 1732, Hist., 85–93.

——— Sur la figure de la terre, et sur les moyens que l'astronomie et la géographie fournissent pour la déterminer.
Acad. d. Sci. Paris, Mém., 1733, 153–164.

——— Sur les figures des corps célestes.
Acad. d. Sci. Paris, Mém., 1734, 55–122; Hist., 88–94.

——— Sur la figure de la terre.
Acad. d. Sci. Paris, 1735, 98–105; Hist., 47–69; 1736, 302–312.

——— La figure de la terre déterminée par Messieurs de l'Académie royale des sciences qui ont mesuré le degré du méridien au cercle polaire.
Acad. d. Sci. Paris, Mém., 1737, 389–466; Hist., 90–96.

——— La figure de la terre déterminée par les observations de Messieurs de l'Académie royale des sciences et de M. l'abbé Outhier, correspondant de la même académie, accompagnés de M. Celsius, professeur d'astronomie à Upsal, faites par ordre du roy au cercle polaire par M. de —.
12°, Paris, 1738, pp. xxiv [iv], 184, 9 plates. (Gore.)
Published with PICARD, Dégré, etc., Paris, 1740.

——— Examen des trois dissertations que M. Desaguliers a publiées sur la figure de la terre, inserrées dans les transactions philosophiques de la Société royale de Londres, No. 386, 387, 388.
12°, Oldenbourg, 1738, pp. 46. (British Museum.)

——— The figure of the earth determined from observations made by order of the French king at the polar circle, by Messrs. Maupertuis, Camus, Clairaut, Le Monnier, Abbé Outhier and Celsius.
8°, London, 1738, pp. vii, 232, 9 plates.
Translated from the French of —.

——— La figure de la terre déterminée par les observations de Messieurs de Maupertuis, Clairaut, Camus, Le Monnier, de l'Académie royale des sciences, et de M. l'Abbé Outhier, correspondant de la même académie, accompagnés de M. Celsius, professeur d'astronomie à Upsal; faites par ordre du roy au cercle polaire, par M. de Maupertuis. Nouvelle édition, dans laquelle on a mis les figures aux pages où elles se rapportent.
12°, Paris, 1739, pp. xxiv, (6), 208. (Gore.)

———: **Euler (L.)**. Methodus determinandi gradus meridiani pariter ac paralleli telluris secundam mensuram a — institutam.
Acad. de St.-Pétersbourg, Com., XII, 1740, 224–240.

——— Examen désintéressé des différens ouvrages qui ont été faits pour déterminer la figure de la terre.
12°, 1e éd., Amsterdam, 1738; 2e éd., Amsterdam, 1741, pp. [1], 160. (British Museum.)

——— Figur der Erde bestimmt durch die Beobachtungen der Herrn von Maupertuis, Clairaut, Camus, Le Monnier, Outhier, und Celsius, auf ordre des Königs beym Polar-Cirkel angestellt durch Herrn von Maupertuis. Aus dem französischen uebersetzt und mit Herrn Celsius Untersuchung der Cassinischen Messungen vermehrt.
8°, Zurich, 1741, pp. [xlviii], 208, 9 plates. (Gore.)

Maupertuis (Pierre-Louis-Moreau de)—Continued.
———: *et* **Picard (J.)**. Degré du méridien entre Paris et Amiens.
Paris, 1740; German translation, Zürich, 1742.
Title in full under PICARD (J.).

——— Figura telluris determinata per observationes dnn de Maupertuis, Clairaut, Camus Le Monnier, Acad. reg. scient. Paris, socior et domini abbatis Outhier, dictæ academ. a commercio epistolico, comitante domino Celsio, profess. astronom. Upsal. Factas Issu Galliar regis Christianiss ad circulum polarem autore dn de Maupertuis civiss. idiomate Gall. in Latinum transtulit notisque prooemalibus auxit Alaricus Zeller, M. D.
16°, Lipsiæ, 1742, pp. [xii], 190, 9 plates. (Gore.)

———: **Celsius**. Tractatus de — de figura telluris.
Upsaliæ, 1743.
Title in full under CELSIUS (A.).

——— Les œuvres de —.
4°, Dresde, 1752, pp. [xxiv], 404. (Gore.)
Mesure de la terre au cercle polaire, 95–143.

——— Élémens de géographie.
8°, Paris, 1740, pp. 141. (British Museum.)
Table of degrees of latitude and of longitude.
It is simply a question of the earth and of the principles by which it is determined as in Œuvres, Lyons III, 1756.

——— Œuvres de Maupertuis. Nouvelle édition, corrigée et augmentée.
4 vols., 12°, Lyon, 1768. (Gore.)
Relation du voyage fait par ordre du roy au cercle polaire pour déterminer la figure de la terre, III, 89–206.
Opérations pour déterminer la figure de la terre et les variations de la pesanteur, IV, 284–385.

Maurer (J.). Einige Bemerkungen über die von General Ibañez angewandte Methode der Temperaturbestimmung bei der Messstange seines Basis apparates.
Zeits. f. Instrumentenkunde, IV, 1884.

Maxwell (C.). On the viscosity or internal friction of air and other gases.
Roy. Soc. London, Phil. Trans., 1866, 249–278.

Mayer (A.). De deviatione et reciprocatione penduli. (H.)
Gryphiæ, 1767.

Mayer (Alfred M.). Methods of determining the density of the earth.
Nature, XXXI, 1885, 408–409.

Mayer (Christian). Pantometrum pacecciauum seu instrumentum novum pro elicienda ex una statione distantia loci inaccessa.
8°, Mannheim, 1762, pp. [iv], 40, [vi], 1 plate. (British Museum.)

——— Series et ordo triangulorum quæ ex propriis suis observationibus anno 1763 habitis deduxit et correxit.
4°, Mannheim, 1763, pp. 23. (British Museum.)

——— Basis Palatina auspiciis, impensis, favore et imperio clementissimo serenissimi ac potentissimi electoris Palatini Caroli Theodori exeunte anno superiore 1762 ad norman academiæ regiæ Prisinæ scientiarum exactam bis dimensa hoc demum anno 1763 novis mensuris aucta et confirmata recentissimisque observationibus et calculis stabilita.
4°, Mannheim, 1763, pp. [20]. (British Museum.)

Mayer (Ernst). Tiefenmessungen. Ein Beitrag zur Geodäsie.
8°, Wien, 1871, pp. 31. (British Museum.)

——— Ueber die Gestalt und Grösse der Erde; eine historisch-geodätische Studie.
8°, Fiume, 1876, pp. 74.
Separat-Abdruck aus den "Mittheilungen aus dem Gebiete des Seewesens."

——— Ueber Küstenaufnahmen. Ein Beitrag zu den Lehr- und Handbüchern der Geodäsie.
8°, Leipzig, 1880, pp. 60, 4 plates. *Teubner.* (British Museum.)

Mayer (John R.). Essay on the stadia.
Journ. Frank. Inst., LXXIX, 1866, 1–16.
Giving reasons why it has not become more generally used in the topographical surveys. A description of the stadia and its use.

——— A mode of determining graphically the correction for the reduction to centre of station and also for oblique illumination on signals in a geodesic survey.
Journ. Frank. Inst., LXXI, 1866, 98–99.

Mayer (J. T.). Method of angle measuring.
See Dirksen (E. H.). Historia progressum instrumentorum.
Göttingen, 1819.

Mayo (Éméric). Relazione sui lavori geodetici eseguiti [in Italia] nel 1873.
Int. Geod. Cong., Gen.-Ber., 1877, 287–292.

——— Relazione della presidenza della commissione italiana sui lavori eseguiti [in Italia] nel 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 87–89.

——— Sommario delle operazioni geodetico-astronomiche eseguite in Italia nell' anno 1879 per la misura dei gradi in Europa.
Int. Geod. Cong., Gen.-Ber., 1879, 96.

——— Rapport sur les travaux géodésiques en Italie pendant l'année 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 16–18.

MEAN ERROR.

CAUCHY (A.-L.). Sur la plus grande erreur à craindre dans un résultat moyen.
Acad. d. Sci. Paris, Comp. Rend., XXXVII, 1853, 326–334.

CZUBER (E.). Geometrische Wahrscheinlichkeiten und Mittelwerte.
Leipzig, 1884.

DORNA (A.). Sulla media aritmetica nel calcolo di compensazione.
Accad. Sci. Torino, Atti, IV, 1868-'69, 757–763.

GERLING (C. L.). Ueber die Schätzung des mittleren Fehlers directer Beobachtungen.
Arch. d. Math. (Grunert), XXV, 1855, 219–222.

HELMERT (F. R.). Ueber die Formeln für den Durchschnittsfehler.
Astron. Nachr., LXXXV, 1875, 354–366.

HELMERT (G.). Strenger Ausdruck für den mittleren Fehler eines Polygonwinkels.
Zeits. f. Vermes., VI, 1877, 112.

JORDAN (W.). Ueber die Bestimmung des mittleren Fehlers durch Wiederholung der Beobachtungen.
Astron. Nachr., LXXIX, 1872, 219–222.

PAUCKER (M. G. VON). ... der mittlere Fehler der Beobachtung.
Kurland. Ges., Arbeit., VII, 91–131.

SCHIAPARELLI (G. N.). Sur le principe de la moyenne arithmétique.
Astron. Nachr., LXXXVII, 1875, 55–58, 141–142.

MEAN ERROR—Continued.

WITTSTEIN (T. L.). Die mittlere Fehler.
Astron. Nachr., LXIX, 1867, 289–298.

ZACHARIAE (G.). Note betreffend die Bestimmung des mittleren Fehlers.
Astron. Nachr., LXXX, 1872, 67–70; LXXXI, 1873, 225–228

Méchain (Pierre-François-André) *et* **Cassini (J.-D.).** La jonction des observatoires de Paris et de Greenwich.
Paris, 1790.
Title in full under CASSINI (J.-D.).

———: **Zach (A. von).** —'s Verlängerung der französischen Gradmessung bis auf die balearischen Inseln.
Mon. Corr. (Zach), VII, 1803, 181–183, 568–569.

——— *et* **Delambre.** Base du système métrique décimal, ou mesure de l'arc du méridien compris entre les parallèles de Dunkerque et de Barcelone, exécutée en 1792 et années suivantes par Méchain et Delambre, rédigée par Delambre.
4 vols., I, pp. ii, 551, 8 plates, Paris, 1806.
Revd. in Conn. d. Temps, 1808, 463–466; Mon. Corr. (Zach), XIII, 1806, 566–576; XIV, 1806, 41–51, 225–239.
II, pp. xxiv, 844, 11 plates, Paris, 1807.
Revd. in Mon. Corr. (Zach), XVII, 1808, 40–61, 103–131; Conn. d. Temps, 1809, 484–485.
III, pp. 4, 704, 9 plates, Paris, 1810.
IV (later by Arago and Biot). (Washington, Observatory.)

MECKLENBURG.

PASCHEN (P.). Ueber die geodätischen Arbeiten in Mecklenburg.
Int. Geod. Cong., Gen.-Ber., 1864, 23–24; 1865, 14–17; 1868, 25; 1869, 19–22.

——— Grossherzoglich mecklenburgische Landesvermessung.
Schwerin, 1882.

Mees (R. A.). Ueber die Berechnung des wahrscheinlichen Fehlers einer endlichen Zahl von Beobachtungen.
Zeits. f. Math. (Schlömilch), XX, 1875, 145–152; XXI, 1876, 126–128.
In reply to HELMERT, in the same, XX, 300–303.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 113.

Meissel. [Eine geodätische Dreiecks-Aufgabe.]
Astron. Nachr., XCV, 1879, 69–74.

Meissner (Ferdinand). Dissertatio de figura terraquei.*
4°, Vratisl., 1765.
POGGENDORFF, II, 105.

Melanderhjelm (Daniel). Nordische Gradmessung.
Mon. Corr. (Zach), I, 1800, 139–145, 372, 380.

——— Ueber eine neue nordische Gradmessung.
Mon. Corr. (Zach), II, 1800, 250–257.

——— Ueber die neue Gradmessung in Lappland.
Mon. Corr. (Zach), V, 1802, 156–169.

——— Vollendung der neuen lappländischen Gradmessung.
Mon. Corr. (Zach), VII, 1803, 561–568.

——— [Relation der Abplattung der Erde zu der des Jupiter.]
Mon. Corr. (Zach), IX, 1804, 494.

——— Letzte Resultate der neuen lappländischen Gradmessung.
Mon. Corr. (Zach), IX, 1804, 491–495.

Melanderhjelm (Daniel)—Continued.

——— : **Svanberg (J.).** Exposition des opérations faites en Laponie pour la détermination d'un arc du méridien. Preface by —.
Stockholm, 1805.
Title in full under SVANBERG (J.).

——— Ueber die schwedische Messung des Meridiangrades in Lappland.
Astron. Jahrb. (Bode), 1806, 219–223.
In lat. 66° 20′ 12″, 1° = 57209.22 toises.

Melvill. Trigonometrical survey (India). Return to an order of the honourable the House of Commons, dated 12 February, 1850.*
East India House, 1851.

Mem. Fis. e Ist. Nat., *for* Memorie sopra la fisica e istoria naturale di diversi valentuomini.
8°, Lucca, 1743–'57.

Mém. Soc. Sav. et Littér. (Prony), *for* Mémoires des sociétés savantes et littéraires de la République française (Prony).
4°, Paris, 1801–'02.

Menabrea (Luigi Federigo). Calcul de la densité de la terre.
Acad. Sci. Torino, Mem., II, 1840, 305–368.

——— Mouvement d'un pendule composé lorsqu'on tient compte du rayon du cylindre qui lui sert d'axe, de celui du coussinet sur lequel il repose, ainsi que du frottement qui s'y développe.
Acad. Sci. Torino, Mem., 1840, ii, 369–378.

Mendenhall (Thomas Corwin). Force of gravity at Tokyo.
Am. Journ. Sci., XX, 1880, 124–133.

——— Force of gravity on the summit of Fujinoyama, Japan.
Am. Journ. Sci., XXI, 1881, 99–104.

——— Measurements of the force of gravity at Tokyo and on the summit of Fujinoyama.
4°, Tokyo, 1881, pp. 17. (Gore.)
Memoirs of the Science Department, Tokyo. Daigaku, No. 5.

Meneses (Frutos Saavedra) *y* **Ibañez (C.).** Experimencias hechas con el aparato de medir bases.
Madrid, 1859.
Title in full under IBAÑEZ (C.).

——— Discurso sobre los progresos de la geodésia.
Acad. de Cien. Madrid, Mem., I, 1863, iii, 641–664.
Reply by QUEIPO, 665–667.

——— ——— Base centrale de la triangulation géodésique d'Espagne.
Madrid, 1865.
Title in full under IBAÑEZ (C.).

Menius [Meine] (Matthias). De rotunditate terræ et aquæ.*
Danzig, 1586.
POGGENDORFF, II, 119.

Mercier (Alexandre). Tables géodésiques donnant tous les multiplicateurs nécessaires à la division de toutes espèces de quadrilatères irréguliers, précédées d'un traité de géodésie, théorique et pratique, des triangles et des quadrilatères irréguliers, en parties égales et en parties inégales, par des lignes qui coupent les côtés en parties proportionnelle et par des angles. A l'usage des géomètres, instituteurs, de

Mercier (Alexandre)—Continued.
ceux qui enseignent la géométrie par les leçons de pratique, et des personnes studieuses.
8°, Beauvais, 1853, pp. 18.
Surveying.

Merino *et* **Perrier (F.).** Jonction astronomique de l'Algérie avec l'Espagne.
Int. Geod. Cong., Gen.-Ber., 1880, 53–57.

Merino (Miguel). Figura de la tierra.
8°, Madrid, 1862, pp. 118.
From: Anuario del Obs. de Madrid para 1862.

——— [Figure of the earth.]
Smithsonian Inst., Rep., 1863, 306–330.
Madrid Observatory, Anuario, 4th year, 1864; continued from the same for 1863. Translated by ALEXANDER (C. A.).

Merriman (Mansfield). Elementary discussion of the principles of least squares.
Journ. Frank. Inst., LXXIV, 1877, 173–187.
Revd. in Jahrb. üb. die Fortschr. d. Math., IX, 1877, 153–154, by B[RUNS].

——— Elements of the method of least squares.
8°, London, 1877, pp. vii, 200. *Macmillan.* (Gore.)

——— List of writings relating to the method of least squares, with historical and critical notes.
Connecticut Acad., Trans., IV, 1877, i, 151–232.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 154, by B[RUNS].
Merriman is an abbreviation for the above.

——— On the history of the method of least squares.
Analyst, IV, 1877, 33–36.

——— Note on the history of the method of least squares.
Analyst, IV, 1877, 140–143.

——— On the shape of the earth.
Van Nostrand's Mag., XII, 1880, 53–62, 115–128, 233–241.
Afterwards published in book form under the following title:

——— The figure of the earth. An introduction to geodesy.
8°, New York, 1881, pp. 88. *Wiley & Sons.* (Gore.)
Revd. in Nature, XXIV, 1881, 259–260.

——— On probable error.
Engineering News, IX, 1882, 4–5.

——— The geodetic triangulation in Pennsylvania. Land-office report of secretary of internal affairs of Pennsylvania.
1883, 58–61; 1884, 73–77; 1885, 42–49; 1886, 44–65.

——— A text book on the method of least squares.
8°, New York, pp. vii, 194. *John Wiley & Sons.* (Gore.)

——— Report of the progress of the geodetic triangulation of Pennsylvania.
Geological Survey of Pennsylvania, Rep., 1885, 681–707.

Mess. Math., *for* Messenger of Mathematics.
8°, Cambridge, 1871+. (Washington, Congress.)

Metzger (E.). [Ueber den gegenwärtigen Stand der Triangulirungs-Arbeiter auf Java.]
Astron. Nachr., XCIII, 1878, 375–378.

——— *und* **Oudemanns (J. A. C.).** Die Triangulation von Java.
Title in full under OUDEMANNS (J. A. C.).

Meyer (Anton). Cours de géodésie, professé au Dépôt de la guerre.
Fol., Bruxelles, 1845, pp. 134. (Brussels, Dépôt de la Guerre.)
Lithographed.

—— Rapport adressé à l'Académie sur les méthodes géodésiques en usage en Allemagne.
Fol., Bruxelles, 1846. (Brussels, Dépôt de la Guerre.)
Manuscript.

—— Sur la base géodésique que l'on mesure actuellement dans les environs de Bonn.
Acad. de Belgique, Bull., XIV, 1847, ii, 14-19.

—— Sur l'héliotrope de Bertram.
Acad. de Belgique, Bull., XIV, 1847, ii, 100-101.

—— *et* **Quetelet.** [Sur la triangulation du royaume.]
Acad. de Belgique, Bull., XIV, 1847, ii, 320-321.

Meyer (O. E.). Ueber die Reibung der Flüssigkeiten.
Ann. d. Phys. (Poggendorff), CXIII, 1861, 55-86, 193-283, 383-425; Journ. f. Math. (Crelle), LIX, 1861, 229-303; LXXII, 1863, 201-214.

—— Ueber die innere Reibung der atmosphärischen Luft.
Deutsch. Naturf.-Versamml., Ber., 1863, 141-144.

—— Ueber die innere Reibung der Gase. Ueber den Einfluss der Luft auf Pendelschwingungen.
Ann. d. Phys. (Poggendorff), CXXV, 1865, 177-209, 401-420, 564-599; CXXVII, 1866, 253-281, 353-382; CXLVIII, 1873, 1-44, 203-236, 526-555.

—— Pendelbeobachtungen.
Ann. d. Phys. (Poggendorff), CXLII, 1871, 481-524.

—— Ueber die innere Reibung der Gase. Ueber Maxwell's Methode zur Bestimmung der Luftreibung.
Ann. d. Phys. (Poggendorff), CXLIII, 1871, 14-26.

—— Ueber die pendelnde Bewegung einer Kugel unter dem Einflusse der inneren Reibung des umgebenden Mediums.
Journ. f. Math. (Crelle), LXXV, 1873, 31-68.

—— Ueber die Bewegung einer Pendelkugel in der Luft.
Journ. f. Math. (Crelle), LXXV, 1873, 336-347.

Michaelis (Gustav). De lineis brevissimis in datis superficiebus imprimis de linea geodetica.
4°, Berolini, 1873, pp. 27. (Berlin, Observatory.)

Michell (John J.). Proposal of a method for measuring degrees of longitude upon parallels of the equator.
Roy. Soc. London, Phil. Trans., LVI, 1766, 119-125.

Miller (A. R. von). Ueber die Methode der kleinsten Quadrate.
Oesterreich. Zeits. f. Bergwes., XV, 1867, 181-194.

Minding (Ernst Ferdinand Adolph). Ueber einige Grundformeln der Geodäsie.
Acad. de St.-Pétersbourg, Cl. Phys. Math., Bull., VIII, 1850, 88-92; Mél. Math. Astron., I, 1853, 44-51.

—— Zur Methode der kleinsten Quadrate.
Acad. de St.-Pétersbourg, Bull., XVI, 1871, 305-308.

Moerman (Ch.). Géodésie théorique et pratique simplifiée, ou division facile et rapide des surfaces agraires au moyen de multiplicateurs, etc. Comprenant la division des triangles et des quadrilatères irréguliers en parties égales, inégales, etc., par les lignes partant de points déterminés, par des parallèles ou des perpendiculaires aux côtés et par des lignes découpant les côtés en parties proportionnelles; contenant, en outre, des théorèmes et problèmes très-intéressants concernant la division des surfaces au moyen d'alignements et d'angles.
8°, Bruxelles, 1877, pp. 75, 5 plates. (Brussels, Royal.)

Moëssard (P.). Topographie et géodésie. Cours de Saint-Cyr.
8°, Paris, 1882, pp. xii, 399. (Paris, National.)

Mohn (H.) *und* **Fearnley (C.).** Geodätische Arbeiten.
Christiania, 1880-'82.
Title in full under FEARNLEY (C.).

Mohn (Karl Friedrich). [Ueber die Ursachen der Abplattung der Erde.]
Niederrhein. Ges., Sitz.-Ber., I, 1864, 106-109.

Moligny (H.): Schaar (M.). Rapport sur un mémoire de — relatif aux expériences pour déterminer la densité de la terre.
Acad. de Belgique, Bull., XIX, 1852, ii, 476-481.

Molins (H.). Sur les lignes de courbure et les lignes géodésiques des surfaces développables dont les génératrices sont parallèles à celles d'une surface réglée quelconque.
Journ. de Math. (Liouville), IV, 1859, 347-365.

—— Sur les lignes géodésiques tracées sur une surface développable donnée.
Acad. de Toulouse, Mém., V, 1861, 401-412.

Moll (Johann. Godofred.). De ratione, terrarum magnitudine ex projectione stereographica inveniendi, et de insigni ejus, adhuch a nemine commemorata, proprietate.
4°, Stuttgart, 1801, pp. 11, 1 plate. (Stuttgart, Royal.)

Mollweide (Karl Brandan). Beitrag zur trigonometrischen Differenzrechnung in Bezug auf Delambre's Méthodes analytiques pour la détermination d'un arc du méridien.
Mon. Corr. (Zach), XV, 1807, 441-451; XVIII, 1808.

—— Einige Projectionsarten der sphäroidischen Erde. I. Stereographische und Mercatorische Projection des elliptischen Erdsphäroids. II. Projectionen, welche die Länder ihrem Flächeninhalte auf dem sphäroid Gemäss vorstellen.
Mon. Corr. (Zach), XVI, 1807, 197-210.

Mon. Corr. (Zach), *for* Monatliche Correspondenz zur Beförderung der Erd- und Himmelskunde (Zach).
8°, Gotha, 1800-'13. (Washington, Observatory.)

Monet (Fernando) *y* **Ibañez (C.).** Base centrale de la triangulation géodésique d'Espagne.
Madrid, 1865.
Title in full under IBAÑEZ (C.).

Monge: Borda (J.-C.). Rapport sur le choix d'une unité de mesures.
Acad. d. Sci. Paris, Mém., 1791, 7-16 (Hist.).
Title in full under BORDA (J.-C.).

Monnier (M.-P.): Bégat (P.). Exposé des opérations géodésiques sous la direction de —.
Title in full under BÉGAT (P.).

Monnier (M.-P.)—Continued.

——— Description nautique des côtes de la Martinique, précédée d'un mémoire sur les opérations hydrographiques et géodésiques exécutées dans cette île en 1824 et 1825; par M.-P. Monnier.

8°, Paris, 1828, pp. 182, 1 chart. (Washington, Congress.)

Montanus (August Schulz). Systematisches Handbuch der gesammten Land- und Erd-Messung mit ebener und sphärischer Trigonometrie auch Beschreibung der neuen brauchbaren Messinstrumente.

12°, Berlin, 1819, I, pp. x, 309, 5 plates; II, pp. xii, 352, 8 plates. (Gore.)

Höhere Land- und Erdmessung, II, 328–452.

Montgomerie (Thomas George). Memorandum drawn up by the order of Col. A. Scott Waugh, surveyor-general of India, on the progress of the Kashmir series of the great trigonometrical survey of India, with maps and observations on the late conquest of Gilgit and other incidental matters.

Asiatic Soc. Bengal, Journ., XXX, 1861, 99–110.

Montigny (Charles). Mémoire relatif aux expériences pour déterminer la densité de la terre.

Acad. de Belgique, Bull., XIX, 1852, ii, 476–481.

——— Essai sur des effets de réfraction et de dispersion produits par l'air atmosphérique.

Acad. de Belgique, Mém. Couron., XXVI, 1854–'55.

Montucla (Jean-Étienne). Histoire des mathématiques, dans laquelle on rend compte de leurs progrès depuis leur origine jusqu'à nos jours; où l'on expose le tableau et le développement des principales découvertes dans toutes les parties des mathématiques, les contestations qui se sont élevées entre les mathématiciens, et les principaux traits de la vie des plus célèbres. Nouvelle édition, considérablement augmentée, et prolongée jusque vers l'époque actuelle; par J.-É. Montucla, achevéé et publiée par Jérôme de la Lande.

4 vols., Paris, 1799–1802. (Washington, Congress.)

De la figure de la terre, telle que la donnent les mesures des astronomes, exécutées dans le cours du dix-huitième siècle, IV, Paris, 1802, 137–178. De la figure de la terre, déduite des calculs de l'attraction, IV, 178–206.

[**More (Samuel)**.] Attempt to obtain and preserve practical standards for adjusting in future the weights and measures of this kingdom.

Soc. Encouragement of Arts, Trans., XII, 1794, 292–301.

Moreira (Carlos Ernesto de Arbués). Rapport sur les travaux géodésiques en Portugal pendant l'année 1879.

Int. Geod. Cong., Gen.-Ber., 1879, 101–102.

——— Rapport sur les travaux géodésiques en Portugal pendant les années 1881 et 1882.

Int. Geod, Cong., Gen.-Ber., 1881–'82, 111–112.

——— Note sur les travaux géodésiques exécutés pendant l'année 1883 (en Portugal).

Int. Geod. Cong., Gen.-Ber., 1883, 269–270.

——— Travaux géodésiques dans l'année 1880. (Portugal.)

Int. Geod. Cong., Gen.-Ber., 1880, 29.

Moreira (Carlos Ernesto de Arbués)—Continued.

——— Relatio dos trabalhos geodesicos, topographicos, hydrographicos e geologicos do reino pertencente ao anno economico de 1884–'85.

8°, Lisboa, 1886, pp. 34. (Berlin, Geodetic Institute.)

——— Calculo das direcções mais provaveis em uma estação geodesica. Direcção geral dos trabalhos geodesicos.

4°, Lisboa, 1887, pp. 18. (Berlin, Geodetic Institute.)

Moret (Theodor). De ponderum gravitate.*

4°, Pragæ, 1663.

POGGENDORFF, ii, 201.

Morgan (A. de). *See* **De Morgan (A.)**.

Morin. Notice historique sur le système métrique, ses développements et sa propagation.*

8°, Paris, pp. 68.

Moritz (A.). Ueber die Anwendung des Pistor'schen Reflexionskreises zum Messen von Angulardistanzen zwischen terrestrischen Objecten.

8°, Tiflis, 1859, pp. 4. (Berlin, Observatory.)

Morozowicz (O. von). Die königlich preussische Landes-Triangulation. Hauptdriecke. Erster Theil. Zweite vermehrte Auflage.

4°, Berlin, 1870, pp. viii, 470, 3 maps. (Gore.)

——— Bericht des geodätischen Institutes, 1873.

Title in full under BAEYER (J. J.).

——— Die königlich preussische Triangulation. Haupt-Dreiecke. Zweiter Theil. Erste Abtheilung: Die Haupt-Triangulation in Schleswig-Holstein.

4°, Berlin, 1873, pp. v, 281, 5 charts. (Berlin, Landes-Aufnahme.)

Zweite Abtheilung: Die märkisch-schlesische und die schlesisch-posen'sche Kette und deren Ergänzungen.

4°, Berlin, 1874, pp. iv, 283–622.

Herausgegeben vom Büreau der Landes-Triangulation.

——— Ueber den mittleren Fehler der Winkelmessung.

Zeits. f. Vermes., VI, 1877, 383–395.

Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 778–779, by B[RUNS].

——— [Ueber Bremikers Theorie der Lothablenkung.]

Astron. Nachr., XC, 1877, 353–356.

——— Die königlich preussische Landes-Aufnahme.

Beiheft zum Militär-Wochenblatt, Berlin, 1879, pp. 35.

Morstein (V.). Ueber die kürzesten Linien auf die dreiaxigen Ellipsoid.

4°, Posen, 1871, pp. 24. (Dresden, Royal.)

Mossbrugger (Leopold). Geodätische Aufgabe.

Arch. d. Math. (Grunert), IV, 1884, 408–410.

The determination of the position and elevation of a point with reference to the position and elevation of two others.

Mossmann (Samuel). Origin of the Ordnance Trigonometrical Survey.

Geographical Mag., V, 1878, 176–179.

——— Ordnance Trigonometrical Survey. Primary base measured on Hounslow Heath.

Geographical Mag., V, 1878, 282–286.

Mossotti (Ottaviano Fabrizio). Sulla riduzione degli angoli fatte dagli archi geodetici formanti un piccolo triangolo agli angoli fatti loco corde.
Ann. di Mat. (Tortolini), I, 1850, 387–398.

——— Soluzione analitica del problema delle oscillazione del pendolo avuto riguardo alla rotazione della terra.
Ann. di Math. (Tortolini), II, 1851, 232–236.

Mudge (William). An account of the trigonometrical survey carried on in 1791, 1792, 1793, and 1794, by order of His Grace the Duke of Richmond, late master-general of ordnance, by E. Williams, W. Mudge, and I. Dalby.
Roy. Soc. London, Phil. Trans., 1795, 414–591.

——— An account of the trigonometrical survey carried on in 1795 and '96, by the order of Marquis Cornwallis, master-general of the ordnance.
Roy. Soc. London, Phil. Trans., 1797, 432–541.

——— *and* **Dalby (I.).** An account of the operations carried on for accomplishing a trigonometrical survey of England and Wales, from the commencement, in the year 1784, to the end of the year 1796. By order of the honorable board of ordnance. First published in, and now revised from, the Philosophical Transactions. Vol. I, Measurement of the base on Hounslow Heath in 1784, and trigonometrical operations.
4°, London, 1799, pp. xx, 437, 22 plates. (Gore.)

——— Account of the trigonometrical survey carried on in 1797–'99.
Roy. Soc. London, Phil. Trans., 1800, 539–724.

——— An account of the operations carried on for accomplishing a trigonometrical survey of England and Wales, continued from the year 1797 to the end of the year 1799. From the Philosophical Transactions. vol. II, An account of the measurement of an arc of the meridian, extending from Dunnose, in the Isle of Wight, to Clifton, in Yorkshire.
4°, London, 1801, pp. vi, 128, 7 plates. (Gore.)
Revd. in Edinb. Rev., V, 1805, 372–392.

——— An account of the measurement of an arc of the meridian, extending from Dunnose, in the Isle of Wight, 50°, 37′ 8″, to Clifton, 53° 27′ 31″, in course of the operation carried on for the trigonometrical survey of England in the years 1800, 1801, 1802.
Roy. Soc. London, Phil. Trans., XCIII, 1803, 383–508.
Published as second part to vol. II. Operations carried on for accomplishing, etc. London, 1804, VI, 128, 7 plates. (Gore.)
Revd. in Bibl. Brit. Genève, XXVIII, 1805, 21–23; Eclectic Rev., I, 1805, 128–132, 199–206.

——— : **Burckhardt (J. K.).** Remarques sur la mesure d'un arc du méridien par —.
Bibl. Brit. Genève, XXVIII, 1805, 284–287.
Title in full under BURCKHARDT (J. K.).

——— *and* **Colby (T.).** An account of the trigonometrical survey carried on by order of the master-general of His Majesty's ordnance in the years 1800, 1801, 1803, 1804, 1805, 1806, 1807, 1808, and 1809.
4°, London, 1811, pp. xv, 382, 14 plates.
Revd. by DELAMBRE (J.-B.-J.), Conn. d. Temps, 1818, 243–278.

——— : **Rodriguez (J.).** Observations on the measurement of three degrees of the meridian in England by —.
Roy. Soc. London, Phil. Trans., CII, 1812, 321–351; Phil. Mag. (Tilloch), XLI, 1813, 20–31, 90–100.

Mudge (William)—Continued.

——— : **Gregory (O.).** Dissertation and letters regarding the survey of England by —.
London, 1815.
Title in full under GREGORY (O.).

Müffling (Friedrich Ferdinand Karl von). Geschichte der Rheinvermessung.
Zeits. f. Astron. (Lindenau), V, 1818, 33–48.

——— [Sur les travaux géodésiques prussiens repris entre la frontière de la France et le Seeberg.]
Corr. Astron. (Zach), IV, 1820, 325–332, 533–537.

——— [Uebersicht der Längengradmessung zwischen Dünkirchen und Seeberg.]
Astron. Nachr., III, 1824, 33–38.

——— Ueber die Längengradmessung zwischen Dünkirchen und dem Seeberg bei Gotha.
Hertha, VII, 1826, i, 5–25.

Müllenhoff. Die Erdmessung des Eratosthenes.*

Müller (Fr. Chr.). Trigonometrische Vermessung der Grafschaft Mark.*
1793.

Müller (Franz). Ueber die Anwendung der anharmonischen und harmonischen Verhältnisse zur Auflösung einiger Aufgaben der Geodäsie.
Arch. d. Math. (Grunert), XLV, 1866, 395–410.

Müller (Qu.). Geschichte der Breitengradmessungen bis zur peruanischen Gradmessung.*
1871, pp. 52, 1 table.

Müller (Th.). Ueber Erdmassenberechnung.
Zeits. f. Vermes., X, 1881, 137–144.

Muhlert (Karl Friedrich). Grundzüge der mathematischen Geographie in der Darstellung der Erde als eine der Planeten.
8°, Leipzig, 1850, pp. iv, 68, 4 plates.

Muncke. Pendel. (H.)
Phys. Wörterbuch (Gehler), Leipzig, VI, 1833, 304–407.
By far the most thorough, and in general correct, review of pendulum research in any language.

Murdoch (P.). Mercator's sailing applied to the true figure of the earth, with an introduction concerning the discovery and determination of that figure. (H.)
London, 1741.

Murhard (Friedrich Wilhelm August). Literatur der mathematischen Wissenschaften.
2 vols., 8°, Leipzig, 1797–'98. (Washington, Congress.)
Vol. II has the title: Bibliotheca mathematica, Leipzig. Praktischer Theil der Geometrie [including geodesy], ii, 144–174.

Muriel. Des opérations géodésiques de détail.
Dépôt de la Guerre, Mém., I, 1829, 235–264.

Muschenbroek (Petrus van). Dissertationes physicæ experimentales et geometricæ, de magnete, magnitudine terræ, ephemerides meteorologicæ Ultrajectinæ.
4°, Lugduni Batavorum, 1729, pp. [vi], 672. (Dresden, Royal.)
Magnitudine terræ, 357–420, 3 plates.

N. Am. Rev., *for* North American Review.
8°.

N. (F. H.). A feat in triangulation.
Nature, XXI, 1880, 157–158.
Connection of Spain with Algiers.

Nagel (August). Ueber die Reduction eines sphärischen Dreiecks von geringer Krümmung auf sein Sehnendreieck.
Zeits. f. Math. (Schlömilch), I, 1856, 257–275.

——— Die Messung der Basis für die Triangulirung des erzgebirgischen Kohlenbassins.
4°, Dresden, 1861, pp. 57, 2 plates. (Gore.)
In Programm zu dem am 18. 19. und 20. März 1861, mit den Schülern der königlichen polytechnischen Schule und der königlichen Baugewerkenschule zu Dresden zu haltenden Prüfungen.

——— Bericht über die im Jahre 1864 ausgeführten geodätischen Arbeiten im Königreich Sachsen für die mitteleuropäische Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1864, 37–41.

——— Bericht im Interesse der europäischen Gradmessung ausgeführten geodätischen Arbeiten im Königreiche Sachsen.
Int. Geod. Cong., Gen.-Ber., 1870, 58–60.

——— Bericht über die geodätischen Arbeiten in Sachsen für das Jahr 1871.
Int. Geod. Cong., Gen.-Ber., 1871, 54–55.

——— *und* **Bruhns (C.).** Bericht der Gradmessungs-Arbeiten in Sachsen, 1872, 1873, 1875, 1876, 1877, 1878, 1880.
Title in full under BRUHNS (C.).

——— Die Hauptmomente der Entwickelungsgeschichte der Gradmessungen.
Dresden, 1873.
Protokolle der 79. Haupt-Versammlung des sächs. Ingenieurs-und Architecten-Vereins.

——— Die Vermessungen im Königreiche Sachsen. Eine Denkschrift mit Vorschlägen für eine auf die europäische Gradmessung zu gründende rationelle Landesvermessung.
8°, Dresden, 1876, I, text, pp. vi, 123; II, atlas. (Gore.)

——— Zur Literatur der Geodäsie. Die practische Geometrie seit 100 Jahren.
Civ.-Ing., XXIII, 1877, 185–206.

——— Zur Literatur der Geodäsie. Drei classische Werke der letzten Jahrzehnte.
Civ.-Ing., XXIII, 1877, 257–290.

——— Zur Literatur der Geodäsie. Ursprung des Repsold-Bertram'schen Heliotropen.
Civ.-Ing., XXIII, 1877, 629–632.

——— Mittheilungen aus dem Gebiete der Geodäsie. Lothungen und Lothungsapparate.
Civ.-Ing., XXIV, 1878, 621–664.

——— Mittheilungen aus dem Gebiete der Geodäsie. 1. Longimeter. 2. Alhidaden-Transporteurs. 3. Der Messtisch von G. Heide in Dresden. 4. Noch einmal der Bertramischen Heliotropen.
Civ.-Ing., XXIV, 1878, 285–294, 298–301.

——— Ueber den Bertramischen Heliotrop.
Zeit. f. Vermes., VII, 1878, 34–36.

——— Mittheilungen aus dem Gebiete der Geodäsie. Bestimmung von Zwischenpunkten langer gerader Linien.
Civ.-Ing., XXVI, 1880, 177–203.

Nagel (August)—Continued.

——— Mittheilungen aus dem Gebiete der Geodäsie. Basismessung auf der Plattform des Polytecknikums zu Dresden.
Civ.-Ing., XXVI, 1880, 293–423.

——— Bericht über die geodätischen Arbeiten in Sachsen für die Jahre 1881 und 1882.
Int. Geod. Cong., Gen.-Ber., 1881–'82, 126–129.

——— *und* **Bruhns (C.).** Die Grossenhainer Grundlinie.
Berlin, 1882.
Title in full under BRUHNS (C.).

——— Mittheilungen aus dem Gebiete der Geodäsie. Die Grossenhainer Basis.
Civ.-Ing., XXVIII, 1883, 1–36, 535–546.

——— Mittheilungen aus dem Gebiete der Geodäsie. Centrirapparat für Theodolit- und Signalaufstellung.
Civ.-Ing., XXXII, 1886, 179–192; Zeits. f. Vermes., XVII, 1888, 39–50.

——— [Bericht über die geodätischen Arbeiten in Sachsen in den Jahren 1884–'86.]
Int. Geod. Cong., Verhandl., 1884–'86, 218–227.

Narrien (John). Practical astronomy and geodesy, including the projections of the sphere and spherical trigonometry for the use of the Royal Military College.
8°, London, 1845, pp. xxviii, 427. (Washington, Congress.)

——— Historical account of the origin and progress of astronomy.
London, 1850, pp. xiv, 520, 5 plates. (Washington, Congress.)
Operations for determining the figure of the earth, 476–487.

Nat. Acad. Sci., Mem., *for* Memoirs of the National Academy of Sciences.
4°, Washington, 1866+. (Washington, Congress.)

Natani (L.). Methode der kleinsten Quadrate, mit den Hülfssätzen aus der Analysis und Wahrscheinlichkeitsrechnung, nebst einem Anhange über die ballistische Linie.
8°, Berlin, 1875, pp. 56. *Winckelmann.* (Berlin, Observatory.)
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 110–111, by SCHL. [SCHEMMEL].

Naturf.-Ges., Schriften, *for* Neueste Schriften der naturforschenden Gesellschaft.
4°, Danzig, 1820+.

Naturf.-Ges. Zürich, Vierteljahrs., *for* Vierteljahrsschrift der naturforschenden Gesellschaft.
8°, Zürich, 1856+. (Washington, Congress.)

Natuurk Ver. Neder.-Indië, Verhandel., *for* Verhandelingen der Natuurkundige Vereeniging in Nederlandsch Indië.
8°, Batavia, 1856–'60 (8 vols.). (Washington, Congress.)

Naturw. Ges. Isis., Sitz.-Ber., *for* Sitzungsberichte der naturwissenschaftlichen Gesellschaft Isis.
8°, Dresden, 1861+. (Washington, Congress.)

Negelein (Julius Ægidius). De figura telluris ad sensum sphærica.
8°, Regiomonti, 1724, pp. 26, 1 plate. (Paris, Observatory.)

Nell (A. M.). Zur höheren Geodäsie.
Zeits. f. Math. (Schlömilch), XIX, 1874, 324–353.
Revd. im Jahrb. üb. d. Fortschr. d. Math., IV, 1874, 726, by B[RUNS].

——— Bericht über die im Jahre 1879 für die europäische Gradmessung ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1879, 94–95.

——— Bericht über die geodätischen Arbeiten im Grossherzogthum Hessen für das Jahr 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 12–15.

——— Schleiermachers Methode der Winkelausgleichung in einem Dreicksnetze.
Zeits. f. Vermes., X, 1881, 1–11, 109–121.

——— Bericht über die geodätischen Arbeiten in Hessen für die Jahre 1881–'82.
Int. Geod. Cong., Gen.-Ber., 1881–'82, 77–83.
Leveling only.

——— Modification von Schleiermachers Methode der Winkelausgleichung in einem Dreicksnetze.
Zeits. f. Vermes., XII, 1883, 313–320.

——— Geodätische Bestimmung der geographischen Breite und Länge aus Linear-Coordinaten.
Zeits. f. Vermes., XIII, 1884, 421–434.

——— Ueber einige Vereinfachungen, welche bei der Anwendung der Methode der kleinsten Quadrate gemacht werden können.
Zeits. f. Vermes., XVI, 1887, 454–467.

Neovius (V.). Lärobok i minsta quadrat-methoden.*
Abo, 1870.

Nerenberger (Adolph Wilhelm). [Sur la base géodésique dans les environs de Bruxelles.]
Acad. de Belgique, Bull., XVII, 1850, ii, 135.

——— Base géodésique mesurée en juillet 1830 aux environs de Bruxelles.
Lithographed by Dépôt de la Guerre, 1851.

——— Compte rendu des opérations de la commission instituée par M. le ministre de la guerre, pour étalonner les règles qui ont été employées en 1850, 1851, 1852, et 1853, par MM. les officiers d'état-major de la section géodésique du dépôt de la guerre, à la mesure des bases géodésiques belges.
4°, Bruxelles, 1855, pp. xiv, 131, 6 plates. (Gore.)

——— Sur la figure de la terre.*
Acad. de Belgique, Bull., XXII, 1855.

——— Sur les triangulations qui ont été faites en Belgique, antérieurement à 1830.
Acad. de Belgique, Bull., XXIII, 1856, ii, 430–479; I, 1857, 281–344.

——— Sur la mesure de l'arc de parallèle européen de plus grand développement.
Acad. de Belgique, Bull., II, 1861, 457–467.

Netto (Friedrich August Wilhelm). Handbuch der gesammten Vermessungskunde, die neuesten Erfindungen und Entdeckungen in derselben zugleich enthaltend; oder vollständige Anleitung zur Messkunst, für Offiziere, Forstbediente, Bergleute und Feldmesser.
2 vols. 8°, Berlin, 1820, I, pp. xvi, 486, 6 plates; II, pp. xxii, 710, 4 plates. (Vienna, War Office).
Appendix, 4°. Beispiel der Anordnung und Berechnung eines trigonometrischen Dreiecksnetzes, pp. xxiv, 1 chart.

Neubig (Andreas). Grundrisse der reinen Mathematik, mit Anweisung zum Feldmessen.
8°, Bayreuth, 1846, pp. viii, 206. (British Museum)

Neumann (Carl). Ueber die Frage, ob die Erde eine Voll- oder Halbkugel sei.
Naturwiss. Ges. Isis. Sitz.-Ber., 1871, 5.

Neumayrs. Erdgeschichte.*
Leipzig.
Ueber die Gestalt und Grösse der Erde.

Neveu (J.). Tableau de comparaison des mesures de l'an X (1801) avec les mesures du système et les anciennes mesures.
Soc. Sav. Littér., Mém., I, 1801, 146–149.

Newton (Isaac). Philosophicæ naturalis principia mathematica; autore Isaaco Newtono. Perpetuis commentariis illustrata, communi studio PP. Thomæ le Seur et Francisci Jacquier. Editio altera longe accuratior et emendatior.
4°, Coloniæ Allobrogum, 1760, I, pp. xxxi, 548; II, pp. [iii], 422. (Washington, Congress.)

———: **Gronau (J. F. W.).** Ueber die Bewegung schwingender Körper, mit Rücksicht auf die Pendelversuche von —.
Danzig, 1850.
Title in full under GRONAU (J. F. W.).

Nicolas (F.). Die Bestimmung der Gestalt der Erdoberfläche.
Gaea, Natur und Leben, XIV, 1878, 570–578.

Nicollet (Jean-N.). Sur la détermination de la grandeur et de la figure de la terre.
Bibl. Univ. Genève, XVIII, 1821, 165–174.

——— *et* **Brousseaud.** Mesure d'un arc du parallèle.
Paris, 1826; Hertha, IX, 1827, 277–288; XI, 1828, 448–456.
Title in full under BROUSSEAU.

——— Mémoire sur un nouveau calcul des latitudes de Mont-Jouy et de Barcelone, pour servir de supplément au traité de la base du système métrique.
8°, [Paris, 1828], pp. 20. (Paris, National.)
Lu à l'Académie des sciences le 10 mars 1828.

——— Sur la mesure d'un arc du parallèle moyen entre le pôle et l'équateur.
Conn. d. Temps, 1829, 252–295.

——— Réflexions sur un mémoire de — inséré dans la Connaissance des Temps, pour l'année 1831, sur un nouveau calcul des latitudes de Mont-Jouy et de Barcelone, pour servir de supplément au traité de la base du système métrique. Communicated by a correspondent.
Phil. Mag. (Taylor), V, 1829, 180–188.
Defending the astronomical observations of Méchain.

——— Mémoire sur un nouveau calcul des latitudes de Mont-Jouy et de Barcelone, pour servir de supplément au traité de la base du système métrique.
Conn. d. Temps, 1831, 58–77.

Niederrh. Ges. Sitz.-Ber., *for* Sitzungsbericht der niederrheinischen Gesellschaft für Natur- und Heilkunde.
8°, Bonn, 1854+. (Washington, Congress.)

Niessl (Gustav von). Ueber die mathematische Gestalt der Erde und die Entwickelung unserer Kenntnisse von derselben.
Brünn. Verhandl., IV, 1865, Sitz.-Ber., 34–37, 42–52.

—— Ueber die europäische Gradmessung.
Brünn. Verhandl., VIII, 1869, Sitz.-Ber., 15–22.

Ninck (C. J. J. Blok). Overzicht van de methode der kleinste kwadraten.*
Leiden, 1876.

Nobert (Friedrich Adolph). Ueber Kreistheilung im Allgemeinen und über einige bei einer Kreistheilungsmaschine angewendete Versuchen zur Erlangung einer grossen Vollkommenheit der Theilung.
Verein Beför. d. Gewerbfleisses in Preussen, Verhandl., 1845, 212–216.

——: **Oertling (J. A. D.).** Bemerkungen zu —'s Aufsatz über Kreistheilung.
Verein Beför. d. Gewerbfleisses in Preussen, Verhandl., 1845, 215–216.

Noliti (A.). Memoria sulle stelle cadenti.*
Napoli, 1838.

NORWAY.

FEARNLEY (C.). Bericht über die Gradmessungsarbeiten in Norwegen.
Int. Geod. Cong., Gen.-Ber., 1865, 39–42; 1871, 58–63; 1875, 180–181; 1877, 292–294; 1878, 90; 1880, 22–23; 1881–'82, 148–150; 1883, 294–295; 1884–'86, 149–151.

—— Geodätische Arbeiten. 6 parts.
Christiania, 1880–'88.

ANON. Norwegian geodetical operations.
Van Nostrand's Eclectic Engineering Magazine, XXVIII, 1883, 283–287.

—— Norwegian geodetical operations.
Nature, XXVII, 1883, 224–226, 341–342; XXX, 1884, 105.
A review of the publications of the Norwegian committee of the European Association for the Measurement of Degrees.

Norwood (Richard). The sea-mans practice, containing a fundamental probleme in navigation experimentally verified: namely, touching the compass of the earth and sea, and the quantity of a degree in our English measure. Also an exact method or form of keeping a reckoning at sea, in any kind or manner of sailing, with certain tables and other rules useful in navigation as also in the plotting and surveying of places, the latitude of the principal places in England, the finding of currents at sea, and what allowance is to be given in respect to them.
12°, London, 1667, pp. iv, 141. (Oxford, Bodleian.)

—— Measure of the earth.*
London, 1794.

Nouet (Nicolas-Antoine). Sur les observations faites pour déterminer la position géographique d'Alexandrie et la direction de l'aiguille aimantée.
Mém. sur l'Égypte, I, Paris, an viii, 327–347.

—— Observations astronomiques faites dans la haute Égypte, pour fixer la position de plusieurs points, et déterminer la direction du Nil depuis Syène jusqu'au Kaire.
Mém. sur l'Égypte, II, Paris, an X, 241–263.

Nulty (Eugenius). Solution of a general case of the simple pendulum.
Am. Phil. Soc., Trans., II, 1825, 466–477.

Nuova Coll. Sci. (Inghirami), *for* Nuova collezione d' opuscoli scientifici e letterari.
8°, Fiesole, 1807–'18 (22 vols.).

Nuovi Ann. Sci. Nat., *for* Nuovi annali delle scienze naturali (Allessandrini, Bertolini, Gherardi).
8°, Bologna, 1838–'54.

Nystrom (John W.). Gravitation from the surface of the earth to its centre.
Jour. Frank. Inst., XXII, 1851, 205–208.

Obers (W.): Schumacher (H. C.). Skrivelse til — inholdende en Beskrivelse over det Apparat han has anwendt til Malingen af Standlinien ved Brak i Aaret.
Altona, 1821.
Also in German. Title in full under SCHUMACHER (H. C.).

O'Brien (Matthew). Mathematical tracts. Part I. On Laplace's coefficients, the figure of the earth, the motion of a rigid body about its centre of gravity, and precession and nutation.*
8°, Cambridge, 1840.
POGGENDORFF, II, 306.

Observatory, *for* The Observatory.
8°, London, 1877+. (Washington, Observatory.)

Oefverbom: Svanberg (J.). Exposition des opérations faites en Laponie pour la détermination d'un arc du méridien, par — . . .
Stockholm, 1805.
Title in full under SVANBERG (J.).

Oertling (Johann August Daniel). Bemerkungen zu Nobert's Aufsatz über Kreistheilung.
Verein z. Beförd. d. Gerwerbfleisses in Preussen, Verhandl., 1845, 215–216.

—— Beschreibung einer auf Veranlassung des Finanzministeriums in den Jahren 1840 und '41 erbauten Kreistheilmaschine.
Verein z. Beförd. d. Gewerbfleisses in Preussen, Verhandl., 1850, 133–191.

Oesfeld (*Major* von). Andeutungen zu zwei wichtigen geodätischen Operationen.
Ann. d. Erdkunde (Berghaus), VIII, 1833, 396.
Spain with Africa, and Asia with America.

Oesterblad (Jacob). De figura telluris ope pendulorum determinanda.
8°, Aboæ, 1810, pp. 11. (British Museum.)

O'Farral (James) *and* **Stotherd (R. H.).** Account of the graphic method in use for determining the co-ordinates of the secondary trigonometrical stations of the Ordnance Survey, by which the measurable effect of the residual errors of observations are clearly shown, with necessary formulæ and examples appended, and also examples of the calculations of co-ordinates of the stations of the primary triangulation.
8°, London, 1886, pp. 12, 7 plates. *Eyre and Spottiswoode.* (Southampton, Ordnance Survey.)

Ogden (Herbert Gouverneur). The survey of the coast.
Nat. Geographic Mag., I, 1888, 59–75.

Ogilby (W.). New theory of the figure of the earth, considered as a solid of revolution, founded on the direct employment of the centrifugal force, instead of the common principles of attraction and variable density.
4°, London, 1872, pp. xiii, 104. *Longmann.* (Gore.)
Revd. in Pop. Sci. Rev., XI, 1872, 189.

OLDENBURG.
SCHENCK (P. A.). Bericht über die geodätischen Arbeiten in Oldenburg.
Int. Geod. Cong., Gen.-Ber., 1865, 21-29; 1866, 22-26; 1868, 25-29; 1870, 29-30.

Oldenburg (Heinrich). A breviate of Monsieur Picart's account of the measure of the earth.
Roy. Soc. London, Phil. Trans., X, 1675, 261-272.

——— Advertisement concerning the quantity of a degree of a great circle in English measure.
Roy. Soc. London, Phil. Trans., XI, 1676, 636-637.

Oliver (J. R.). A course of practical astronomy for surveyors, with the elements of geodesy.
8°, Kingston, 1883, pp. viii, 185. (Oxford Bodleian.)

Oltmanns (Jabbo). Ueber die Wahre geographische Länge des in Peru gemessenen Breitengrades.
Astron. Jahrb. (Bode), 1810, 154-162.

——— [Abplattung der Erde nach den Pendelbeobachtungen von Biot in Dünkirchen und Formentera bestimmt.]
Mon. Corr. (Zach), XXI, 1810, 536.

——— Aus beobachteten Höhen-Winkeln und Azimuthen die Distanz und relative geographische Lage zweyer Oerter herzuleiten.
Astron. Jahrb. (Bode), 1811, 213-215.

——— Die trigonometrisch-topographische Vermessung des Fürstenthum Ostfriesland durch den Artillerie-Capitän Camp, nach dessen Beobachtungen dargestellt, mit Bemerkungen und Nachrichten über die oldenburgische und neue holländische Vermessung begleitet von —.
8°, Leer, 1815, pp. [i], 84. (Berlin, Royal.)

——— Hilfstafeln zur Berechnung der Länge und Breite aus gemessenen Meridian- und Perpendicular-Abständen.
Astron. Jahrb. (Bode), 1825, 196-199.

——— Hülfstafeln zur Berechnung der Längen- und Breiten-Unterschiede aus gemessenen Meridian- und Perpendicular-Abständen nach rheinländischem Maass, in der Erdabplattung für die Breiten-Parallele der preussischen Monarchie.
4°, Berlin, 1826, pp. 12. (Oxford, Bodleian.)

——— Beobachtungen über die Schwere, welche in den Häfen von Europa, America und Asien auf dem stillen Meere und in Neu-Holland während Malaspina's Weltumsegelung mit dem unveränderlichen Pendel angestellt worden sind.
Journ. f. Math. (Crelle), IV, 1829, 72-84.

Oppolzer (Theodor von). Rapport sur les travaux géodésiques en Autriche pendant l'année 1874.
Int. Geod. Cong., Gen.-Ber., 1874, 58-62.

——— *und* Ganahl. Bericht über die für die europäische Gradmessung ausgeführten Arbeiten, 1875, 1877.
Int. Geod. Cong., Gen.-Ber., 1875, 181-189; 1877, 294-298.

——— Gutachten der Pendel-Commission.
Int. Geod. Cong., Gen.-Ber., 1875, 78-79.

——— Erste Note zu Herrn Peirce's Mittheilung: De l'influence du trépied sur l'oscillation du pendule à réversion.
Int. Geod. Cong., Gen.-Ber., 1877, 188-190.

Oppolzer (T. R. von)—Continued.

——— Bericht des k. k. Gradmessungsbüreaus in Wien für das Jahr 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 91-96.

——— Bericht des k. k. Gradmessungsbüreau in Wien.
Int. Geod. Cong., Gen.-Ber., 1879, 97-88.

——— Bericht über die (geodätischen) Arbeiten in Oesterreich für 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 23.

——— Bericht des k. k. österreichischen Gradmessungsbüreau.
Int. Geod. Cong., Gen.-Ber., 1881-'82, 89-90.

——— Bericht des k. k. österreichischen Gradmessungsbüreau.
Int. Geod. Cong., Gen.-Ber., 1883, 261.

——— Bericht über die Bestimmung der Schwere mit Hilfe verschiedener Apparate.
Int. Geod. Cong., Gen.-Ber., 1883, 1-28.

——— Bericht über die Fortschritte und Arbeiten der Emopaischer Gradmessung.*
Geogr. Jahr., IX, 1883; X, 1884.

——— Berichte des k. k. österreichischen Gradmessungs-Büreaus, über die in den Jahren 1884, 1885, und 1886 ausgeführten Arbeiten.
Int. Geod. Cong., Verhandl., 1884-'86, 151-153.

Orff (Carl von) *und* **Bauernfeind (C. M. von).** Die bayerische Landesvermessung in ihrer wissenschaftlichen Grundlage. Mit höchster Genehmigung von der königl. Steuer-Cataster-Commission in Gemeinschaft mit dem topographischen Büreau des k. Generalstabes herausgegeben.
4°, München, 1873, pp. x, 768, 14 plates.

——— *und* Lamont (J. von). Astronomisch-geodätische Ortsbestimmungen in Bayern.
München, 1880.
Title in full under LAMONT (J. VON).

——— Bestimmung der Länge des einfachen Secundenpendels auf der Sternwarte zu Bogenhausen.
K. bayer. Ak. d. Wiss., Abhandl., XIV, 1883, iii, 161-294.

Oriani (Barnaba). Istruzione su le misure e sui pesi che si usano nella Republica Cisalpina, publicata per ordine del comitato governativo.
12°, Milano, 1801, pp. xiv, 128. (Gore.)

——— [Formeln zur Berechnung der Länge und Breite auf dem Erd-Sphäroid.]
Mon. Corr. (Zach), X, 1804, 244-251.

——— Formole per calcolare la latitudine e la longitudine sullo sferoide ellittico.
Eff. Astron., Milano, 1807, 3-34.

——— Opuscoli astronomici. Formole per calcolare la latitudine e la longitudine sulla sferoide ellittico.
8°, Milano, 1806, pp. 52, 1 plate; Milano, 1821. (Vienna, War Office).

——— [Moyen facile de tirer la longitude et la latitude des mesures géodésiques ordinaires.]
Astron. Nachr., IV, 1826, 461-466.

——— Misura dell' arco del meridiano compreso fra Milano e Genova.
Eff. Astron., Milano, 1827, 25-33.

Osterwald (Peter). Bericht über die vorgenommene Messung einer Grundlinie von München bis Dachau, welche der churfürstlich-bayerischen Akademie der Wissenschaften erstattet worden den 17ten May 1764.
K. bay. Ak. d. Wiss., 1764, ii, 363–386.

Oudemans (J. A. Ch.). Die Vermessungen auf Java.
Int. Geod. Cong., Gen.-Ber., 1872, 78–79.

——— Ueber den Schlussfehler wegen der sphäroidischen Gestalt der Erde.
Astron. Nachr., LXXXI, 1873, 21–26.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VI, 1874, 726–727, by B[RUNS].

——— [Ueber die Triangulation auf Java.]
Astron. Nachr., LXXXI, 1873, 273–282.

——— Ueber das Problem, aus dem Breiten- und Längen-Unterschiede zweier Oerter auf dem Erd-Sphäroid ihre Entfernungen und die gegenseitige Azimuth zu berechnen.
Astron. Nachr., LXXXI, 1873, 305–320.

——— Die Triangulation von Java, ausgeführt vom Personal des geographischen Dienstes in Niederländisch Ost-Indien. Erste Abtheilung: Vergleichung der Maassstäbe des Repsold'schen Basis-Mess-Apparates mit dem Normalmeter.
Fol., Batavia, 1875, pp. vi, 84, 3 plates. (Gore.)

———, **Metzger (E.)** *und* **Woldringh (C.).** Die Triangulation von Java ausgeführt vom Personal des geographischen Dienstes in Niederländisch Ost-Indien. Zweite Abtheilung: Die Basismessung bei Simplak.
Fol., Haag, 1878, pp. [ii], 34, 3 plates. (Gore.)
Revd. by HELMERT (F. R.), Astron. Ges., Vierteljahrs., XVI, 1881, 120–134.

——— Rapport sur les travaux géodésiques dans les Pays-Bas pendant l'année 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 18–20.

——— Ueber die Compensation eines Secundenpendels für Temperatur und Luftdruck mittels eines Quecksilbercylinders und eines Krüger'schen Manometers.
Zeits. f. Instrumentenkunde, I, 1881, 190–205; Astron. Nachr., C, 1881, 17–58.

——— Het problema van Snellius, opgelost door Ptolemæus.
K. Ak. Weten. Amsterdam, Versl. XIX, 1885, 431–436.
Pothenot problem as used by Ptolemy in astronomy before Snellius applied it geodetically.

Outhier (Reginald): Maupertuis (P.-L.-M. de). La figure de la terre déterminée par les observations de — et —.
Paris, 1738, 1739.
English translation, London, 1738; German translation, Zürich, 1741; Latin translation, Lipsiæ, 1742.
Title in full under MAUPERTUIS (P.-L.-M. DE).

——— Journal d'un voyage au nord, en 1736 et 1737. Par M. Outhier, prêtre du diocèse de Besançon, correspondant de l'Académie royale des sciences à Paris.
4°, Paris, 1844, pp. iv, 238, 2. (Gore.)

Ozanam (Jacques). Traité de l'arpentage et du toisé, ou méthode facile pour arpenter et mesurer toutes sortes de superficies.
8°, Paris, 1747, pp. x, 481, 12 plates. (Munich, Royal.)

Paine (Robert Treat) *and* **Borden (S.).** Account of a trigonometrical survey of Massachusetts, with a comparison of its results with those obtained from astronomical observations.
Am. Acad., Mem., I, 1833, 338–344.

——— Trigonometrical survey of Massachusetts by Borden.
Am. Phil. Soc., Trans., IX, 1846, 33–93.
Title in full under BORDEN (S.).

Palander: Svanberg (J.). Exposition des opérations faites en Laponie pour la détermination d'un arc du méridien par —.
Stockholm, 1805.
Title in full under SVANBERG (J.).

Palfrey (John G.). Tables of bearings, distances, latitudes, etc., ascertained by the astronomical and trigonometrical survey of Massachusetts. Published agreeably to a resolve of the General Court.
4°, Boston, 1846, pp. xxxviii, 73. (Washington, Congress.)

Palmer (H. S.) *and* **Wilson (C. W.).** Ordnance Survey of the peninsula of Sinai.
Southampton, 1869.
Title in full under WILSON (C. W.).

——— The Ordnance Survey of the kingdom; its objects, mode of execution, history, and present condition. Reprinted, with permission, and slightly altered, from "Ocean Highways."
8°, London, 1873, pp. 77. (Oxford, Bodleian.)

——— The state of the surveys in New Zealand. Correspondence relative to, and report by —. Presented to both houses of the general assembly by command of his excellency.
Fol., 1875, pp. 32. (Southampton, Ordnance Survey.)

Paoli (Pietro). Ueber die Schwingungen eines Körpers, welches an einem seiner Länge nach sich verändernden Faden befestiget ist.
Mon. Corr. (Zach), XIX, 1809, 301–316.

Parrot (Fr.): Reise zum Ararat.*
Berlin, 1834.
Pendulum observations.

———: **Stebnitzki (J.).** Beobachtungen mit dem unveränderlichen Pendel angestellt von — in Dorpat, Tiflis, etc.
Astron. Nachr., CIII, 1882, 375–378.

Parry: Sabine (E.). Beobachtungen über die Beschleunigung des Secundenpendels in höheren Breiten, angestellt unter —.
Ann. d. Phys. (Gilbert), LXIX, 1821, 402–416.

Paschen (F.). Ueber das sogenannte Drehen der Beobachtungspfeiler auf den trigonometrischen Stationen.
Astron. Nachr., LXIII, 1865, 49–72.

——— Bericht über die geodätische Arbeiten in Mecklenburg im Jahre 1864.
Int. Geod. Cong., Gen.-Ber., 1864, 23–24.

——— Bericht über den Stand der geodätischen Arbeiten in Mecklenburg.
Int. Geod. Cong., Gen.-Ber., 1865, 14–17.

——— Bericht über den Stand der geodätischen Arbeiten in Mecklenburg.
Int. Geod. Cong., Gen.-Ber., 1868, 25.

Paschen (F. —Continued.
——— Jahres-Bericht über den Stand der geodätischen Arbeiten in Mecklenburg-Schwerin.
Int. Geod. Cong., Gen.-Ber., 1869, 19–22.

Paschen (P.), **Köhler, Bruhns,** *und* **Foerster.** Grossherzoglich mecklenburgische Landesvermessung.
4°, Schwerin, 1882, I, pp. xii, 251; II, pp. x, 79, 1 map; III, pp. 80; IV, pp. 106, 5 plates in all.
Revd. by JORDAN, Zeits. f. Vermes., XII, 1883, 355–367; HELMERT (F. R.), Astron. Ges., Vierteljahrs., XIX, 1884, 39–58.

Pasley (C. W.). Plan for simplifying and improving the measures, weights, and money of this country without materially altering the present standards.
8°, London, 1857, pp. 16. (Southampton, Ordnance Survey.)

Pasquich (Johann). Ueber den Gebrauch der neuesten französischen Gradmessung bei geographischen Untersuchungen.
Mon. Corr. (Zach), I, 1800, 435–447.

——— Etwas über den Gebrauch der Pendellehre bei der Annahme der ellipsoidischen Gestalt der Erde.
Mon. Corr. (Zach), II, 1800, 3–14.

——— Ueber die Krümmungs-Ellipsoide für die nördliche Hälfte unserer nördlichen Halbkugel.
Mon. Corr. (Zach), VIII, 1803, 411–417.

——— Gedanken über den Prony'schen Vorschlag zur Bestimmung der Länge des Secundenpendels.
Mon. Corr. (Zach), XII, 1805, 137–147.

Pattenhausen (B.). Ueber die Ausdehnung des Meridians von Paris bis zur Sahara.
Zeits. f. Vermes., X, 1881, 247–257.

——— Geodäsie und Topographie auf dem dritten internationalen geographischen Congresse.
Zeits. f. Vermes., XI, 1882, 73–94, 105–126, 169–181, 433–455.
Separately, 8°, Karlsruhe, 1882, pp. 25.

Paucker (Magnus Georg von). Ueber astronomisch-trigonometrische Landesvermessungen.*
4°, Mitau, 1817.
POGGENDORFF, II, 377.

——— Ueber die Anwendung der Methode der kleinsten Quadratsumme auf physikalische Beobachtungen.*
4°, Mitau, 1819.
POGGENDORFF, II, 377.

——— Der Ausgleichungsbau und der mittlere Fehler der Beobachtung.
Arbeit. Kurländ. Gesell., VII, 1849, 91–131.
MERRIMAN, 191.

——— Zur Theorie der kleinsten Quadrate.
Acad. de St.-Pétersbourg, Bull., Phys. Math., IX, 1851, 113–125; X, 1852, 33–43, 233–238; Mél. Math., I, 188–204, 333–346, 433–439.

——— Die Gestalt der Erde.
Acad. de St.-Pétersbourg, Bull., XII, 1854, 97–128; XIII, 1855, 49–89; XIII, 1855, 225–249; Mél. Math. et Astr., I, 1853, 609–648; II, 1859, 113–172, 297–330.

Paucton (Alexis-Jean-Pierre). Métrologie, ou traité des mesures, poids et monnoies des peuples anciens et modernes.
4°, Paris, 1780, pp. xv, 955–956.
Chapter I contains numerous references to degree measures and the length of the pendulum.

Paul (Henry Martyn). Recent gravity determinations in and near Japan.
Science, VI, 1885, 319–320.

Paulussen. Nog een leerwijze tot het oplossen van normaal-vergelijkingen.*
Tijdschrift voor Kadaster en Landmeetkunde, II, 1886, 221.

Peacock (G.) *and* **Hampden** (J.). Is the world flat or round?
London (?), 1871.

Pearce (James Alfred). Speech on the subject of the Coast Survey of the United States. Delivered in the Senate of the United States, February 17, 1849.
8°, Washington, 1849, pp. 16 (Gore); 2d ed., Waterman pamphlets, XLV, No. 10.

Pechmann (Eduard). Die Abweichung der Lothlinie bei astronomischen Beobachtungsstationen und ihre Berechnung als erforderniss einer Gradmessung.
K. k. Ak. d. Wiss., math. naturwiss. Cl., Denkschr., XXII, 1864, ii, 41–48; Sitz.-Ber., XLVII, 1863, ii, 432–437.

Peirce (Benjamin). [A report upon the results of the United States Coast Survey.]
Am. Acad. Sci., Proc., II, 1848–'52, 124–128.

——— On the relation between the elastic curve and the motion of the pendulum. (H.)
A. A. A. S., Proc., 1849, 128–130.

———: **Gould** (B. A.). —'s criterion for the rejection of doubtful observations.
U. S. C. and G. Survey, Rep., 1854, 131–138.

——— Note upon the conical pendulum.
Astron. Journ. (Gould), II, 1852, 137–140.

——— Abstract of a paper on the resistance to the motion of the pendulum.
A. A. A. S., Proc., 1855, 74.

Peirce (Charles Sanders). On the theory of errors of observations.
U. S. C. and G. Survey, Rep., 1870, 200–224.

——— Measurements of gravity at initial stations in America and Europe.
U. S. C. and G. Survey, Rep., 1876, 202–337.
Addendum, 410.

——— De l'influence de la flexibilité du trépied sur l'oscillation du pendule à réversion.
Int. Geod. Cong., Gen.-Ber., 1877, 171–187; fol., New York, 1877, 23.
Note communiquée par M. E. Plantamour. Lithographed.

———: **Oppolzer** (T. von). Erste Note zu Herrn —'s Mittheilung "De l'influence du trépied sur l'oscillation du pendule . . ."
Int. Geod. Cong., Gen.-Ber., 1877, 188–190.

——— On the influence of internal friction upon the correction of the length of the seconds pendulum for the flexibility of the support.
Am. Acad., Proc., XIII, 1877–'78, 396–401.

——— Esposizione del metodo dei minimi quadrati. Per Annibale Ferrero, Firenze, 1876.
Am. Journ. Math., I, 1878, 59–63.

——— Experimental pendulum work during the year 1878. (U. S. Coast Survey.)
Int. Geod. Cong., Gen.-Ber., 1878, 116–120.

Peirce (Charles Sanders)—Continued.

——— On a method of swinging pendulums for the determination of gravity, proposed by M. Faye.
Am. Journ. Sci., XVIII, 1879, 112–119.
Read before Nat. Acad. Sci., April 17, 1879.

——— Sur la valeur de la pesanteur à Paris. Note de M. C.-S. Peirce.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1401–1403.

———: **Faye (H.-A.-E.-A.)**. Rapport sur un mémoire de M. — concernant la constante de la pesanteur à Paris.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1463–1466.

——— Results of pendulum experiments. (H.)
Am. Journ. Sci., XX, 1880, 327; L., E., D. Phil. Mag., X, 1880, 387.

——— Ueber eine Methode mit schwingender Pendeln die Schwere zu bestimmen. (H.)
Ann. d. Phys. (Poggendorff), IV, 1880, 240.

——— Comparison between the yard and metre by means of the reversible pendulum. (Abstract.)
A. A. A. S., Proc., XXX, 1881, 20.

——— On the flexure of pendulum supports.
U. S. C. and G. Survey, Rep., 1881, 359–441.

——— On a method of observing the coincidence of vibration of two pendulums.
U. S. C. and G. Survey, Rep., 1881, 457–460.

——— On the deduction of the ellipticity of the earth, from pendulum experiments.
U. S. C. and G. Survey, Rep., 1881, 442–456, Appendix 15.

——— On the value of gravity at Paris.
U. S. C. and G. Survey, Rep., 1881, 461–463, Appendix 17.

——— Determinations of gravity at Allegheny, Ebensburgh, and York, Pa.
U. S. C. and G. Survey, Rep., 1883, 473–487, Appendix 19.

——— Note on the effect of the flexure of a pendulum on its period of oscillation.
U. S. C. and G. Survey, Rep., 1884, 483–485.

——— On the influence of a noddy on the period of a pendulum.
U. S. C. and G. Survey, Rep., 1885, 509–510.

——— On the effect of unequal temperature upon a reversible pendulum.
U. S. C. and G. Survey, Rep., 1885, 511–512, Appendix 17.

——— Use of the noddy for measuring the amplitude of swaying in a pendulum support.
U. S. C. and G. Survey, Rep., 1884, 475–482.

Pelission (Jacob Philipp). Beschreibung eines zu astronomischer und geometrischer Ausmessung bequemen Instrumentes.
Ges. d. naturf. Freunde, Berlin, Schriften, II, 1781, 277–284.

PENDULUM, LENGTH OF SECONDS.

ALBRECHT (T.). Bestimmungen der Länge des Secundenpendels in Leipzig, Dresden und Freiberg.
Berlin, 1885.

BAILY (F.). On the discordancies in the results of the methods for determining the length of the simple pendulum.
Phil. Mag. (Taylor), V, 1829, 97–104.

PENDULUM, LENGTH OF SECONDS—Continued.

——— Captain Foster's pendulum experiments.
Roy. Astron. Soc., Month. Not., III, 1833–'36, 1–3; Mem., VII, 1834, 1–378.

——— Experiments made in London and at two stations on the river Euphrates with three pendulums.
Roy. Astron. Soc., Mem., XII, 1842, 61–81.
At the Cape of Good Hope, 83–101.

BASEVI (J. P.). Pendulum experiments about to be undertaken in India.
Indian Eng. (Medley), IV, 1867, 97–199.

——— Abstract of mean results with pendulums.
Roy. Soc. London, Proc., XIX, 1871, 105.

——— Details of pendulum operations and their reduction.
India, Trig. Survey, V, 1879.

BESSEL (F. W.). Untersuchungen über die Länge des einfachen Sekunden-Pendels.
K. Ak. d. Wiss., math.-phys. Cl., Abhandl., 1826, 1–256.

——— Bestimmung der Länge des einfachen Secundenpendels für Berlin.
K. Ak. d. Wiss., math.-phys. Cl., Abhandl., 1835, 161–262.

BIDONE (G.). Note sur la longueur du pendule simple . . .
Ann. Math. (Gergone), XVIII, 1827–'28, 341–352.

BIGNON. Différence de la longueur du pendule à Paraübe ét à Paris.
Acad. d. Sci. Paris, Mém., 1700, 175–178.

BIOT (J.-B). Expériences sur la mesure du pendule à secondes, sur différens points de l'arc du méridien compris entre Dunkerque et l'île de Formentera.
Soc. Philom., Bull., I, 1807, 261–262; Bibl. Brit. Genève, XLII, 1809, 20–26; Bibl. Univ. Genève, X, 1819, 225–238.

——— Sur la longueur absolue du pendule à secondes mesurée en Angleterre et en Écosse . . .
Soc. Philom., Bull., VI, 1821, 70–78.

BOHNENBERGER (J. G. F.). Ueber die Bestimmung der Länge des einfachen Secundenpendels.
Würtemberg, Abhandl., I, 1826, 1–34.

BORENIUS (H. G.). Ueber die Berechnung der mit dem unveränderlichen Pendel zur Bestimmung der Abplattung der Erde angestellten Beobachtungen.
Acad. de St.-Pétersbourg, Bull., I, 1843, 1–29.

BOSCOVICH (R. G.). De deviationibus pendulorum ex asperitate superficei terrestris.
Phil. Recent. (Stay), II, 1760, 380–385.

——— Opera pertinenta ad opticam et astronomicam.
Bassani, 1785.

BOUGUER (P.). Sur la longueur du pendule (dans l'isle de St.-Domingue).
Acad. d. Sci. Paris, Mém., 1735, 522–528.

BRADLEY (J.). Account of some observations made in London by G. Graham, and in Jamaica by C. Campbell . . . in order to determine the difference between the lengths of isochronal pendulums in those places.
Roy. Soc. London, Phil. Trans., XXXVIII, 1735, 302–314.

BREDICHIN (T.). Expériences faites avec le pendule à réversion.
Obs. de Moscou, Ann., VIII, 1882, 31–56.

BRUHNS (C.). Bestimmung der Länge des Secundenpendels in Bonn, Leyden und Mannheim.
Leipzig, 1871.

BÜRJA (A.). Sur la longueur du pendule à secondes à Berlin.
Acad. d. Sci. Berlin, Mém., 1799–1800, 3–17.

BUNT (T. J.). On pendulum experiments.
L., E., D. Phil. Mag., I, 1851, 552–554; II, 1851, 37–41; IV, 1852, 272–275.

CARLINI (F.). Osservazione della lunghezza del pendolo simplici fatte all' altezza di mille tese sul livello del mare.
Eff. Astron., Milano, 1824, 28–40.

CASSINI (J.). Observations de la longueur des pendules à la Martinique.
Acad. d. Sci. Paris, Mém., I, 1708, 16.

CLARKE (A. R.). Account of the remeasurement of the length of Kater's pendulum.
India, Trig. Survey, V, 1879, I, 1–9.

PENDULUM, LENGTH OF SECONDS—Continued.

CONDAMINE (C.-M. DE LA). De la mesure du pendule à St.-Domingue.
Acad. d. Sci. Paris, Mém., 1735, 529–544.

COUPLET. Différence de la longueur du pendule à Lisbonne et à Paris.
Acad. d. Sci. Paris, Mém., 1700, 174–175.

DARQUIER (A.). Observations astronomiques faites à Toulouse.
Paris, 1782.

DULONG (T.). Expériences faites avec un pendule invariable à la Nouvelle-Galles.
Bull. Sci. Math. (Saigey), II, 1824, 123–124.

DUPERREY (L.-I.). Observations du pendule invariable . . faites dans la campagne de la corvette La Coquille.
Paris, 1827; Conn. d. Temps, 1830, 83–99.

FALLOWS (F.). Observations made with the invariable pendulum at the Cape of Good Hope.
Roy. Soc. London, Phil. Trans., 1830, 153–175.

FONTENELLE. Sur la longueur du pendule dans la zone torride.
Acad. d. Sci. Paris, Hist., 1736, 115–117.

FOSTER (H.). Account of experiments made with an invariable pendulum at Greenwich and Port Bowen.
Roy. Soc. London, Phil. Trans., 1826, IV, 1–70.

—— Notice of his pendulum experiments in different parts of the world.
Roy. Astron. Soc., Month. Not., II, 1831–'33, 66–68.

—— Experiments made with an invariable pendulum near the equator, and on the coast of Mexico and Brazil.
Edinb. Phil. Journ., X, 1824, 91–95.

FRANCŒUR (L.-B.). Résultats des expériences de Sabine pour déterminer la longueur du pendule à secondes.
Soc. Philom., Bull., 1826, 65–66.

FREYCINET (L. DE). Voyage autour du monde.
Paris, 1826.

GALBRAITH (W.). Remarks on the experiments of the pendulum made by Kater and Biot.
Phil. Mag. (Tilloch), LXIV, 1824, 161–170.

GERARD (A.). On pendulum observations.
Edinb. Phil. Journ., LV, 1853, 14–16.

GODIN (L.). La longueur du pendule simple qui bat les secondes à Paris et à l'isle de St.-Dominique.
Acad. d. Sci. Paris, Mém., 1735, 505–521.

GOLDINGHAM (J.). Observations for ascertaining the length of the pendulum at Madras.
Roy. Soc. London, Phil. Trans., 1822, 127–170.

—— Report of the length of the pendulum at the equator.
Ann. Phil. (Thomson), XII, 1826, 281–299, 342–354.

GOVI (G.). Metodo per determinare la lunghezza del pendolo.
Accad. Sci. Torino, Atti, I, 1866, 505–513.

—— Nouvelle méthode pour déterminer la longueur du pendule simple.
Acad. d. Sci. Paris, Comp. Rend., XCI, 1880, 105–106.

GREGORY (O. G.). . . . with remarks upon various other pendulum experiments.
Phil. Mag. (Tilloch), LIII, 1819, 426–445.

HALL (B.). Detail of experiments made with an invariable pendulum.
Roy. Soc. London, Phil. Trans., CXIII, 211–288.

HÄLLSTROM (G. G.). De longitudine penduli pro Aboa.
Aboæ, 1805.

HAYES (I. J.). Physical observations in the Arctic seas.
Smith. Contrib., XV, 1867, 29–68.

HEAVISIDE (W. J.). Preliminary abstract of approximate mean results with the invariable pendulum.
Roy. Soc. London, Proc., XIII, 1875, 316–317.

HELMERT (F. R.). Rapport sur les mesures de pendule exécutées dans les dernières années.
Int. Geod. Cong., Verhandl., 1887, II, 1–17.

HENRY (M.). Essai sur la détermination de la longueur du pendule simple sous la latitude de St.-Pétersbourg.
Acad. de St.-Pétersbourg, Acta, XI, 1793, 524–530.

PENDULUM, LENGTH OF SECONDS—Continued.

HERSCHEL (J.). Note on the length of the pendulum observed by de l'Isle de la Croyère at Archangel in 1728.
Astron. Register, XIX, 1882, 5.

—— Pendulum observations in London.
Nature, XXV, 1882, 196–197.

HILGARD (J. E.). Pendulum observations.
Johnson's Cycl., III, 1878, 1143.

HORSLEY (S.). Remarks on . . . the acceleration of the pendulum.
London, 1774.

IVORY (J.). Short abstract of M. de Freycinet's experiments for determining the length of the pendulum.
Phil. Mag. (Tilloch), LXVIII, 1826, 350–353.

—— Notice relating to the seconds pendulum at Port Bowen.
Phil. Mag. (Taylor), I, 1827, 170–171.

JIMENEZ (F.). Determinacion de la longitud del péndulo de segundos en México.
Observatorio Astron. Central, México, 1878–'79, 1–61.

KÄMTZ (L. F.). Ueber die Länge des Secundenpendels, nach den neueren Untersuchungen.
Hertha, IX, 1827, 71–122, 197–208, 417–442; X, 1827, 376–386.

KATER (H.). An account of experiments for determining the length of the pendulum vibrating seconds in London.
Roy. Soc. London, Phil. Trans., 1818, 32–109.

—— An account of experiments for determining the length of the seconds pendulum at the trigonometrical stations in Great Britain.
Edinb. Phil. Jour., II, 1820, 319–325; Roy. Soc. London, Phil. Trans., CIX, 1819, 337–508.

—— An account of experiments made with an invariable pendulum at New South Wales, by Brisbane.
Roy. Soc. London, Phil. Trans., CXIII, 1823, 308–325.

KRAFT (W.-L.). Analyse des expériences faites en Russie sur la longueur du pendule à secondes.
Acad. de St.-Pétersbourg, Acta, VII, 1793, 215–228.

KUHLBERG (P.). Resultate aus Pendelbeobachtungen im Kaukasus.
Astron. Nachr., XCIX, 1881, 282–288.

LACAILLE (N.-L. DE). Diverses observations . . . pour la longueur du pendule.
Acad. d. Sci. Paris, Mém., 1754, 108.

—— Mesure de la longueur du pendule à 33° 55′ de latitude australe.
Acad. d. Sci. Paris, Mém., 1751, 436–438; Hist., 158–160.

—— Observations pour la longueur du pendule à l'Isle de France.
Acad. d. Sci. Paris, Mém., 1754, 54–56.

LA HIRE (P. DE). Sur les pendules à secondes.
Acad. d. Sci. Paris, Mém., 1715, 130–132.

LAPLACE (P.-S. DE). Sur les longueurs observées du pendule.
Acad. d. Sci. Paris, Mém., 18–43.

—— Sur la longueur du pendule à secondes.
Ann. de Chim., III, 1816, 92–95 . . .

LENZ (H. F. E.). Pendelbeobachtungen.
Acad. de St.-Pétersbourg, Mém., I, 1831, 226–228.

L'ISLE DE LA CROYÈRE (L. DE). Observatio longitudinis penduli simplicis facta Archangelopoli.
Acad. de St.-Petersbourg, Com., IV, 1729, 322–328.

LITTROW (J. J.). Beobachtungen an zwei unveränderlichen Reversionspendeln.
Zeits. f. Phys. u. Math. (Baumgärtner), V, 1837, 97–116.

LUBBOCK (J. W.). Expression for the time of vibration of a simple pendulum.
L., E., D. Phil. Mag., IV, 1828, 338–339.

LÜBECK (G.). Notiz zu den Bessel'schen Pendelversuchen.
Ann. d. Phys. (Poggendorff), CL, 1873, 476–483.

LUETKE (F. B. VON). Les observations du pendule invariable.
Acad. de St.-Pétersbourg, Mém., I, 1831, xi–xv; Mém. Savans Étrang., III, 1837, 1–242.

PENDULUM, LENGTH OF SECONDS—Continued.

LULOFS (J.). Over de langte van den enkelen slinger te Leiden.
Acad. d. Sci. Haarlem, Verhandl., 1757.

MACLEAR (T.). An account of some experiments made with an invariable pendulum at the Cape of Good Hope.
Roy. Astron. Soc., Month. Not., v, 1839-'43, 57-58.

MAIRAN (J.-J.). Expériences sur la longueur du pendule à secondes à Paris.
Acad. d. Sci. Paris, Mém., 1735, 153-221, 505-544.

MALLET (J. A.). Observationes variæ in Lapponia ad Ponoi institutæ.
Acad. de St.-Pétersbourg, Com., XIV, 1769, ii, 14-15, 24-33; Roy. Soc. London, Phil. Trans., 1770, 363-367.

MATHIEU (C.-L.). Sur les expériences du pendule faites . . . en différents points du globe.
Conn. d. Temps, 1816, 314-332; 1826, 280-307.

MEYER (O. E.). Pendelbeobachtungen.
Ann. d. Phys. (Poggendorff), CXLII, 1871, 481-524.

OPPOLZER (T. VON). Gutachten der Pendel-Commission.
Int. Geod. Cong., Gen.-Ber, 1875, 78-89.

ORFF (C. VON). Bestimmung der Länge des einfachen Secundenpendels zu Bogenhausen.
K. bayer. Ak. d. Wiss., Abhandl., XIV, 1883, iii, 161-294.

PASQUICH (J.). Gedanken über den Prony'schen Vorschlag zur Bestimmung der Länge des Secundenpendels.
Mon. Corr. (Zach), XII, 1805, 137-147.

PEIRCE (C. S.). Experimental pendulum work.
Int. Geod. Cong., Gen.-Ber., 1878, 116-120; Am. Journ. Sci., XX, 1880, 327; L., E., D. Phil. Mag., X, 1880, 387.

PETERS (C. A. F.). Bestimmung der Länge des einfachen Secundenpendels auf dem Schlosse Güldenstein.
Altona, 1855; Astron. Nachr., XL, 1855, 1-152.

—— Ueber die mit einem Reversionspendel in Altona und Berlin angestellten Beobachtungen.
Astron. Nachr., LXXVI, 1870, 145-148.

—— Beobachtungen mit dem Bessel'schen Pendel-Apparate in Königsberg und Güldenstein.
Hamburg, 1874; Astron. Nachr., CVI, 1883, 1-4.

—— Bestimmung der Länge des einfachen Secundenpendels in Altona, Berlin und Königsberg.
Astron. Nachr., XCVII, 1880, 1-36.

PETIT (F.). Observations du pendule à Toulouse.
Revue Scientifique, II, 1840, 86-88; Acad. d. Sci. Paris, Comp. Rend., XI, 1840, 21-22; XLVI, 1858, 516-518; Acad. de Toulouse, Mém., VI, 1850, 166-190.

PHIPPS (C. J.). A voyage towards the North Pole.
London, 1774.

PISATI (G.). Sulla lunghezza del pendolo a secondi.
Accad. d. Lincei, Atti, XV, 1883, 57-231.

PLANTAMOUR (E.). Expériences pour la détermination de la longueur du pendule simple à Genève.
Soc. Sci. Neuchâtel, Bull., VII., 1866, ii, 160-170, 416-420.

—— Expériences faites à Genève avec le pendule à réversion.
Soc. Phys. Genève, Mém., XVIII, 1866, 309-416; Genève, 1866.

—— Nouvelles expériences faites avec le pendule à réversion . . . à Genève et au Righi-Kulm.
Genève, 1872.

POUILLET (C.-S.). Lettre du capitaine B. Hall au M. Kater sur les observations du pendule . . .
Bull. Sci. Math. (Saigey), I, 1824, 151-152.

—— Élements de physique.
Paris, 1853.

PRONY (R. DE). Méthode pour déterminer la longueur du pendule simple.
Soc. Philom., Bull., II, 1801, 159-160; 1816, 173-174; 1817, 193-194.

RICHER (J.). Observations . . . de longueur du pendule à Paris et à Cayenne.
Acad. d. Sci. Paris, Hist., I, 116-117; Mém., VII, 87-88; Paris, 1679.

PENDULUM, LENGTH OF SECONDS—Continued.

ROBERT (H.). Usage de la table des longueurs du pendule.
Paris.

ROIFFÉ (DE LA P. DE). Expériences du pendule de le Mercier.
Journ. Encycl. ou Univ., CXXX, 1772, 250.

ROZET (C.-A.). Sur . . . la longueur du pendule à la surface des eaux tranquilles.
Soc. Géogr., Bull., 1842-'43, 276-286; Soc. Philom., Proc.-Verb., 1843, 22-33.

RÜMKER (K.-L.-C.). Observations à Londres sur la longueur du pendule simple.
Corr. Astron. (Zach), V, 1821, 66-67.

—— Pendelbeobachtungen.
Astron. Nachr., III, 1824, 261-262; Roy. Astron. Soc., Month. Not., I, 1827-'30, 75-76; Mem., III, 1827, 277-298.

RUMOVSKI (S.). Experimenta circa longitudinem penduli simplicis (Selenginsk, Kolae, etc.).
Acad. de St.-Pétersbourg, Com., XI, 1765, 468-480; XVI, 1771, 567-585.

S. Comparaison des observations du pendule à diverses latitudes.
Bull. Sci. Math. (Saigey), VII, 1827, 31-43, 171-184.

SABINE (E.). An account of experiments to determine the acceleration of the pendulum in different latitudes.
Roy. Soc. London, Phil. Trans., 1821, 163-190; Ann. d. Phys. (Gilbert), LXIX, 1821, 402-416.

—— Experiments to determine the difference in the length of the seconds pendulum in London and Paris.
Roy. Soc. London, Phil. Trans., CXVIII, 1828, 35-77; 1829, 83-102; 1831, 459-488.

—— Account of M. Bessel's pendulum experiments.
Quart. Journ. Sci., V, 1829, 1-27.

—— Experiments to determine the difference in the number of vibrations made by an invariable pendulum in the royal observatories of Greenwich and Altona.
Roy. Soc. London, Phil. Trans., 1830, 239-249.

SANG (E.). Pendulum.
Encycl. Brit., 8th ed., XVII, 1859, 376-388.

SAWITSCH (A. N.). Pendulum observations made in 1865 at St. Petersburg, Torneå, Pulkowa.
Acad. de St.-Pétersbourg, Appendix.

—— Les longueurs du pendule à secondes à Pulkowa, St.-Petersbourg.
Roy. Astron. Soc., Mem., XLIV, 1877-'79, 307-315; Month. Not., XXXIX, 1878-'79, 365-366.

—— Quelques remarques sur la détermination de la longueur du pendule à secondes.
Int. Geod. Cong., Gen.-Ber., 1883, 30-32.

STAMPFER (S.). Beobachtungen an zwey unveränderlichen Reversions-Pendeln.
K. k. Sternwarte, Ann., XVI, 1836, xxvi-xxvii.

STEBNITZKI (J.). Beobachtungen mit dem unveränderlichen Pendel. . . .
Astron. Nachr., CIII, 1882, 375-378.

STEWART (B.). An account of the base observations with the Indian pendulums.
Roy. Soc. London, Proc., XIV, 1865, 425-439; XVII, 1869, 488-499.

STRUVE (O.). Mittheilung über Pendelbeobachtungen.
Int. Geod. Cong., Gen.-Ber., 1824, 76-77.

SVANBERG (J.). Berättelse öfver försök till bestämmende af Secundenpendels Längd och vattnets tyngl.
Quart. Journ. Sci., XXII, 1826, 152-180; K. Vetens. Ak., Handl., 1825, 1-116.

—— Berättelse öfver de ar 1833 pa Stockholms Observatorium, verkställda Pendel Försök.
K. Vetens. Ak., Handl., 1834, 184-317.

TENNANT (J. F.). Note on the coefficient of expansion of the brass pendulums used in India.
Roy. Astron. Soc., Month. Not., XXVII, 1867, 284-286.

TROUGHTON (E.). Comparison between the length of the seconds pendulum, as determined by Whitehurst and Kater.
Edinb. Phil. Journ., I, 1819, 75-76.

PENDULUM, LENGTH OF SECONDS—Continued.

WAGNER. Ueber die sogenannte Pendel-Versuche.
Ann. d. Phys. (Gilbert), LIX, 1818, 328–332.

WALBECK (H. J.). Vergleichung der Secundenpendel-Beobachtungen.
Astron. Nachr., I, 1823, 253–256.

WALKER (J. T.). On the Indian pendulum observations.
Roy. Soc. London, Proc., XV, 1866–'67, 254–255, 318–319; XIX, 1871, 97–104; Indian Eng. (Medley), V, 1868, 305–314.

WARREN (J.). An account of experiments made at the observatory near Fort St. George for determining the length of the seconds pendulum.
Asiatic Researches, XI, 1810, 293–308.

WATTS (W.). . . . length of the seconds pendulum in latitude 50° 22′ 28″.
Ann. Nat. Phil. (Thompson), VIII, 1816, 284–288.

—— On the length of the seconds pendulum.
Edinb. Phil. Jour., I, 1819, 325–337; III, 1820, 27–32.

WIJKANDER (A.). Pendel-bestamninger under den Svenska arktiska expeditionen 1872–'73.
Acta Universitatis, Lundensis, XIV, 1877–'78, 1–32, 1 plate.

ZOÉGA. Expérience du pendule faite à Beauvoir en 1851.
Soc. Acad. Oise, Mém., II, 1852–'54, 145–147.

ANON. [Différence de la longueur du pendule de Paris à celle du pendule de Cäienne].
Acad. Sci. Paris, Hist., I, 177–178.

—— On the figure of the earth, and on the length of the seconds pendulum in different latitudes.
Quart. Journ. Sci., V, 1818, 235–249.

—— Pendulum; length of simple and invariable pendulum.
Penny Cycl., XVII, 1840, 405–410.

—— Pendel.
Universal-Lexikon (Pierer's), XII, 1861, 799–801.

—— Pendulum.
English Cycl., VI, 1861, 371–383.

—— Report of a conference on gravity determinations, held at Washington, D. C., in May, 1882.
U. S. C. and G. Survey, Rep., 1882, 503–516, Appendix 22.

—— *Bestimmung der Länge des Secundenpendels in Gotha, auf dem Seeberge, dem Josselberge und in Berlin.* Astronomisch-geodätische Arbeiten in den Jahren 1872, 1869 und 1867.
Leipzig, 1874.

PENDULUM, THEORY OF.

BAEYER (J. J.). Gutachten der Pendel-Commission.
Int. Geod. Cong., Gen.-Ber., 1875, 78–89, 90–101.

BAILY (F.). Short account of two invariable pendulums.
Roy. Astron. Soc., Month. Not., I, 1827–'30, 78–80.

—— On the correction of a pendulum for the reduction to a vacuum.
Roy. Soc. London, Phil. Trans, 1832, 399–492.

—— Account of some experiments on two invariable pendulums.
Roy. Astron. Soc., Month. Not., IV, 1836–'39, 141–143.

BENDER (C.). Bestimmung der Schwingungsdauer materieller Pendel.
Ann. d. Phys. (Poggendorff), CL, 1873, 295–303.

BESSEL (F. W.). Die Unrichtigkeit der bisher bei Pendelversuchen angewandten Reductionen auf den Luftleeren-Raum.
Astron. Nachr., VI, 1827, 149–150.

—— Ueber den Einfluss eines wiederstehenden Mittels auf die Bewegung eines Pendels.
Astron. Nachr., IX, 1831, 221–236.

—— Construction eines symmetrisch geformten Pendels mit reciproken Axen.
Astron. Nachr., XXX, 1849, 1–6.

BIRNBAUM (J. H. L.). Disquisitio de penduli simplicis oscillationibus in arcus circuli æque in vacuo ac fluido resistente.
Marburgi, 1828.

PENDULUM, THEORY OF—Continued.

BORENIUS (H. G.). Calcul comparatif de différentes observations du pendule constant.
Acad. de St.-Pétersbourg, Bull. Sci., IX, 1842, 73–75.

BRASCHMANN (N.). Note sur le mouvement du pendule simple.
Acad. de St.-Pétersbourg, Bull., X, 1852, 81–86.

BRIOSCHI (C.). Della variazione del moto dei pendoli dipendente da quella della temperatura.
Eff. Astron., Milano, 1812, 114–123.

BRITO-LIMPO (F. A.). Memoria sobre a determinação do comprimento do pendulo.
Lisboa, 1865.

BRUHNS (C.). Gutachten der Pendel-Commission.
Int. Geod. Cong., Gen.-Ber., 1875, 78–89.

CASSINI (J.). Moyens de construire un pendule qui ne puisse s'allonger par la chaleur.
Acad. d. Sci. Paris, Mém., 1741, 363–371.

CASSINI (J.-D.). Mémoire sur les expériences faites par Borda sur la longueur du pendule.
Paris, 1792.

CELLÉRIER (C.). Note sur le mouvement simultané d'un pendule et de ses supports.
Int. Geod. Cong., Gen.-Ber., 1877, 163–170.

CHALLIS (J.). Theory of the correction to be applied to a ball pendulum for the reduction to a vacuum.
L., E., D. Phil. Mag., I, 1832, 40–45; III, 1833, 185–187.

CLAUSEN (T.). De reductione temporis, quo oscillationes quotcunque penduli . . .
Astron. Nachr., V, 1827, 91–94.

CROSTHWAITE (J.). An account of three pendulums constructed by the author.
Roy. Inst. Acad., Trans., II, 1788, 7–12.

CZERMAK (P.). Pendelversuche.
Wien, 1885.

DEFLERS. Problème sur le pendule simple.
École Polytech., Corr., III, 1814–'16, 183–197.

DERHAM (W.). Experiments about the motion of pendulums in vacuo.
Roy. Soc. London, Phil. Trans., XXIV, 1704, 1785–1789; 1735, 201–203.

DUBOIS (E.). Note sur le mouvement du plan d'oscillation d'un pendule.
Ann. Génie Civil, I, 1862, 313–328.

ELVIUS (P.). Theorema de oscillationibus pendulorum in arcubus circularibus.
Soc. Sci. Upsala, Acta, III, 1734, 71–75.

EULER (L.). De oscillationibus minimis penduli quotcunque pondusculis onusti.
Acad. de St.-Pétersbourg, Com., XIX, 1775, 38–39; Acta, I, 1777, ii, 159–182.

EVEREST (G.). On the errors likely to arise in the determination of the length of the pendulum from a false position of the fixed axis.
Roy. Astron. Soc., Month. Not., I, 1827–'30, 117–119; Mém., IV, 1830–'31, 25–37.

FARQUHAR (H.). Empirical formulæ for the diminution of a freely oscillating pendulum.
Phil. Soc. Wash., Bull., VII, 1885, 89–92.

FAYE (H.-A.-E.-A.). Sur la réduction des observations du pendule au niveau de la mer.
Acad. d. Sci. Paris, Comp. Rend., XC, 1880, 1443–1447.

FINGER (J.). Ueber ein Analogon des Kater'schen Pendels und dessen Anwendung zu Gravitationsmessungen.
K. k. Ak. d. Wiss., Sitz.-Ber., LXXXIV, 1881, ii, 166–193.

FLIEDNER (C.). De pendulo inprimis, de pendulo centrifugo.
Hersfeldæ, 1841.

FORDYCE (G.). Account of a new pendulum.
Roy. Soc. London, Phil. Trans., LXXXIV, 1794, 2–20.

FRODSHAM (W. J.). Experiments on the variation of the pendulum.
Roy. Soc. London, Proc., IV, 1838, 78.

PENDULUM, THEORY OF—Continued.

Fuss (N.). Determinatio motuum penduli compositi.
Acad. de St.-Pétersbourg, Acta, I, 1787, 184–212.

G. (J.). Remarks on invariable pendulums.
Journ. Nat. Phil., XV, 1806, 84–86.

Galen (P.). De pendulo ejusque adplicatione ad telluris figuram determinandam.
Amsterdam, 1830.

Girault (C.). De la résistance de l'air dans le mouvement oscillatoire du pendule.
Acad. d. Sci. Caen, Mém., 1860, 3–45; 1862, 3–30.

Giulio (C.-J.). Recherches expérimentales sur la résistance de l'air au mouvement des pendules.
Accad. Sci., Torino, XIII, 1853, 299–357.

Green (G.). Researches on the vibrations of pendulums in fluid media.
Roy. Soc. Edinb., Trans., XIII, 1836, 54–62.

Gronau (J. F. W.). Ueber die Bewegung schwingender Körper im widerstehenden Mittel.
Danzig, 1850.

——— Ueber die Entwickelung der Lehre von Luftwiderstande.
Danzig, 1868.

Gudermann (C.). De pendulis sphæricis et de curvis quæ ab ipsis describuntur.
Journ. d. Math. (Crelle), XXXVIII, 1849, 185–215.

Hansen (P. A.). Theorie der Pendelbewegung mit Rücksicht auf die Gestalt der Erde.
Ann. d. Phys. (Poggendorff), XCII, 1854, 21–33.

——— Ueber die Anziehung eines Rotations-Ellipsoids und die Wirkung desselben auf die Pendel-Bewegung.
Astron. Nachr., XXXVIII, 1854, 129–138.

Huyghens (C.). Horologium oscillatorium, sive de motu pendulorum . . .
Parisiis, 1673.

Ivory (J.). On the method proper to be used for deducing a general formula for the length of the seconds pendulum.
Phil. Mag. (Tilloch), LXVIII, 1826, 241–245, 246–251.

Jackwitz (E.). Ueber die unendlich kleinen Schwingungen eines Pendels.
Posen, 1881.

Jacquin (E.). Théorie du pendule.
Ann. Conduct. Ponts et Chauss., V, 1861, 66–70.

Krafft (W. L.). De tempore oscillationis pendulorum.
Acad. de St.-Pétersbourg, Acta, IX, 1792, 225–242.

Krüger (P.). Rotations- und Pendelbewegung eines Körpers in einer Flüssigkeit.
Danzig, 1882.

Kuhlberg (P.). Untersuchungen über den Einfluss des Mitschwingens des Reversion-Pendel-Apparate Stativs auf die Länge des Secundenpendels.
Astron. Nachr., CI, 1882, 243–246.

Laplace (P.-S. de). Sur l'action réciproque des pendules.
Ann. de Chim., III, 1816, 162–166.

——— Sur la réduction de la longueur du pendule au niveau de la mer.
Ann. de Chim., XXX, 1825, 381–387.

Lejonmark (G. A.). Om pendlars svängningstider.
K. Svenska Veten. Ak., Handl., XXIII, 1802, 165–176.

Lorentzen (G. W. F. K.). Theorie des Gaussischen Pendels.
Kiel, 1886.

Lubbock (J. W.). On the pendulum.
Roy. Soc. London, Phil. Trans., CXX, 1830, 201–208.

Lübeck (G.). Ueber den Einfluss auf die Bewegung eines Pendels in ihm enthaltene reibende Flüssigkeit.
Journ. f. Math. (Crelle), LXXVII, 1874, 1–37.

Mallet (F.). Vom Widerstande der Luft gegen Pendel.
Ak. d. Wiss. Stockholm, Handl., 1762.

Matthes (C. J.). Elementarer Beweis des . . . Ausdrucks für die Dauer der Pendelschwingungen.
Arch. d. Math. (Grunert), XLIX, 1869, 358–364.

Maxwell (C.). On the viscosity or internal friction of air and other gases.
Roy. Soc. London, Phil. Trans., 1866, 249–268.

PENDULUM, THEORY OF—Continued.

Menabrea (F.-L.). Mouvement d'un pendule . . .
Accad. Sci. Torino, Mem., II, 1840, 369–378.

Meyer (O. E.). Ueber die Reibung der Flüssigkeiten.
Ann. d. Phys. (Poggendorff), CXIII, 1861, 55–86, 193–283, 383–425; Journ. f. Math. (Crelle), LIX, 1861, 229–303; LXII, 1863, 201–214.

——— Ueber die innere Reibung der atmosphärischen Luft.
Deutsch. Naturf.-Versamml., Ber., 1863, 141–144; Ann. d. Phys. (Poggendorff), CXXV, 1865, 177–209, 401–420, 564–599; CXLIII, 1871, 14–26; Journ. f. Math. (Crelle), LXXIII, 1871, 31–68; LXXV, 1873, 336–347.

Massotti (O. F.). Soluzione analitica del problema delle oscillazioni del pendolo avuto riguardo alla rotazione della terra.
Ann. d. Mat. (Tortolini), II, 1851, 232–236.

Muncke. Pendel.
Phys. Wörterbuch (Gehler), VI, 1833, 304–407.

Nulty (E.). Solution of a general case of the simple pendulum.
Am. Phil. Soc., Trans., II, 1825, 466–477.

Oudemans (J. A. C.). Ueber die Compensation eines Secundenpendels für Temperatur und Luftdruck.
Zeits. f. Instrumentenk., I, 1881, 190–205.

Pasquich (J.). Etwas über den Gebrauch der Pendellehre bei der Annahme der ellipsoïdischen Gestalt der Erde.
Mon. Corr. (Zach), II, 1800, 3–14.

Peirce (B.). On the relation between the elastic curve and the motion of the pendulum.
A. A. A. S., Proc., 1849, 128–130.

——— Abstract of a paper on the resistance of the air to the motion of the pendulum.
A. A. A. S., Proc., 1855, 74.

Peirce (C. S.). De l'influence de la flexibilité du trépied sur l'oscillation du pendule à réversion.
Int. Geod. Cong., Gen.-Ber., 1877, 171–187.

——— On the influence of internal friction upon the correction of the length of the seconds pendulum for the flexibility of the support.
Am. Acad., Proc., XIII, 1877–'78, 396–401.

——— On a method of swinging pendulums for the determination of gravity.
Am. Journ. Sci., XVIII, 1879, 112–119.

——— On the flexure of pendulum supports.
U. S. C. and G. Survey, Rep., 1881, 359–441.

——— On the deduction of the ellipticity of the earth from pendulum experiments.
U. S. C. and G. Survey, Rep., 1881, 442–456.

——— On a method of observing the coincidence of vibration of two pendulums.
U. S. C. and G. Survey, Rep., 1881, 457–460.

——— On the effect of unequal temperature upon a reversible pendulum.
U. S. C. and G. Survey, Rep., 1885, 511–512.

Peters (C. A. F.). De motu penduli in aëre resistente.
Astron. Nachr., XII, 1835, 73–86, 89–104.

Piola (G.). Sul moto d' un pendolo.
Eff. Astron., Milano, 1831, 35–75; 1832, 65–93.

Plana (G.-A.-A.). Sur le pendule composé dans un milieu résistant.
Acad. de Belgique, Bull., 1832–'34, 190–193.

——— Mouvement d'un pendule dans un milieu résistant.
Accad. Sci. Torino, Mem., XXXVIII, 1835, 209–375.

Plantamour (E.). Recherches expérimentales sur le mouvement simultané d'un pendule et de ses supports.
Int. Geod. Cong., Gen.-Ber., 1877, 1–52.

Poisson (S. D.). Sur les oscillations du pendule dans un milieu résistant.
École Polytech., Journ., VII, 1808, 143–158; VIII, 1809, 345–353; Conn. d. Temps, 1834, 18–32.

——— Mémoire sur les mouvements d'un pendule de l'air environnant.
Ann. de Chim., XLVII, 1831, 242–250; Acad. d. Sci. Paris, Comp. Rend., XI, 1832, 521–581; Ann. Journ. Sci., XXIII, 1833, 391–392 . . .

PENDULUM, THEORY OF—Continued.

POISSON (S. D.). Sur l'influence réciproque de deux pendules voisins.
Conn. d. Temps, 1833, 3-40.

—— Sur le pendule de Borda.
Conn. d. Temps, 1833, 41-76.

PRATT (J. H.). Problem in pendulums.
Indian Eng. (Medley), v, 1868, 218-221.

—— Formulæ for calculating the vertical attraction at a station with a view to correct pendulum observations.
Dehra Dún, 1869.

PRONY (R. DE). Note sur un nouveau moyen de régler la durée des oscillations du pendule.
Conn. d. Temps, 1817, 229-236; 1820, 402-408; Soc. Philom., Bull., 1817, 53-57.

QUET. Oscillation du pendule dans un milieu résistant.
Acad. d. Sci. Paris, Comp. Rend., XXXIV, 1852, 804.

RAMUS (C.). Om uligheder i pendulsvingningerne formedlst et himmellegems tiltrækning.
K. Danske Videns., Forhandl., 1847, 9-15.

RENIER (C.). Pendule.
Encycl. Moderne, XXIII, 1852, 523-542.

RESAL (A.-H.). Note sur la loi des petites oscillations du pendule simple dans un milieu résistant.
Ann. de Math., XIX, 1860, 165-170.

RESPIGHI (L.). Sul moto dal pendolo.
Accad. Sci. Bologna, Mem., 1854, 22.

ROHDE. Ueber noch fehlende Versuche mit dem Pendel.
Potsdam, 1820.

ROSSI (M. S. DE). Primi risultati delle osservazioni fatte sulle oscillazioni microscopiche dei pendoli.
Bull. d. Vulcanismo, II, 1875, 103-106.

ROTHE (H. A.). Ueber Pendelschwingungen in grösseren Bogen.
Arch. f. Naturlehre (Kästner), II, 1824, 137-150.

ROZET (C.-A.). Recherches relatives à l'influence des inégalités de la structure du globe sur la marche du pendule.
Soc. Philom., Proc. Verb., 1842, 27-29; 1844, 18-22; Acad. d. Sci. Paris, Comp. Rend., XVIII, 1844, 180-185.

SABINE (E.). On the reduction to a vacuum of the vibrations of an invariable pendulum.
Roy. Soc. London, Phil. Trans., 1829, 207-239, 331-338.

—— Experiments to ascertain the correction for variations of temperature in variable pendulums employed by British observers.
Roy. Soc. London, Phil. Trans., 1830, 251-255.

SAMTER (H.). Theorie des Gaussischen Pendels.
Berlin, 1886.

SANG (E.). On the proper form for a convertible pendulum.
Edinb. Phil. Journ., XXXI, 1841, 34-38.

SANGER (T.). Verallgemeinerung des zusammengesetzten Pendels.
Cassel, 1880.

SAWITSCH (A. N.). Observations on the oscillations of the pendulum.
St. Petersburg, 1866.

—— Sur la détermination de la résistance de l'air au mouvement du pendule.
Acad. de St.-Pétersbourg, Bull., IX, 1866, 477-482; Mél. Math. Astron., III, 1866, 681-688.

SCHAAR (M.). Sur le mouvement du pendule en ayant égard à la rotation de la terre.
Acad. de Belgique, Mém., XXVI, 1851, 1-14.

SCHIMPF (E. R.). Eine Verallgemeinerung des Pendelproblems.
Halis Sax. 1882.

SCHINZ (E.). Ueber die Schwankungen des Reversions-pendels im widerstehenden Mittel.
Aarau, 1847.

SCHLÄFLI (L.). Lösung einer Pendel-Aufgabe.
Bern, 1867.

PENDULUM, THEORY OF—Continued.

SCRYMGEOUR (J.). Narrative of experiments made with the seconds pendulum . . . to determine minute forces on its rate of motion.
Phil. Mag. (Tilloch), II, 1832, 244-251, 344-350, 434-442.

SECCHI (A.). Sulle oscillazioni del pendolo avuto riguardo alla rotazione della terra.
Ann. d. Math. (Tortolini), II, 1851, 238-242.

STAMPFER (S.). Beschreibung eines apparates um den Abstand der Schneider bei einem Reversionspendel zu messen.
K. k. Sternwarte, Ann., XV, 1835, 1-lxi.

STERNECK (R. VON). Der neue Pendelapparat des k. k. militär-geographischen Institutes.
K. k. milit.-geogr. Inst., Mittheil., VII, 1887, 83-116.

STOKES (G. G.). On the resistance of the air to pendulums.
Brit. A. A. S., Trans., XVIII, 1848, 7-8.

—— On the effect of the internal friction of fluids on the motions of pendulums.
L., E., D. Phil. Mag., I, 1851, 337-339; Bibl. Univ. Genève, Arch., XXI, 1852, 15-28 . . .

SVANBERG (J.). De motu pendulorum.
Upsaliæ, 1824.

TENNANT (J. F.). Note on the coefficient of expansion of the brass pendulums used in the Indian trigonometrical survey.
Roy. Astron. Soc., Month. Not., XXVII, 1867, 284-286.

THACKER (A.). On the motion of a free pendulum.
L., E., D. Phil. Mag., II, 1851, 275-278.

THELIN (M.). De oscillatione pendulorum.
Lund., 1804.

UNFERDINGER (F.). Aufstellung einer neuen Pendelformel . . . die Form und Grösse der Erde zu bestimmen.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., XLIX, 1864, ii, 210-219.

—— Vergleichung der Pendelformel mit den Beobachtungen.
K. k. Ak. d. Wiss., math.-naturwiss. Cl. XLIX, 1864, ii, 220-228.

—— Das Pendel als geodätisches Instrument.
Arch. d. Math. (Grunert), XLIX, 1869, 309-331.

VERHULST (P. F.). Sur l'intégration de quelques équations relatives au problème des oscillations du pendule dans un milieu résistant.
Corr. Math., V, 1829.

WEBER (W.). Ueber die Construction des Bohnenberg'schen Reversionspendels . . .
Ann. d. Phys. (Poggendorff), XXII, 1884, 439-449.

WERNEBURG (J. F. C.). Ueber die zeitherige Bestimmung der Dauer eines Pendelschlags.
Eisenach, 1817.

WILSING (J.). Ueber den Einfluss von Luftdruck und Wärme auf die Pendelbewegung.
Berlin, 1880.

YOUNG (T.). The resistance of the air, determined from Capt. Kater's experiments on the pendulum.
Quart. Journ. Sci., XV, 1823, 351-356.

—— . . . on the reduction of the length of the pendulum to the level of the sea.
Quart. Journ. Sci., XXI, 1826, 167-168.

YVON-VILLARCEAU (A.-J.-F.). Mémoires sur les effets du roulement dans la théorie du pendule à réversion.
Paris, 1880.

ZACH (F. X. VON). Doutes sur . . . l'attraction et répulsion du pendule.
Corr. Astron. (Zach), I, 1825, 35-38.

Pereira da Silva (F. M.). *See* **Silva (F. M. Pereira da).**

Perewoschtschikow (Demetrius). **Die Figur der Erde nach den Meridianen von Paris und Ostindien und nach Pendelbeobachtungen.***
POGGENDORFF, II, 404.

Perini (Ludovico). Geometria prattica in cui oltre i principi di essa vi sono molti insegnamenti intorno alle varie misure di terre, acque, fienii, pietri, grani, fabriche ed altro. Secondo l' uso di Verona, ed di altre città d' Italia, raccolti d' alle opere di molti autore e dall' esperienza a comodo degli studioso di tal professione.

8°, 2d ed., Verona, 1739; 8th ed., Bassano, 1781; 10th ed., Bassano, 1799, pp. 163. (Oxford, Bodleian.)

Perliczy (J. D.). De magnitudine et dimensione terraquei ad institutionum geographicum Wideburginarum.*

Jenæ, 1727.

Perny (M.-J.). Méthode pour réduire les angles observés au centre d'une station, avec les types de calculer. Table pour obtenir les angles de réduction à moins d'un centième de seconde, et en beaucoup moins de tems que les calculs ordinaires.

4°, Angers, 1808, pp. iv, 54, 1 plate. (Vienna, Geographic Institute.)

Perrier (François): Francœur (L.-B.). Géodésie.

Paris, 1869.

Title in full under FRANCŒUR (L.-B.).

——— Description géométrique de l'Algérie. Pt. 1. Mémoire sur la mesure des bases.

Mém. du Dépôt Général de la Guerre, Paris, x, 1871, pp. vii, 135, 4 plates.

——— De la méridienne de France.

Assoc. Française, Comp. Rend., I, 1872, 101–130; Soc. Géogr., Bull., III, 1872, 613–653.

——— Prolongation de la méridienne de France jusqu'au Sahara, par la jonction de l'Algérie avec l'Espagne.

Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1237–1244.

——— Nouvelle détermination de la méridienne de France.

Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1682–1686.

——— Réponse à la note de M. A. Laussedat sur le prolongement de la méridienne d'Espagne en Algérie.

Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1696–1699.

———: **Cornu.** Geodetic operations in Algeria, of —.

Nature, VII, 1873, 450–451.

——— Sur la nouvelle triangulation de l'île de Corse. Mémoire de M. F. Perrier, présenté par M. A. d'Abbadie.

Acad. d. Sci. Paris, Comp. Rend., LXXVIII, 1874, 1569–1572.

——— Description géométrique de l'Algérie. Pt. 2. Chaîne primordiale de la triangulation algérienne. Mém. du Dépôt Général de la Guerre.

Paris, x, 1874, pp. [II], 410, 1 map. (Washington, Coast Survey.)

——— Rapport sur les travaux géodésiques exécutés en France et en Algérie en 1874.

Int. Geod. Cong., Gen.-Ber., 1874, 25.

——— Étude comparative des observations de jour et de nuit.

Int. Geod. Cong., Gen.-Ber., 1875, 144–150.

Perrier (François).—Continued.

——— Rapport sur les travaux géodésiques exécutés en France en 1875.

Int. Geod. Cong., Gen.-Ber., 1875, 169–175.

——— Nouvelle mesure de la méridienne de France.

Acad. d. Sci. Paris, Comp. Rend., LXXXIII, 1876, 1277–1280.

——— Rapport sur les travaux géodésiques exécutés au dépôt de la guerre en 1876. (France.)

Int. Geod. Cong., Gen.-Ber., 1876, 98–100.

——— Étude comparative des observations de jour et de nuit faites par MM. F. Perrier et L. Bassot.

Acad. d. Sci. Paris, Comp. Rend., LXXXIV, 1877, 1312–1315, 1380–1383.

The first article is reprinted from Int. Geod. Cong., Gen.-Ber., 1875, 144–150. It is also incorporated in JORDAN, Handbuch d. Vermess., II, 67–68.

——— Verzeichniss der alten und neuen Grundlinien. Genauigkeit der Messungen. Neu zu vermessende Grundlinien.

Int. Geod. Cong., Ger.-Ber., 1877, 39–57; French, 119–137.

——— Versuche, welche in Betreff des relativen Vorzugs von Tag- oder Nachtbeobachtungen, und die Resultate, welche mit dem beweglichen Faden an Azimuthal kreisen erhalten worden sind.

Int. Geod. Cong., Gen.-Ber., 1877, 59–65.

——— Rapport sur les travaux (géodésiques) en France et en Algérie pendant l'année 1877.

Int. Geod. Cong., Gen.-Ber., 1877, 283–286.

——— Jonction géodésique de l'Algérie avec l'Espagne.

Acad. d. Sci, Paris, Comp. Rend., LXXXIX, 1879, 885–889; Observatory, III, 1880, 326–327.

——— Rapport sur les travaux exécutés par le dépôt de la guerre en 1878. (France.)

Int. Geod. Cong., Gen.-Ber., 1878, 82–85.

——— Rapport sur les travaux exécutés pendant l'année 1879. (Geodetic.)

Int. Geod. Cong., Gen.-Ber., 1879, 87.

——— Rapport sur les travaux géodésiques en France et en Algérie pendant l'année 1880.

Int. Geod. Cong., Gen.-Ber., 1880, 9–11.

——— Jonction géodésique de l'Algérie avec l'Espagne.

Int. Geod. Cong., Gen.-Ber., 1880, 47–53.

——— Rapport sur les mesures des bases géodésiques.

Int. Geod. Cong., Gen.-Ber., 1880, vii, 1–8.

——— Note sur les travaux géodésiques et astronomiques exécutés par le dépôt de la guerre pendant les années 1881 et 1882. (France.)

Int. Geod. Cong., Gen.-Ber., 1881–'82, 75–77.

——— Rapport sur les travaux (géodésiques) exécutés en France, en 1883.

Int. Geod. Cong., Gen.-Ber., 1883, 230–233.

——— Rapport sur la mesure des bases.

Int. Geod. Cong., Gen.-Ber., 1883, 1–9, Appendix 3.

——— Nouvelle méridienne de France. Mémorial du Dépôt général de la guerre, tome xii, publié par le colonel Perrier.

4°, Paris, 1885, pp. xix, 230, 13 plates. (Southampton, Ordnance Survey.)

Perrier (François).—Continued.

——— Travaux exécutés par le service géographique pendant les années 1883–'86. [France et Algérie.]
Int. Geod. Cong., Verhandl., 1884'–86, 128–129.

——— *et* **Ibañez (C.).** Jonction géodésique et astronomique de l'Algérie avec l'Espagne.
Paris, 1886.
Title in full under IBAÑEZ (C.).

——— Rapport sur la mesure des bases.
Int. Geod. Cong., Verhandl., pp. 1–6, French; pp. 1–6, German.

——— Rapport sur les travaux d'astronomie et de géodésie exécutés en France et en Algérie par le service géographique de l'année (Section de géodésie). (Octobre 1886–octobre 1887.)
Int. Geod. Cong., Verhandl., 1887, v, 1–6.

——— Note de M. le général Perrier, accompagnant la présentation d'un volume relatif à la jonction géodésique et astronomique de l'Algérie avec l'Espagne.
Acad. d. Sci. Paris, Comp. Rend., CIV, 1887, 1817–1821.

Perrot. Appareils destinés à rendre manifestes et mesurables les variations occasionnées dans l'intensité et la direction de la pesanteur à la surface de la terre par les divers mouvements de notre globe et l'attraction des corps célestes.
Acad. d. Sci. Paris, Comp. Rend., LIV, 1862, 728–729, 851–852; Ann. de Phys., CXVI, 1862, 511.

Perry (J.) *and* **Clyrton (W. E.).** Determination of gravity at Tokio.
L., E., D. Phil. Mag., IX, 1880, 292–301.

PERU.

BOUGUER (P.). Relation abrégée du voyage fait au Pérou . . . pour mesurer les degrés du méridien aux environs de l'équateur.
Acad. d. Sci. Paris, Mém., 1744, 249–297; 1746, 569–606.

GRENUS (T.). Ueber einige Bemerkungen über die Gradmessung in Peru.
Mon. Corr. (Zach), XIII, 1806, 398–404.

——— Resultate einer Vergleichung der Werke von Bouguer, Condamine und Ulloa über die peruanische Gradmessung.
Mon. Corr. (Zach), XVI, 1807, 238–256.

JUAN (J.). Relacion histórica del viage á (Perú) . . .
Madrid, 1748; Leipzig, 1751; Paris, 1752; Goes, 1771; London, 1772; Madrid, 1773.

OLTMANNS (J.). Ueber die wahre geographische Länge des in Peru gemessenen Breitengrades.
Astron. Jahrb. (Bode), 1810, 154–162.

Peschel. Ueber die Gestalt der Erde.
Abhandl. zur Erd- u. Völkerkunde, 1878, 210.
HOUZEAU, II, 1722.

Peters (Christian August Friedrich). De motu penduli in aëre resistente.
Astron. Nachr., XII, 1835, 73–86, 89–104.

——— Uebersicht der in Hamburg und dessen Umgegend angestellten geodätischen Messungen.*
(Excerpt), 1837.

——— Von den kleinen Ablenkungen der Lothlinie und des Niveaus, welche durch die Anziehungen der Sonne, des Mondes und einigen terrestrischen Gegenstände hervorgebracht werden.
Astron. Nachr., XXII, 1844, 32–42; Acad. de St.-Pétersbourg, Bull., III, 1844, 212–223.

Peters (Christian August Friedrich)—Continued.

——— Bestimmung der Länge des einfachen Secundenpendels auf dem Schlosse Güldenstein aus den von Schumacher in den Jahren 1829 und 1830 ausgeführten Beobachtungen.
4°, Altona, 1855.
Taken from Astron. Nachr., XL, 1855, 1–152.

——— Ueber die Bestimmung des wahrscheinlichen Fehlers einer Beobachtung aus den Abweichungen der Beobachtungen von ihrem arithmetischen Mittel.
Astron. Nachr., XLIV, 1856, 29–32.
Translations in U. S. C. and G. Survey, Rep., 1856, 307–308.

——— Bericht über die Arbeiten in Holstein.
Int. Geod. Cong., Gen.-Ber., 1866, 27–29.

——— Bericht über die Wiederherstellung der Schumacher'schen Dreiecke in Schleswig-Holstein.
Int. Geod. Cong., Gen.-Ber., 1868, 34–37.

——— Ueber die im Jahre 1869 mit einem von Lohmeier angefertigten Reversionspendel in Altona und Berlin angestellten Beobachtungen.
Astron. Nachr., LXXVI, 1870, 145–148.

——— Bericht über die neue Berechnung der von Schumacher bei Braack gemessenen Basis.
Den danske Gradmaaling, andet Bind, 1872, 391–420.

——— **Bremiker** *und* **Albrecht.** [Bericht über die geodätische Arbeiten in Preussen für das Jahr 1874.]
Int. Geod. Cong., Gen.-Ber., 1874, 63–66.

——— Gutachten der Pendel-Commission.
Int. Geod. Cong., Gen.-Ber., 1875, 78–89.

———: **Helmert (F. R.).** Die Genauigkeit der Formel von — zur Berechnung des wahrscheinlichen Fehlers.
Astron. Nachr., LXXXVIII, 1876, 113–132.

——— Ueber die Zerlegung eines Dreiecksnetzes nach Gruppen, und über die Ausgleichung der in den einzelnen Gruppen ausgeführten Messungen von Richtungen und Grundlinien.
Int. Geod. Cong., Gen.-Ber., 1877, 210–216.

Peters (C. F. W.). Bericht . . . über die in Königsberg im Sommer 1870 angestellten Pendelbeobachtungen. (H.)
Int. Geod. Cong., Gen.-Ber., 1870, 54–56.

——— Astronomische Tafeln und Formeln.
8°, Hamburg, 1871, pp. xvi, 217. (Washington, Coast Survey.)
Tafeln für die Gestalt der Erde, 53–58.

——— Beobachtungen mit dem Bessel'schen Pendel-Apparate in Königsberg und Güldenstein, ausgeführt im Auftrage des geodätischen Instituts.
4°, Hamburg, 1874, pp. 151, 1 plate.
Publikationen des geodätischen Instituts. Revd. by HELMERT (F. R.), Astron. Ges., Vierteljahrs., XI, 1876, 33–61.

——— Bestimmung der Länge des einfachen Secundenpendels in Altona, Berlin, und Königsberg. Mit einer Bemerkung von W. Foerster.
Astron. Nachr., XCVII, 1880, 1–36; XCIX, 1881, 129–138, 379–382.

——— Notiz über die Bessel'schen Pendelbeobachtungen.
Astron. Nachr., CVI, 1883, 1–4.

Peters (C. F. W.)—Continued.

——— Zur Geschichte und Kritik der Toisen-Maassstäbe. Ein Beitrag zur definitiven Einordnung auf das altfranzösische System begründeten Messungen in das metrische System von C. F. W. Peters.
Berlin, 1885; Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 568.

——— Eine neue Methode zur Beobachtung der Coincidenz der Schwingungen Zweier Pendel.
Astron. Nachr., CX, 1885, 231–232.

Petit (Frédéric). Observations du pendule à Toulouse.
Revue Scientifique, II, 1840, 86–88.

——— Sur la longueur du pendule à secondes à Toulouse.
Acad. d. Sci. Paris, Comp. Rend., XI, 1840, 21–22.

——— Détermination de la longueur du pendule à secondes et de l'intensité de la pesanteur à l'observatoire de Toulouse.
Acad. de Toulouse, Mém., VI, 1850, 166–190.

——— Détermination de la longueur du pendule à secondes et de l'intensité de la pesanteur au nouvel observatoire de Toulouse.
Acad. d. Sci. Paris, Comp. Rend., XLVI, 1858, 516–518.

Petzell (J.). Vorlesungen über Geodäsie an der Universität Pest.*
Pest 1847.

Petzold (M.). Uebersicht der Literatur für Vermessungswesen vom Jahre 1887.
Zeits. f. Vermes., XVII, 1888, 404–416, 425–429, 465–479, 497–510, 527–543.
Methode der kleinsten Quadrate, 505–507; Höhere Geodäsie, Gradmessung, 507–510.

Peucero (Gasprus) [Kaspar Peucer]. De dimensione terræ et geometrice numerandis locorum particularium intervallis ex doctrinâ triangulorum sphæricorum et canone subtensarum. Liber denuo editus, sed auctius multo et correctius, quam antea.
24°, Witterbergæ, 1554, pp. [x], 287.
Also published together with: Descriptio locorum terræ sanctæ, à quodam Brocardo Monarcho. Aliquot insignium terræ sanctæ locorum explicatio et historiæ per Phil. Melanchthonem, 8°, Witterbergæ, 1554. — La Lande, 77, 108.
Also bound with: Logistice astronomica, etc., Witterbergæ, 1556.

Peytier, Puillon-Boblaye et Servier. Sur les opérations géodésiques exécutées en Morée, en 1829 et 1830.
Conn. d. Temps, 1835, 63–76.
Revd. in Soc. Géogr., Bull., XIX, 1833, 89–106.

Peytier (E.) et Puissant (L.). Nouvelle description géométrique de la France.
Paris, 1832–'53.
Title in full under Puissant (L.).

Pfändler (L.). Mittheilungen über die Gradmessungsarbeiten auf dem Gebiete der Schweiz.*
Autographirtes Bulletin, No. 1, 1876.

Pfeil (Ludwig von). Messung auf der kurzen Basis.
Arch. d. Math. (Grunert), XLVII, 1867, 49–73.

——— Mathematische und physikalische Entdeckungen. Gefunden und zusammengestellt von L. Graf von Pfeil.
8°, Berlin, 1880, pp. v, 152, 6 plates.
Messung auf der kurzen Basis, 79–103, 1 plate.
From: Arch. d. Math. (Grunert), XLVII, 1867, 49–73.

Phil. Mag. (Taylor), *for* Philosophical Magazine, or annals of chemistry, mathematics, astronomy, natural history, and general science (Taylor).
8°, London, 1827–'32. (Washington, Patent Office.)

Phil. Mag. (Tilloch), *for* Philosophical Magazine (Tilloch).
8°, London, 1798–1826. (Washington, Patent Office.)

Phil. Recent. (Stay), *for* Philosophiæ recentioris (Stay).
4°, Rome, 1759+. (British Museum.)

Phil. Soc. Cambridge, Trans., *for* Transactions of the Philosophical Society of Cambridge.
4°, Cambridge, 1821+. (Washington, Observatory.)

Phil. Soc. Wash., Bull., *for* Bulletin of the Philosophical Society of Washington.
8°, Washington, 1871+. (Gore.)

Phipps (John Constantine): Horsley (S.). Remarks on the observations made for determining the acceleration of the pendulum. Letter to —.
London, 1874.
Title in full under Horsley (S.).

——— A voyage towards the North Pole, undertaken by His Majesty's command, 1773.
4°, London, 1774, pp. viii, 250.
Observations for determining the acceleration of the pendulum, pp. 153–182, 1 plate.
See Horsley (S.).

Picard (Jean). La mesure de la terre.
Paris, [1671]; Acad. d. Sci. Paris, Mém., IV, 1736, 1–60.

———: **Oldenburg (H.).** A breviate of M. Picart's account of the measure of the earth.
Roy. Soc. London, Phil. Trans., X, 1675, 261–272.

——— Sur l'avance des pendules en été et sur leur retard en hiver.
Hist. Acad. d. Sci., Paris, I, 73.

——— Observations sur les différentes méthodes employées pour mesurer la terre.
Hist. Acad. d. Sci., Paris, I, 82–87.

——— Traité du nivellement, avec une relation de quelques nivellements par ordre du roi et un abrégé de la mesure de la terre du même auteur mis en lumière par M. de la Hire.
24°, Paris, 1684, pp. [x], 248. (Oxford, Bodleian.)

——— De mensuris. Divers ouvrages de Math. et Phys. par Messieurs de l'Acad. Roy. des Sci. Paris, 1693, 366–368.
Acad. d. Sci. Paris, Mém., 1729, 313–331.

——— Mesure de la terre.
Acad. d. Sci. Paris, Mém., I, VII, 1729, 1–59; VII, 1729, 133–190.

——— Degré du méridien entre Paris et Amiens déterminé par la mesure de M. Picard et par les observations de MM. de Maupertuis, Clairaut, Camus, Le Monnier, de l'Académie royale des sciences, d'où l'on déduit la figure de la terre, par la comparaison de ce degré avec celui qui a été mesuré au cercle polaire.
12°, Paris, 1740, pp. lvi, 116, 4 plates. (Gore.)
Bound in volume with Maupertuis, La figure, etc., 1738.

Picard (Jean)—Continued.

——, **Maupertuis, Clairant, Camus, Le Monnier.** Der Meridiangrad zwischen Paris und Amiens, woraus man die Figur der Erde herleitet durch Vergleichung dieses Grads mit dem so beym Polar-Cirkel gemessen worden. Aus dem Französichen übersetzet.

8°, Zürich, 1742, pp. 130, 4 plates. (Berlin, Observatory.)

——: **Delambre** (J.-B.-J.). Histoire de l'astronomie moderne. Treats of —

II, 1821, 597–632.

Piccolomini (Alessandro). Della grandezza della terra e dell' acqua.*

4°, Venezia, 1558, 1561.

POGGENDORFF, II, 442.

—— Sphæra libri quatuor ex italico in latinum sermonem conversi ejusdem compendium de stellis fixis cognoscendis, et libro de magnitudine terræ et aquæ. Joan Nicol. Stupano Rheto interprete.

8°, Basileæ, 1568, pp. 121. (Oxford, Bodleian.)

De aquæ ac terræ magnitudine, 65–131.

Pick. Die Kugelgestalt der Erde.

Zeits. f. math. u. naturwiss. Unterricht, II, 1871, 504+.

Pictet (Marc Auguste) [*sometimes* **Pictet Turretini**]. Considerations of the convenience of measuring an arch of the meridian and of the parallel of longitude, having the observatory of Geneva for their common intersection.

Roy. Soc. London, Phil. Trans., LXXXI, 1791, 106–127.

—— [Comparaison du mètre étalon de l'Institut avec le pied anglais.]

Soc. Sav. et Littér., Mém., II, 1801, 265–269.

—— Comparaison du mètre définitif avec un étalon des mesures anglaises.

Bibl. Brit. Genève, XIX, 1802, 109–114; Journ. Nat. Phil. (Nicholson), II, 1802, 244–252; Roy. Inst. Journ., I, 1802, 122–131; Phil. Mag. (Tilloch), XII, 1802, 229–235.

—— Sur un appareil géodésique très-complet et très-portatif.

Bibl. Brit. Genève, LII, 1803, 105–137.

—— Note sur la position géographique de Genève, et sur d'autres résultats géodésiques et barométriques.

Bibl. Brit. Genève, XLI, 1809, 305–323.

—— Rapport fait à la Société des arts de Genève sur une machine à diviser et sur des instrumens de géodésie et de mathématique, construits à Berne par Mr. Schenk.

Bibl. Brit. Genève, LIX, 1815, 77–102.

Pieper (M.). Zur Kritik der Theorie des Foucault'schen Pendelversuches.*

Dessau.

Pinelli (G. V.). Breve esposizione della teoria degli errori di osservazione.*

Genova, 1883.

Pingré *et* **Bouguer** (P.). Opérations pour mesurer l'intervalle entre Villejuif et Juvisy.

Acad. d. Sci. Paris, Mém., 1754, 172–186; Hist., 103–107.

Pinkerton (John). A general collection of the best and most interesting voyages and travels in all parts of the world, many of which are now first translated into English. Digested on a new plan.

Vol. XIV, 4°, London, 1813, pp. 881.

Abridged narrative of travels of de la Condamine, Bouguer and Ulloa, omitting all reference to their geodetic work, 211–496.

Piobert (Guillaume). De la forma mejor que conviene dar á los triángulos geodésicos.

Revista Cien. Fís., Madrid, I, 1850, 373–380.

—— Question de la meilleure forme à donner aux triangles géodésiques.

Acad. d. Sci. Paris, Comp. Rend., XXXI, 1850, 151–159.

—— Sur la rectification des angles dans le calcul des triangles géodésiques.

Acad. d. Sci. Paris, Comp. Rend., XXXI, 1850, 409–418.

Piola (Gabbrio). Sul moto d' un pendolo.

Eff. Astron., Milano, 1831, 35–75.

—— Supplemento alla memoria sulla teorica del pendolo.

Eff. Astron., Milano, 1832, 65–93.

Pisati (G.) *e* **Pucci** (E.). Sulla lunghezza del pendolo a secondi.

Accad. d. Lincei, Rend., 1880; Atti, XV, 1883, 57–231.

Pissis (A.). Mesure de la méridienne du Chili.

Acad. d. Sci. Paris, Comp. Rend., LXIV, 1876, 265–267.

Pitiscus (Bartholomæus). Trigonometriæ sive de dimensione triangulor. Libri quinque, item problematum variorum nempe geodæticorum, altimetricorum, geographicorum, gnomonicorum et astronomicorum. Editio tertia.

8°, Francofurti, 1612, pp. [vi], 183, 270, [with six-place table of sines and tangents.] (Oxford, Bodleian.)

The geodetic part is simple computation of areas.

Pizzetti (P.). Sulla compensazione delle osservazioni secondo il metodo dei minimi quadrati.

Accad. d. Lincei, Rend., III, 1887, 230–235, 288–293.

Placentinus (Johann). Geotomia, sive terræ sectio, exhibens præcipua et difficiliora problemata.

I. Explorandi latitudines locorum.

II. Inquirendi longitudines.

III. Determinandi distantias.

4°, Francofurti ad Oderam, 1657, pp. [vi], [110]. (Berlin, Royal.)

Plana (Giovanni Antonio Amedeo). Sulla teoria dell' attrazione degli sferoidi elittici.

Soc. Italiana, Mem. d. Mat., XV, 1811, 370–390.

—— Note sur la densité et la pression des couches du sphéroïde terrestre.

Corr. Astron. (Zach), V, 1821, 97–125, 191–214.

—— [Report on geodetic work in Italy.]

Accad. Sci. Torino, Mem., XXVIII, 1824, 34–50.

—— Relazione delle operazioni astronomiche eseguite in Savoja dai due astronomi Plana e Carlini, per la misura di un parallelo terrestre.*

Accad. Sci. Torino, Mem., XXVIII, 1824.

Plana (Giovanni Antonio Amedeo)—Continued.

——— : (B.). Ueber die Längen-Gradmessung im parallel des 45. Grades.
Hertha, IX, 1827, 277-288; XI, 1828, 448-456.
Title in full under B.

——— Sur le pendule composé dans un milieu résistant. (H.)
Acad. de Belgique, Bull., 1832-'34, 190-193.

——— Mouvement d'un pendule dans un milieu résistant.
Accad. Sci. Torino, Mem., XXXVIII, 1835, 209-375.

——— Mémoire sur la théorie mathématique de la figure de la terre, publiée par Newton en 1687. Et sur l'état équilibre de l'ellipsoïde fluide à trois axes inégaux.
Astron. Nachr., XXXVI, 1853, 149-176.

——— Note sur la densité moyenne de l'écorce superficielle de la terre.
Astron. Nachr., XXXV, 1853, 177-192; Roy. Astron. Soc., Month. Not., XIII, 1852-'53, 59-60; Edinb. Phil. Journ., LV, 1853, 152-153.

——— Note sur la figure de la terre et la loi de la pesanteur à sa surface d'après l'hypothèse d'Huyghens, publiée en 1690.
Astron. Nachr., XXXV, 1853, 371-378.

——— Sur la loi des pressions, et la loi des ellipticités des couches terrestres en supposant leur densité uniformement croissante depuis la surface de la terre jusqu'à son centre.
Astron. Nachr., XXXVI, 1853, 313-334.

——— Mémoire sur la loi de la pesanteur à la surface de la mer, dans son état d'équilibre.
Astron. Nachr., XXXVIII, 1854, 225-238.

Planman (—). De figura telluris pendulorum ope definiende. (H.)
Aboæ, 1778.

Plantamour (Émile). [Expériences pour la détermination de la longueur du pendule simple à Genève.]
Soc. Sci. Neuchâtel, Bull., VII, 1866, ii, 160-170, 416-420.

——— Expériences faites à Genève avec le pendule à réversion.
Soc. Phys. Genève, Mém., XVIII, 1866, 309-416. Published separately, 4°, Genève et Bâle, 1866, pp. 108, 3 plates.

——— *et* **Hirsch (A.)**. Note sur la détermination du coefficient de dilatation d'un barreau d'argent.
Bibl. Univ. Genève, Arch., XXXVIII, 1870, 37-61.

——— Nouvelles expériences faites avec le pendule à réversion et détermination de la pesanteur à Genève et au Righi-Kulm.
4°, Genève et Bâle, 1872, pp. viii, 88.
Revd. by HELMERT (F. R.), Astron. Ges., Vierteljahrs., XI, 1876, 13-15.

——— : **Peirce (C. S.)**. De l'influence de la flexibilité du trépied sur l'oscillation du pendule à réversion. Note communiquée par —.
New York, 1877.
Title in full under PEIRCE (C. S.).

——— Recherches expérimentales sur le mouvement simultané d'un pendule et de ses supports.
Int. Geod. Cong., Gen.-Ber., 1877, 1-52.
Revd by SAWITSCH (A. N.), Astron. Ges., Vierteljahrs., XIII, 1878, 264-274.

Plantamour (Émile)—Continued.

——— *et* **Cellérier (C.)**. Tableau résumant par ordre alphabétique l'état actuel des travaux entrepris dans les différents pays pour la détermination de la pesanteur à l'aide du pendule à réversion.
Int. Geod. Cong., Gen.-Ber., 1880, Appendix 2, 1-8.

Playfair (John). Investigation of certain theorems relating to the figure of the earth.
Roy. Phil. Soc. Edinb., Trans., IV, 1805, 3-30; Journ. Nat. Phil. (Nicholson), VII, 1804, 102-116, 167-176.
The principle laid down by Mr. Dalby, that in a spheroidal triangle, of which the angle at the pole and the two sides are given, the sum of the angles at the base is the same as in a spherical triangle having the same sides, and the same vertical angle, is not strictly true, unless the eccentricity of the spheroid be infinitely small, or the triangle nearly isosceles.

Plesse (August Friedrich). Die königliche sächsische Unterrichtsanstalt für Geodäten.*

Poggendorff, *for* Poggendorff (J. C.). Biographisch-literarisches Handwörterbuch zur Geschichte der exacten Wissenschaften.
8°, Leipzig, 1863 (2 vols.). (Gore.)

Poincaré (H.). Sur la figure de la terre.
Bull. Astronomique, VI, 1889, 1-5, 49-60.

Poisson (Siméon-Denis). Sur les oscillations du pendule dans un milieu résistant.
École Polytech., Journ., VII, 1808, 143-158; VIII, 1809, 345-353.

——— Sur la probabilité des résultats moyens des observations.
Conn. d. Temps, 1827, 273-302; 1832, 3-22.
These memoirs are a commentary on Laplace's fourth chapter (1812) and seem to form a kind of translation which Poisson made of Laplace's investigations for his own satisfaction.—MERRIMAN, p. 175.

——— Mémoire sur les mouvements simultanés d'un pendule de l'air environnant.
Ann. de Chim., XLVII, 1831, 242-250; Bull. Sci. Math. (Saigey), XV, 1831, 65-71; Acad. d. Sci. Paris, Comp. Rend., XI, 1832, 521-581; Am. Journ. Sci., XXIII, 1833, 391-392; Conn. d. Temps, 1834, 33-73.

——— Sur l'influence réciproque de deux pendules voisins.
Conn. d. Temps, 1833, 3-40.

——— Sur le pendule de Borda.
Conn. d. Temps, 1833, 41-76.

——— Mémoire sur le mouvement du pendule dans un milieu résistant.
Conn. d. Temps, 1834, 18-32.

——— Mémoire sur l'attraction d'un ellipsoïde homogène.
Acad. d. Sci. Paris, Mém., XIII, 1835, 497-545; Conn. d. Temps, 1837, 93-102.

——— Formules relatives aux probabilités qui dépendent de très-grands nombres.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 603-612.

——— Note sur une propriété générale des formules relatives aux attractions des sphéroïdes.
Acad. d. Sci. Paris, Comp. Rend., VII, 1838, 3-5.

Polinskiego (Michala Pelke). O geodezyi.
4°, Wilnie, 1816, pp. 58. (Heidelberg, University.)

Polytech. Journ. (Dingler), *for* Polytechnisches Journal (Dingler).
8°, Stuttgart, 1820+. (Washington, Patent Office.)

Poppe (Johann Heinrich Moritz von). Geschichte der Mathematik seit der ältesten bis auf die neueste Zeit.
8°, Tübingen, 1828, pp. x, 666. (British Museum.)
Die Literatur der Mathematik, 569–666.

Pop. Sci. Monthly, *for* Popular Science Monthly.
8°, New York, 1872+.

Porriau (A.) *et* **Garnault (E.).** Instruments de précision.
Paris, 1878.
Title in full under GARNAULT (E.).

Porro (Ignazio): Senarmont (H.-H. de). Sur quelques instruments imaginés par —, pour abréger les opérations de géodésie . . .
Ann. d. Mines, XVI, 1849, 383–426.

——— Nouvel appareil destiné à la mesure des bases trigonométriques.
Acad. d. Sci. Paris, Comp. Rend., XXIX, 1849, 666; XXX, 1850, 550; XXXI, 1850, 232–247.

——— Noticia del instrumento llamado teodolito olométrico y del aparato para la medicion exacta de bases geodésicas.
Revista Cien. Fís., Madrid, I, 1850, 192–202, 317–321.

——— Mémoire sur les nouveaux instruments et procédés de géodésie, de nivellement et d'arpentage.
Ann. Ponts et Chauss., Paris, IV, 1852, 273–387.

——— Aparato para medir bases.
Revista Cien. Fís., Madrid, *III*, 1853, 336–345.

——— La fotografia applicata all' astronomia e alla geodesia.
Ist. Lombardo, Rend. Sci. Mat., *II*, 1866, 27–41.

Portlock *and* **Hemming (John).** Account of survey operations at the Cape of Good Hope for the verification of the labours of Lacaille.
Roy. Eng. Papers, I, 1851, 27–45.

PORTUGAL.

AVILA (A.-J. D'). Rapport sur l'état actuel des travaux géodésiques en Portugal.
Int. Geod. Cong., Verhandl., 1884–'86, 183–186; 1887, IX, 1–3.

FERREIRA DE CASTRO (A. G.). Trabalhos geodesicos en Angolo.
N. d.

FOLQUE (F.). Memorias sobre os trabalhos geodesicos executados em Portugal.
Lisboa, 1841; Acad. Sci. Lisboa, Mem., I, 1843, 1–140; II, 1843, 1–291; II, 1843, ii, 1–163; III, 1843, 1–59, 233–333; III, 1843, ii, 1–435; Lisboa, 1869, 1871–'73, 1874.

——— Diccionario do serviço dos trabalhos geodesicos do reino.
Lisboa, 1861.

——— Rapport sur les travaux géodésiques du Portugal.
Lisbonne, 1868.

MOREIRA (C. E. DE A.). Rapport sur les travaux géodésiques en Portugal.
Int. Geod. Cong., Gen.-Ber., 1879, 101–102; 1880, 29; 1881–'82, 111–112; 1883, 269–270.

——— Relatorio dos trabalhos geodesicos [of Portugal].
Lisboa, 1886.

SILVA (F. M. P. DA). Rapport sur l'état des travaux géodésiques du Portugal.
Int. Geod. Cong., Gen.-Ber., 1875, 190–205; 1877, 302–304; 1878, 96–98; Lisboa, 1876, 1878.

Posch (Lorenz). Geschichte und System der Breiten-Grad-Messungen.
8°, Freysing, 1860, pp. 95. (Gore.)

Poselger (Friedrich Theodor). Ueber die Figur der Erde.
K. Ak. d. Wiss., Abhandl. math. Cl., 1827, 57–84.

——— Anleitung zu Rechnungen der Geodäsie.
4°, Berlin, 1831, pp. [i], 57. (Berlin, Royal.)

——— Ortsentfernung auf der Oberfläche des Erdsphäroids.
K. Akad. d. Wiss., Abhandl. math. Cl., 1833, 59–76.

Pouillet (Claude-Servais-Mathias). Lettre du capitaine Basil Hall, R. N., au capitaine Kater, sur les observations du pendule invariable, qu'il a faites en commun avec M. Henri Foster, à Londres, aux îles Galapagos, à San-Blas en Californie, à Rio-Janeiro et à Londres, après son retour.
Bull. Sci. Math. (Saigey), I, 1824, 151–152; Roy. Soc. London, Phil. Trans., 1823, ii, 211.

——— Éléments de physique expérimentale, et de météorologie. (H.)
2 vols., 8°, Paris, 1853.
Pendulum research, I, 73–87.

Powalky (Karl Rudolph). Logarithmisch-trigonometrische Dreiecksberechnungen.
8°, Berlin, 1858, pp. 43. (Oxford, Bodleian.)

——— On the combination of the different results of various series of observations.
Roy. Astron. Soc., Month. Not., XXXIV, 1874, 476–479.

Powell (John Wesley). On the organization of scientific work of the General Government.
8°, *Washington*, 1885, pp. 468. (*Gore.*)
Extracts from the testimony taken by the joint commission of the Senate and House of Representatives to "consider the present organizations of the Signal Service, Geological Survey, Coast and Geodetic Survey, and the Hydrographic Office of the Navy Department, with a view to secure greater efficiency and economy of administration." (Act of July 7 1884.) Geographic surveys as conducted by various European governments, pp. 398–417.

Pratt (John Henry). On the curvature of the Indian arc; and the great geological law, that the various parts of the solid crust of the earth are perpetually undergoing a change of level.
L., E., D. Phil. Mag., X, 1855, 340–345.
The conclusion is that wherever the exterior surface of the crust rises into mountains or sinks into ocean beds, immediately beneath this the inner surface takes a precisely similar but inverse form, so as nearly to double the amount of increase or decrease in the thickness of the crust.

——— On the attraction of the Himalaya Mountains, and of the elevated regions beyond them, upon the plumb-line in India.
Roy. Soc. London, Phil. Trans., CXLV, 1855, 53–100.
Revd. in Roy. Astron. Soc., Month. Not., XVI, 1855–'56, 36–41, 104–105.

———: **Tennant (J. F.).** An examination of the figure of the Indian meridian as deduced by —.
Roy. Astron. Soc., Month. Not., XVII, 1857, 58–63.

——— On the effect of local attraction upon the plumb-line at stations on the English arc of the meridian, between Dunnose and Burleigh Moor; and a method of computing its amount.
Roy. Soc. London, Phil. Trans., CXLVI, 1856, 31–52.
Revd. in Roy. Astron. Soc., Month. Not., XVIII, 1858, 219–220.

Pratt (**John Henry**)—Continued.

——: **Clarke** (**A. R.**). Note on the effect of local attraction on the English arc by —.

Roy. Soc. London, Proc., ix, 1858, 496–497; Phil. Trans., cxlviii, 1858, 496–497.

—— On the figure of the Indian meridian.

L., E., D. Phil. Mag., xvi, 1858, 401–408; Asiatic Soc., Journ., xxvii, 1858, 201–213.

A reply to Lieut. J. F. Tennant's article in the Notices of the Royal Astronomical Society for January 9, 1857.

—— On the influence of the ocean on the plumb-line in India. Communicated by Professor Stokes.

Roy. Soc. London, Proc., ix, 1858, 597–599; Phil. Trans., 1859, 779–796.

—— On the deflection of the plumb-line in India caused by the attraction of the Himalaya Mountains and the elevated regions beyond, and its modification by the compensating effect of a deficiency of matter below the mountain mass. Communicated by Mr. Stokes.

Roy. Soc. London, Proc., ix, 1858, 493–496, 597–599; Postscript, 701–702; Phil. Trans., 1859, 745–748.

——: **Tennant** (**J. F.**). Reply to —'s letter on the Indian arc of meridian.

Asiatic Soc., Journ., xxviii, 1859, 17–22.

—— Second letter on the Indian arc.

Asiatic Soc., Journ., xxviii, 1859, 22–27.

—— On the curvature of the Indian arc. Communicated by Professor Stokes.

Roy. Soc. London, Proc., x, 1859, 197–199, 648–650.

The two ends of the Indian arc have widely different curvatures, which is attributed to varying densities, as shown by marine fossils, in high altitudes, indicating great upheavals. Hence the absolute change of distance of the land from the center of the earth may have been much greater than the elevation relatively to the water.

—— A treatise on attractions; Laplace's functions and the figure of the earth.

1st ed., Cambridge, 1860; 2d ed., 1861; 3d ed., 1865; 4th ed., Cambridge, 1865–'67, pp. xv, 245; 6th ed., 1871. (Gore.)

Revd. by J. Stuart in Math. Monthly, ii, 1860, 356; in Nature, vi, 1872, 79–80.

—— On the Indian arc of meridian.

Roy. Soc. London, Phil. Trans., 1861, 579–594.

—— Memorandum showing the final results of Archdeacon Pratt's calculations regarding the effect of local attraction upon the operations of the great trigonometrical survey of India.

Asiatic Soc., Journ., xxxi, 1862, 146–150.

—— Tests of the truth of the fluid theory of the figure of the earth.

L., E., D. Phil. Mag., xxiv, 1862, 409–417, 507–508.

Several proofs in support of the fluid theory

—— On the degree of uncertainty which local attraction, if not allowed for, occasions in the map of a country and in the mean figure of the earth as determined by geodesy; a method of obtaining the mean figure free from ambiguity, from a comparison of the Anglo-Gallic, Russian, and Indian arcs; and speculation on the constitution of the earth's crust.

Roy. Soc. London, Proc., xiii, 1863, 18–19, 253–276; Asiatic Soc., Journ., xxxiv, 1865, ii, 34–42.

Pratt (**John Henry**)—Continued.

—— The mass of the earth is arranged in nearly spherical strata around its centre; and if the outer surface be a spheroid of equilibrium, then all the strata are so also, whether they acquired that form from once being a fluid or not.

L., E., D. Phil. Mag., xxvi, 1863, 342–346.

—— On the effect of local attraction on geodetic operations. (H.)

Roy. Soc. London, Proc., 1864, 253–276.

——: **Clarke** (**A. R.**). On —'s figure of the earth.

L., E., D. Phil. Mag., xxxi, 1866, 193–196.

—— On the fluid theory of the earth.

L., E., D. Phil. Mag., xxxi, 1866, 430–435.

—— Reply to Captain A. R. Clarke's remarks on his determination of the figure of the earth from geodetic data.

L., E., D. Phil. Mag., xxxii, 1866, 17–22.

—— On the figure of the earth measured geodetically.

L., E., D. Phil. Mag., xxxii, 1866, 313–315.

Containing a correction to article in same journal, p. 17.

—— On the figure of the earth as obtained from geodetic data.

L., E., D. Phil. Mag., xxxiii, 1867, 10–16.

Deducing formulæ for computing the figure of the earth, in which the effect of local attraction at the reference station of the arc is introduced.

—— Comparison of the Anglo-Gallic, Russian, and Indian arcs, with a view to deduce from them the mean figure of the earth.

L., E., D. Phil. Mag., xxxiii, 1867, 145–152.

Allowing for local attractions, it was found, a=20926184 ft., b=20855304 ft., e=1: 295.3.

—— On Professor Stokes' proof of Clairaut's theorem.

L., E., D. Phil. Mag., xxxiv, 1867, 25–26.

Retracting the adverse criticisms on Stokes' proof.

—— Problem in pendulum.

Indian Eng. (Medley), v, 1868, 218–221.

—— On the mean figure of the earth determined from arcs of latitude or longitude or both and azimuths, local attraction taken into account.*

Dehra Dún, 1868, pp. 19.

—— Formulæ for calculating the vertical attraction at a station with a view to correct pendulum observations.*

Dehra Dún, 1869, pp. 21.

—— On the variation of gravity at Kaliána, Kalianpoor, and Dansargida, produced by the irregularities of the earth's crust.*

Dehra Dún, 1869, pp. 22.

—— Reply to M. Delaunay's objection to the late Mr. Hopkins' method of determining the thickness of the earth's crust, by the precession and nutation of the earth's axis.

Geol. Mag., vii, 1870, 421–424; L., E., D. Phil. Mag., xl, 1870, 10–14.

—— On the constitution of the solid crust of the earth [1870].

Roy. Soc. London, Phil. Trans., clxi, 1871, 335–358; Proc., xix, 1871, 223–225; L., E., D. Phil. Mag., xli, 1871, 307–309.

Pratt (John Henry)—Continued.

——— On Mr. Hopkins' method of determining the thickness of the earth's crust.
L., E., D. Phil. Mag., XLII, 1871, 98–103, 400.

——— The solid crust of the earth can not be thin.
L., E., D. Phil. Mag., XLII, 1871, 280–290.

Prazmovski (A.). Rapport fait à M. le directeur de l'observatoire central sur les travaux de l'expédition de Bessarabie, entreprise en 1852, pour terminer les opérations de la mesure de l'arc du méridien.
Acad. de St.-Pétersbourg, Bull. Cl. Phys. Math., XII, 1853, 84–86; Mél. Math. Astron., I, 1853, 593–608.

PRECISION OF OBSERVATIONS.

ADAN (E.-H.-J.). Les limites à la mesure de précision des observations immédiates.
Acad. de Belgique, Bull., XXII, 1866, 480–502.

BERTRAND (J.). Sur ce qu'on nomme le poids et la précision d'une observation.
Acad. d. Sci. Paris, Comp. Rend., CV, 1887, 1099–1102.

DEDEKIND (J. W. R.). Ueber die Bestimmung der Präcision einer Beobachtungsmethode nach der Methode der kleinsten Quadrate.
Naturf. Ges. Zürich, Vierteljahrs., V, 1860, 76–83.

HAUBER (C. F.). Ueber die Bestimmung der Genauigkeit der Beobachtungen.
Zeits. f. Phys. (Baumgärtner), VII, 1830, 406–429.

HOLMAN (S. W.). Discussion of the precision of measurements.
Technology Quarterly, I, 1887, 121–140.

JORDAN (W.). Ueber die Bestimmung der Genauigkeit mehrfach wiederholter Beobachtungen einer Unbekannten.
Astron. Nachr., LXXIV, 1869, 209–226.

LALANDE (J.-J. DE). Du milieu qu'il faut choisir entre les résultats d'un grand nombre d'observations.
Conn. d. Temps, 1813, 213–223.

Pressler (Max-Rob.). Traité de géodésie, ou exposition des méthodes trigonométriques et astronomiques.*
2e éd., 2 vols., Paris, 1819.

Preston (Erasmus Darwin). Determinations of gravity and other observations made in connection with the solar eclipse expedition, May, 1883, to Caroline Island.
U. S. C. and G. Survey., Rep., 1883, 379–381.

——— On the deflection of the plumb-line and variations of gravity in the Hawaiian Islands.
Am. Jour. Sci., CXXXVI, 1888, 305–317.

——— Determinations of latitude and gravity for the Hawaian Government.
U. S. C. and G. Survey, Bull., No. XI, 1889, 137–142.

Prinsep (James). On the general principles of geodesy, and on the several methods by which may be constructed a map of any country.
Gleanings in Sci., II, 1830, 18–21.

——— Determination of the constant of expansion of the standard 10-foot iron bar of the great trigonometrical survey of India; and expansions of gold, silver, and copper by the same apparatus.
Asiat. Soc., Journ., II, 1833, 130–142.

Prittwitz (Moritz Karl Ernst von). Ueber die Triangulirung der Schweiz.
Zeits. allg. Erdkunde, XII, 1862, 81–86.

——— Die Fortschritte und der jetzige Stand der mitteleuropäischen Gradmessung.
Zeits. allg. Erdkunde, XIX, 1865, 324–345.

PROBABLE ERROR.

ANDRÆ (C. C. G.). Ueber die Bestimmung des wahrscheinlichen Fehlers durch die gegebenen Differenzen von *m* gleich genauen Beobachtungen einer Unbekannten.
Astron. Nachr., LXXIX, 1872, 257–272.

BÖRSCH (O.). Ueber den mittleren Fehler der Resultate aus trigonometrischen Messungen.
Arch. d. Math. (Grunert), XLVI, 1866, 40–44.

DIENGER (J.). Ueber die Ermittelung des wahrscheinlichen Fehlers bei Längenmessungen.
Arch. d. Math. (Grunert), XXXI, 1858, 225–228.

FECHNER (G. T.). Ueber die Bestimmung des wahrscheinlichen Fehlers eines Beobachtungsmittels.
Ann. d. Phys. (Poggendorff), 1874, 66–81.

HAGEN (G.) Die wahrscheinlichen Fehler der Constanten.
K. Ak. d. Wiss., Sitz. Ber., XLIV, 1883, 1169–1172.

HELMERT (F. R.). Ueber die Berechnung des wahrscheinlichen Fehlers aus einer endlichen Anzahl wahrer Beobachtungsfehler.
Zeits. f. Math. (Schlömilch), XX, 1875, 300–303.

——— Die Genauigkeit der Formel von Peters zur Berechnung des wahrscheinlichen Fehlers directer Beobachtungen gleicher Genauigkeit.
Astron. Nachr., LXXXVIII, 1876, 113–132.

JORDAN (W.). Die Fechner'sche Formel für den wahrscheinlichen Fehler.
Zeits. f. Vermes., XVII, 1888, 374–375.

LAPLACE (P.-S. DE). Ueber die Bestimmung des wahrscheinlichsten Resultats aus den Resultaten einer grossen Menge von Beobachtungen.
Mon. Corr. (Zach), XXV, 1812, 105–120.

LAZARUS (W.). Die Bestimmung und Ausgleichung der aus Beobachtungen abgeleiteten Wahrscheinlichkeiten.
Math. Ges. Hamburg, Mittheil., 1878, 7–27.

MEES (R. A.). Ueber die Berechnung des wahrscheinlichen Fehlers einer endlichen Zahl von Beobachtungen.
Zeits. f. Math. (Schlömilch), XX, 1875, 145–152; XXI, 1876, 126–128.

MERRIMAN (M.). On probable error.
Engineering News, IX, 1882, 4–5.

PETERS (C. A. F.). Ueber die Bestimmung des wahrschein lichen Fehlers . . .
Astron. Nachr., XLIV, 1856, 29–32; U. S. C. and G. Survey, Rep., 1856, 307–308.

SCHOLS (CH. M.). Over de theorie der fouten in de ruimte en in het platte vlak.
K. Ak. van Wetens. Amsterdam, Verhandl., XV, 1875.

STRUCKI. Een voorbild van constante fouten.
Tijdschrift voor Kadaster en Landmeetkunde, II, 1886, 181.

TILLY (J.-M. DE). Note sur le principe de la moyenne arithmétique et sur son application à la théorie des erreurs.
Corr. de Math., I, 1875, 137–147.

WRIGHT (T. W.). On the computation of probable errors.
Analyst, IX, 1882, 74–78.

YOUNG (T.). Remarks on the probability of error in physical observations.
Roy. Soc. London, Phil. Trans., 1819, 70–75.

Probst (J.). Klima und Gestaltung der Erdoberfläche in ihren Wechselwirkungen.
8°, Stuttgart, 1887, pp. x, 173.

Prondzynski (Boguslaw von). Ueber die Aufstellung bisher noch nicht angewandter Bedingungsgleichungen geodätischer Dreieckskette.
Astron. Nachr., LXXI, 1868, 145–154.

——— Ueber die Anzahl der Winkel- und Sinus-Gleichungen bei Ausgleichung trigonometrischer Dreiecksnetze.
Astron. Nachr., LXXV, 1869, 81–90.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1867–'70, 483, by BRUNS.

Prony (Gaspard-Clair-François-Marie-Riche de). Description des moyens employés pour mesurer la base de Hounslow Heath, par le major général William Roy; traduite de l'anglois par —.
4°, Paris, 1787, pp. 100.
Also bound with Description des moyens employés, etc., Paris, 1791.

——— Formules pour déduire le rapport des axes de la terre de la longueur de deux arcs du méridien.
Soc. Philom., Bull., I, 1797, 5–6.

——— Méthode pour déterminer la longueur du pendule simple qui bat les secondes, d'après des expériences faites sur un corps solide de figure quelconque.
Soc. Philom., Bull., II, 1801, 159–160.

——— Formules pour la comparaison des longueurs de deux règles de métal, lorsque leur température varie.
Bibl. Brit. Genève, XIX, 1802, 316–320.

——— Résultats des expériences faites avec un instrument français et un instrument anglais pour déterminer le rapport du mètre au pied anglais, et pour comparer entr'eux les étalons originaux de mesure appartenant à l'Institut national de France.
Bibl. Brit. Genève, XX, 1802, 105–118.

——— Description et usage du comparateur de Lenoir employé pour faire des expériences sur la dilatation des métaux et pour comparer les divers étalons de mesure de l'Institut national, tant entr'eux qu'avec d'autres étalons de mesures françaises et étrangères.
Bibl. Brit. Genève, XIX, 1802, 301–315; Ann. d. Phys. (Gilbert), LII, 1816, 329–338; Phil. Mag. (Tilloch), XLVII, 1816, 125–130.

——— Mémoire sur le calcul des longitudes et des latitudes d'après les distances à la méridienne et à la perpendiculaire et sur le calcul inverse.
Conn. d. Temps, 1808, 366–379.

——— Note relative à l'article précédent (sur la longueur du pendule à secondes; par La Place).
Soc. Philom., Bull., 1816, 173–174; 1817, 193–194.

——— Note sur le rapport du mètre au pied anglais, déterminé par une commission de l'Institut royal de France, et comparé aux meilleurs résultats obtenus en Angleterre sur le rapport de la toise du Pérou au pied anglais.
Ann. de Chim., V, 1817, 166–171; Bibl. Univ. Genève, VII, 1819, 239–243.
Toise = 76.7365 inches; mètre = 39.3702 inches.

——— Note sur un nouveau moyen de régler la durée des oscillations du pendule.
Conn. d. Temps, 1817, 229–236; Oken Isis, 1818, 1484–1485; Soc. Philom., Bull., 1817, 53–57; Conn. d. Temps, 1820, 402–408.

——— Ueber die Vergleichung der halben Wiener Klafter mit dem Meter.
Conn. d. Temps, 1837, 28–36; K. k. poly. Inst., Jahrb., XX, 1839, 155–164.
A part of STAMPFER, Ueber das Verhältniss, etc.

Prosperin (Erik). Ueber die geographische Lage des 1736 und 1737 in Lappland gemessenen Breitengrades.
Geogr. Ephem. (Zach), IV, 1799, 97–104.

——— Vermischte astronomische und geographische Nachrichten aus Schweden.
Mon. Corr. (Zach), I, 1800, 113–119.

Prosperin (Erik)—Continued.
——— Etwas über die schwedische Gradmessung in Lappland.
Astron. Jahrb. (Bode), 1806, 193–195.

Pross (Friedrich). Abhandlung über practische Geometrie. Einladungsschrift zu der Feier des Geburtsfestes Seiner Majestät des Königs Wilhelm von Würtemberg.
8°, Stuttgart, 1844, pp. 54, 4 charts. (British Museum.)

Proteus (Pereguinis). On the figure of the earth.
Journ. Nat. Phil. (Nicholson), VIII, 1804, 12–19; VIII, 1804, 151–161.
A defense of the method of solving spheroidal triangles.

PRUSSIAN GEODETIC INSTITUTE.

BAEYER (J. J.). Bericht über den Stand der Organization des Centralbüreaus.
Int. Geod. Cong., Gen.-Ber., 1864, 29–33; 1865, 29; 1866, 26–27; 1867, 16–22; 1869, 23–58; 1870, 30–58; 1871, 11–24; 1872, 22–53; 1873, 14–79; 1874, 15–23; 1875, 7–10, 205–212; 1876, 8–13; 1877, 12–18; 1878, 10–14, 99–104; 1879, 102–109; 1880, 15–19, 29–35; 1881, 113–123; 1883, 20–24, 270–277.

——— Wissenschaftliche Begründung der Rechnungsmethoden des Central-Büreaus der europäischen Gradmessung.
Berlin, 1870.

HELMERT (F. R.). Bericht des geodätischen Institutes.
Int. Geod. Cong., Verhandl., 1884–'86, 187–199; 1887, X, 1–5.

——— Uebersicht der Arbeiten des königl. geodätischen Institutes unter Baeyer.
Berlin, 1886.

——— Jahresbericht des Direktors.
Berlin, 1887.

SADEBECK (B. A. M.). Bericht des Centralbüreaus der europäischen Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1868, 30–34; Schles. Ges. Breslau, Ber., XLVII, 1869, 301–307.

ANON. Astronomisch-geodätische Arbeiten, 1870–'86.
13 vols. Berlin, 1871–'87. *Stanciewicz.*

——— Protokoll der Sitzungen der permanenten Commission der mitteleuropäischen Gradmessung, 1862–'67.
5 vols., Berlin, 1882.

——— Verhandlungen des wissenschaftlichen Bliraths des königl. geodätischen Instituts, 1876–'86.
9 vols. 8°, Berlin, 1879–'86.

PRUSSIAN LANDESAUFNAHME.

BAEYER (J. J.). Die k. preussische Landestriangulation.
Berlin, 1865; Astron. Nachr., LXIX, 1867, 1–4.

——— Vergleichung einiger Hauptdreieckskettender königl. Landestriangulation.
Berlin, 1879.

BESSEL (F. W.). Trigonometrische Bestimmung einiger Punkte in Königsberg und Prüfung einiger Winkel der Textor'schen Vermessung von Preussen.
Zeits. f. Astron. (Lindenau), IV, 1817, 286–296.

——— *und* BAEYER (J. J.). Gradmessung in Ostpreussen.
Berlin, 1838.

ERFURTH. Technischer Betrieb der Feldarbeiten der Triangulation der preussischen Landesaufnahme.
Zeits. f. Vermes., XVI, 1887, 377–383, 421–437.

HANSEN (P. A.). Gegenbericht . . . über die Arbeiten der k. preuss. Landestriangulation.
Gotha, 1868.

HESSE (VON). Die preussische Landes-Triangulation.
Berlin, 1867.

JORDAN (W.). Die Basismessung der preussischen Landesaufnahme bei Göttingen.
Zeits. f. Vermes., IX, 1880, 377–403.

——— Die Basismessung bei Meppen.
Zeits. f. Vermes., XII, 1883, 577–584.

PRUSSIAN LANDESAUFNAHME—Continued.

KÖPEN (M.). On the triangulation of royal Prussian survey.
Inst. Civil Eng., Proc., XLII, 1875, 391-392.

LINDEMANN (F.). Das Vermessungswesen im preussischen Staate.
Zeits. f. Vermes., IV, 1875, 147-152, 161-175.

MOROZOWICZ (O. VON). Die königliche preussische Landes-Triangulation.
Berlin, 1870, 1873, 1874.

SCHREIBER (O.). Die königlich preussische Landes-Triangulation.
Berlin, 1876, 1878, 1887.

TEXTOR (J. C. VON). Nachricht von den ost- und westpreussischen Landes-Vermessungen.
Allg. geogr. Eph., II, 1798, 3-23, 109-117; Mon. Corr. (Zach), I, 1800, 307-319; XIV, 1811, 101-120; Berlin, 1810.

WAEGE (W.). Die Mängel des preussischen Vermessungswesen und Ansichten über deren Abhilfe.
Görlitz, 1850.

WITTSTEIN (T. L.). . . . Die preussische Landestriangulation.
Astron. Nachr., LXIX, 1867, 289-298, 321-328.

ZACH (F. X. VON). Ueber die königl. preussische trigonometrische Aufnahme von Thüringen und dem Eichsfelde.
Mon. Corr. (Zach), IX, 1804, 1-26, 89-120, 189-220, 269-295, 437-471; X, 1804, 1-26, 97-132, 193-209, 289-320, 389-411, 485-506; Gotha, 1806.

ANON. Technische Anleitung vom 16. Februar 1870 zu Ausführung einzelner Theile der bei den Grundsteuervermessungsarbeiten vorkommmenden trigonometrischen und polygometrischen Rechnungen.
8°, Berlin, 1870, pp. 223.

Psellus (Michael). De terræ situ, figura et magnitudine.*
POGGENDORFF, II, 541.

Pucci (Enrico). Sulle posizioni geografiche.
Gior. Math. (Battaglini), XVIII, 1880, 358-367.
Concerning the computation of the longitude, latitude, and azimuth from the geodetic arc, and the converse problem.

——— Sulla teoria delle basi geodetiche.
Giornale Math. (Battaglini), XIX, 1881, 151-156.

——— Réduction des observations astronomiques et des angles géodésiques d'une surface de niveau à une autre.
Astron. Nachr., XCIX, 1881, 161-168.

——— *e* **Pisati (G.).** Sulla lunghezza del pendolo a secondi.
Accad. dei Lincei, Atti, XV, 1883, 57-231.

——— Fondamenti di geodesia.
8°, Milano, 1883-'87, I, pp. xxi, 403; II, pp. x, 401. (Berlin, Geodetic Institute.)

——— Sulle formule fondamentali della geodesia geoidica.*
Ann. d. Mat. (Brioschi), XIV, 1886-'87.

Puille (D.). Traité complet de la division des champs dans tous les cas de géodésie usuelle, etc.
8°, Paris, 1858, 3e éd.
Simple surveying.

Puillos-Boblaye *et* **Peytier.** Sur les opérations géodésiques exécutées en Morée en 1829-'30.
Conn. d. Temps, 1835, 63-76.
Revd. in Soc. Geogr., Bull., XIX, 1833, 89-106.

——— Travaux astronomiques et géodésiques exécutés dans la province de Constantine.
Soc. Géogr., Bull., IX, 1838, 295-304.

Puissant (Louis). Sur la détermination d'un arc perpendiculaire à une méridienne terrestre, et sur diverses questions qui y sont relatives.
Conn. d. Temps, 1820, 281-304.

——— Notice des opérations géodésiques faites vers la fin du siècle dernier pour former le plan topographique de la Corse, ainsi que lier cette île aux côtes de Toscane et aux îles intermédiaires.
Conn. d. Temps, 1822, 293-297.

——— Formules pour ramener à une valeur quelconque d'aplatissement terrestre, tant les latitudes et longitudes des points d'un réseau de triangles, que les coordonnées rectangles des projections de ces points, calculées pour une autre valeur d'aplatissement.
Conn. d. Temps, 1823, 239-257.

——— Application de la méthode la plus avantageuse à la détermination de l'aplatissment du sphéroïde osculateur en France, par la comparaison d'un arc de méridien avec un arc de parallèle.
Bull. Sci. Math. (Saigey), I, 1824, 271-274; Conn. d. Temps, 1827, 230-232.

——— Moyen d'évaluer rigoureusement la longueur d'une ligne géodésique et celle de ses différentes parties, à l'aide d'un réseau de triangles appuyé sur deux bases qui présentent entre elles une petite discordance.
Soc. Philom., Bull., 1824, 17-20.

——— Sur la correction à appliquer à la longueur d'une ligne géodésique liée à deux bases non concordantes.
Soc. Philom., Bull., 1824, 145-146.

——— Sur les opérations trigonométriques qui rattachent l'île d'Elbe et la côte de Toscane à l'île de Corse.
Conn. d. Temps, 1824, 348-354.

——— Note sur une formule générale propre à donner l'aplatissement terrestre par la comparaison de deux arcs.
Bull. Sci. Math. (Saigey), III, 1825, 74-76.

——— Note sur les opérations géodésiques de la France.
Soc. Géogr., Bull., IV, 1825, 311-315; Hertha, IX, 1827, 335-338.

——— Opérations géodésiques.
Soc. Philom., Bull., 1825, 161-163, 177-178.

——— Mémoire sur la détermination de la figure de la terre par les mesures géodésiques et astronomiques.
Dépôt de la Guerre, Mém., III, 1826, 61-100.

——— Extrait d'une note [relative à la question de déterminer, sur le sphéroïde terrestre, la plus courte distance de deux points quelconques donnés, par leur latitude et leur longitude].
Soc. Géogr., Bull., IX, 1828, 184-187.

———: **Mathieu (C.-L.).** Rapport sur un mémoire de M. — sur la détermination de la figure de la terre.
Conn. d. Temps, 1829, 229-235.

——— Sur la mesure et le calcul des azimuths propres à la détermination des longitudes terrestres.
Dépôt de la Guerre, Mém., V, 1829, 434-457.

——— Analyse appliquée aux opérations géodésiques.
Dépôt de la Guerre, Mém., II, 1831, 379-429.

Puissant (Louis)—Continued.

——— Analyse appliquée aux opérations géodésiques.
8°, Paris, 1831, pp. 64, 1 plate.
Extrait du 5e numéro du Mémorial du Dépôt général de la guerre.

——— Nouvel essai de trigonométrie sphéroïdique.
Acad. d. Sci. Paris, Mém., x, 1831, 457-529; Errata, p. vii of preface.

——— Sur la trigonométrie sphéroïdique, dans laquelle on détermine généralement la plus courte distance de deux points donnés sur la terre par leur latitude et leur longitude.
Conn. d. Temps, 1832, 34-48; 1833, 78-85.

——— *et* **Peytier (E.)**. Nouvelle description géométrique de la France, ou précis des opérations et des résultats numériques qui servent de fondement à la nouvelle carte du royaume; suivie d'une carte générale des triangles de premier ordre, comprenant le tableau d'assemblage des feuilles de gravure.
Dépôt de la Guerre, Mém., VI, 1832, i-xv, 1-616, 2 plates; VII, 1840, i-xvi, 1-680, 3 charts (Ellipsoïde osculateur en France, 626; Éléments du sphéroïde terrestre, 643); IX, 1853, i-xii, 1-540, 6 plates.

——— Deuxième mémoire sur l'application du calcul des probabilités aux mesures géodésiques.
Acad. d. Sci. Paris, Mém., XI, 1832, 123-156.

——— Mémoire sur la comparaison des mesures geodésiques et astronomiques de France, et les conséquences qui en résultent relativement à la figure de la terre.
L'Institut, Journ., I, 1833, 85-86.

——— Note sur un mémoire de — par Arago.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 450-453.

——— Nouvelles remarques sur la comparaison des mesures géodésiques et astronomiques de France.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 50-53.

——— Nouvelle détermination de la longueur de l'arc de méridien compris entre Montjouy et Formentera, dévoilant l'inexactitude de celle dont il est fait mention dans la Base du système métrique décimal.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 428-433; Acad. d. Sci. Paris, Mém., XVI, 1836, 1-25, 457-477.

——— Dernières remarques sur une nouvelle détermination de l'arc de méridien compris entre Montjouy et Formentera, en réponse à la note de MM. Biot et Arago, lue à l'Académie et insérée au compte rendu de ses séances.
Acad. d. Sci. Paris, Comp. Rend., II, 1836, 483-486.

——— Note sur un moyen fort simple d'appliquer la trigonométrie à la détermination d'un arc de méridien mesuré par de très grands triangles.
Acad. d. Sci. Paris, Comp. Rend., III, 1836, 739-742.

——— Notice sur les opérations géodésiques et astronomiques qui servent de fondement à la nouvelle carte de France.
Acad. d. Sci. Paris, Mém., XIV, 1838, 1-80 (read Jan. 14, 1833).

——— Supplément à une nouvelle détermination de la distance méridienne de Montjouy à Formentera.
Acad. d. Sci. Paris, Comp. Rend., VI, 1838, 770.

——— Note sur un nouveau moyen d'abréger considérablement les calculs relatifs à la rectification d'un arc de méridien.
Acad. d. Sci. Paris, Comp. Rend., XIII, 1841, 53-58.

Puissant (Louis)—Continued.

——— Traité de géodésie, ou exposition des méthodes trigonométriques et astronomiques, applicables soit à la mesure de la terre, soit à la confection des canevas des cartes et des plans topographiques.
4°, Paris, 1805.
Revd. in Mon. Corr. (Zach), XVI, 1807, 443-463; Conn. d. Temps, 1808, 480.
2e éd., 2 vols., Paris, 1819: I, pp. xx, 376 [32], 2 plates; II, pp. viii, 360 [20], 2 plates. (Gore.)
3e éd., Paris, 1843.
Revd. in Calcutta Rev., VII, 1845, 62.
Supplément au traité de géodésie, contenant de nouvelles remarques sur plusieurs questions de géographie mathématique, et sur l'application des mesures géodésiques et astronomiques à la détermination de la figure de la terre.
4°, Paris, 1827, pp. viii, 123.

Purdon (William H.). On the trigonometrical survey and physical configuration of the valley of the Kashmir.
Roy. Geogr. Soc., Journ., XXXI, 1861, 14-30.

Putnam's Monthly Magazine.
8°, New York, 1853-'69 (16 vols.).

Quart. Journ. Sci., *for* Quarterly Journal of Science, Literature, and the Arts, Royal Institution of Great Britain.
8°, London, 1819-'29. (Washington, Patent Office.)

Queipo (Vincente Vazquez). Essai sur les systèmes métriques et monétaires des anciens peuples depuis les premiers temps historiques jusqu'à la fin du khalifat d'Orient.
8°, Paris, 1859: I, pp. xxii, 608, 1 plate; II, pp. xiv, 455; III, tables, pp. 603. (Southampton, Ordnance Survey.)
Containing an elaborate discussion of the standards used in the early degree measurements.

——— Contestacion al discurso anterior (sobre los progressos de geodésia).
Acad. d. Cien., Madrid, Mem., I, 1863, iii, 645-664.
See MENESES (F. S.). Discurso que sobre, etc.

Quet. Oscillation du pendule dans un milieu résistant.
Acad. d. Sci. Paris, Comp. Rend., XXXIV, 1852, 804.

Quetelet (Lambert-Adolphe-Jacques). Histoire des sciences mathématiques et physiques chez les Belges.
8°, Bruxelles, 1864, pp. 479. (Washington, Congress.)
Nouvelle éd., Bruxelles, 1871, pp. 479, 2 tables.
Travaux géodésiques, 359-362.

——— Sciences mathématiques et physiques chez les Belges au commencement du XIXe, siècle.
Bruxelles, 1866, pp. iii, 754; 2e éd., Bruxelles, 1867.
Aplatissement du globe, p. 7.

——— *et* **Liagre (J.-B.-J.)**. Rapport à la commission permanente de l'Association géodésique internationale.
Acad. de Belgique, Bull., XLI, 1876, 397-407.

Quiroga (Cesáreo) *et* **Ibañez (C.)**. Base centrale de la triangulation géodésique d'Espagne.
Madrid, 1865.
Title in full under IBAÑEZ (C.).

R. New theory of the figure of the earth. An answer to Blakewell. New theory, etc.
Civil Eng. and Arch. Journ., XXIV, 1861, 278.

R. (**S. W.**). U. S. Survey of the North and Northwest lakes.
Journ. Frank. Inst., LXXXIV, 1867, 399–401.

Radau (**Rodolphe**). Ueber die persönlichen Gleichungen bei Beobachtungen derselben Erscheinungen durch verschiedene Beobachter. Uebersetzt aus dem "Moniteur scientifique (Quesneville)," 1865.
Rep. f. phys. Tech. (Carl), I, 1865–'66, 202–218, 306–321; II, 1866–'67, 115–160.

——— Ueber die persönlichen Fehler.
Rep. f. phys. Tech. (Carl), IV, 1868, 147–156.
Translated from Moniteur scientifique.

——— Géodésie d'une partie de la haute Éthiopie.
Paris, 1860–'63.
Title in full under ABBADIE (A. D').

——— Géodésie d'Éthiopie.
Paris, 1873.
Title in full under ABBADIE (A. D').

——— The interior of the earth. Translated from the "Revue des deux Mondes."
Pop. Sci. Monthly, XVII, 1880, 289–303, 453–467.
Incidentally discusses the figure of the earth.

Ramsden (**Jesse**). Description of an engine for dividing mathematical instruments.
4°, London, 1877, pp. 16, 3 plates.

Ramus (**Christian**). Om Uligheder i Pendulsvingningerne formedlest et Himmellegems Tiltrækning.
K. danske Videns., Forhandl., 1847, 9–15.

Ratzel (**Friedrich**). Die Erde in gemeinverständlichen Vorträgen über allgemeine Erdkunde.
8°, Stuttgart, 1881, pp. vi, 440. (Gore.)
Die Gestalt der Erde, 11–23.

Ray (**J.**). The wisdom of God manifested in the works of the creation, in two parts; viz., the heavenly bodies, elements, meteors, fossils, vegetables, animals; more particularly in the body of the earth, its figure, motion, and consistency, etc.*
8th ed., 8°, 1722.

Raynolds (**W. F.**). Annual report on the survey of the northwest lakes for the year ending June 30, 1867.
U. S. Army, Eng. Rep. for 1867, 553–864.

——— Annual report of the survey of the north and northwest lakes for the year ending June 30, 1868.
U. S. Army, Eng. Rep. for 1867–'68, 925–1187.

——— Annual report of the survey of the northern and northwestern lakes for the year ending June 30, 1869.
U. S. Army, Eng. Rep. for 1869, 549–648.

——— Report of Lieutenant-Colonel W. F. Raynolds, Corps of Engineers, upon the survey of the north and northwestern lakes [for 1870].
U. S. Army, Eng. Rep. for 1870, 535–613.

Rebstein (**J.**): **Helmert** (**F. R.**). Die mathematischen und physikalischen Theorieen der höheren Geodäsie.
Leipzig, 1880–'84. Revd. by —.
Zeits. f. Vermess., XIV, 1885, 451–457.

REDUCTION OF ANGLES. *See* **ANGLES, REDUCTION OF.**

REFRACTION, TERRESTRIAL.

BAEYER (J. J.). Die Beziehungen der Strahlenbrechung in der Atmosphäre zu der Witterung.
Arch. d. Landeskunde, V, 1858, 1–40.

——— Strahlenbrechung in der Atmosphäre.
Acad. de St.-Pétersbourg, Mém., III, 1860, 1–82.

REFRACTION, TERRESTRIAL—Continued.

——— Ueber die Gründung eines Observatoriums zur Erforschung der terrestrischen Refraction.
Int. Geod. Cong., Gen.-Ber., 1878, 23–26.

BAUERNFEIND (C. M.). Ergebnisse aus Beobachtungen der terrestrischen Refraction.
K. bayer. Ak. d. Wiss., math.-phys. Cl., Abhandl., XIII, 1880, iii, 181–310; XV, 1883, i, 1–102; XVI, 1888, iii. 519–567.

——— Ueber Refractionsbeobachtungen.
Int. Geod. Cong., Gen.-Ber., 1880, 1–6.

——— Neue Untersuchungen über terrestrische Refraction.
Int. Geod. Cong., Gen.-Ber., 1883, 1–5.

BIOT (J.-B.). Recherches sur les réfractions extraordinaires qui s'observent très-près de l'horizon.
Inst. d. Sci., Mém, .Cl. Math., 1809, 1–266.

——— Nouvelles études sur les réfractions atmosphériques.
Paris, 1855.

BRITO LIMPO (F. A.). Taboas parao calculo das refracções terrestres.
Lisboa, 1865.

DANGOS. Observations sur les réfractions terrestres.
Mém. Sav. Étrang., I, 1806, 463–468; Ann. d. Phys. (Gilbert), XLVII, 1814, 442–446.

DIETZE (M.). Beiträge zur Aufsuchung von Refractions-Coefficienten.
Zeits. f. Vermes., XXII, 1884, 245–259.

FEARNLEY (C.). Zur Theorie der terrestrischen Refraction.
Int. Geod. Cong., Gen.-Ber., 1883, 13–27.

FISCHER (A.). Der Einfluss der Lateralrefraktion auf das Messen von Horizontalwinkeln.
Berlin, 1882.

GLYDÉN (H.). Untersuchungen über die Constitution der Atmosphäre und die Strahlenbrechung in derselben.
Acad. d. St.-Pétersbourg, Mém., X, 1866, 1–82; XII, 1868, 1–58.

GRUNERT (J. A.). Ueber die atmosphärische, vorzüglich die terrestrische Refraction.
Arch. d. Math. (Grunert), X, 1847, 1–41.

IVORY (J.). Calculation of the horizontal refraction in an atmosphere of uniform temperature.
Phil. Mag. (Tilloch), LIX, 1822, 90–93.

JORDAN (W.). Ein Beitrag zur Theorie der terrestrischen Strahlenbrechung.
Astron. Nachr., LXXXVIII, 1876, 99–110.

——— Ueber Seitenrefraction bei Triangulirungen.
Zeits. f. Vermes., VI, 1877, 192–195.

——— Die Grundformeln der terrestrischen Refraction.
Zeits. f. Vermes., XVIII, 1889, 176–183.

LINDENAU (B. A. VON). Beobachtungen über terrestrische Strahlenbrechung in Ostindien.
Zeits. f. Astron. (Lindenau), III, 1817, 190–198.

LINDHAGEN (D. G.). Om terrestra refractions theorie.
K. Svenska Veten., Handl., I, 1855–'56, 395–439.

LOEWY (M.). Nouvelles méthodes pour la détermination complète de la réfraction.
Acad. d. Sci. Paris, Comp. Rend., CII, 1886; separate, pp. 47.

MONTIGNY (C.). Essai sur des effets de réfraction . . . produits par l'air atmosphérique.
Acad. de Belgique, Mém. Couron., XXVI, 1854–'55.

STERNECK (R. VON). Ueber die Aenderung der Refractions-Constante . . .
Wien, 1879.

WALKER (J. T.). On observations of terrestrial refraction.
India, Trig. Survey, II, 1879, iii, 77–93

ZINGER (O. N.). Uebersicht der in Russland ausgeführter Arbeiten über terrestrische Refraction.
Int. Geod. Cong., Gen.-Ber., 1883, 6–12.

Reggio (**Francesco**). De mensione basis habita anno 1788 ab astronomis Mediolanensibus.
Eff. Astron., Milano, 1794 (App.), 3–20.

Regnault (E.-E.). Traité de topographie et de géodésie forestières; comprenant la solution des difficultés que présentent les triangulations et les opérations de détails dans les forêts, les éléments de leur statistique, la manière de diviser et de subdiviser les terrains boisés, la vérification des plans, etc.
8°, Nancy, 1844, pp. iv, 400, 8 plates. (Paris, National.)

Rehm (Edgar). Tafeln der Krümmungshalbmesser des Bessel'schen Erdsphäroides für die Breiten von 40° bis 51° 30′.
K. k. militär-geogr. Inst., Mittheil., III, 1883, 137-177.

[Reich (F. [Ferdinand]).] Ueber die mittlere Dichtigkeit der Erde.
Physikalisches Wörterbuch (Gehler), iii, 940-970.

——— Gestalt und Grösse der Erde.
Physikalisches Wörterbuch (Gehler), iii, 832-940.

——— Extrait d'un mémoire sur la densité de la terre.
Acad. d. Sci. Paris, Comp. Rend., V, 1837, 697-700.

——— Versuche über die mittlere Dichtigkeit der Erde mittelst der Drehwage.
4°, Freiberg, 1838, pp. 66, 2 plates. (Berlin, Geodetic Institute.)

——— Neue Versuche über die mittlere Dichtigkeit der Erde.
Ann. d. Phys. (Poggendorff), LXXXV, 1852, 189-198; Ann. de Chim., XXXVIII, 1853, 382-383; Phil. Mag. (Tilloch), V, 1853, 154-159.

——— Neue Versuche mit der Drehwage zur Bestimmung der mittleren Dichtigkeit der Erde.
K. sächs. Ges. d. Wiss., Abhandl. math. phys. Cl., I, 1852, 383-430.

Reichenbach (O.). Die Gestaltung der Erdoberfläche nach bestimmten Gesetzen.*
Berlin, 1870.
Milit.-geogr. Inst., Cat., 287.

Reilin (Abraham). Dissertatio academica de figura telluris ope pendulorum determinanda.
8°, Aboæ, 1810, pp. 9. (British Museum.)

Reinke (Johann Theodor). Darstellung und Resultate von der im Jahre 1814 angefangenen trigonometrischen Messung im Hamburgischen Gebiet und in den zunächst angränzenden Gegenden.
8°, Hamburg, 1815, pp. vi, 32, 2 charts. (British Museum.)

Reissig (Cornelius von). Der Apparat zur Messung einer Basis. Verfertigt im mechanischen Institute des kaiserlichen Generalstabs und beschrieben von —.
Fol., St. Petersburg, 1823, pp. [iv], 15, [2], 6 copper plates. (Gore.)

Reitz (F. N.). Ueber einen Hülfsheliotropen am Fernrohre.
Zeits. f. Instrumentenk., I, 1881, 338-340.

——— Apparat zum Messen von Grundlinien.
Zeits. f. Vermes., X, 1881, 233-237.

——— Ueber die trigonometrische Verbindung von Spanien und Algerien.*
Hamburg, 1883.

Remusat (A.): Jomard (E.-F.). Lettre à — sur une nouvelle mesure trouvée à Memphis.
Paris, 1827.
Title in full under JOMARD (E.-F.).

Renier (Charles). Pendule.
Encyclopédie Moderne, XXIII, Paris, 1852, 523-542.

Renny (Thomas). Ueber die trigonometrische Vermessung von Indien.
Ann. d. Erdkunde (Berghaus), VIII, 1833, 75-76; I, 1836, 353-359.

Renow (Fr.). Exposé de la méthode suivie pour la triangulation du département de la Sarthe.
4°, Le Mans, 1836, pp. 8, 1 plate. (Paris, National.)

Renwick (James): Sabine (E.). An account of experiments to determine the figure of the earth by means of a pendulum, vibrating seconds, in different latitudes. Revd. by —.
Journ. Frank. Inst., I, 1826, 164-172, 203-213.

——— On the plans, arrangements, and methods proposed and used by Mr. F. R. Hassler, with a view to an accurate survey of the coast of the United States by F. W. Bessel. Translated by —.
Am. Jour. Sci., XVI, 1829, 225-234; Phil. Mag. (Taylor), VI, 1829, 401-409; Hassler (F. R.). Documents relating to the survey of the coast, I, 1834, 50-67.
Commending the methods and instruments employed by Hassler for originality and excellence.

Rep. f. phys. Tech. (Carl), *for* Repertorium für physikalische Technik, für mathematische und astronomische Instrumentenkunde (Carl).
8°, München, 1866-'67.
Repertorium für Experimental-Physik, für physikalische Technik, mathematische und astronomische Instrumentenkunde (Carl).
8°, München, 1868+. (Washington, Patent Office.)

Repsold (Adolph). Beschreibung eines Basis-Mess-Apparates.
Astron. Nachr., LXX, 1868, 65-80.
Fol., Hamburg, 1869, pp. 13. (Berlin, Geodetic Institute.)
A report to the permanent Commission der europäischen Gradmessung. (Lithographed.)

———: **Chisholm (H. W.).** Comparison of the scale of — with standard yard.
1873-'74.
Title in full under CHISHOLM (H. W.)

Resal (Amé-Henri). Note sur la loi des petites oscillations du pendule simple dans un milieu résistant.
Nouv. Ann. de Math., XIX, 1860, 165-170.

Resal (Henry). Traité élémentaire de mécanique céleste.
2e éd., 4°, Paris, 1884, pp. xx, 468.
Revd. in Jahrb. üb. d. Fortschr. Math., XVI, 1884, 1078-1082, by L[AMPE].

——— Sur la courbure des lignes géodésiques d'une surface de révolution.*
Nouv. Ann. de Math., 1887, 57.

Respighi (Lorenzo). Sul moto dal pendolo. (H.)
Accad. Sci. Bologna, Mem., 1854, pp. 22.

——— Esperienze fatte al R. Osservatario del Campidoglio per la determinazione del valore della gravità.
Accad. d. Lincei, Atti, XII, 1882, 346-369.

Reuss (Jeremias David). Repertorium commentationum a societatibus literariis editarum. Secundum disciplinarum ordinem degessit J. D. Reuss.
v, Gottingæ, 1804.
Longitudo pendulorum, 79–80; Figura magnitudo telluris, 80–85; Attractio et densitas telluris, 85.

Reuter (A. P.). Vollständiges Handbuch der mathematischen Geographie mit einer kurzen Darstellung von Construction der Charten, künstlichen Erdkugeln, und barometrischen Höhen- und Nivellement-Bestimmungen, nebst einem Verzeichnisse der geographischen Längen, Breiten und Höhen der vorzüglicheren Oerter, zum Gebrauche für den Unterricht in den höheren Bildungsanstalten und zum Selbstunterricht.
8°, Mainz, 1828, pp. xxviii, 498, 5 plates. (British Museum.)
Gestalt der Erde, 78–97.

——— Lehrbuch der mathematischen und physikalischen Geographie für Gymnasien.
8°, Nürnberg, 1830, pp. xxviii, 466, 4 plates. (Berlin, Royal.)
Gestalt und Grösse der Erde, I, 42–64.

Revista Cien. Fís., Madrid, *for* Revista de los progresos de las ciencias exactas, físicas y naturales.
4°, Madrid, 1850–'62 (12 vols.). (Oxford, Bodleian.)

Rex (Fr. Wilhelm). Die trigonometrische Punkteinschaltung nach der Methode der kleinsten Quadrate unter Anwendung logarithmischer Differenzen.
Zeits. f. Vermes., x, 1881, 377–386.

Reymers (Nicolaum). Geodæsia Ranzoviana. Landrechnen und Feldmessen sammt messen allerley Grössen. Alles auf eine leichte, behende und vormahls unbekante neue Art künstlich, gründlich und deutlich beschrieben.
4°, Lipsiæ, 1583, pp. [84].
Simple land measuring.

Rheiner *und* Klose. Triangulirung des Grossherzogthums Baden.
Carlsruhe, 1873.
Title in full under KLOSE.

Rhind (William). On the irregularities of the earth's surface and the probable mean line of the terraqueous circumference.
Roy. Phys. Soc. Edinb., Proc., 1867, 149–152.

Riccardi (Pietro). Cenni sulla storia della geodesia in Italia dalle prime epoche fin oltre alla metà del secolo XIX.
4°, Bologna, 1879, pp. 100, 1 plate.
Reprinted from Accad. Sci. Bologna, Mem., x, 1879.

——— Costruzione di basi geodetiche stabili.
Accad. Sci. Bologna, Mem., VI, 1885, 678–682.

——— Sopra un antico metodo per determinare il semidiametro della terra. Nota del prof. Pietro Riccardi.
4°, Bologna, 1887, pp. 8, 1 plate.
Reprint from: Accad. Sci. Bologna, Mem., VIII, 1887.
The method here referred to was that of Maurolico, first published in his Cosmographia, Venetiis, 1543. He determined the distance from the top of a mountain of a known height to the horizon; then, regarding the earth as a sphere, computed the radius geometrically. The same method was afterwards adopted by others, each regarding it as original with himself.

Ricchebach (Giacomo). Esame imparziale della triangolazione del P. G. Ruggero Boscovich. Memoria postuma del canonico Giacomo Ricchebach.
4°, Roma, 1846, pp. 118, 1 plate. (British Museum.)

Ricci (G.). Exposé de l'état actuel des travaux de géodésie en Italie. Communiqué à la conférence internationale par le commissaire italien, lieutenant-général Ricci.
Int. Geod. Cong., Gen.-Ber., 1864, 18–21.

——— Rapporto intorno alla misura di una base nella pianura di Catania.
4°, Torino, 1867, pp. 19, 1 plate. (Gore.)

Riccioli (Giovanni Battista). Almagestum novum, astronomiam veterem novamque complectem, observationibus aliorum et propriis, novisque theorematibus, problematibus et tabulio promotam.
2 vols., fol., Bononiæ, 1651, I, pp. xlvii, 762.
De terræ simul et aquæ figura, 47–66.
II, pp. xviii, 675.
De magnitudine telluris, 585–592.

——— *et* **Grimaldi.** De semidiametro terræ.*
Fol., Bononiæ, 1665.

———: **Zach (F. X. von).** Notice sur les opérations géodésiques de —.
Corr. Astron. (Zach), II, 1819, 115–126.

Richarz (Franz) *und* König (Arthur). Eine neue Methode zur Bestimmung der Gravitations-Constante.
K. Ak. d. Wiss., Sitz.-Ber., 1884, 1203–1205; Nature, XXXI, 1885, 260, 484.

Riche de Prony (G.-C.-F.-M.). *See* **Prony (G.-C.-F.-M.-R. de).**

Richer (Jean). Observations sur l'inclinaison de l'aiguille aimantée et sur les différentes de longueur du pendule à Paris et à Cayenne.
Acad. d. Sci. Paris, Hist., i, 116–117.

——— De la longueur du pendule à secondes de temps (observée à Cayenne).
Acad. d. Sci. Paris, Mém., vii, 87–88.

——— Observations astronomiques et physiques faites en l'île de Cayenne.
(Printed in 1679), pp. 71.
It is No. 2 of Recueils d'observations faites en plusieurs voyages, par ordre de S. M. pour perfectionner l'astronomie et la géographie; avec divers traités astronomiques, par MM. de l'Académie royale des sciences, fol., Paris, 1693. (Oxford, Bodleian.)

Riemann (B.). Vorlesungen über Schwere, Elektricität und Magnetismus.*
Hannover, 1876.

Ritchie (Archibald Tucker). The dynamical theory of the formation of the earth, based on the assumption of its non-rotation during the whole period called "The Beginning."
2d ed., 8°, London, 1854, pp. xv, 704. (Washington, Congress.)

Ritter (Élie). Manuel théorique et pratique de l'application de la méthode des moindres carrés au calcul des observations.*
8°, Paris, 1853–'58.
POGGENDORFF, II, 1439.

——— Recherches sur la figure de la terre.
Soc. Phys. de Genève, Mém., xv, 1860, 441–465; XVI, 1862, 165–194.

Ritter (Friedrich). Ueber die Fehler der Winkelmessungen mittelst Theodolit.
Allg. Bauzeit. (Förster), XXXIII–IV, 1868–'69, 112–125.

Robert de Vaugondy (Didier). Mémoire sur une question de géographie pratique, si l'aplatissement de la terre peut être rendu sensible sur les cartes, et si les géographes peuvent le négliger sans être taxés d'inexactitude?
4°, Paris, 1775, pp. viii, 37. (Paris, National.)

Robert (Henri). Usage du table des longueurs du pendule.
8°, Paris, pp. 4, 1 plate.
Time-keepers.

Roberts (Frank C.). The figure of the earth.
Van Nostrand's Mag., XXXII, 1887, 228–242.
Afterwards published in Van Nostrand Science Series, No. 79, 18°, New York, 1885, pp. iv, 95. (Gore.)

Roberts (Michel). Sur quelque propriétés des lignes géodésiques et des lignes de courbure de l'ellipsoïde.
Journ. de Math. (Liouville), XI, 1846, 1–4.

——— Les lignes géodésiques sur l'ellipsoïde.
Journ. de Math. (Liouville), XII, 1847, 491–492.

——— Nouvelles propriétés des lignes géodésiques et des lignes de courbure sur l'ellipsoïde.
Journ. de Math. (Liouville), XIII, 1848, 1–11.

Roberts (William). Sur une ligne géodésique de l'ellipsoïde.
Journ. de Math. (Liouville), II, 1857, 213–216.

Roche (Édouard-Albert). Recherches sur la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XXVII, 1848, 443.

——— Note sur la loi de la densité à l'intérieur de la terre.
Acad. d. Sci. Montpellier, Mém., III, 1855–'57, 107–124; Acad. d. Sci. Paris, Comp. Rend., XXXIX, 1854, 1215–1217.

Rodenbach (Constantine). Note sur l'étalon prototype universel des mesures de longueur.
Acad. de Belgique, Bull., XXIX, 1870, 559–575.

Rodrigues. Mémoire sur l'attraction des sphéroïdes.
École Polytech., Corr., III, 1814–'16, 361–385.

Rodriguez (Joseph). Observations on the measurement of three degrees of the meridian in England by Lieut.-Col. William Mudge.
Roy. Soc. London, Phil. Trans., CII, 1812, 321–351; Journ. Nat. Phil. (Nicholson), XXXIII, 1812, 321–334; Phil. Mag. (Tilloch), XLI, 1813, 20–31, 90–100.
Attributes the error in this work to error in latitude determinations and to the formula used in computing the sides of the triangles.

———: **Gregory (O.).** Remarks on —'s animadversions on part of the trigonometrical survey of England.
Phil. Mag. (Tilloch), XLI, 1813, 178–194.

———: **Gregory (O.).** Dissertations and letters of — regarding the survey of England.
London, 1815.
Title in full under GREGORY (O.).

———: **Delambre (J.-B.-J.).** Réflexions sur un mémoire de — sur la mesure de trois degrés du méridien en Angleterre.
Conn. d. Temps, 1816, 256–274.

Rodriguez (Joseph)—Continued.
——— Ueber die Grössenverhältnisse des Erdsphäroids.
Zeits. f. Astron. (Lindenau), III, 1817, 71–81.

Röhl *und* **Assmann.** Trigonometrische Vermessung des Oderstromes.
Hertha, III, 1825, 327–369; V, 1826, 182–235; VII, 1826, 80–124; VIII, 1826, 5–34.

Roger (A.). Opérations trigonométriques au Grand Saint-Bernard.
Bibl. Univ. Genève, Arch., I, 1858, 241–256.

Rogers (Fairman). An account of the measurement of two base lines in Florida, Section VI, United States Coast Survey.
Journ. Frank. Inst., LX, 1855, 361–372; Polytechnisches Journ. (Dingler), CLXV, 1857, 180–185; Zeits. hannoverischen Architekten- und Ingenieur-Vereins, III, 1857, 113.

Rogers (William A.). Determination of the relation between the imperial yard and the metre of the archives. (Abstract.)
A. A. A. S., Proc., XXXII, 1883, 127.

Rogg (Ignaz). Handbuch der mathematischen Literatur vom Anfange der Buchdruckerkunst bis zum Schlusse des Jahres 1830. Erste Abtheilung, welche die arithmetischen und geometrischen Wissenschaften enthält.
Göttingen, 1830, pp. vi, 578. (Washington, Congress.)
List of abbreviations at the end. Praktische Geometrie [including geodesy], 410–480.

——— Ueber geodätische Ortsberechnungen und die geographische Lage von Tübingen.
4°, Stuttgart, 1856, pp. 16. (British Museum.)
Program des k. würtembergischen Gymnasiums in Ehningen zum Schluss des Studienjahres 1855–'56.

——— Abriss einer Geschichte der astronomisch-trigonometrischen Vermessungen im südlichen Deutschland und der Schweiz. Einladungsschrift des k. Gymnasiums in Ehningen.
4°, Stuttgart, 1859, pp. 32. (Berlin, Royal.)

——— Formeln und Tafeln zur geodätischen Ortsberechnung.
Zeits. f. Math. (Schlömilch), VI, 1861, 58–67.

——— Tafel der zuverlässigsten Breiten-Grad-Messungen.
Geogr. Mittheil. (Petermann), 1864, 311–312.
Good: Pennsylvania, East India, Good Hope (Maclear), French (1792–1802), English, Hanover, Holstein (Schumacher), Prussia, England and Scotland, Russia, and Skandinavia. Unreliable: Lacaille's Good Hope, Mason and Dixon, Boscovich's Italy, Lacaille, Cassini, France, Bugge, Denmark, and Maupertuis.

Rohde. Ueber noch fehlende Versuche mit dem Pendel. (H.)
Potsdam, 1820.

Roiffé (de la Peirrère de). Expérience du pendule de le Mercier aux Alpes du Valais.
Journ. Encyclopédique ou Universel, CXXX, 1772, 250.
It appears that le Mercier had found that there is an acceleration in the pendulum when it is elevated above sea-level.—HOUZEAU, II, 1164.

Rosén (Per Gustaf). Om de geodetiska och astronomiska ortsbestämmelserna i Sverige.
Svenska Sällskapet för Antropologi och Geografi, Geografiska Sektionens Tidskrift, I, No. 9, 1879, 28, 1 map.

——— Die astronomisch-geodätische Arbeiten der topographischen Abtheilung des schwedischen Generalstabes, 1882.
I: 4°, Stockholm, 1882–'85, pp. [ii], 168, 3 plates; II: 4°, Stockholm, 1888. (Southampton, Ordnance Survey.)

——— Bericht über die astronomisch-geodätischen Arbeiten I. Ordnung in Schweden.
Int. Geod. Cong., Verhandl., 1884–'86, 218–231.

Rosenberger (Otto August). Ueber die, auf veranstaltung der französischen Academie, während der Jahre 1736 und 1737 in Schweden vorgenommene Gradmessung.
Astron. Nachr., VI, 1828, 1–32.

Ross (James Clark). A voyage of discovery and research in the southern and Antarctic regions during the years 1839–'43.
4°, London, 1847, I, pp. lii, 366; II, pp. x, 447. (Washington, Coast Survey.)

Ross (John) : Sabine (E.). Beobachtungen über die Beschleunigung des Secundenpendels in höheren Breiten, angestellt unter —.
Ann. d. Phys. (Gilbert), LXIX, 1821, 402–416.

——— [A plan for measuring an arc of the meridian at Spitzbergen.]
Roy. Astron. Soc., Month. Not., VII, 1845–'47, 175.

Rossi (Michele Stefano de). Primi risultati delle osservazioni fatte in Roma ed in Rocca di Papa sulle oscillazioni microscopiche dei pendoli.
Bullettino del Vulcanismo Italiano, Roma, II, 1875, 103–106; Accad. d. Lincei, Atti, XXVIII, Sess. ii, 24, gennaio 1875.

Rothe (Heinrich August). Ueber Pendelschwingungen in grösseren Bogen.
Arch. f. Naturlehre (Kästner), II, 1824, 137–150.

Roudaire. Méridienne de Biskra, en Algerie.
Acad. d. Sci. Paris, Comp. Rend., LXXVIII, 1874, 1825–'28.

———: **Abbadie (A. d').** Note accompagnant la présentation des premiers résultats des observations sur les mouvements microscopiques des pendules librement suspendus, faites par —.
Acad. d. Sci. Paris, Comp. Rend., LXXX, 1875, 1236.

ROUMANIA.

BAROZZI (C.). Rapport sur les travaux géodésiques en Roumanie.
Int. Geod. Cong., Gen.-Ber., 1874, 74–75; 1875, 212–213; 1882, 123–126.

Roy (William). An account of the measurement of a base on Hounslow Heath.
Roy. Soc. London, Phil. Trans., LXXV, 1785, 385–480.

——— An account of the mode proposed to be followed in determining the relative situation of the royal observatories of Greenwich and Paris.
Roy. Soc. London, Phil. Trans., LXXVII, 1787, 188–196, 465–469.

Roy (William)—Continued.

——— Comparison of the celestial arc of the meridian, comprehended between the parallels of Greenwich and Perpignan, with the corresponding portion, measured and computed, of the terrestrial arc of the said meridian.
Roy. Soc. London, Phil. Trans., LXXVII, 1787, 197–228.

——— Description des moyens employés pour mesurer la base de Hounslow-Heath, dans la province de Middlesex. Publiée dans le vol. LXXV des Transactions philosophiques. Traduit de l'anglais par Prony.
4°, Paris, 1787, pp. xviii, 80, 5 plates. (British Museum.)

——— An account of the trigonometrical operations whereby the distance between the meridian of the royal observatories of Greenwich and Paris has been determined.
Roy. Soc. London, Phil. Trans., LXXX, 1790, 111–270.

———: **Dalby (J.).** Remarks on —'s account of trigonometrical operations.
Roy. Soc. London, Phil. Trans., LXXX, 1790, 593–614.

——— Description des opérations faites en Angleterre pour déterminer les positions respectives des observatoires de Greenwich et de Paris. Contenant les détails les plus circonstanciés sur les instruments qu'on a employés, les méthodes de travail qu'on a suivies, les résultats des observations et des mesures, etc. Traduite de l'anglais par R. de Prony.
4°, Paris, 1791, pp. vii, lxxx, 157. (Vienna, War Office.)

———: **Galbraith (W.).** Recomputation of —'s triangulation for connecting the observatories of Greenwich and Paris.
Roy. Astron. Soc., Month. Not., V, 1839–'43, 292–293.

Roy. Astron. Soc., Mem., *for* Memoirs of the Royal Astronomical Society.
4°, London, 1821+. (Washington, Observatory.)

Roy. Astron. Soc., Month. Not., *for* Monthly Notices of the Royal Astronomical Society.
8°, London, 1827+. (Washington, Observatory.)

Roy. Geogr. Soc., Journ., *for* Journal of the Royal Geographical Society.
8°, London, 1830+. (Washington, Congress.)

Roy. Institution, Journ., *for* Journal of the Royal Institution of Great Britain.
8°, London, 1802–'03 (3 vols.); 1830–'31 (2 vols.). (British Museum.)

Roy. Irish Acad., Proc., *for* Proceedings of the Royal Irish Academy.
8°, Dublin, 1836+. (Washington, Congress.)

Roy. Irish Acad., Trans., *for* Transactions of the Royal Irish Academy.
4°, Dublin, 1787+. (Washington, Congress.)

Roy. Scot. Soc. Arts., Trans., *for* Transactions of the Royal Scottish Society of Arts.
8°, Edinburgh, 1841+. (Washington, Patent Office.)

Roy. Soc. Edin., Proc., *for* Proceedings of the Royal Society of Edinburgh.
8°, Edinburgh, 1832+. (Washington, Observatory.)

Roy. Soc. London, Proc., *for* Proceedings of the Royal Society of London.
8°, London, 1854+. (Washington, Observatory.)

Roy. Soc. London, Phil. Trans., *for* Philosophical Transactions of the Royal Society of London.
4°, London, 1665+. (Washington, Observatory.)

Rozet (Claude-Antoine). Recherches relatives à l'influence des inégalités de la structure du globe sur la marche du pendule.
Soc. Philom., Proc.-Verb., 1842, 27–29.

——— Sur les inégalités des hauteurs de la colonne barométrique et de la longueur du pendule à la surface des eaux tranquilles.
Soc. Géogr., Bull, 1842–'43, 276–286; Soc. Philom., Proc.-Verb., 1843, 22–33.

——— *et* **Hossard (P.)**. Sur les causes probables des irrégularités de la surface de niveau du globe terrestre, des anomalies observées dans la direction de la verticale, la marche du pendule et la hauteur de la colonne barométrique ramenées à cette même surface.
Acad. d. Sci. Paris, Comp. Rend., XVIII, 1844, 180–185; Soc. Philom., Proc.-Verb., 1844, 18–22.

R. R. Eng. Journ., *for* The Railroad and Engineering Journal.
4°, New York, 1832+. (Washington, Patent Office.)

Rüdiger (W. von). Die Methode der kleinsten Quadrate abgeleitet aus der Wahrscheinlichkeitslehre und ihre Anwendung auf naturwissenschaftliche Messungen. Zum Selbstunterricht.
8°, Berlin, 1877, pp. 49. *Kuhn.* (Munich, Royal.)

Rüdgisch (R. von). Instrumente und Operationen der niederen Vermessungskunst.
2 parts, 8°, Cassel, 1875, pp. viii, 436. (British Museum.)
Ueber Gradmessungen, pp. 425–436.

Rümker (Karl Ludwig Christian). Observations à Londres sur la longueur du pendule simple.
Corr. Astron. (Zach), V, 1821, 66–67.

——— [Pendel-Beobachtungen.]
Astron. Nachr., III, 1824, 261–262.

——— Observations for determining the absolute length of the pendulum vibrating seconds at Paramatta, according to Borda's method.
Roy. Astron. Soc., Mem., III, 1827, pp. 277–298; Month. Not., I, 1827–'30, 75–76.

Rumovski (Stephanus). Experimenta circa longitudinem penduli simplicis minuta secunda oscillantis in urbe Selenginsk instituta.
Acad. de St.-Pétersbourg, Com., XI, 1765, 465–480.

——— Experimenta circa longitudinem penduli simplicis minuta secunda Kolæ Archangelopoli oscillantis.
Acad. de St.-Pétersbourg, Com., XVI, 1771, 567–585.

——— Meditatio de figura telluris exactius cognoscenda.
Acad. de St.-Pétersbourg, Acta, XIII, 1802, 407–417.

Runge (Carl). Ueber die Krümmung, Torsion und geodätische Krümmung der auf einer Fläche gezogenen Curven.
8°, Berlin, 1880, pp. 27. (Cambridge, University.)

Russel (W. H. L.). On the calculation of the potential of the figure of the earth.
Brit. A. A. S., Trans., XXXV, 1865, 8.

RUSSIA.

A. (G.). Sur les mesures récentes d'arcs du méridien effectués dans la partie nord-est de l'Europe.
Bibl. Univ. Genève, XXIII, 1853, 275–278.

BESSEL (F. W.). Nachricht von der Vereinigung der russischen Gradmessungen.
Astron. Nachr., X, 1833, 325–328.

CHANOINE. Les travaux géodésiques de la Société impériale géographique de Russie en Asie.
Soc. Géogr., Bull., XIV, 1877, 624–638.

ERMANN (G. A.). Ueber geodätische Arbeiten . . . des russischen Generalstabes.
Arch. Russ. (Ermann), I, 1841, 17–34; IV, 1845, 274–319.

FEDOROW (V. T.). Vorläufige Berichte . . . der astronomisch-geographischen Arbeiten.
St. Petersburg, 1838.

FORSCH (E.). Bericht über die geodätischen Arbeiten in Russland.
Int. Geod. Cong., Gen.-Ber., 1871, 42–52; 1874, 75–76; 1875, 213–214; 1876, 121-122; 1878, 105-106; 1880, 35; 1881–'82, 125–126.

——— Note sur les expériences avec le pendule, exécutées en Russie.
Int. Geod. Cong., Gen.-Ber., 1883, 29–30.

GOLDBACH (C. F.). . . . nebst einer Ankündigung einer geodätischen und astronomischen Vermessung im Gouvernement Moskau's.
Astron. Jahrb. (Bode), 1811, 211–212.

LITTROW (K. L. VON). Bericht über die österreichisch-russische Verbindungs-Triangulation.
K. k. Ak. d. Wiss., naturwiss. Cl., Sitz.-Ber., IX, 1852, 912–915; Denkschr., V, 1853, 111–128.

SANTINI (G.). Cenni storici intorno alla misura dell' arco del meridiano di 25° 20′ eseguita in Russia dal 1812 fino al 1852.
Accad. d. Sci. Padova, Rivista, X, 1862, 37–78.

SCHUBERT (T. F. DE). Sur la géodésie en Russie.
Corr. Astron. (Zach), IX, 1823, 171–175; XII, 1825, 76–89; St. Petersburg, 1832, 1842, 1858.

STEBNITZKI (J.). Bericht über die . . . ausgeführten geodätischen Arbeiten.
Int. Geod. Cong., Verhandl., 1884–'86, 200–204; 1887, XI, 1–3; Geogr. Mittheil. (Petermann), 1863, 340–344.

STRUVE (F. G. W.). Nachricht von der russischen Gradmessung.
Astron. Nachr., I, 1823, 67–68; II, 1824, 135–136, 145–148; VI, 1828, 391–394; VII, 1829, 385–400; X, 1833, 323–325; Corr. Astron. (Zach), XI, 1824, 23–33, 34–42; Dorpat, 1827, 1831; Dorpat, Jahrb., I, 1833, 87–89; Acad. de St.-Pétersbourg, Mém., II, 1833, 401–425; IV, 1850, 1–86; Recueil, Séance Publique, 1836, 103–108; Bull. Sci., VII, 1840, 280–288; VIII, 1850, 337–368; XI, 1853, 113–136; St. Petersburg, 1852, 1857; K. k. Ak. d. Wiss., Sitz.-Ber., XXI, 1856, 3–5.

STRUVE (O. VON). Ueber die geodätische Arbeiten in Russland.
Int. Geod. Cong., Gen.-Ber., 1884–'86, 204–218.

TENNER (C.). Nachricht von der Vollendung der Gradmessung Zwischen Donau und Eismeer.
Acad. de St.-Pétersbourg, 1853.

——— Verbindung der russischen Triangulation mit den preussischen bei Memel.
Breslau, 1858.

ANON. Uebersicht der astronomischen und geodätischen Arbeiten in Russland bis zum Jahre 1855.
Zeits. f. allg. Erdkunde, VI, 1859, 257–274.

RUSSIA—Continued.

ANON. Memoirs of the army topographic department of Russia. Vols. 1-41.
1837-'86.
In charge of Blaramberg, Forsch, Stebnitzki, Tutschkow. The entire work is printed in the Russian language, which renders the work useless to such a large class of geodesists, that no analysis of the work is deemed necessary in this place.

—— Anleitung zu den Berechnungen der trigonometrischen Aufnahme, und zu den Arbeiten des topographischen Büreaus; nebst die gehörigen Hülfstafeln.
St. Petersburg, 1826.
Russian and German.

Ryde (Edward). The Ordnance Survey of the United Kingdom.
Surveyor's Inst., Trans., XV, 1882-'83, ii, 25-62.

Ryff (Petrus). Quæstiones geometricæ in Euclidis et P. Rami quibus geodæsiam adjecimus per usum radii geometrici.
8°, Francofurti, 1606, pp. 135. (British Museum.)

—— Quæstiones geometricæ in Euclidis et P. Rami Στοιχειωσιν in usum scholæ mathematicæ collectæ a doctore —, Basil mathematum professore. Quibus geodæsiam adjecimus per usum radii geometrici. Postremo accessit commentatio optica, sive brevis tractatio de perspectiva communi diu optata nec no juventuti fatis perspicua.
16°, Oxoniæ, 1665, pp. 316. (Gore.)

S. Comparaison des observations du pendule à diverses latitudes, faites par MM. Biot, Kater, Sabine, de Freycinet et Duperrey.
Bull. Sci. Math. (Saigey), VII, 1827, 31-43, 171-184.

S. Nordamerikanische Vermessung.
Astron. Nachr., X, 1833, 385-388.

S. (F.): L'Isle de la Croyère (J.-N. de). Proposition de la mesure de la terre en Russie. Translated by —.
Roy. Soc. London, Phil. Trans., XL, 1737-'38, 27-51.

Sabine (Edward). An account of experiments to determine the acceleration of the pendulum in different latitudes.
Roy. Soc. London, Phil. Trans., 1821, 163-190.

—— Beobachtungen über die Beschleunigung des Secundenpendels in höheren Breiten, angestellt auf den Expeditionen unter Kapit. Ross und unter Kapit. Parry.
Ann. d. Phys. (Gilbert), LXIX, 1821, 402-416.

——: **Biot (J.-B.).** Exposé d'expériences avec le pendule par —.
Journ. d. Savans, 1825, 643-651; 1826, 3-18; 1827, 208-217; 1829, 205-222.

—— An account of experiments to determine the figure of the earth, by means of the pendulum vibrating seconds in different latitudes; as well as on various other subjects of philosophical inquiry.
4°, London, 1825, pp. xv, 509. (Washington, Observatory.)
Of which the first 372 pages relate to the pendulum observations.
Revd. in Monthly Review, CVIII, 1825, 270-278. Revd. by RENWICK (J.), Journ. Frank. Inst., I, 1826, 164-172, 203-213. Revd. in Bull. Sci. Math. (Saigey), VII, 1827, 25-28.

——: **Blosseville.** Note sur les observations du —.
Corr. Astron. (Zach), XIII, 1825, 422-427.

Sabine (Edward)—Continued.

——: **Francœur (L.-B.).** Résultats des expériences de — pour déterminer la longueur du pendule à secondes.
Soc. Philom., Bull., 1826, 65-66.

——: **Ivory (J.).** The grounds for adopting the ellipticity of the earth as deduced by —.
Phil. Mag. (Tilloch), LXVIII, 1826, 321-326.

—— On the measurement of an arc of the meridian at Spitzbergen.
Quart. Journ. Sci., XXI, 1826, 101-108.

—— An account of the arcs perpendicular to the meridian, which are now measuring on the continent of Europe.
Quart. Journ. Sci., I, 1827, 177-204.

—— An account of Prof. Carlini's pendulum experiments on Mont-Cenis.
Quart. Journ. Sci., II, 1827, 153-159.

—— Reply to Mr. Henderson's remarks on Capt. Sabine's pendulum observations.
Phil. Mag. (Taylor), II, 1827, 176-177.

—— Experiments to determine the difference in the length of the seconds pendulum in London and Paris.
Roy. Soc. London, Phil. Trans., CXVIII, 1828, 35-71.
Revd. in Bull. Sci. Math. (Saigey), X, 1828, 254-255.

—— Account of M. Bessel's pendulum experiments.
Quart. Journ. Sci., V, 1829, 1-27.

—— Experiments to determine the difference in the number of vibrations made by an invariable pendulum in the Royal Observatory at Greenwich, and in the house in London in which Capt. Kater's experiments were made.
Roy. Soc. London, Phil. Trans., 1829, 83-102.

—— Nouvelles expériences sur le pendule.
Corr. Math. (Quetelet).
Revd. by L. (Fr.), Bull. Sci. Math. (Saigey), XII, 1829, 236-239.

—— On the reduction to a vacuum of the vibrations of an invariable pendulum.
Roy. Soc. London, Phil. Trans., 1829, 207-239.

—— On the reduction to a vacuum of Capt. Kater's convertible pendulum.
Roy. Soc. London, Phil. Trans., 1829, 331-338.

——: **Fallows (Fearon).** Observations made with the invariable pendulum. Note by —.
Roy. Soc. London, Phil. Trans., 1830, 153-175.

—— Experiments to determine the difference in the number of vibrations made by an invariable pendulum in the royal observatories of Greenwich and Altona.
Roy. Soc. London, Phil. Trans., 1830, 239-249.

—— Experiments to ascertain the correction for variations of temperature, within the limits of the natural temperature of the climate of the south of England, of the invariable pendulum recently employed by British observers.
Roy. Soc. London, Phil. Trans., 1830, 251-255.

—— Experiments on the length of the seconds pendulum at the Royal Observatory of Greenwich.
Roy. Soc. London, Phil. Trans., 1831, 459-488.

Sabitsch (A. N.). *See* **Sawitsch (A. N.).**

Sabler (G.). Beobachtungen über die irdische Strahlenbrechung.*
Dorpat, 1839.

——: **Struve (F. G. W.).** *Résultats des opérations géodésiques de — . . . en 1836 et 1837.*
Acad. de St.-Pétersbourg, Bull. Phys. Math., VIII, 1850, 337–368; Conn. d. Temps, 1853, 49–78; Acad. d. Sci. Paris, Comp. Rend., XXX, 1850, 541–549.

Sadebeck (Benjamin Adolph Moritz). Triangulation der Stadt Breslau.
4°, Breslau, 1855, pp. 30. (British Museum.)
Festschrift zur Feier des 25jähr. Amtsjubiläums des Gymnasiums, Director Dr. Schönborn in Breslau.

—— Ueber die neueren, zur Bestimmung der Gestalt und Grösse der Erde unternommenen Messungen.
Schles. Ges., Jahresber., XLI, 1863, 23–24.

—— *und* **Bremiker (C.).** Bericht des Centralbüreaus der europäischen Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1868, 30–34.

—— Ueber die im Jahre 1869 ausgeführte geodätischen Arbeiten für die europäische Gradmessung.
Schles. Ges. Breslau, Ber., XLVII, 1869, 301–307.

—— Bericht über die Thätigkeit des geodätischen Instituts, 1869, 1870, 1872, 1873, 1878, 1879, 1880, 1881–'82.
Title in full under BAEYER (J. J.).

—— Entwickelungsgang der Gradmessungs-Arbeiten mit einer Uebersichtskarte der deutschen Gradmessungs-Arbeiten.
8°, Berlin, 1876.
VIRCHOW (R.). Sammlung gemeinschaftlicher Wissenchaften, Ser. XI, Heft 258, pp. 727–770.

—— Schreiben an den Herausgeber. [Regarding the precision of the "Küstenvermessung" and the "Bonner Basis".]
Astron. Nachr., LXXXVII, 1876, 29.

—— Zusammenstellung der Literatur des Gradmessungs-Arbeiten.
4°, Berlin, 1876.

—— Schreiben an den Herausgeber. [Containing a refutation of a theory advanced by Jordan concerning the mean error in angle measurements.]
Astron. Nachr., LXXXIX, 1877, 29–32.
See JORDAN. Ueber d. Bestimmung, etc.

—— Ueber den Einfluss der Lothablenkungen auf Winkelmessungen.
Astron. Nachr., XC, 1877, 113–118; XCI, 1877, 145–152.

—— Hilfstafel für die Differenz zwischen dem sphäroidischen und sphärischen Längen-Unterschiede zweier Punkte auf der Erdoberfläche.
Astron. Nachr., XCV, 1879, 207–220.

—— Literatur der praktischen und theoretischen Gradmessungs-Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1880, ix, 1–108.
Also published separately.

—— Das hessische Dreiecksnetz. Publication des königl. preuss. geodätischen Instituts.
4°, Berlin, 1882, pp. vi, 230, 5 plates. (Gore.)

—— Ueber eine neue Methode, die Ausdehnung von Maasstäben zu bestimmen.
Leopoldina, XIX, 1883, 141–144.

Sächs. Ges. Wiss., math.-phys. Cl., Ber., *for* Bericht der sächsischen Gesellschaft der Wissenschaften, mathematisch-physikalische Classe.
8°, Leipzig, 1849+. (Washington, Congress.)

Sänger (Theodor). Verallgemeinerung des zusammengesetzten Pendels.
8°, Cassel, 1880, pp. 35. (Berlin, Royal.)

Safford (Truman Henry). On the method of least squares.
Am. Acad., Proc., II, 1876, 193–201.

S[aigey (Jacques-Frédéric)]. Sur les opérations géodésiques exécutées en Italie par les ingénieurs-géographes français.
Bull. Sci. Math. (Saigey), III, 1825, 238–239; Conn. d. Temps, 1827, 385.

——: **Carlini (F.).** Lunghezza del pendolo. (Eff. Astron., Milano, 1824, 28–40.) Revd. by —.
Bull. Sci. Math. (Saigey), III, 1825, 298–301.
Title in full under CARLINI (F.).

——: **Ivory (J.).** On the theory of the figure of the earth. Phil. Mag., LXV, 1825, 241–249. Revd. by —
Bull. Sci. Math. (Saigey), V, 1826, 87–97.

——: **Ivory (J.).** Ellipticity of the earth as deduced from experiments made with the pendulum. (Phil. Mag., LXVIII, 1826, 92–101.) Revd. by —.
Bull. Sci. Math. (Saigey), VI, 1826, 269–270.

—— Comparaison des observations du pendule à diverses latitudes; faites par MM. Biot, Kater, de Freycinet et Duperrey.
Bull. Sci. Math. (Saigey), VII, 1827, 31–43, 171–184; Hertha, XIII, 1829, 287–290.

—— La pratique des poids et mesures du système métrique.*
16°, Paris, 1839.
POGGENDORFF, II, 735.

—— Sur la figure de la terre, déterminée par les observations du pendule.*
POGGENDORFF, II, 735.

Saint-Claire-Deville (Henri) *et* **Moscart (E.).** Sur la construction de la règle géodésique internationale.
Int. Geod. Cong., Gen.-Ber., 1878, 1–50; 1879, 1–12.

Saint-German (A. de). Sur la durée des oscillations du pendule composé.*
Soc. Math. de France, Bull., II.

Salneuve (J.-F.). Cours de topographie et de géodésie.
8°, Paris, 1841; 2e éd., Paris, 1850; 3e éd., Paris, 1869, pp. xviii, 663, 24 plates. (Gore.)

Samter (Heinrich). Theorie des Gaussischen Pendels mit Rücksicht auf die Rotation der Erde.
8°, Berlin, 1886, pp. 99. (Oxford, Bodleian.)

Sands (B. F.). Description and drawing of a convenient signal for observing on secondary stations. (Sands' heliotrope.)
U. S. C. and G. Survey, Rep., 1855, 364.

Sande Bakhuyzen (H. G. van de). Résumé des travaux géodésiques pendant l'année 1881. (Pays-Bas.)
Int. Geod. Cong., Gen.-Ber., 1881–'82, 84–85.

—— Résumé des travaux géodésiques exécutés dans les Pays-Bas en 1883.
Int. Geod. Cong., Gen.-Ber., 1883, 257–259.

Sande Bakhuyzen (H. G. van de)—Continued.

——— Résumé des travaux géodésiques exécutés dans les Pays-Bas en 1881.
Int. Geod. Cong., Gen.-Ber., 1881, 259–261.

——— Résumé des travaux géodésiques exécutés dans les Pays-Bas en 1884, 1885 et 1886.
Int. Geod. Cong., Verhandl., 1884–'86, 178–182.

——— Résumé des travaux géodésiques exécutés dans les Pays-Bas en 1887.
Int. Geod. Cong., Verhandl., 1887, viii, 1–3.

Sanders (Christopher Knight). A series of tables in which the weights and measures of France are reduced to the English standard.
8°, London, 1825, pp. 109. (Southampton, Ordnance Survey.)

Sang (Edward). Notice of an erroneous method of using the theodolite, with a strict analysis of the effects of various arrangements of readers.
Edinb. Phil. Journ., XXVI, 1838, 173–182; Roy. Scot. Soc. Arts, Trans., I, 1841, 264–273.
Criticising the method used by the Ordnance Survey. Also concludes that the same instrument is capable of giving much better results by the method of repetition than by that of single observations.

——— On a method of obtaining the greatest possible degree of exactitude from the data of a survey.
Edinb. Phil. Journ., XXVI, 1838, 327–346; Roy. Scot. Soc. Arts, Trans., I, 1841, 287–304.
Criticising the Ordnance Survey, saying their value of e is 1 : 149, and an error of 11″ would change it to 1 : 99 or 1 : 298. He also satirizes the method of allowing for spherical excess, which has been doubtfully computed, and showing their observed spherical excess gave for R. values differing from one another by nearly 7,000 feet. He also obtains five equations which contain all that is needed for deducing, with the greatest possible probability of exactness, the latitudes and longitudes of the station, and the figure of the earth from geodetical operations.

——— On the proper form for a convertible pendulum.
Edinb. Phil. Journ., XXXI, 1841, 34–38.

——— Pendulum.
Encycl. Brit., 8th ed., XVII, 1859, 376–388.

——— On our means for estimating the density and temperature of the earth.
Roy. Scot. Soc. Arts, Trans., X, 1883, 278–285.

Sanson. Instruction sur la disposition et la tenue des régistres de calculs géodésiques.
Fol., Paris, an XII (1804), pp. xvi, 10 tables. (Vienna, War Office.)

Sansone (Francesco). Measuring the earth's surface.
Pop. Sci. Month., XXX, 1886, 242–255.

Santini (B.). Sulla forza centrifuga terrestre in quanto sturba la direzione della gravità.
Annali d. Scienze Math. e Fisiche, VII, 1856, 445–453.

Santini (Giovanni). Elementi di astronomia, con le applicazioni alla geografia, nautica, gnonomica e cronologica.
4°, Padova, 1830, I, pp. vii, 303, 3 plates; II, pp. 366, 2 plates. (Oxford, Bodleian.)
Della figura della terra, II, 169–195.

——— Cenni storici intorno alla misura dell' arco del meridiano di 25° 20′ eseguita in Russia dal 1812 fino al 1852.
Accad. d. Sci. Padova, Rivista, X, 1862, 37–38.

Santini (Giovanni)—Continued.

——— Delle recenti ricerche intorno alla vera figura della terra, dedota dalle principali misure eseguite nella direzione de' suoi meridiani.
Ist. Veneto Mem., XI, 1862, 219–267. (Published separately.)
4°, Venezia, 1863, pp. 51.
A notice of the methods of Bessel, Schubert, and Clarke.

——— Relazioni intorno alle attrazioni locali risultanti nei contorni di Mosca dietro il confronto delle posizioni geodetiche con le osservazioni astronomiche instituti in diversi punti di quel circondario.
Ist. Veneto Mem., XII, 1864, 77–79.

——— Compendiata esposizione del modo più vantagiosa di risolvere una serie di equazioni lineari, risultante da osservazioni tutte egualmente probabili, per la determinazione degli elementi di una proposta teorica.
Ist. Veneto, Mem., XIV, 1870, 477–510.

Sawitsch (Alexis). Auszug aus Herrn C. F. Gauss' Untersuchungen über die Berechnung trigonometrischer Messungen.
Acad. de St.-Pétersbourg, Bull. Cl. Phys. Math., VI, 1848, 257–266.

———: **Struve (F. G. W.).** Résultats des opérations géodésiques de — . . . en 1836 et 1837.
Acad. de St.-Pétersbourg, Bull., VIII, 1850, 337–368; Conn. d. Temps, 1853, 49–78; Acad. d. Sci. Paris, Comp. Rend., XXX, 1850, 541–549.

——— Die Anwendung der Wahrscheinlichkeitstheorie auf die Berechnung der astronomischen Beobachtungen und geodätischen Messungen, oder die Methode der kleinsten Quadrate. Deutsch bearbeitet von C. G. Lais.
8°, Leipzig, 1863, pp. vi, 338. (British Museum.)
This is a translation of a work in Russian, published at St. Petersburg, 1857.

——— *and* **Lenz (R.).** Pendulum observations, made in 1865 at St. Petersburg, Torneå.*
Acad. de St.-Pétersbourg, Appendix.

——— *and* **Smyslow (P. M.).** Pendulum observations in 1866 at Pulkowa, Dorpat.*
Acad. de St.-Pétersbourg, Appendix.

——— Sur la détermination de la résistance de l'air au mouvement du pendule.
Acad. de St.-Pétersbourg, Bull., IX, 1866, 477–482; Mél. Math. Astron., III, 1866, 681–688.

——— *and* **Smyslow (P. M.).** Pendulum observations in 1868–'69, at St. Petersburg, Vilna.*
Acad. de St.-Pétersbourg, Appendix.

——— Les variations de la pesanteur dans les provinces occidentales de l'empire russe.
Roy. Astron. Soc., Month. Not., XXXI, 1871, 221–224; Mem., XXXIX, 1872, 19–29.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IV, 1872, 575, by GLR. [GLAISHER].

——— Analyse des observations faites au Caucase sur les refractions terrestre.
Acad. de St.-Petersbourg, Bull., XX, 1875.

———: **Plantamour (E.).** Recherches expérimentales sur le mouvement simultané d'un pendule et de ses supports. Revd. by —.
Astron. Ges., Vierteljahrs., XIII, 1878, 264–274.

Sawitsch (Alexis)—Continued.

——— Les longueurs du pendule à secondes à Pulkowa, St.-Pétersbourg, et aux différents points de la Russie occidentale, corrigées de l'influence produite par la flexion des supports du pendule construit par M. Repsold.
Roy. Astron. Soc., Mem., XLIV, 1877–'79, 307–315; Month. Not., XXXIX, 1878–'79, 365–366.

——— Quelques remarques sur la détermination de la longueur du pendule à secondes.
Int. Geod. Cong., Gen.-Ber., 1883, 30–32.

SAXONY.

BRUHNS (C.). Bericht über die geodätischen und astronomischen Arbeiten im Königreich Sachsen.
Int. Geod. Cong., Gen.-Ber., 1865, 35–37; 1866, 45–46; 1867, 12–15; 1872, 53–57; 1873, 29–32; 1875, 215–216; 1876, 122–123; 1877, 304–305; 1878, 106–110; 1880, 36–37.

NAGEL (A.). Bericht über die geodätischen Arbeiten im Königreich Sachen.
Int. Geod. Cong., Gen.-Ber., 1864, 37–41; 1870, 58–60; 1871, 54–55; 1881–'82, 126–129; 1884–'86, 218–227.

——— Die Vermessungen im Königreich Sachsen.
Dresden, 1876.

SCHIFFNER (A.). Ueber das gebrauchte Grundmass.
Ann. d. Erdkunde (Berghaus), VIII, 1833, 64–74; X, 1834, 85–100.

WEISBACH (J.). Auszug aus dem Bericht der k. sächs. Commission der mitteleuropäischen Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1863, 26–27; 1865, 32–35; 1866, 43–45; 1868, 49–53; 1869, 58–60.

——— Europäische Gradmessung im Königr. Sachsen. Astronomisch-geodätische Arbeiten für die Gradmessung im Königreiche Sachsen. 4 Abtheilungen.
4°, Berlin, 1882–'86.

Schaar (Matthieu). Sur le mouvement du pendule en ayant égard au mouvement de rotation de la terre.
Acad. de Belgique, Mém., XXVI, 1851, 1–14.

——— Rapport de M. Schaar sur un mémoire de M. Moligny relatif aux expériences pour déterminer la densité de la terre.
Acad. de Belgique, Bull., XIX, 1852, ii, 476–481.

Schäfer (Wilhelm). Entwickelung der Ansichten des Alterthums über die Gestalt und Grösse der Erde.
4°, Insterburg, 1868, pp. 26. (Gore.)

Schaefer (H. W.). Die astronomische Geographie der Griechen bis auf Eratosthenes.
8°, Flensburg, 1873, pp. 32. (Gore.)

Schaubach (Johann Konrad). Geschichte der griechischen Astronomie bis auf Eratosthenes.
8°, Göttingen, 1802, pp. xviii, 507, 4 plates. (British Museum.)
Vermuthung über die Krümmung der Erde, 229–281.

Scheffler (Hermann). Ueber die mittlere Dichtigkeit der Erde.
Zeits. f. Math. (Schlömilch), X, 1865, 224–227.

Schenk (J.). Ueber die Bestimmung der Dimensionen des Erdkörpers aus Messungen von Meridianbögen.*
Olmütz, n. d.

Scherffer (Karl). Trigonometrischer Versuch von der Wahl des Standes, aus welchen man die Entfernung zweyer Oerter àbmisst, deren nur einem beyzukommen ist, wenn in Bestimmung der nöthigen Winkel entweder nur in einem, oder in zweyen ein Fehler begangen wird.
8°, Wien, 1766, pp. 43, 2 plates. (Berlin, Royal.)

Schering (Ernst). Erweiterung des Gauss'schen Fundamentalsatzes für Dreiecke in stetig gekrümmten Flächen.
Ges. d. Wiss. Göttingen, Nachr., 1868, 389–391.

Schiaparelli (G. V.). Delle operazioni fatte negli anni 1857–'58–'64 alla R. specola di Brera per determinare il rapporto del klafter normale di Vienna col metro legale di Francia e colle pertiche impiegate nel 1788 per la misura della base del Ticino.
Ist. Lombardo, Rend., I, 1864, 312–316; 8°, Milano, 1866, pp. 41; Eff. Astron. Milano, 1866, 3–41.

——— Sulla compensazione delle reti trigonometriche di grande estensione.
Ist. Lombardo, Rend., II, 1865, 348–359; III, 1866, 27–41.

——— Sul principio della media arithmetica nel calcolo dei resultati delle osservazioni.
Ist. Lombardo, Rend., I, 1868, 781–778.

Schiaparelli (G. N.). Sur le principe de la moyenne arithmétique.
Astron. Nachr., LXXXVII, 1875, 55–58, 141–142.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 109.

Schiavoni (Federigo). Sulla misura della base geodetica eseguita in Puglia.
8°, Napoli, 1861, pp. 14. (Gore.)

——— Principii fondamentali intorno alla misura di una base geodetica esposti dal —.
8°, Napoli, 1862, pp. [ii], 62. (Gore.)

——— Confronto tra la base di Napoli e quella di Castelvolturno.*
8°, Napoli, 1863.

——— Intorno a' lavori geodetici nella città di Napoli.*
Napoli, 1863.

——— Relazione sulla base misurata ne' piani di Catania, e sulla rete circonstante.
Int. Geod. Cong., Gen.-Ber., 1865, 58–67.

——— Relazione sugli studii fatti per assegrare il coefficiente di temperatura, e la lunghezza della tesa del Spano inviata a Berlino.
Int. Geod. Cong., Gen.-Ber., 1866, 16–21.

——— Sulla base geodetica misurata in Sicilia nella piana di Catania l' anno 1865.
8°, Napoli, 1867, pp. 12, 1 plate. (Gore.)

——— Osservazioni geodetiche sul Vesuvio eseguite in aprile 1868.
4°, n. d., pp. 8, 1 chart. (Berlin, Geodetic Institute.)

——— Relazione sulle esperienze fatte 1869 nel gabinetto geodetico dello stato maggiore per determinare definitivamente il rapporto fra la tesa italiana e la prussiana.
4°, Napoli, 1869, pp. 26. (Berlin, Geodetic Institute.)

——— Relazione su' lavori geodetici che il corpo dello stato maggiore italiano va compiendo per contribuire alla misura del grado europeo.
Int. Geod. Cong., Gen.-Ber., 1871, 25–31.

——— Osservazioni geodetische sul Vesuvio, eseguite nell' anno 1872.
[Napoli, 1872], pp. 6, 1 plate.

Schiavoni (Federigo)—Continued.

——— Relazione sul calcolo della triangolazione di 1mo ordine, fra la Calabrie e la Basilicata.
Int. Geod. Cong., Gen.-Ber., 1872, 4–6.

——— Principii di geodesia.
I: Napoli, 1863, pp. [ii], 300, 9 plates; II: Napoli, 1864, pp. 226, 4 plates. (Berlin, Geodetic Institute.)

Schiegg (Ulrich). Ueber die Vermessung von Bayern, nebst Bemerkungen von Zach.
Mon. Corr. (Zach), VIII, 1803, 354–355; X, 1804, 253–267, 278–288.

Schiffner (Albert). Ein Wort über das bei den sächsischen Landesvermessungen gebrauchte Grundmass, ingleichen über die Breiten- und Längen-Angaben der Herren Oberreit und Lohrmann.
Ann. d. Erdkunde (Berghaus), VIII, 1833, 64–74.

——— Noch einige Bemerkungen über die sächsischen Landes-Vermessungen.
Ann. d. Erdkunde (Berghaus), X, 1834, 85–100.

Schimpf (Ernst Reinhold). Eine Verallgemeinerung des Pendelproblems.
8°, Halis Sax., 1882, pp. 32. (Oxford, Bodleian.)

Schindler. Ueber Fehler bei der Berechnung eines ebenen Dreiecks.*
4°, Prag.

Schinz (Emil). Ueber die Schwingungen des Reversionspendels im widerstehenden Mittel.
4°, Aarau, 1847. (Berlin, Royal.)
Zur Feier der 25. Lehrwirksamkeit des Rectors der Aargauischen Kantonsschule, 23–40.

Schlaefli (Ludwig). *Bemerkungen über confocale Flächen zweiten Grades und geodätische Linie auf dem Ellipsoid.*
Naturf. Ges. Bern, Mittheil., 1847, 97–101.

——— Lösung einer Pendel-Aufgabe.
4°, Bern, 1867, pp. 27. (Gore.)
[*Zum Lections-Katalog der Berner Hochschule, 1867.*]

Schlebach. Ueber Genauigkeit und Brauchbarkeit des Messrades bei gewöhnlichen Längenmessungen.
Zeits. f. Vermes., VI, 1877, 241–249.

———: **Koppe (C.).** Der Basisapparat des General Ibañez und die Aarberger Basismessung.
Nordhausen, 1881. Revd. by —.
Zeits. f. Vermes., XI, 1882, 95–98.

Schleicher (Franz Karl). Beiträge zur praktischen Messkunst.
8°, Frankfurt, 1793, pp. xvi, 144, 4 plates. (Berlin, Royal.)

Schlesinger (Josef). Eine neue Beweisführung über die Lehmann'schen Sätze bei der Pothenot'schen Aufgabe und Ableitung einer neuen Formel für die Basislänge des Fehlerdreiecks.
Arch. d. Math. (Grunert), LIV, 1872, 144–182.
The length of the base referred to is the distance between points occupied by a plane table.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IV, 1872, 579, by B[RUNS].

——— Der geodätische Tachygraph und das Tachygraph-Planimeter, Instrumente zur schnellen und genauen graphischen Construction der aus den Daten einer Theodolitvermessung herzustellenden Detail-

Schlesinger (Josef)—Continued.
pläne, sowie zur Ausmittlung der Flächeninhalte, nebst Studien über die Libelle und das umlegbare Nivellir-Fernrohr.
8°, 1877, pp. 115, 2 plates. *Falsey u. Frick.* (British Museum.)
Revd. by B[RUNS], Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 785–786.

Schleiben (Wilhelm Ernst August von). Vollständiges Hand- und Lehrbuch der gesammten niederen Messkunde.
3d ed., Leipzig, 1845, pp. XXVI, 432, 48 plates.
Simple surveying.

Schleyermacher *et* Eckhardt (C. L. P.). Mémoire sur la mesure de la base de Darmstadt.
Bibl. Univ. Genève, XI, 1819, 3–16, 81–100.

Schlömilch (Oscar). Ueber die Bestimmung der Wahrscheinlichkeit eines Beobachtungsfehlers.
Zeits. f. Math. (Schlömilch), XVII, 1872, 87–88.

Schmidt (Johann Karl Eduard). Bestimmung der Grösse der Erde aus den vorzüglichsten Messungen der Breitengrade.
Astron. Nachr., VII, 1829, 329–332; Roy. Astron. Soc., Mem., VI, 1833, 139; Phil. Mag. (Taylor), VII, 1830, 409–412.

——— Lehrbuch der mathematischen und physischen Geographie.
8°, Göttingen, 1829–'30, I, pp. xii, 564, 3 plates; II, pp. vi, 544, 1 plate. (Gore.)
Von der Gestalt der Erde im Allgemeinen, I, 33–45; Genauere Bestimmung der Grösse und Gestalt der Erde durch Gradmessungen, I, 162–241; Theoretische Untersuchungen über die Gestalt der Erde, I, 241–364; Bestimmung der Abplattung der Erde durch die an den verschiedenen Oertern gemessenen Längen des Secundenpendels, I, 365–437.

——— Ueber die Dimensionen des Erdkörpers.
Astron. Eph. für 1831, Göttingen, 1830, 105–108.

——— Ueber die Dimensionen der Erde.
Astron. Nachr., IX, 1831, 315–316, 371–372.

——— Mathematische Geographie, oder Darstellung unserer Erde, nach ihrem Stande und Verhältnisse zu den übrigen Himmelskörpern des gewöhnlichen Sonnensystems, so wie nach ihrer eigenthümlichen Grösse und der auf ihr durch Natur und Politik gemachten Eintheilung mit besonderer Berücksichtigung der auf ihr wohnenden Menschen. Für Schulen und zum Privatgebrauch.
4°, Leipzig, 1832, pp. 45, 5 plates. (Munich, Royal.)

Schneitler (C. F.). Die Instrumente und Werkzeuge der höheren und niederen Messkunst, sowie der geometrischen Zeichnenkunst, ihre Theorie, Construction, Gebrauch und Prüfung.
2d ed., 8°, Leipzig, 1848, pp. viii, 372; 4th ed., Leipzig, 1861, pp. xxxvi, 592.

——— Lehrbuch der gesammten Messkunst, oder Darstellung der Theorie und Praxis des Feldmessens, Nivellirens und des Höhenmessens, der militairischen Aufnahmen, des Markscheidens und der Aufnahme ganzer Länder, sowie der geometrischen Zeichnenkunst. Zum Selbststudium und Unterricht.
2d ed., 8°, Leipzig, 1854, pp. x, 388; 3d ed., Leipzig, 1861, pp. xii, 474. (Washington, Congress.)

Schoder. Schreiben an die Gradmessungs-Commission, 1866, 1868, 1869, 1870, 1873.
Title in full under BAUR (C. W.).

——— Ueber die Genauigkeit der Messungen mit Messstange und Messband.
Zeits. f. Vermes., II, 1873, 201–206.

——— [Bericht von der württembergischen Landesvermessung.]
Int. Geod. Cong., Gen.-Ber., 1874, 85.

——— Bericht über die geodätischen Arbeiten in Württemberg für das Jahr 1877.
Int. Geod. Cong., Gen.-Ber., 1877, 313.

——— Bericht über die geodätischen Arbeiten in Württemberg für die Jahre 1881–'82.
Int. Geod. Cong., Gen.-Ber., 1881–'82, 141–143.

Schols (Ch. M.). Over de theorie der fouten in de ruimte en in het platte vlak.
K. Ak. van Wetens. Amsterdam, Verhandel., XV, 1875.
Regarding the law of errors and their limits.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 114–115.

——— Over de aansluiting van een driehoeksnet van lagere orde aan een drie punten van een driehoeksnet van hoogere orde.
K. Ak. van Wetens. Amsterdam, Versl., XVI, 1880, 297–349.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XIII, 1881, 835–836, by G[EER (VAN)].

——— Le calcul de la distance et de l'azimut au moyen de la longitude et de la latitude.
Arch. Néerl., XVII, 1882, 101–167; K. Ak. van Wetens. Amsterdam, Versl., II, 1882–'83, xvii–xviii.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XIV, 1882, 942, by G[EER (VAN)]; Zeits. f. Vermes., XI, 1882, 555–568, 589–597, by F.

——— Over het gebrink van determinanten bij de metodé der kleinste kwadraten.*
Nieuwe Arch. d. Wisk., i.

——— Over de spherische behandeling van de spheroidische geodesie met normale doorsneden.
K. Ak. van Wetens. Amsterdam, Versl., XVIII, 1883, i.

——— Sur l'emploi de la projection de Mercator pour le calcul d'une triangulation dans le voisinage de l'équateur.
École Polytech., Ann., I, 1885, 1–64.

——— La courbure de la projection de la ligne géodésique.
École Polytech., Ann., II, 1886, 179–230.

Schott (Charles Anthony). Adjustment of horizontal angles.
U. S. C. and G. Survey, Rep., 1854, 70–86.

——— Probable error of observation derived from observations of horizontal angles at any single station depending on directions.
U. S. C. and G. Survey, Rep., 1854, 86–95.

———: **Peters (C. A. F.)**. [Probable error] from Astron. Nachr., XLIV, 1856, 29–32. Translated by —.
U. S. C. and G. Survey, Rep., 1856, 307–308.

———: **Maedler (J. H.)**. The figure of the earth. Translated by —.
Am. Journ. Sci., XXX, 1860, 46–52.

Schott (Charles Anthony)—Continued.

——— Problem in Geodesy. Determining a position by angles observed from it on any number of stations.
U. S. C. and G. Survey, Rep., 1864, 116–119.

——— Solution of normal equations by indirect elimination.
U. S. C. and G. Survey, Rep., 1855, 255–264.

——— Epping base line. Report on the method of computation and resulting connection with the primary triangulation.
U. S. C. and G. Survey, Rep., 1864, 120–144; 1866, 141.

——— Primary triangulation of the Atlantic coast. Geodetic connection of the two primary base-lines in New York and Maryland.
U. S. C. and G. Survey, Rep., 1866, 49–54.

——— Length of the Kent Island base.
U. S. C. and G. Survey, Rep., 1866, 140.

———: **Hayes (I. I.)**. Physical observations in the Arctic seas. Reduced by —.
Washington, 1867.
Title in full under HAYES (I. I.).

——— Method of adjustment of the secondary triangulation of Long Island Sound.
U. S. C. and G. Survey, Rep., 1868, 140–146.

——— Results of the measurement of an arc of the meridian.
U. S. C. and G. Survey, Rep., 1868, 147–153.

——— Connection of the primary base-lines on Kent Island, Md., and on Craney Island, Va., and on the accuracy of the intervening primary triangulation.
U. S. C. and G. Survey, Rep., 1869, 105–112.

——— Local deflection of the zenith in the vicinity of Washington.
U. S. C. and G. Survey, Rep., 1869, 113–115.

——— Adaptation of triangulations to the various conditions of configuration and character of the surface of country and other causes.
U. S. C. and G. Survey, Rep., 1871, 185–188.
Reprinted with additions, 1876, 391–399.

——— Peach Tree Ridge base, near Atlanta, Ga.
U. S. C. and G. Survey, Rep., 1873, 123–136.
Measurement by C. O. Boutelle.

——— *and* **Doolittle (M. H.)**. Method of closing a circuit of triangulation under certain conditions.
U. S. C. and G. Survey, Rep., 1875, 279–292.

——— The Pamplico-Chesapeake arc of the meridian and its combination with the Nantucket and the Peruvian arcs, for a determination of the figure of the earth from American measures.
U. S. C. and G. Survey, Rep., 1877, 84–95.

——— Primary triangulation between the Maryland and Georgia base lines.
U. S. C. and G. Survey, Rep., 1878, 92–120.

——— Comparisons of local deflections of the plumb-line.
U. S. C. and G. Survey, Rep., 1879, 110–123.

——— Description and construction of a new compensation base apparatus, with a determination of the length of two five-meter standard bars.
U. S. C. and G. Survey, Rep., 1882, 107–138.

Schott (Charles Anthony)—Continued.

——— Results for the length of the primary base-line in Yolo County, California, measured in 1881 by the party of George Davidson.
U. S. C. and G. Survey, Rep., 1883, 273–288.

——— International Geodetic Association of Europe. A review of Verhandlungen der vom 11. bis 15. September 1882, im Haag vereinigten permanenten Commission der europäischen Gradmessung.
Science, II, 1883, 656–658.

——— Connection of Lake and Coast Survey triangulations.
U. S. C. and G. Survey, Rep., 1884, 387–390.

——— Geographical positions of trigonometrical points in the States of Massachusetts and Rhode Island, determined by the United States Coast and Geodetic Survey between the years 1835 and 1885, and including those determined by the Borden Survey in the years 1832 to 1838.
U. S. C. and G. Survey, Rep., 1885, 285–439.

——— Results deduced from the geodetic connection of the Yolo base-line with the primary triangulation of California. Also a reduction and adjustment of the Davidson quadrilaterals forming a part of that triangulation.
U. S. C. and G. Survey, Rep., 1885, 441–467.

Schreiber (O.). Die königlich preussische Landes-Triangulation, Polar-Coordinaten, geographischen Positionen und Höhen sämmtlicher von der trigonometrischen Abtheilung der Landes-Aufnahme bestimmten Punkte von 34° bis 36° der Länge und von 53° der Breite bis zur Ostsee.
4°, Berlin, 1876, pp. [1], 443. (Berlin, Landesaufnahme.)
Herausgegeben von der trigonometrischen Abtheilung der Landes-Aufnahme.

——— Die königlich preussische Landes-Triangulation. Haupt-Dreiecke. Dritter Theil.
4°, Berlin, 1876, pp. vi, 340. (Berlin, Landesaufnahme.)
Herausgegeben von der Abtheilung der Landes-Aufnahme.

——— Ueber die Anordnung von Horizontalwinkel Beobachtungen auf der Station.
Zeits. f. Vermes., VII, 1878, 209–240.

——— Rechnungsvorschriften für die trigonometrische Abtheilung der Landesaufnahme. Formeln und Tafeln zur Berechnung der geographischen Coordinaten aus den Richtungen und Längen der Dreiecksseiten.
8°, Berlin, 1878. *Mittler u. Sohn.*
Erste Ordnung, pp. 26; Zweite Ordnung, pp. 24; Dritte Ordnung, pp. 13. (Berlin, Landesaufnahme).
Herausgegeben von der trigonometrischen Abtheilung der Landes-Aufnahme.

——— Richtungsbeobachtungen und Winkelbeobachtungen.
Zeits. f. Vermes., VIII, 1879, 97–149.

——— Die Resultate der Basismessung bei Göttingen.
Zeits. f. Vermes., XI, 1882, 1–17.

Schreiber (O.)—Continued.

——— Die Anordnung der Winkelbeobachtungen im Göttinger Basisnetz.
Zeits. f. Vermes., XI, 1882, 129–161.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XIV, 1882, 914–915, by B[RUNS].

———: **Jordan (W.).** Basis-Messung der preussischen Landesaufnahme unter der Leitung von —.
Zeits. Vermes., XII, 1883, 577–584.

——— Untersuchung von Kreistheilung mit zwei und vier Mikroscopen.
Zeits. f. Instrumentenkunde, VI, 1886, 1–5, 47–55, 93–104.

——— Bericht der trigonometrischen Abtheilung der königlich preussischen Landesaufnahme.
Int. Geod. Cong., Verhandl., 1887, x, 6–13.

——— Die königl. preussische Landestriangulation, IV. Theil, die Elbe Kette.
Berlin, 1887.

——— Ueber günstigste Gewichtsvertheilung.
Zeits. f. Vermes., XVIII, 1889, 57–59.

Schrenk (A. P. von). Resultate der Behufs der höchstverordneten Landes-Parzellar-Vermessung in den Jahren 1835, 1836, und 1837 ausgeführten Trianguliring des Herzogthums Oldenburg. Abgeleitet aus der hannoverischen Gradmessung.
Folio, Oldenburg, 1838, pp. 16, 1 map. (Berlin, Geodetic Institute.)

——— Bericht über die geodätischen Arbeiten in Oldenburg.
Int. Geod. Cong., Gen.-Ber., 1865, 21–29.

——— Bericht über die im Jahre 1866 im Grossherzogthum Oldenburg im Interesse der mitteleuropäischen Gradmessung ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1866, 22–26.

——— Bericht über die geodätischen Arbeiten in Oldenburg.
Int. Geod. Cong., Gen.-Ber., 1868, 25–29.

——— Schreiben an den Generallieutenant z. D. Baeyer [regarding the geodetic work in Oldenburg in 1870].
Int. Geod. Cong., Gen.-Ber., 1870, 29–30.

Schrötz (O.) *und* **Fearnley (C.).** Publication der norwegischen Commission der Gradmessung
Christiania, 1880–'82.
Title in full under FEARNLEY (C.).

Schubert (Friedrich Theodor). Problematis quisdam sphærici solutio.
Acad. de St.-Pétersbourg, Acta, XIV, 1786, 89–94 (Hist.).

——— Populäre Astronomie, von Friedrich Theodor Schubert.
8°, Hamburg, 1834, I, pp. xiv, 337, 1 chart; II, pp. xiv, 388, 5 plates; III, pp. xi, 391, 5 plates. (Washington Observatory.)
Gestalt und Grösse der Erde, ii, 51–75.

Schubert (T.-F. de). [Sur la géodésie en Russie.]
Corr. Astron. (Zach), IX, 1823, 171–175.

——— [Opérations géodésiques en Russie.]
Corr. Astron. (Zach), XII, 1825, 76–84, 84–89.

——— Anleitung zu den Berechnungen einer trigonometrischen Aufnahme, und zu den Arbeiten des topo-

Schubert (T.-F. de)—Continued.
graphischen Büreaus; nebst den dazu gehörigen Hülfstafeln. Verfasst für die Offiziere des Corps der Topographen von —.
8°, St. Petersburg, 1826, pp. viii, 92, [iii], 90; tables. (Berlin, Royal.)
German and Russian.

——— Notice historique sur les travaux géodésiques en Russie.*
St.-Pétersbourg, 1832.

——— Memoirs of the army topographic department of Russia.
Vols. 1-9, 1837-'44.

———: **Ermann (A.)**. Ueber die Resultat der Triangulation von —.
Arch. Rus. (Ermann), IV, 1845, 274-319.

——— Exposé des travaux astronomiques et géodésiques exécutés en Russie dans un but géographique jusqu'à l'année 1855.
4°, St.-Pétersbourg, 1858, pp. xvi, 877; Supplément, pp. 168; Supplement, No. 2, pp. 161, 1862, 6 loose maps. (Gore.)
Revd. in Zeits. f. allg. Erdkunde, VI, 1859, 257-274.

——— Essai d'une détermination de la véritable figure de la terre.
Acad. de St.-Pétersbourg, Mém., I, 1859, No. 6, pp. 32.
Revd. in Astron. Nachr., LI, 1859, 9-12; Geogr. Mittheil. (Petermann), 1859, 446; Roy. Astron. Soc., Month. Not., XIX, 1859, 104-107, by G. B. AIRY; Am. Journ. Sci., XXX, 1860, 46-52.

——— Sur l'influence des attractions locales dans les opérations géodésiques, et particulièrement dans l'arc scandinavo-russe.
Astron. Nachr., LII, 1860, 321-362.
Also published separately, 4°, Altona, 1860, pp. 22, 1 plate.

——— Ueber die Figur der Erde.
Astron. Nachr., LV, 1861, 97-112.

———: **Struve (O.)**. Ueber einen von — an die Academiè gerichteten Antrag betreffend die russisch-scandinavische Meridian-Gradmessung.
Acad. de St.-Pétersbourg, Bull., III, 1861, 396-424; Mél. Math. et Astron., III, 1866, 319-359.
Revd. in Geogr. Mittheil. (Petermann), 1861, 247.

[**Schultz, Marcard** *und* **Meineske.**] Die Landmesser und Feldmesser, ihre Ausbildung, Prüfung und Bestaltung, nebst den allgemeinen Vorschriften über Vermessungsarbeiten.
8°, Berlin, 1884, pp. 143. (Berlin, Royal.)

Schumacher (Heinrich Christian). Danish standards of length.
Quart. Journ. Sci., II, 1821, 184-185.

——— Skrivelse til Herr Doctor W. Obers i Bremen inholdende en Beskrivelse over det Apparat han har anvendt til Malingen af Standlinien ved Brak i Aaret 1820.
4°, Altona, 1821, pp. 12, 2 plates.
In German, 4°, Altona, 1821, pp. 13, 2 plates. (British Museum.)

——— Sur la triangulation du Danemark.
Corr. Astron. (Zach), I, 1825, 273-278.

Schumacher (Heinrich Christian)—Continued.
——— Populäre Vorlesungen von Bessel (F. W.).
Hamburg, 1848.
Title in full under BESSEL (F. W.).

———: **Peters (C. A. F.)**. Bestimmung der Länge des einfachen Secundenpendels, auf dem Schlosse Güldenstein. Aus den Beobachtungen von —.
Altona, 1855.
Title in full under PETERS (C. A. F.).

———: **Peters (C. A. F.)**. Bericht über die neue Berechnung der von — bei Braack gemessenen Basis.
Den danske Gradmaaling, I, 1872, 391-420.

Schur (Wilhelm): **Orff (C. von)**. Astronomisch-geodätische Ortsbestimmungen in Bayern. Revd. by —.
Astron. Ges., Vierteljahrs., XVI, 1881, 135-145.

Schwahn (Paul). Ueber Aenderungen der Lage der Figur und der Rotations-Axe der Erde, sowie über einige mit dem Rotationsproblem in Beziehung stehende geophysische Probleme.
4°, Berlin, 1887, pp. 51. (Berlin, Geodetic Institute.)

Schweins (Franz Ferdinand). Handbuch der Geodäsie.
8°, Giessen, 1811, pp. vi, 174, 4 plates. (Stuttgart, Royal.)

Schweizer (Kaspar Gottfried). Untersuchungen über die in der Nähe von Moscau stattfindenden Localattractionen.
Soc. Nat., Moscou, Bull., XXXVII, 1864, 96-171.

Schwenter (Daniel). Geometria practica nova. Tractatus II. Ohne einig künstlich geometrisch Instrument allein mit der Messruhte und etlichen Stäben (welche ein Landmesser dess Absteckens halben mit wol entrahten kan) zur Noht vielerley Weite, Breite, Länge, Höhe und Tieffe zu erkundigen. Allerley Flechen als Felder, Wisen, Holzwachs, Teiche, etc., auszumessen und dan solche wie auch Städte, Vestungen, Schlösser und andere Gebäu, in Grund zu legen und aufs Papier zu bringen oder die gerissenen Figuren abzutragen und auff dem Lande abzustecken.
8°, Nürnberg, 1617, pp. [xiii], 191. (British, Museum.)

Schwerd (Friedrich Magnus). Die kleine Speyerer Basis, oder Beweis, dass man mit einem geringen Aufwand an Zeit, Mühe und Kosten durch eine kleine genau gemessene Linie die Grundlage einer grossen Triangulation bestimmen kann.
4°, Speyer, 1822, pp. 99, 3 plates. (Gore.)

Schwering (K.). Neue geometrische Darstellung der geodätischen Linie auf dem Rotationsellipsoid.
Zeits. f. Math. (Schlömilch), XXIV, 1879, 405-407.

Science.
4°, New York, 1883+.

Sci. Mem. (Taylor), *for* Scientific Memoirs (Taylor).
8°, London, 1837-'47. (Washington, Congress.)

Sci. Mem. (Tyndall), *for* Scientific Memoirs, Natural Philosophy (Tyndall).
8°, London, 1852. (Washington, Congress.)

Scrymgeour (James). Narrative of experiments made with the seconds pendulum, principally in order to determine the hitherto unassigned amount of the influence of certain minute forces on its rate of motion.
Phil. Mag. (Tilloch), II, 1833, 244–251, 344–350, 434–442.

Secchi (Angelo). Sugli sperimenti del pendolo fatti in Roma a prova della rotazione della terra e per la determinazione assetuta della gravità.
Accad. d. Lincei, Atti, IV, 1850–'51, 325–346; Osservatorio, Mem., 1852, xxxviii–xlvi.

——— Sulle oscillazione del pendolo avuto riguardo alla rotazione della terra.
Ann. di Mat. (Tortolini), II, 1851, 238–242.

——— Descrizione degli istrumenti, adoperati nella misura della base romana sulla via Appia.
Corrisp. Scient., IV, 1856, 171–188.

——— Misura della base trigonometrica esegnita sulla via Appia per ordine del governo pontificio nel 1854–'55.
4°, Roma, 1858, pp. [i], 197, 5 plates. (Gore.)

——— Une nouvelle mesure de la base de Boscovich.
Acad. d. Sci. Paris, Comp. Rend., 1860, 377–378.

——— Schreiben an den Generallieutenant z. D. Baeyer.
Int. Geod. Cong., Gen.-Ber., 1869, 18–19.
Regarding the geodetic work in Italy for 1869.

——— Rapporto della commissione per la misura del meridiano centrale europeo negli Stati Pontifici.
Accad. d. Lincei, Atti, XXIV, 1871, 232–258.

——— Sur les expériences du pendule qui vont être entreprises dans le tunnel des Alpes occidentales.
Acad. d. Sci. Paris, Comp. Rend., LXXIII, 1871, 1192–1193.

Sédillot (Louis-Amédée). Notice historique sur le Coast Survey des États-Unis.
Soc. Géogr., Bull., I, 1851, 41–51.
Taken from the paper of Lt. C. H. DAVIS.

——— Sur les déterminations des arcs du méridien terrestre et les mesures de superficie des Arabes.
Soc. Géogr., Bull., I, 1851, 226–231.

Sedlaczek (Ernest). Tafel der auf die Bessel'schen Erddimensionen bezogenen Grössen und ihrer gemeinen und natürlichen Logarithmen in elf Stellen.
Wien, 1879, 1 lithograph plate. (Vienna, Geographic Institute.)

——— Mittheilungen des kaiserl. königl. militär-geographischen Institutes. Herausgegeben auf Befehl des k. k. Reichs-Kriegs-Ministeriums.
8°, Wien, 1881, pp. 124, vol. 1, 1881, mit 7 Beilagen. (Gore.)

——— Katalog der mit Ende 1881 vorhanden Bücherwerke des k. k. militär-geographischen Institute-Archives für den eigenen Gebrauch der Instituts-Abtheilungen zusammengestellt.
Wien, 1884; Nachträge, 1882–'87, 6 vols., Wien, 1884–'88. (Gore.)
This catalogue contains an analysis of all the serial publications in the library.

Sedlmayer (von). Theoretische Bestimmungen über die Grösse des Erd-Halbmessers.*
Sirius, VIII, 1875, 128.
Derived from the moon's constants and gravity.

Seeliger (Hugo). Ueber die Jacobi'sche Auflösung eines Systems von Normalgleichungen mit drei Unbekannten.
Astron. Nachr., LXXXII, 1873, 249–252.

——— Ueber die Vertheilung der Vorzeichen der nach einer Ausgleichung übrig bleibenden Fehler.
Astron. Nachr., XCVI, 1879, 49–62.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XI, 1879, 797 by B[RUNS].

——— Wahrscheinlichkeitsbetrachtungen über die Vertheilung zufälliger Fehler.
Astron. Nachr., XCVII, 1880, 289–304.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XII, 1880, 158–159, by B[RUNS].

Seelstrang (A.). Ideas sobre la triangulacion y mapá general de la república.*
8°, Buenos Aires, 1879.

Seetzen (D.). Geographische Bestimmung einiger Orte in Ungarn aus Liesganig's ungarischer Gradmessung, astronomisch und trigonometrisch bestimmten Orte.
Mon. Corr. (Zach), VII, 1803, 37–48.

Seidel (Günther Carl Friedrich). Eratosthenis geographicorum fragmenta. Edited by —.
12°, Gœttingæ, 1789, pp. xxii, 200. (Gore.)
The account of the determination of the arc between Alexandria and Syene is given on pp. 53–90.

Seidel (Ludwig). Ueber eine Anwendung der Wahrscheinlichkeitsrechnung bezüglich auf den Schwankungen in den Durchsichtigkeitsverhältnissen der Luft.
K. bayer. Ak. d. Wiss., Sitz.-Ber., II, 1863, 320–349.

——— Bericht der Gradmessungs-Commission, 1868.
Title in full under BAUERNFEIND (C. M. VON).

——— Ueber ein Verfahren die Gleichungen, auf welche die Methode der kleinsten Quadrate führt, sowie lineare Gleichungen überhaupt durch successive Annäherung aufzulösen.
K. bayer. Ak. d. Wiss., Abhandl., XI, 1874, iii, 81–108.

——— Ueber die Berechnung der wahrscheinlichsten Werthe solcher Unbekannten zwischen welchen Bedingungsgleichungen bestehen.
Astron. Nachr., LXXXIV, 1874, 193–210.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VI, 1874, 279, by B[RUNS].

Selander (Nils Haquin). Gradmätning och nivellering i Lappland.
K. Ak. Widens., Öfversigt, VII, 1850, 250–252.

——— : **Struve (F. G. W.).** Arc du méridien de 25° 20′ mesuré depuis 1816 jusqu'en 1850 sous la direction de —.
St.-Pétersbourg, 1857, 1860.
Title in full under STRUVE (F. G. W.).

Senarmont (Henri-Hureau de). Sur quelques instruments imaginés par M. Porro, pour abréger et simplifier les opérations de la géodésie, de la topographie, du nivellement et de l'arpentage.
Ann. d. Mines, XVI, 1849, 383–426.

Sereni (Carlo). Geodesia.*
8°, Roma, 1829, 16 tables.

Servier *et* Peytier. Sur les opérations géodésiques exécutées en Morée, en 1829–'30.
Conn. d. Temps, 1835, 63–76.
Revd. in Soc. Géogr., Bull., XIX, 1833, 89–106.

Servus (H.). Geschichte des Fernrohrs bis auf die neuste Zeit, mit acht in dem Text gedruckten Abbildungen.
8°, Berlin, 1886 [1885], pp. iv, 134. (Oxford, Bodleian.)

Seyffer (Karl Felix von). De positu basis et retis triangulorum impensa Regis per totam Bojoariam porrectorum ad meridianum speculæ astronomicæ Regiæ relato azimuthis observatis et ad calculos revocatis nunc primum definito.
K. bayer. Ak. d. Wiss., Denkschr., III, 1811–'12, 449–521.
Also issued as a separate.

Sheepshanks (Richard). [Account of his experiments for restoring the standard yard.]
Roy. Astron. Soc., Mem., XVI, 1847, 423–494, 541–542; XVII, 1849, 146–147; XVIII, 1850, 188–189; XIX, 1851, 262; XX, 1851, 218; XXI, 1852, 201; XXII, 1854, 235–238; XXIII, 1854, 100–103; XXIV, 1856, 230–233.

Short (James). An account of a book entitled: P. D. Pauli Frisii Mediolanensis, "Disquisitio mathematica in causam physicam figuræ et magnitudinis telluris nostræ", Milan, 1752.
Roy. Soc. London, Phil. Trans., 1753, 5–17.

Shortrede (Robert). Logarithmic and new astronomical and geodesical tables.
4°, Edinburgh, 1844, pp. iii, 634. (Oxford, Bodleian.)

——— On the latitude of Dehra, and of the disturbing attraction of the Himalayas, 1848.
Roy. Astron. Soc., Mem., XVII, 1849, 93–106.

Shuckburgh-Evelyn (George Augustus William). Account of some endeavors to ascertain a standard of weights and measures.
Roy. Soc. London, *Phil.* Trans., LXXXVIII, 1798, 133–182.
Revd. in Bibl. Brit. Genève, X, 1799, 189–228.

Sickdhar (Babu Radhanath). Tables to facilitate the computation of a trigonometrical survey, and the projection of maps for India. Computed and arranged by Babu Radhanath Sickdhar. Published by order of Lt. Col. A. S. Waugh. For the use of the survey department.
8°, Calcutta, pp. xvi, 30. (Gore.)

Sid. Mess., *for* Sidereal Messenger.
4°, Cincinnati, 1846–'48. (Washington, Observatory.)

Siebert (John S.). The heliotrope and its uses.
Eng. Soc. of Lehigh Univ., Journ., I, 1885, 31–34.

Siefert (Otto). Entwickelung der Ansichten des Alterthums über Gestalt und Grösse der Erde.*
Separatabdruck aus dem Program des Gymnasiums zu Insterburg 1868.

Siegfried. Bericht über die geodätischen Arbeiten in der Schweiz für das Jahr 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 112.

SIGNALS.

BOUTELLE (C. O.). Description of tripods and scaffolds.
U. S. C. and G. Survey, Rep., 1855, 361–363; 1882, 199–208.

——— Geodetic night signals.
U. S. C. and G. Survey, Rep., 1880, 96–109.

C. Geodetic observations by night.
Journ. Frank. Inst., CIV, 1877, 227.

CARLINI (F.). Esposizione delle osservazioni di signali a polvere.
Eff. Astron., Milano 1828, 33–36; 1829, 25–33.

SIGNALS—Continued.

CUTTS (R. D.). Signals.
U. S. C. and G. Survey, Rep., 1882, 156–160.

FARLEY (J.). Description of a convenient signal.
U. S. C. and G. Survey, Rep., 1855, 363–364.

HILGARD (J. E.). Description of a new form of geodetic signals.
U. S. C. and G. Survey, Rep., 1867, 145.

JAMES (H.). Sketches of scaffolds erected over the stations of the Ordnance Survey.
Southampton, 1865.

LAUSSEDAT (A.). Sur l'emploi des signaux lumineux dans les opérations géodésiques.
Acad. d. Sci. Paris, Comp Rend., LXXVIII, 1874, 898–901.

MARTINS (C.). Une station géodésique au sommet du Canigou.
Paris, 1872.

PASCHEN (F.). Ueber das sogenannte Drehen der Beobachtungspfeiler.
Astron. Nachr., LXIII, 1865, 49–72.

PERRIER (F.). Étude comparative des observations de jour et de nuit.
Int. Geod. Cong., Gen.-Ber., 1875, 144–150; Acad. d. Sci. Paris, Comp. Rend., LXXXIV, 1877, 1312–1315, 1380–1383; Int. Geod. Cong., Gen.-Ber., 1877, 59–65.

SANDS (B. F.). Description of a convenient signal.
U. S. C. and G. Survey, Rep., 1855, 364.

WERNER (W.). Die Winkelmessungen bei Tage und bei Nacht.
Zeits. f. Instrumentenkunde, III, 1883, 225–237.

WILSON (O. S.). Method of reconnoissance, signal building and naming of stations.
Final Results N. Y. State Survey, 1887, 115–122.

——— Night signals for geodetic work.
Science, I, 1883, 70–71.

ZACH (F. X. VON). Sur les signaux de feu.
Corr. Astron. (Zach), VII, 1822, 272–273.

Sigorgne (de) Démonstration de la création immédiate de la terre en état solide, et de l'impossibilité des causes physiques pour la formation de sa figure.
Bibl. Brit. Genève, XXXVIII, 1809, 99.

Silva (Francisco Maria Pereira da). Rapport sur l'état des travaux géodésiques du Portugal en 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 190–205.

——— Direcção geral dos trabalhos geodesicos topographicos, hydrographicos e geologicos do reino. Relatorio do anno de 1875.
8°, Lisboa, 1876, pp. 43. (Vienna, Geographic Institute.)

——— Direcção geral dos trabalhos geodesicos, topographicos, hydrographicos e geologicos do reino. Relatorio dos trabalhos executados n'esta direcção durante o anno de 1874.
8°, Lisboa, 1876, pp. 18. (Vienna, Geographic Institute.)

——— Rapport sur les travaux géodésiques, topographiques, hydrographiques, et géologiques du Portugal, 1878.
8°, Lisbonne, 1878, pp. 53, 4 plates. (Vienna, Geographic Institute.)

——— Rapport sur les travaux géodésiques en Portugal pendant l'année 1877.
Int. Geod. Cong., Gen.-Ber., 1877, 302–304.

——— Travaux géodésiques exécutés en Portugal pendant l'année 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 96–98.

Simon. Mémoire sur les opérations géodésiques et topographiques du département du Calvados.
Acad. de Caen, Mém., 1829, 155–168.

Simon (Paul). Gewichtsbestimmung für Seitenverhältnisse in schematischen Dreiecksnetzen.
4°, Berlin, 1889, pp. 39. (Gore.)
Veröffentlichung des königl. preussichen Geodätischen Instituts.

———: **Gauss (C. F.).** Abhandlungen zur Methode der kleinsten Quadrate.
Berlin, 1887.
Title in full under GAUSS (C. F.).

Simons (P.). Triangulation du royaume de Belgique exécutée par MM. les officiers de la section géodésique du dépôt de la guerre. Mesure des bases et observations astronomiques. Publiée avec l'autorisation de M. le Ministre de la guerre.
4°, Bruxelles, 1867, pp. vi, 728. (Southampton, Ordnance Survey.)

——— Schreiben an den Generallieutenant z. D. Baeyer.
Int. Geod. Cong., Gen.-Ber., 1869, 4–5.
Concerning the geodetic work done in Belgium during 1869.

——— Rapport sur les travaux géodésiques exécutés en Belgique pendant l'été de 1870.
Int. Geod. Cong., Gen.-Ber., 1870, 6.

Simpson (T.). Mathematical dissertations.
4°, London, 1740.
One finds in this several curious memoirs on the figure of the earth.—LALANDE, 420.

Siraped (William-Smith de). De la forme de la terre et son influence sur la géographie et l'astronomie; mémoire présenté à l'Académie des sciences de Philadelphie par —. Traduit par Lamarche.
8°, Paris, 1828, pp. 52, 1 plate. (Berlin, Geodetic Institute.)

Skogman (C.). Completion of the preliminary survey of Spitzbergen, undertaken by the Swedish Government with the view of ascertaining the practicability of the measurement of an arc of the meridian.
Roy. Soc. London, Proc., XIII, 1864, 551–553.

Sloudsky (Th.). Problème principal de la haute géodésie.*
Moscou, 1883. *Katkoff.*
Revd. in Jahrb. üb. d. Fortschr. d. Math., XVI, 1884, 1081–1082, by P[ETZOLD].

——— Essai de solution du problème géodésique.*
Moscou, 1884. *Katkoff.*
Jahrb. üb. d. Fortschr. d. Math., XVI, 1884, 1082.

——— La figure de la terre d'après les observations du pendule.*
Moscou, 1886.

Smith (Edwin). Determinations of gravity with the Kater pendulums at Auckland, New Zealand; Sydney, New South Wales; Singapore, British India; Tokio, Japan; San Francisco, Cal.; and Washington, D. C.
U. S. C. and G. Survey, Rep., 1884, 439–473.

Smith (Henry John Stephen). On a property of a small geodesic triangle on any surface.
Brit. A. A. S., Rep., 1882, 548.

Smith (William). Terrestrial measurement between the observatories of Norriton and Philadelphia, with the difference of latitude and longitude thence deduced.
Am. Phil. Soc., Trans., I, 1771, 114–120.

Smyslow (P. M.) *et* Sawitsch (A. N.).
Titles in full under SAWITSCH (A. N.).

Smyth (R.) *and* Thuillier (H. L.). Manual of surveying for India, detailing the mode of operations on the trigonometrical, topographic, and revenue surveys of India.
Calcutta, 1851–'55.
Title in full under THUILLIER (H. L.).

Snellius van Roijen (Willebrord): Cassini (J.). Sur la mesure de la terre par —.
Acad. d. Sci. Paris, Mém.. 1702, 60–66.
Title in full under CASSINI (J.).

———: **Cassini de Thury (C.-F.).** Jonction de la méridienne de Paris avec celle de —.
Acad. d. Sci. Paris, Mém., 1748, 123–132.
Title in full under CASSINI DE THURY (C.-F.).

———: **Delambre (J.-B.-J.).** Histoire de l'astronomie moderne. Treats of ———
II, 1821, 92–125.

———: **Oudemans (J. A. C.).** Het problema van —.
K. Ak. van Wetens., Versl, XIX, 1885, 436–441.

——— Eratosthenes Batavus, seu de terræ ambitus vera quantitate suscitatus.
12°, Lugduni Batavorum, 1617, pp. [x], 263, [1]. (Oxford, Bodleian.)

Soc. Belge Géogr., Bull., *for* Bulletin de la Société belge de géographie.
8°, Anvers, 1870+. (Washington, Congress.)

Soc. Géogr. Bull., *for* Bulletin de la Société de géographie.
8°, Paris, 1821+. (Washington, Congress.)

Soc. Nat. Moscou, Bull., *for* Bulletin de la Société impériale des naturalistes.
8°, Moscou, 1829+. (Washington, Congress.)

Soc. Ital. Verona, Mem. Mat. Fis., *for* Memorie di matematica e di fisica della Società italiana delle scienze.
4°, Verona, 1782+.

Soc. Mex. Geogr., Bol., *for* Boletin de la Sociedad mexicana de geografía y estadística.
8°, México, 1861–'65 (11 vols.). (Washington, Congress.)

Soc. Philom., Bull., *for* Bulletin de la Société philomatique de Paris, Bulletin des sciences.
8°, Paris, 1791–1811; Nouveau Bulletin, 1814–'26, 1832–'33. (Cambridge, University.)

Soc. Phys. Genève, Mém., *for* Mémoires de la Société de physique et d'histoire naturelle de Genève.
4°, Genève, 1821+. (Washington, Congress.)

Soc. Sci. Montpellier, Rec. d. Bull., *for* Recueil des bulletins de la Société libre des sciences et belles-lettres.
8°, Montpellier, 1803–'15 (6 vols.). (Oxford, Bodleian.)

Soc. Sci. Neuchâtel, Bull., *for* Bulletin de la Société des sciences naturelles.
8°, Neuchâtel, 1843+. (Washington, Congress.)

Soc. Sci. Upsala, Acta, *for* Acta literaria et scientiarum sueciæ.
4°, Upsaliæ, 1730–'39 (20 vols.). (Oxford, Bodleian.)

Sohncke (Ludwig Adolph). Bibliotheca mathematica. Verzeichniss der Bücher über die gesammten Zweige der Mathematik, als: Arithmetik, höhere

Sohncke (Ludwig Adolph (—Continued.
Analysis, construirende und analytische Geometrie, Mechanik, Astronomie und Geodäsie, welche in Deutschland und dem Auslande vom Jahre 1830 bis Mitte des Jahres 1854 erschienen sind.
8°, Leipzig, 1854, pp. ix, 388. (Gore.)

Soldner (Johann von). Vorschlag zur Grad-Messung in Afrika.
Mon. Corr. (Zach), IX, 1804, 357–362.

——— Ueber die kürzeste Linie auf dem Sphäroide.
Mon. Corr. (Zach), XI, 1805, 7–22.

——— Ueber die schwedische Messung des Meridiangrades.
Astron. Jahrb. (Bode), 1806, 268.

Soleil (Henri). Note sur une mesure de longueur invariable avec les changements de température.
Acad. d. Sci. Paris, Comp. Rend., LXIX, 1869, 954.

Sonderhof (A.). Die geodätischen Correctionen der auf dem Sphäroid beobachteten Horizontalwinkel.
Arch. d. Math. (Grunert), LI, 1870, 20–41,
Nachtrag zu der Abhandlung: Die geodätischen Correctionen, etc. [the above], pp. 42–45.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869–'70, 838, by BRUNS.

——— Ein Beitrag zur höheren Geodäsie.
Zeits. f. Math. (Schlömilch), XVII, 1872, 89–128, 177–231.
As a separate, 8°, Leipzig, 1872, pp. i–vii, 1–95.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IV, 1872, 576, by B[RUNS].

Späth (Johann Leonhard). Geodäsie, oder Anweisung zum Feldmessen, zum Gebrauch auf Schulen.
Allg. litt. Zeit., 1790, ii, 267; Gött. Anzeigen, 1791, ii, 806.

——— Die höhere Geodäsie, oder die Wissenschaft, die Reiche der Erde, und diese selbst, geographisch aufzunehmen und zu chartieren.
8°, München, 1816, pp. xii, 436, 4 plates. (Gore.)

SPAIN.

ADAN (E.-H.-J.). La jonction géodésique entre l'Espagne et l'Algérie.
Acad. de Belgique, Bull., I, 1881, 8–18.

BARRAQUER (J.-M.). Jonction géodésique de l'Algérie avec l'Espagne.
Int. Geod. Cong., Gen.-Ber., 1880, 47–53.

FENNER (P.). Das Verbindungsviereck zwischen den Dreiecksnetzen von Spanien und Algier.
Zeits. f. Vermes., XI, 1882, 303–308.

IBAÑEZ (C.). Exposé de l'état des travaux géodésiques poursuivis en Espagne.
Int. Geod. Cong., Gen.-Ber., 1865, 57–58; 1869, 62–65; 1870, 69–70; 1871, 65–66; 1872, 57–58; 1874, 83–85; 1875, 219–222; 1876, 125–128; 1877, 309–312; 1878, 112–115; 1879, 115–117; 1880, 41–47; 1881–'82, 134–141; 1883, 283–285; 1884–'86, 124–127; 1887, xiii, 1–3.

——— Memorias del Instituto geográfico y estadístico.
7 vols., Madrid, 1875–'88.

——— Jonction géodésique et astronomique de l'Algérie avec l'Espagne.
Paris, 1886.

LAUSSEDAT (A.). Notice sur les travaux géodésiques de la carte d'Espagne.
Acad. d. Sci. Paris., Comp. Rend., XLVIII, 1859, 473–475; LXII, 1866, 1007–1010.

——— Note relative au prolongement de la méridienne de France et d'Espagne en Algérie.
Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1492–1500.

SPAIN—Continued.

N. (T. H.). A feat in triangulation.
Nature, XXI, 1880, 157–158.

OESFELD. Andeutungen zu zwei wichtigen geodätischen Operationen.
Ann. d. Erdkunde (Berghaus), VIII, 1833, 394–396.

PERRIER (F.). Jonction géodésique de l'Espagne avec l'Algérie.
Acad. d. Sci. Paris, Comp. Rend., LXXXIX, 1879, 885–889; Observatory, III, 1880, 326–327; Int. Geod. Cong., Gen.-Ber., 1880, 47–53; Acad. d. Sci. Paris, Comp. Rend., CIV, 1887, 1817–1821.

REITZ (F. H.). Ueber die trigonometrische Verbindung von Spanien und Algerien.
Hamburg, 1883.

ANON. Estados de las operaciones geodésicas de España en 1° de abril de 1869.
8°, Madrid, 1869, pp. 15, 1 map.

Sparre (de). Sur le pendule de Foucalt.
8°, Bruxelles, 1883, pp. 16.

Spencer (Herbert). The form of the earth no proof of original fluidity.
L., E., D. Phil. Mag., XXX, 1847, 194–196.

Spencer (J. C.). Plan for reorganization of the Coast Survey, with directions and instructions from the Treasury Department, June 3, 1843.
8°, [Washington, 1843]. (Gore.)

SPHEROID, BESSEL'S.

ALBRECHT (T.). Die Umkehrung der Bessel'schen Methode der sphäroidischen Uebertragung.
Astron. Nachr., XCVI, 1880, 209–218.

BRUNS (H.). Ueber die Umkehrung der Bessel'schen Methode der sphäroidischen Uebertragung.
Astron. Nachr., XCVII, 1880, 73–74.

Stähelin (Chr.). Die Lehre der Messung von Kräfte mittelst der Bifilarsuspension. (H.)
4°, [Basel, 1852], pp. 204, 9 plates.

Stambucchi. Triangolazione della città di Milano e suoi sobborghi.*

Stamkart (F. J.). Verhandeling over de meetkundige inhoudsvinding der Nederlandsche Matendoor.*
's Gravenhage, 1844.
Sohncke, 292.

——— Over het bepalen van kleine verschillen tusschen lengte afmetingen.*
Amst., 1851.

——— Over de basismeting in de Haarlemmermeer in den zomer van het jaar 1868.
K. Ak. van Wetens., Mededeelingen, IX, 1869, iii, 267–294.

——— Sur une méthode simple pour la comparaison exacte des mesures de longueur.
Arch. Néerl., V, 1870, 15–23.

——— Berichte über die geodätischen Arbeiten. [Netherlands during 1870.]
Int. Geod. Cong., Gen.-Ber., 1870, 8–10.

——— Bericht über die geodätischen Arbeiten in Holland pro 1873.
Int. Geod. Cong., Gen.-Ber., 1873, 4.

——— Rapport sur les travaux géodésiques en Néerlande en 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 179–180.

——— Rapport sur les travaux géodésiques exécutés en Néerlande en 1876.
Int. Geod. Cong., Gen.-Ber., 1876, 105–106.

Stamkart (F. J.)—Continued.

——— Rapport sur les travaux géodésiques en Hollande pendant l'année 1878.
Int. Geod. Cong., Gen.-Ber., 1878, 86.

——— Résumé des travaux géodésiques faits dans les Pays-Bas en 1879.
Int. Geod. Cong., Gen.-Ber., 1879, 92–94.

——— *et* **Bosscha (J.)**. Résumé des travaux géodésiques exécutés dans les Pays-Bas en 1880.
Int. Geod. Cong., Gen.-Ber., 1880, 20–22.

Stampfer (Simon). Ueber die Genauigkeit des Visirens beim Winkelmessen.
Polytech. Inst., Jahrb., XVIII, 1834, 211–236.

——— Beschreibung eines Apparates um den Abstand der Schneiden bei einem Reversionspendel zu messen.
K. k. Sternwarte, Ann., XV, 1835, 1–lxi.

——— Beobachtungen an zwey unveränderlichen Reversions-Pendeln.
K. k. Sternwarte, Ann., XVI, 1836, xxvi–xxxii.

——— Ueber die technische Bearbeitung der Rotationszapfen an astronomischen und geodatischen Instrumenten und über den Einfluss ihrer Unvollkommenheit auf die Beobachtungen.
Polytech. Inst., Jahrb., XIX, 1837, 1–33.

——— Ueber das Verähltniss der Wiener Klafter zum Meter.
K. k. polytech. Inst., Jahrb., 1839, XX, 145–176.
See PRONY, Ueber die Vergleichung, etc.

Stancari: Zach (F. X. von). Notice sur les opérations géodésiques de —.
Mon. Corr. (Zach), II, 1819, 115–126.

STANDARDS OF LENGTH.

AIRY (G. B.). Construction of the new national standard of length.
Roy. Soc. London, Phil. Trans., CXLVII, 1857, 621–702.

AUZOUT (A.). Mesures prises sur les originaux, et comparées avec le pied du Chastelet de Paris.
Paris, 1693.

BAEYER (J. J.). Die Anfertigung einiger Copien von der Bessel'schen Toise.
Astron. Nachr., XXXVIII, 1854, 273–288.

——— Die Veränderungen, welche Massstäbe von Eisen und Zink mit der Zeit erleiden.
Int. Geod. Cong., Gen.-Ber., 1866, 34–41.

——— Massvergleichungen.
Berlin, 1872, 1876.

——— [Regarding the length of the standard toise.]
Int. Geod. Cong., Gen.-Ber., 1880, 50–53.

BAILY (F.). Report on the new standard scale of the society.
Roy. Astron. Soc., Month. Not., III, 1833–'36, 179–183; Mem., IX, 1836, 35–184.

BARNARD (F. A. P.). Comparison of metres.
U. S. C. and G. Survey, Rep., 1867, 134–137.

BARRAQUER (J. M.). Estudios experimentales en que se funda la equacion del metro de platino definido por trazos de la comision de pesas.
Inst. Geogr. y Estadistico, Mem., IV, 1883, 1–96

BASSOT (L.). Étalonnage des règles géodésiques du service géographique de France.
Int. Geod. Cong., Verhandl., 1887, [VI], 1–4.

BEIGEL (G. W. S.). Ueber den französischen mètre als materielles Mass betrachtet.
Mon. Corres., VIII, 1803, 101–115.

BENOIT. Résultats des comparaisons de la toise du Pérou au mètre international.
Acad. d. Sci. Paris, Comp. Rend., CVI, 1888, 977–982.

STANDARDS OF LENGTH—Continued.

BESSEL (F. W.). Darstellung der Untersuchungen und Massregeln durch die Einheit des preussischen Längenmasses veranlasst worden sind.
Berlin, 1839.

BIOT (J.-B.). Lettre sur le rapport du mètre au piéd anglais.
Ann. de Chim., VII, 1817, 13–16.

BOAZ (J.). Proposal for a new method of determining a fixed unit of measure, by deducing the same from the curvature of the earth.
Phil. Mag. (Tilloch), LXI, 1823, 266–269.

BOECK (A.). Metrologische Untersuchungen über . . . Masse des Alterthums.
Berlin, 1838.

BÖRSCH (A.). Die Bestimmung der Ausdehnungs coefficient von Eisen und Zink . . .
Astron. Nachr., XCIX, 1881, 177–190.

BOHN (C.). Ueber einen Temperatureinfluss bei geodätischen Längenmessungen.
Zeits. f. Vermes., XI, 1882, 514–523.

BOND (G. M.). Standards of length and their subdivisions.
Journ. Frank. Inst., CXVII, 1884, 281–295.

BONNE (R.). Principes sur les mesures en longueur . . .
Paris, 1790.

BORDA (J.-C. DE). Rapport fait à l'Académie des sciences sur le choix d'unité de mesures.
Acad. d. Sci. Paris, Mém., 1791, 7–16 (Hist.).

BOSSCHA (J.). Relation des expériences qui ont servi à la construction de deux mètres étalons en platine iridié.
École Polytech., Ann., I, 1885, 65–144; II, 1886, 1–122.

BOUCHOTTE (É.). Étude sur la valeur du stade, de la coudée et de quelques autres mesures anciennes.
Acad. de Metz, Mém., XLI, 1859–'60, 416–448.

BOUGUER (P.). Expériences faites à Quito . . . sur la dilatation et la contraction que souffrent les métaux par le chaud et par le froid.
Acad. d. Sci. Paris, Hist., 1745, 230–260.

BRISSON (M.-J.). Essai sur l'uniformité des mesures . . .
Acad. d. Sci. Paris, Mém., 1788, 722–727.

BRIX (A. F. W.). Bericht über die Vergleichungen zweier Metermaasse mit Urmeter zu Paris.
Berlin, 1864.

CARNEY. Mémoire sur les poids et les mesures.
Montpellier, 1792.

CHISHOLM (H. W.). An account of comparisons between two Russian pendulums and Repsold's scale, and between Repsold's scale and the standard yard.
Warden of the Standards, Rep., V, 1873–'74, 26, 39–43.

——— Science of weighing . . . and standards of measure and weight.
London, 1877.

CLARK (J. M.). The English mile; its relation to the size of the earth.
Van Nostrand's Mag., XXVIII, 1883, 383–386.

CLARKE (A. R.). Comparisons of the standards of length of England, France . . .
London, 1866; Roy. Soc. London, Phil. Trans., 1873, 445–469.

COLE (W. H.). Comparisons of the length of 10-feet standards *A* and *B*, and determinations of the difference of their expansions.
India, Trig. Survey, I, 1870, ii, 3–7, 8–12.

COMSTOCK (C. B.). Ratio of the metre to the yard.
Nat. Acad. Sci., Mem., III, 1886, 101–102.

CONDAMINE (C.-M. DE LA). Nouveau projet d'une mesure invariable.
Acad. d. Sci. Paris, Mém., 1747, 489.

——— Remarques sur la toise-étalon du Châtelet.
Acad. d. Sci. Paris, Mém., 1772, ii, 482–501.

COOKE (J.). A description of a new standard for weights and measures.
Am. Phil. Soc., Trans., III, 1793, 328–330.

STANDARDS OF LENGTH—Continued.

Cristiani (G. F.). Delle misure d' ogni genere, antiche e moderne.
Brescia, 1760.

Dove (H. W.). Ueber Mass und Messen.
Berlin, 1833.

Eisenschmidt (J. C.). De ponderibus et mensuris veterum.
Argentorati, 1708.

Emelin (E. H.). Zusammenstellung einiger altrömischer Maassbestimmungen.
Ak. d. Wiss. Bern, Arch., III, 1813, 501–521.

Eytelwein (J. A.). Ueber die Prüfung der Normal-Maasse . . . für Preussen.
K. Ak. d. Wiss., math. Cl., Abhandl., 1825, 1–21.

—— Vergleichung der neuesten englischen Maasse mit den preussischen.
K. Ak. d. Wiss., math. Cl., Abhandl., 1827, 1–8.

Fenner (L. F.). Ueber die Verschiedenheit der griechischen Stadien und Fussmaasse.
Berlin, 1858.

Firminger (T.). A copy of the experiments made . . . to establish a standard of weights and measures.
Phil. Mag. (Tilloch), XLV, 1815, 33–38.

Fischer (A.). Versuche den Gang der Temperaturen des Stabes am Basis-Apparat zu bestimmen.
Astron. Nachr., CIII, 1882, 33–46.

Foerster (W.). Sur la toise du Pérou.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 122–124.

—— [Concerning the length of the standard toises.]
Int. Geod. Cong., Gen.-Ber., 1880, 48–49.

Fonville (W. de). Le mètre international définitif.
Paris, 1875.

Fouchy (G. de). Sur la comparaison des différentes toises qui ont servi à la mesure des degrés terrestres.
Acad. d. Sci. Paris, Hist., 1772, 8–13.

Freret (N.) Observations sur le rapport des mesures grecques et des mesures romaines.
Acad. d. Inscr., Mém., XXIV, 1754, 548–568, 432–547.

Geisler (E. A.). Standard measures.
Journ. Frank. Inst., XCVI, 1888, 115–133.

Gosselin (P.-F.-J.). Recherches sur . . . différens systèmes métriques linéaires de l'antiquité.
Acad. d. Inscr., Mém., VI, 1822, 44–164.

Govi (G.). Sur l'invention de quelques étalons de mesure.
Accad. Sci. Torino, Atti, VII, 1871–'72, 362–376.

Graham (G.) An account of the proportions of the English and French measures . . .
Roy. Soc. London, Phil. Trans., 1742, 185–188.

Grant (R.). Note on the origin of attempts made to derive . . . a standard of measure.
Roy. Astron. Soc., Month. Not., XV, 1855, 36–40.

Hamilton-Smythe (A.). Comparison of British and metric measures for engineering purposes.
Inst. Civil Eng., Proc., LXXX, 1884–'85, ii, pp. 66.

Hansen (P. A.). Von der Bestimmung der Theilungsfehler eines geradlinigen Maassstabes.
K. sächs. Ges. d. Wiss., math.-phys. Cl., Abhandl., XV, 1874, 527–667.

Harkness (W.). On the progress of science as exemplified in the art of weighing and measuring.
Phil. Soc. Wash., Bull., X, 1888, xxxix–lxxxvi.

Hassler (F. R.). An account of pyrometric experiments.
Am. Phil. Soc., Trans., I, 1818, 210–227.

—— Documents relating to the construction of standards of weights and measures.
New York, 1835, 1836.

Hennessey (J. B. N.). Comparisons of standard bars.
India, Trig. Survey, II, 1873, vi, 24–36.

Hermann (F.). Ueber die neuen metrischen Probemasse.
Naturf. Ges. Bern, Mittheil., 1870, 243–247.

Herr. Mittheilung über die Glasstäbe.
Int. Geod. Cong., Gen.-Ber., 1871, 70–71.

STANDARDS OF LENGTH—Continued.

Hilgard (J. E.). The relations of the lawful standards of measure of the United States to those of Great Britain and France.
U. S. C. and G. Survey, Rep., 1876, 402–406.

—— Comparison of American and British standard yards.
U. S. C. and G. Survey, Rep., 1877, 148–181.

Hultsch (F.). Griechische und römische Metrologie.
Berlin, 1862, 1882.

Ibañez (C.). Comparacion de la regla geodésica perteneciente al gobierno de Egipto con la que sirvió para la medicion de la base central de España.
Acad. Cien. Madrid, Mem., I, 1863, ii, 47–170.

Ideler (C. L.). Ueber die Längen- und Flächenmasse der Alten.
K. Ak. d. Wiss., hist. Cl., Abhandl., 1825, 169–189; 1827, 111–128.

—— Ueber die von d'Anville in die alte Geographie eingeführten Stadien.
K. Ak. d. Wiss., phil. Cl., Abhandl., 1826, 1–18.

Ismaïl-Effendi. Recherches des coefficients de dilatation et étalonnage de l'appareil à mesurer les bases géodésiques. (Egyptian.)
Paris, 1864.

Jacobi (H.). Note sur la fabrication des étalons de longueur par la galvanoplastie.
Acad. de St.-Pétersbourg, Mél. Phys. Chim., VIII, 1872, 582–589.

Jervis (T. B.). Records of ancient science exemplified in the primitive universal standard of weights and measures.
Calcutta, 1835.

Jomard (E.-F.). Mémoire sur le système métrique des anciens Égyptiens.
Paris, 1817.

—— Description d'un étalon métrique.
Paris, 1822; Paris, 1827.

Kater (H.). On the length of the French metre estimated in parts of the English standard.
Roy. Soc. London, Phil. Trans., 1818, 110–117, etc.

—— An account of the comparisons of various British standards of linear measure.
Roy. Soc. London, Phil. Trans., CXI, 1821, 75–94.

—— On the error in standards of linear measure arising from the thickness of the bar on which they are traced.
Roy. Soc. London, Phil. Trans., CXX, 1830, 359–382.

—— Account of the construction and adjustment of standards.
Roy. Soc. London, Phil. Trans., 1826, ii, 551–552; 1831, 345–347; London, 1832.

Kelly (P.). Metrology.
London, 1816.

Krafft (W. L.). Sur la mesure universelle.
Journ. d. Sav., 1791, 154–155.

Kupffer (A. T.). Travaux pour fixer les mesures de Russie.
St.-Pétersbourg, 1841.

La Hire (P. de). Comparaison du pied antique romain à celui du Châtelet de Paris.
Acad. d. Sci. Paris, Mém., 1714, 394–400.

Lalande (J. le F. de). Sur . . . les nouvelles mesures.
Conn. d. Temps, 1801, X, 455–474.

Lambton (W.). Correction to the Indian arc to reduce it to parliamentary standards.
Roy. Soc. London, Phil. Trans., CXIII, 1823, 27–33.

—— Sur le nouveau système des poids et mesures adopté en France.
Ann. de Chim., XXII, 1823, 407–410.

Lane (J. H.). On the coefficient of expansion of the British standard yard bar.
U. S. C. and G. Survey, Rep., 1877, 148–181.

Leake (W. M.). On the stade as a linear measure.
Roy. Geogr. Soc. London, Journ., IX, 1839, 1–25.

STANDARDS OF LENGTH—Continued.

LEPSIUS (R.). Die Längenmasse der Alten.
Berlin, 1884.

LESLIE (R.). On a method of ascertaining a universal and invariable standard of measure.
Rep. Acts of Parliament, 1794, 170–174.

LETRONNE. Recherches . . . du système métrique égyptien.
Paris, 1851.

LINDHAGEN (D. G.). Komparationer mellan Struves dubbeltoise och den Svenska kopian af densamma.
K. Svenska Vetens., Handl., IV, 1864, V.

MAHMOUD-BEY. Le système métrique actuel d'Égypte.
Copenhague, 1872.

MORE (S.). Attempt to obtain standards of weights and measures.
Soc. Encouragement of Arts, Trans., XII, 1794, 292–301.

MORIN. Notice historique sur le système métrique.
Paris, ——.

NEBENBURGER (A.-W.). Compte rendu des opérations . . . pour étalonner les règles qui ont été employées . . . à la mesure des bases géodésiques.
Bruxelles, 1855.

NEVEU (T.). Tableau de comparaison des mesures de l'an X avec les mesures du système et les anciennes mesures.
Soc. Sav. Littér., Mém., I, 1801, 146–149.

ORIANI (B.). Istruzione su le misure e su i pesi che si usano nella Republica Cisalpina.
Milano, 1801.

OZANAM (J.). Traité de l'arpentage et du toisé.
Paris, 1747.

PASLEY (C. W.). Plan for simplifying and improving the measures.
London, 1857.

PAUCTON (A.-J.-P.). Métrologie.
Paris, 1780.

PEIRCE (C. S.). Comparison between the yard and metre.
A. A. A. S., Proc., XXX, 1881, 20.

PETERS (C. F. W.). Zur Geschichte und Kritik der Toisen-Maasstäbe . . .
Berlin, 1885.

PICTET (M.-A.). Comparaison du mètre étalon de l'Institut avec le pied anglais.
Soc. Sav. et Littér., Mém., II, 1801, 265–269; Bibl. Brit. Genève, XIX, 1802, 109–114; Journ. Nat. Phil. (Nicholson), II, 1802, 244–252.

PLANTAMOUR (E.). Note sur la détermination du coefficient de dilatation d'un barreau d'argent.
Bibl. Univ. Genève, Arch., XXXVIII, 1870, 37–61.

PRINSEP (J.). Determination of the expansion of the standard 10-feet iron bar of the survey of India.
Asiat. Soc., Journ., II, 1833, 130–142.

PRONY (R. DE). Formules pour la comparaison des longueurs de deux règles de métal . . .
Bibl. Brit. Genève, XIX, 1802, 316–320.

—— Résultats des expériences faites . . . pour déterminer le rapport du mètre au pied anglais . . .
Bibl. Brit. Genève, XX, 1802, 105–118; Ann. de Chim., V, 1817, 166–171; Bibl. Univ. Genève, VII, 1819, 239–243.

—— Description et usage du comparateur de Lenoir . . .
Bibl. Brit. Genève, XIX, 1802, 301–315; Ann. d. Phys. (Gilbert), LII, 1816, 329–338; Phil. Mag. (Tilloch), XLVII, 1816, 125–130.

—— Ueber die Vergleichung der halben Wiener Klafter mit dem Meter.
K. k. Polytech. Inst., Jahrb., XX, 1839, 155–164.

QUEIPO (V.). Essai sur les systèmes métriques des anciens peuples.
Paris, 1859.

RODENBACH (C.). Note sur l'étalon prototype universel des mesures de longueur.
Acad de Belgique, Bull., XXIX, 1870, 559–575.

STANDARDS OF LENGTH—Continued.

ROGERS (W. A.). Determination of the relation between the yard and the metre.
A. A. A. S., Proc., XXXII, 1883, 127.

SADEBECK (B. A. M.). Ueber eine neue Methode, die Ausdehnung von Maassstäben zu bestimmen.
Leopoldina, XIX, 1883, 141–144.

SAIGEY (J.-F.). La pratique des poids et mesures du système métrique.
Paris, 1839.

SAINTE-CLAIRE-DEVILLE (H.). Sur la construction de la règle géodésique internationale.
Int. Geod. Cong., Gen.-Ber., 1878, I, 1–50; 1879, I, 1–12; Paris, 1879.

SCHIAPARELLI (G. V.). Delle operazioni per determinare il rapporto del klafter col metro.
Ist. Lombardo, Rend., I, 1864, 312–316; Milano, 1866; Eff. Astron. Milano, 1866, 3–41.

SCHIAVONI (F.). Relazione sugli studii fatti per assegrare . . . la lunghezza della tesa del Spano.
Int. Geod. Cong., Gen.-Ber., 1866, 16–21.

—— Relazione sulle esperienze fatte per determinare il rapporto fra la tesa italiana e la prussiana.
Napoli. 1869.

SCHIFFNER (A.). Ein Wort über das bei dem sächsischen Landesvermessungen gebrauchte Grundmass.
Ann. d. Erdkunde (Berghaus), VIII, 1833, 64–74.

SCHUMACHER (H.). Danish standards of length.
Quart. Journ. Sci., XI, 1821, 184–185.

SHEEPSHANKS (R.). Account of his experiments for restoring the standard yard.
Roy. Astron. Soc., Mem., XVI–XXIV.

SHUCKBURGH (G. A. W.). Account of some endeavors to ascertain a standard of weights and measures.
Roy. Soc. London, Phil. Trans., LXXXVIII, 1798, 133–182.

SOLEIL (H.). Note sur une mesure de longueur invariable.
Acad. d. Sci. Paris, Comp. Rend., LXIX, 1869, 954.

STAMKART (F.-J.). Sur une méthode simple pour la comparaison exacte des mesures de longueur.
Arch. Néerl., V, 1870, 15–23.

STAMPFER (S.). Ueber das Verhältniss der Wiener Klafter zum Meter.
Polytech. Inst., Jahrb., XX, 1839, 145–176.

STEINHEIL (K. A. VON). Copie des Mètre des archives à Paris.
K. bayer. Ak. d. Wiss., math.-phys. Cl., Abhandl., 1884, I, 247–280.

—— Ueber Maasse à bout und deren Vergleichung.
K. bayer. Ak. d. Wiss., Sitz.-Ber., I, 1863, 329–332.

—— Ueber genaue Copien des Mètre des archives, welche in Oesterreich . . . dienen sollen.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Denkschr., XXVII, 1867, 151–189.

—— Vergleichung der Leistung des Bessel'schen Längen-Comparators mit der des Fühlspiegel-Comparators von Steinheil.
K. bayer. Ak. d. Wiss., Sitz.-Ber., math.-phys. Cl., II, 1868, 493–496.

—— Ueber einen cylindrischen Maassstab in Gestalt eines Rades der Abstand von zwei festen Punkten zu messen.
Astron. Nachr., LXXII, 1868, 369–378.

—— Bericht über seinen Comparator zur Vergleichung der Toise mit dem Meter.
K. bayer. Ak. d. Wiss., Sitz.-Ber., 1870, I, 1–13; Int. Geod. Cong., Gen.-Ber., 1869, 73–80.

—— Copie der Bessel'schen Toise du Pérou in zwei Glasstaben.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Denkschr., XXX, 1870, 21–28.

SWINDEN (J. H. VAN). Bestimmung des vom Thomas bei dessen chinesischer Gradmessung gebrauchten Maases.
Mon. Corr. (Zach), X, 1804, 522–531.

STANDARDS OF LENGTH—Continued.

TITTMANN (O. H.). Relative expansion of bronze and Low Moor iron.
U. S. C. and G. Survey, Rep., 1877, 148–181.

—— On the relation of the yard to the meter.
U. S. C. and G. Survey, Bull., IX, 1889, 45–50.

TRALLES (J. G.). Ueber eine Methode, die Ausdehnung der Körper durch die Wärme zu bestimmen.
Ann. d. Phys. (Gilbert), XXVII, 1807, 241–260.

TRESCA (H.). Note sur la forme qu'il convient de donner aux mètres.
Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1223–1230.

V. (LE. S. C. DE). Recherches curieuses des mesures du monde.
Paris, 1636.

VERDET. Étalon fixe des poids et mesures.
Paris, 1815.

WAGNER. Ueber die Maassvergleichungen für die europäische Gradmessung.
Gotha, 1868.

WALKER (J. T.). Description of the method of comparing, and the apparatus employed.
India, Trig. Survey, I, 1870–'71, 1–2.

WEINSTEIN (B.). Handbuch der physikalischen Maasbestimmungen.
Berlin, 1887.

WESTPHAL (A.). Die Ausdehnungscoefficienten der Küstenvermessung.
Berlin, 1881.

WHITEHURST (J.). An attempt towards obtaining invariable measures of length.
London, 1787.

WILD (H.). De la détermination de la dilatation . . . du barreau normal.
Soc. Phys. Genève, Arch., XL, 1871, 373–393.

—— Bericht über die Arbeiten zur Reform der schweizerischen Urmaasse.
Zürich, 1868.

WOLF (C. I. E.). Les étalons de poids et mesures de l'observatoire de Paris.
Acad. d. Sci. Paris, Comp. Rend., XCII, 1881, 1202–1204; XCIII, 1881, 297–299; XCIV, 1882, 1503–1505; Ann. de Phys. Chim., XXV, 1882, 5–112.

—— Sur l'authenticité de la toise du Pérou.
Acad. d. Sci. Paris, Comp. Rend., CII, 1886, 567–574; CVI, 1888, 977–982.

WOODWARD (R. S.). Results of some experiments made to determine the variations in length of certain bars at the temperature of melting ice.
Am. Journ. Sci., XXV, 1883, 448–459.

—— On the diffusion of heat in homogenous masses.
Ann. Math., IV, 1888, 101–127.

WURM (J. F.). De ponderum, nummorum et mensurarum.
Stutgardiæ.

YATES (J.). On the unit of length.
Journ. Frank. Inst., XLII, 1861, 348–351.

ZECH (P. H.). Das württembergische Längenmass.
Württemberg. Jahresheft, XXVII, 1871, 51–58.

ANON. Notice historique sur le système métrique, sur ses développements et sur sa propagation. Extrait des Annales du Conservatoire des arts et métiers.
Paris, n. d., pp. 68.

—— Discours prononcé à la barre des deux conseils du Corps législatif, au nom de l'Institut national des sciences et des arts, lors de la présentation des étalons prototypes du mètre et du kilogramme, et du rapport sur le travail de la commission des poids et des mesures.
4°, Paris, 1802, pp. 63.
Giving an excellent history of the geodetic operations for the measurement of a quadrant.

—— Exposé des résultats des grandes opérations géodésiques, faites en France et en Espagne pour la mesure d'un arc du méridien et la détermination du mètre définitif.
Bibl. Brit. Genève, XXXVIII, 1808, 305–312; Conn. d. Temps, 1810, 485–488.

Stansel (Valentine). Dioptra geodætica.*
8°, Pragæ, 1653.
POGGENDORFF, II, 986.

STATION MARKING.

ANDREWS (H.). Marking geodetic stations.
Science, I, 1883, 458; Final Results N. Y. State Survey, 1887, 122–126.

BLAIR (H. W.). Marking geodetic stations.
Science, I, 1883, 394–395.

Staude (Otto). Ueber geodätische Bogenstücke vom algebraischen Längendifferenz auf dem Ellipsoid.
Ann. d. Math. (Schlömilch), XX, 1882, 185–186.

—— Ueber geodätische Polygone auf den Flächen zweiten Grades.
Math. Ann. (Clebsch), XXI, 1883, 219–252.

Stebnitzki (J.). Ueber die Ablenkung der Lothlinie durch die Anziehung der kaukasischen Berge.
Acad. de St.-Pétersbourg, Bull., XV, 1871, 232–245; Mél. Math. Astron., IV, 1871, 633–651.

—— Beobachtungen mit dem unveränderlichen Pendel, angestellt von Dr. Fr. Parrot in den Jahren 1829 und 1833 in Dorpat, Tifflis und auf dem Abhange des grossen Ararat.
Astron. Nachr., CIII, 1882, 375–378.

——: **Faye (H.-A.-E.-A.).** Sur une lettre du général — relative à la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XCVII, 1883, 508–515.

—— Bericht der topographischen Abtheilung des General-Stabes über die in den Jahren 1884 und 1885 ausgeführten Arbeiten. (Russland.)
Int. Geod. Cong., Verhandl., 1884–'86, 200–204.

—— Russie. Travaux exécutés par la section topographique militaire de l'état-major pendant les années 1886 et 1887.
Int. Geod. Cong., Verhandl., 1887, xi, 1–3.

—— Bericht über die caucasische Triangulation im Jahre 1862.
Geogr. Mittheil. (Petermann), 1863, 340–344.

Stegmann (Friedrich Ludwig). Ueber die Bestimmung des Drehungswinkels an Messinstrumenten die mit einem beweglichen Spiegel versehen sind, welcher das Bild einer feststehenden Scala in einem Fernrohre erscheinen lässt.
Arch. d. Math. (Grunert), XXV, 1855, 376–386.

Stein (Johann Peter Wilhelm). Geographische Trigonometrie, oder die Auflösung der geradlinigen, sphärischen und sphäroidischen Dreiecke, mit ihrer Anwendung bei grossen geodätischen Vermessungen und der Projection der Charten, sowohl theoretisch als auch rein praktisch dargestellt und mit einem Anhange über Winkelmessinstrumente begleitet.
4°, Mainz, 1825, pp. xx, 315, 8 plates. (British Museum.)

—— Ueber das Auftragen eines trigonometrischen Netzes nach der modifizirten Flamstead'schen Projecktion.
4°, Frier, 1828, pp. 18. (Berlin, Royal.)

Steinhauser. Sur les mesures universelles et la figure de la terre. (H.)
Wittemberg, 1807.

Steinhauser (Anton). Grundzüge der mathematischen Geographie und der Landkartenprojection.
8°, Wien, 1857, pp. 138. (Southampton, Ordnance Survey.)

——— Neue Berechnung der Dimensionen des Erdsphäroids.
Geogr. Mittheil. (Petermann), 1858, 465–468.

——— Ueber die Ermittelung der Winkelsumme ebener Polygone.
Archiv f. Math. (Grunert), LII, 1871, 294–309.

Steinheil (Karl August von). Copie des Mèter des Archives à Paris.
K. bayer. Ak. d. Wiss., math.-phys. Cl., Abhandl., 1844, i, 247–280.

——— Ueber Maasse à bout und deren Vergleichung nach einem neuen Princip.
K. bayer. Ak. d. Wiss., Sitz.-Ber., I, 1863, 329–332.

——— Ueber genaue und invariable Copien des Kilograms und des Mèter, prototype der Archive zu Paris, welche in Oesterreich bei Einführung des metrischen Maass- und Gewichtssystems als Mittel zu ihrer Vervielfältigung.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Denkschr., XXVII, 1867, 151–189.

——— Bericht der Gradmessungs-Commission.
1868.
Title in full under BAUERNFEIND (C. M. VON).

——— Beitrag zur Geodäsie.
K. bayer. Ak. d. Wiss., Sitz.-Ber., II, 1868, 465–469.
Advocating the use of cyclometers in measuring arcs along railroads instead of by triangulation.

——— Vergleichung der Leistung des Bessel'schen Längen-Comparators mit dem Fühlspiegel-Comparator von Steinheil.
K. bayer. Ak. d. Wiss., Sitz.-Ber., math.-phys. Cl., II, 1868, 493–496.

——— [Ueber einen cylindrischen Massstab in Gestalt eines Rades der Abstand von zwei festen Punkten zu messen.]
Astron. Nachr., LXXII, 1868, 369–378.

——— Bericht über seinen Comparator zur Vergleichung der Toise mit der Längen-Ausdehnung der Stäbe.
K. bayer. Ak. d. Wiss., Sitz.-Ber., 1870, i, 1–13; Int. Geod. Cong., Gen.-Ber., 1869, 73–80.

——— Copie der Bessel'schen Toise du Pérou in zwei Glasstäben.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Denkschr., XXX, 1870, 21–28.

Steinthal (A. E.). The method of least squares applied to conditioned observations.
Mess. Math., x, 1881, 186–190.

Steppes (K.) *und* **Jordan (W.).** Das deutsche Vermessungswesen.
Stuttgart, 1882.
Title in full under JORDAN (W.).

Sterneck (Robert von). Ueber den Einfluss des Mondes auf die Richtung und Grösse der Schwerkraft auf der Erde.*
Wien, 1876.

——— Ueber die Aenderungen der Refractions-Constants und Störungen der Richtung der Lothlinie im Gebirge.*
Wien, 1879.

Sterneck (Robert von)—Continued.

——— Untersuchungen über die Schwere im Innern der Erde, ausgeführt im Jahre 1882 in dem 1000 Meter tiefen Adalbert-Schachte des Silberbergwerkes zu Příbram in Böhmen.
K. k. militär-geogr. Inst., II, 1882, 77–120; IV, 1884, 89–155; V, 1885, 77–106.

——— Wiederholung der Untersuchungen über die Schwere im Innern der Erde, ausgeführt im Jahre 1883 in dem 1000 Meter tiefen Adalbert-Schachte des Silberbergwerkes zu Příbram in Böhmen.
K. k. militär-geogr. Inst., Mittheil., III, 1883, 59–94.

——— *und* **Hartl (H.).** Bericht über die Leistung der geodätischen Gruppe des militär-geographischen Institutes.
Int. Geod. Cong., Verhandl., 1884–'86, 154–177.

——— Bericht über die von ihm bisher ausgeführten Schwerebestimmungen.
Int. Geod. Cong., Verhandl., 1884–'86, 177–178.

——— Untersuchungen über die Schwere im Innern der Erde, ausgeführt im Jahre 1885 in dem Abrahamschachte des Silberbergwerkes "Himmelfahrt-Fundgrube" bei Freiberg in Sachsen.
K. k. geogr. Inst. (Mittheil.), VI, 1886, 97–119.
Revd. in Bull. Astron., IV, 234.

——— Der neue Pendelapparat des k. k. militär-geographischen Institutes.
K. k. militär-geogr. Inst. (Mittheil.), VII, 1887, 83–116.

——— *und* **Kalmár (A. von).** Bericht über die Gradmessungs-Arbeiten des k. k. militär-geographischen Instituts im Jahre 1887.
Int. Geod. Cong., Gen.-Ber., 1887, viii, 1–18.

Sternickel (Franz Wilhelm). Praktische Geodäsie, oder landwirthschaftliche Messkunst.*
4°, Sondershausen, 1830.

Stewart (Balfour) *and* **Loewy (Benjamin).** An account of the base operations made at the Kew Observatory with the pendulums to be used in the Indian trigonometrical survey.
Roy. Soc. London, Proc., XIV, 1865, 425–439.

——— ——— An account of experiments made at the Kew Observatory determining the true vacuum and temperature corrections to pendulum observations.
Roy. Soc. London, Proc., XVII, 1869, 488–499.

Stieltjes (M.-T.-J.). Quelques remarques sur la variation de la densité dans l'intérieur de la terre.
Arch. Néerl., XIX, 1884, 435–460.

Stirling (James). On the figure of the earth, and the variation of gravity on the surface.
Roy. Soc. London, Phil. Trans., XXXIX, 1735, 98–105.

Stokes (George Gabriel). On the resistance of the air to pendulums.
Brit. A. A. S., Trans., XVIII, 1848, 7–8.

——— On attractions and on Clairaut's theorem.
Camb. Dubl. Math. Journ., IV, 1849, 194–219.

——— On the variation of gravity at the surface of the earth.
Phil. Soc. Camb., Trans., VIII, 1849, 672–695; L., E., D. Phil. Mag., XXXV, 1849, 228–229.

Stokes (George Gabriel)—Continued.

——— On the effect of the internal friction of fluids on the motion of pendulums.
L., E., D. Phil. Mag., I, 1851, 337–339; Bibl. Univ. Genève, Arch., XXI, 1852, 15–28; Phil. Soc. Camb., Trans., IX, 1856, ii, 8–106.

——— [On the effect of the rotation and ellipticity of the earth in modifying the numerical results of the Harton pendulum experiments.]
Roy. Soc. London, Proc., VIII, 1856–57, 59; Phil. Trans., 1856, 353–355.

———: **Gumpach (J. von)**. A letter to — on the true figure and dimensions of the earth.
Guernsey, 1862.
Title in full under GUMPACH (J. VON).

——— On the internal distribution of matter which shall produce a given potential at the surface of a gravitating mass.
Roy. Soc. London, Proc., XV, 1867, 482–486.

———: **Pratt (J. H.)**. On —'s proof of Clairaut's theorem.
L., E., D. Phil. Mag., XXXIV, 1867, 25–26.

Stone (Edmund). Some reflections on the uncertainty of many astronomical and geographical positions with regard to the figure and magnitude of the earth, the finding the longitude at sea by watches, and other assertions of the most eminent astronomers, with some hints towards their reformation and emendation.
8°, London, 1766, pp. xv, 19–134. (British Museum.)

Stone (E. J.). On the most probable results which can be derived from a number of direct determinations with assigned weights.
Roy. Astron. Soc., Month. Not., XXXVI, 1876, 290–292.

——— Reduction of latitude and logarithm of the earth's radius with Col. Clarke's value of the earth's compression.
Roy. Astron. Soc., Month. Not., XLIII, 1882–'83, 102–110.

Stotherd (R. H.) *and* **O'Farral (James)**. Account of the graphic method for determining the co-ordinates of trigonometrical stations.
London, 1886.
Title in full under O'FARRAL (J.).

Strange (Alexander). Announcement of new instruments about to be supplied by government to the Great Trigonometrical Survey of India.
Roy. Astron. Soc., Month. Not., XXII, 1862, 261–263.

——— Geodesy, especially relating to the Great Trigonometrical Survey of India.
United Service Journ., VI, 1863, 457–486.

Strömer. Tentamina pro invenienda figuram et magnitudinem telluris. (H.)
Upsaliæ, 1750.

Strucki. Een voorbild van constante fouten.*
Tijdschrift voor Kadaster en Landmeetkunde, II, 1882, 181.

Struve (Friedrich Georg Wilhelm). Ueber die trigonometrische Vermessung Liefland's.
Zeits. f. Astron. (Lindenau), VI, 1819, 343–355; Astron. Jahrb. (Bode), 1819, 247–250.

Struve (Friedrich Georg Wilhelm)—Continued.

——— Nachricht von der russischen Gradmessung in den Ostseeprovinzen.
Astron. Nachr., I, 1823, 67–68.

——— [Nachricht von der russischen Gradmessung.]
Astron. Nachr., II, 1824, 135–136, 145–148.

——— [Sur la mesure des degrés du méridien de Dorpat.]
Corr. Astron. (Zach), XI, 1824, 23–33, 34–42.

——— Vorläufiger Bericht von der russischen Gradmessung mit allerhöchster Genehmigung auf veranstaltung der kaiserlichen Universität zu Dorpat während der Jahre 1821 bis 1827 in den Ostseeprovinzen des Reichs, ausgeführt von —.
Fol., Dorpat, 1827, pp. iv, 24, 1 plate. (Berlin, Observatory.)
Revd. in Hertha, XII, 1828, 3–26.

——— Ueber die Vereinigung zweier in Russland ausgeführten Breitengradmessungen.
Astron. Nachr., VI, 1828, 391–394.

——— Resultate der Gradmessung in den Ostseeprovinzen Russlands.
Astron. Nachr., VII, 1829, 385–400.

——— Beschreibung der unter allerhöchstem kaiserlichen Schutze von der Universität zu Dorpat veranstalteten Breitengradmessung in den Ostseeprovinzen Russlands ausgeführt und bearbeitet in den Jahren 1821 bis 1831, mit Beihülfe des Capitain-Lieutenants B. W. von Wrangell und anderer.
4°, Dorpat, 1831, I, pp. [x], 360; II, pp. [vi], 424, 11 maps. (Washington, Observatory.)

——— Ueber die neuesten geodätischen Arbeiten in Russland.
Dorpat Jahrbuch, I, 1833, 87–89.

——— Vereinigung der beiden in den Ostseeprovinzen und in Lithauen bearbeiteten Bogen der russischen Gradmessung.
Acad. de St.-Pétersbourg, Mém., II, 1833, 401–425; Astron. Nachr., X, 1833, 323–325.

——— Bericht über die Fortsetzung der russischen Gradmessung nach Norden.
Recueil des Actes de la Séance Publique de l'Acad. de St.-Pétersbourg, 1836, 103–108.

———: **Fedorow (V. T.)**. Berichte über die astronomisch-geodätischen Arbeiten. Edited by —.
St. Petersburg, 1838.
Title in full under FEDOROW (V. T.).

——— Sur la mesure des degrés de méridien en Russie.
Acad. de St.-Pétersbourg, Bull. Sci., VII, 1840, 280–288.

——— [Ueber die Bestimmung der Dichtigkeit der Erde.]
Astron. Nachr., XXII, 1845, 37.

——— Rapport fait à l'Académie impériale des sciences par — sur une mission scientifique dont il fut chargé en 1847. (Gore.)
4°, n. d., pp. 15.
Regarding comparisons of geodetic standards.

——— Resultate der in den Jahren 1816 bis 1819 ausgeführten astronomisch-trigonometrischen Vermessung Livlands.
Acad. de St.-Pétersbourg, Mém., IV, 1850, 1–86.

Struve (Friedrich Georg Wilhelm)—Continued.

——— Résultats des opérations géodésiques de MM. Fuss, Sawitsch et Sabler, exécutées en 1836 et 1837 dans la province ciscaucasienne.

Acad. de St.-Pétersbourg, Cl. Phys. Math., Bull., VIII, 1850, 337–368; Conn. d. Temps, 1853, 49–78; Acad. d. Sci. Paris, Comp. Rend., XXX, 1850, 541–549.

——— Exposé historique des travaux exécutés jusqu'à la fin de l'année 1851 pour la mesure de l'arc du méridien entre Fuglenaes, 70° 40′, et Ismaïl, 45° 20′, publié au nom de l'Académie impériale des sciences de St.-Pétersbourg. Suivi de deux rapports de M. G. Lindhagen sur l'expédition de Finnmarken, faite par ordre du gouvernement norwégien en 1858 et sur les opérations de Lapponie exécutées en 1851 sous les auspices de l'Académie royale des sciences de Stockholm.

4°, St.-Pétersbourg, 1852, pp. 44, 2 maps. (Gore.)

——— Sur la jonction des opérations astronomico-géodésiques exécutées par ordre des gouvernements russe et autrichien.

Acad. de St.-Pétersbourg, Cl. Phys. Math., Bull., XI, 1853, 113–136; Mél. Math., I, 1853, 502–534.

——— Arc du méridien de 25° 20′ entre le Danube et la mer glaciale mesuré depuis 1816 jusqu'en 1850 sous la direction de C. de Tenner, N. H. Selander, Chr. Hansteen et F. G. W. Struve.

4°, St.-Pétersbourg, I, 1860, pp. cxliv, 336.

Catalogue chronologique des publications qui se rapportent à la mesure de l'arc du méridien de 25° 20′, I, cxli–cxliv.

II; pp. viii, 483, St.-Pétersbourg, 1857; volume of 26 plates.

St.-Pétersbourg, 1857. (Gore.)

Noticed in Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 509–513; note par Biot, the same, 513–514.

Revd. in Roy. Astron. Soc., Month. Not., XX, 1862, 24–62.

——— Ueber die Breiten-Gradmessung zwischen der Donau und dem Eismeer.

K. k. Ak. d. Wiss., Sitz.-Ber., XXI, 1856, 3–5.

———: **Faye (H.-A.-E.-A.)**. Sur les propositions de M. —, relatives aux opérations géodésiques.

Acad. d. Sci. Paris, Comp. Rend., XLV, 1857, 669–674.

——— Vergleichung der Wiener Maasse mit den zu Pulkowa befindlichen Maasseinheiten.

K. K. Ak. d. Wiss., Sitz.-Ber., XLIV, 1861, ii, 7–20.

Struve (Otto). Ueber einen vom General Schubert an die Academie gerichteten Antrag betreffend die russischscandinavische Meridian-Gradmessung.

Acad. de St.-Pétersbourg, Bull., III, 1861, 396–424; Mél. Math., III, 1866, 319–359.

Revd. in Geogr. Mittheil. (Petermann), 1861, 247.

This paper marks an era. Ignoring Laplace's instruction (1825), there had grown a dogma that local effect should be allowed for to the utmost assignable. In furtherance of this, Schubert proposed that the Russian latitude stations should be specially contoured, as had been done in England. The Academy referred the point to Döllen, acting for Struve (absent in Spain). Returned, Struve indorses Döllen's advice. Together they lay it down that reduction for local attraction is (with certain exceptions) only justifiable on assumptions for which there is ordinarily no foundation. The position is quite different from Laplace's, and in fact quite novel. Moreover there is no allusion to Laplace's ruling—which appears to be very little known—on this point. (H.)

Struve (Otto)—Continued.

——— [On a remarkable local deviation in the direction of gravity, lately observed in Russia.]

Roy. Astron. Soc., Month. Not., XXIII, 1863, 185–188.

——— [Mittheilung über Pendelbeobachtungen.]

Int. Geod. Cong., Gen.-Ber., 1824, 76–77.

——— Note on a deviation of the plumb-line.

Roy. Astron. Soc., Month. Not., XXXVII, 1876–'77, 362.

——— [Vortrag über die geodätischen Arbeiten in Russland für die Jahre 1884–'86.]

Int. Geod. Cong., Verhandl., 1884–'86, 204–218.

Struyck (N.). Van de groote der aarde. (H.)

Amsterdam, 1740.

Stuart (Cohen) *en* **Kaiser (F.)**. De eischen der medewerking aan de ontworpen graadmeting in midden Europa.

Amsterdam, 1864.

Title in full under KAISER (F.).

Stuart (James): **Pratt (J. H.)**. The figure of the earth. Revd. by —.

Nature, VI, 1872, 79–80.

Stück (H.). Vermessung der Stadt Hamburg. Verzeichniss der trigonometrisch bestimmten Punkte, nebst Dreieckskarte.

Fol., Hamburg, 1872, pp. 45, 1 chart. (Gore.)

——— Vermessung der freien und Hansestadt Hamburg. Erster Theil: Geschichte des hamburgischen Vermessungs-wesens.

4°, Hamburg, 1885, pp. xii, 87.

——— Triangulation der freien und Hansestadt Hamburg.

4°, Hamburg, 1886, pp. 158, 1 chart. (Berlin, Geodetic Institute.)

Studnička (Frantisck Josef). Mathematical geography.* Chapter I. The figure of the earth.

Prague, 1882.

The above is in the Bohemian language. Jahrb. üb. d. Fortschr. d. Math., XIV, 1882, 917.

Suter (Heinrich). Geschichte der mathematischen Wissenschaften. Erster Theil: Von den ältesten Zeiten bis Ende des 16. Jahrhunderts.

8°, Zürich, 1871–'75; 2d ed., in 2 parts: I, Zürich, 1873, pp. vi, 196; II, Zürich, 1875, pp. 380. (British Museum.)

Wahrscheinlichkeitsrechnung, II, 344–365.

Svanberg (Jöns). Berättelse öfver resan til Pello, företagen på Kongl. Vetenskaps Academiens bekostnaet, för af efterse hurrivida uti localn derstädes men ellenminder omständighter kunna gifva anledning at misstänka den Franska gradmätningen omkring Tornea år 1736.

Vetens. Acad. Handlingar, XX, 1799, 299–291.

——— Ueber die alte nordische Gradmessung.

Mon. Corr. (Zach), II, 1800, 257–261.

——— Neue Gradmessung in Lappland.

Mon. Corr. (Zach), V, 1802, 161–169.

——— Historisk öfversigt af problemet om jordens figur, jemte anledningar till den nya Lappska gradmätningen och definitiva resultaterne deraf, framställde i sina rapporter till de physico-mathemat. vetenskapernas kraf.

Vetens. Acad. Handlingar, XXV, 1804, 125–140.

Svanberg (Jöns)—Continued.

—— Exposition des opérations faites en Lapponie pour la détermination d'un arc du méridien en 1801, 1802 et 1803 par Messieurs Öfverbom, Svanberg, Holmquist et Palander. Rédigée par —, et publiée par l'Académie des sciences. Au Lecture, pp. xvi, by Melanderhjelm.

8°, Stockholm, 1805, pp. xxi, 196, 3 plates. (Gore.)

Revd. by DELAMBRE (J.-B.-J.), Conn. d. Temps, 1808, 466-479.

—— De motu pendulorum. (H.)

Upsaliæ, 1824.

—— Berättelse öfver försök till bestammende af secundenpendels längd och vattnets tyngl.

K. Vetens. Ak. Handl., 1825, 1-16; Quart. Journ. Sci., XXII, 1826, 152-180.

——: **Young (T.)**. Note on —'s reduction of the length of the pendulum.

Quart. Jour. Sci., XXII, 1826, 365-367.

—— Berättelse öfver de år 1833 på Stockholm Observatorium verkstälda pendel försök.

K. Vetens. Ak., Handl., 1834, 184-317.

SWEDEN.

LINDHAGEN (D. G.). Bericht über die ausgeführten Arbeiten in Schweden.

Int. Geod. Cong., Gen.-Ber., 1863, 28-29; 1864, 43-48; 1865, 37-38; 1866, 46-47; 1869, 61; 1875, 216-217.

PROSPERIN (E.). Vermischte astronomische und geographische Nachrichten aus Schweden.

Mon. Corr. (Zach), I, 1800, 113-119.

ROSÉN (P. G.). Die astronomisch-geodätische Arbeiten des schwedischen Generalstabes.

Stockholm, 1882-'88; Int. Geod. Cong., Verhandl., 1884-'86, 228-231.

ZACH (F. X. VON). Schwedische Gradmessung.

Mon. Corr. (Zach), XII, 1805, 421-449, 513-541; XIII, 1806, 3-20, 330-345; XIV, 210-224, 327-332.

Swinden (Jan Hendrik van). Rapport sur la mesure de la méridienne de France, et les résultats qui en ont été déduits pour déterminer les bases du nouveau système métrique.

Inst. de France, Cl. Math. Phys., II, an VII, 23-80 (Hist.); Journ. Nat. Phys. (Nicholson), III, 1800, 316-324, 365-369.

—— Précis des opérations qui ont servi à déterminer les bases du nouveau système métrique.

4°, Paris, 1799, pp. 18. (British Museum.)

—— Bestimmung des vom Herrn P. Thomas bei dessen chinesischer Gradmessung gebrauchten Masses.

Mon. Corr. (Zach), X, 1804, 522-531.

SWITZERLAND.

ESCHMANN (J.). Ergebnisse der trigonometrischen Vermessung in der Schweiz.

Zürich, 1840.

FEER (J.). Ueber die trigonometrische ... Vermessung des Rheinthales der Schweiz.

Geogr. Eph. (Zach), III, 1799, 350-362, 462-472.

HIRSCH (A.). Bericht über die geodätischen Arbeiten in der Schweiz.

Int. Geod. Cong., Gen.-Ber., 1870, 63-68; 1871, 63-65; 1872, 58-73; 1874, 79-82; 1875, 217-219; 1876, 122-125; 1877, 307-308; 1880, 38-41; 1881-'82, 130-134; 1883, 279-283; 1884-'86, 232-238; 1887, XII, 1-5.

—— Le réseau de triangulation suisse.

Lausanne, 1888.

SWITZERLAND—Continued.

PFÄNDER (L.). Mittheilungen über die Gradmessungsarbeiten auf dem Gebiete der Schweiz.

1876.

PRITTWITZ (M. K. E. VON). Ueber die Triangulirung der Schweiz.

Zeits. allg. Erdkunde, XII, 1862, 81-86.

ROGG (J.). Abriss einer Geschichte der trigonometrischen Vermessung ... in der Schweiz.

Stuttgart, 1859.

SIEGFRIED. Bericht über die geodätischen Arbeiten in der Schweiz für das Jahr 1878.

Int. Geod. Cong., Gen.-Ber., 1878, 112.

TRALLES (J. G.). Ueber die Landes-Vermessung der Schweiz.

Allg. geogr. Eph., I, 1798, 267-280.

TRECHSEL (F.). Nachricht von der in 1811 angefangenen trigonometrischen Aufnahme des Canton Bern.

Ak. zu Bern., litter. Arch., III, 1812, 424-463; Bibl. Univ. Genève, X, 1819, 77-89.

WOLF (R.). Notizen zur Geschichte der Vermessungen in der Schweiz.

Naturf.-Ges. Bern, Mittheil., 1844, 111-117, 185-196, 148, 93-95; 1862, 52-89.

—— Geschichte der Vermessungen in der Schweiz.

Zürich, 1879.

ANON. Commission géodésique suisse. Procès-verbaux des séances de la commission géodésique suisse tenues à l'observatoire de Neuchâtel, 1862+.

In Bulletin de la Société des sciences naturelles de Neuchâtel. Also published separately.

—— Rapport de la commission géodésique suisse [concerning the work done in 1879].

Int. Geod. Cong., Gen.-Ber., 1879, 113-115.

Sylow (Th.). Geodäsie.*

8°, Christiania, 1859, pp. 178.

Szekscö (T.). Bericht über die Gradmessung.*

Pressburg, 1866.

Szily (C.). Neue Daten über die Dimensionen des Erdkörpers.*

K. ungar. Ak. d. Wiss., III.

Taaks. Geodätische Tafeln für die Nord- und Ostsee Küste, nebst Erläuterungen und nebst einem Coordinaten-Verzeichnisse von 336 an der Ems, Jade, Weser, Elbe, und an der Nordsee belegenen festen Punkten für Nautiker, Techniker, und Geometer berechnet nach Gauss'schen Formeln.

4°, Zürich, 1865. (British Museum.)

I. Heft, Tafeln, pp. 29; II. Heft, Erläuterungen, pp. 44.

Tarragon (J.-B.). Nouveau traité du toisé.*

BRUGHEM, 189.

Tassius (Johannus Adolphus) [Johann Adolph Tasse]. Geographiæ universalis compendium in usum studiosæ juventutis.

8°, Hamburgi, 1679, pp. [xxii], 88; explicatio, pp. 63. (Gore.)

De situ et figura telluris, 1-14; explicato, 1-9.

—— Geodesiæ sive geometricæ practicæ compendium, in usum gymnasii Hamburgensis editum, ex recensione Henrici Siveri, cujus animadversiones quædam cum scragraphia operis præcedunt.

4°, Hamburgi, 1677, pp. xi, 87. (Berlin, Royal.)

Tédénat. Mesure de la distance de la tour de l'horloge de Nismes à la méridienne de Paris.

Acad. du Gard, Notice d. Travaux, 1808, 212-277.

Contains a good discussion of the theories of the figure of the earth.

Tellkampf (Johann Dietrich Adolph). Darstellung der mathematischen Geographie, mit besonderer Rücksicht auf geographische Ortsbestimmung.
4°, Hannover, 1824, pp. viii, 158, 2 plates. (British Museum.)
Gestalt der Erde, 19-22, 101-125.

Tengström (Johan Magnus af). Dissertatio academica de figura telluris ope pendulorum determinanda.
8°, Aboæ, 1815, pp. 10. (British Museum.)

Tennant (James Francis). An examination of the figure of the Indian meridian as deduced by Archdeacon Pratt from the two northern Indian arcs; with a proposition for testing that form by astronomical observations.
Roy. Astron. Soc., Month. Not., XVII, 1857, 58-63.

——— On the effect of local attraction in modifying the apparent form of the earth, and on some remarks on the real existence of diversity of form, independent of their effect.
Roy. Astron. Soc., Month. Not., XVII, 1857, 236-241.

——— Reply to Mr. Pratt's letter on the Indian arc of meridian.
Asiat. Soc. Bengal, Journ., XXVIII, 1859, 17-22.

——— Note on the coefficient of expansion of the brass pendulums used in the Indian trigonometrical survey.
Roy. Astron. Soc., Month. Not., XXVII, 1867, 284-286.

Tenner (C.). Nachricht von der Vollendung der Gradmessung zwischen Donau und Eismeer.*
Acad. de St.-Pétersbourg, 1853.

——— Verbindung der russischen Triangulationen mit den preussischen bei Memel ausgeführt auf allerhöchsten Befehl in den Jahren 1832 und 1833. Als Manuscript gedruckt.*
Breslau, 1858. Milit.-geogr. Inst., Cat. 206.

———: **Struve (F. G. W.).** Arc du méridien de 25° 20′ mesuré depuis 1816 jusqu'en 1850, sous la direction de —.
St.-Pétersbourg, 1857-'62.
Title in full under STRUVE (F. G. W.).

Testu (P.). Topographie et géodésie élémentaire, manuel à l'usage des officiers de l'armée. Théorie; formules et exemples numériques; distribution des calculs dans les tableaux du dépôt de la guerre; tables pour faciliter les calculs; modèles de topographie distribués aux officiers attachés au service de la carte de France; supplément sur les reconnaissances militaires.
4°, Paris, 1849, pp. xx, 191, 9 plates. (Berlin, Royal.)

Textor (Johann Christoph von). Nachricht von den ost- und westpreussischen Landes-Vermessungen.
Allg. geogr. Eph., II, 1798, 3-23, 109-117.

——— Ueber die ost- und west-preussische Landes-Vermessung.
Mon. Corr. (Zach), I, 1800, 307-319.

——— Beschreibung des Verfahrens bei dem trigonometrisch-topographischen Vermessen von Ost- und Westpreussen; nebst Bemerkungen über die Vermessungen ganzer Länder.
8°, Berlin, 1810, pp. vi, 214, 1 chart. (Stuttgart, Royal.)

Textor (Johann Christoph von)—Continued.
——— Nachricht von den trigonometrischen Vermessungs-Arbeiten in der Kurmark in den Sommermonaten vom Anfange May bis Ausgang Octobers 1810.
Mon. Corr. (Zach), XXIV, 1811, 101-120.

Thacker (Arthur). On the motion of a free pendulum.
L., E., D. Phil. Mag., II, 1851, 275-278.

Thelin (M.). De oscillatione pendulorum. (H.)
Lund., 1804.

Thersner (U.). Om triangelmätningen i Skåne, åren 1812 en 1815.
K. Svenska Ak., Handl., 1819, 9-50.

Theunuis (Henricus). Dissertatio cosmographica de magnitudine telluris ad cœlum comparatæ.
8°, Jenæ, 1658, pp. 22. (Paris, Observatory.)

Thiele (F. N.). Sur la compensation de quelques erreurs quasi-systématiques par la méthode des moindres carrés.
4°, Copenhague, 1880, pp. 29.

——— Om Anweldelse af mindeste kvadraters Methode.*
Kjøbenhavn, 1880.

——— Ueber Ausgleichung abgegrundeter Beobachtungen.
Astron. Nachr., CX, 1885, 257-262.
See Lehmann-Filhés (R.).

Thomas (P.): Swinden (J. H. van). Bestimmung des vom—bey dessen chinesischer Gradmessung gebrauchten Masses.
Mon. Corr. (Zach), X, 1804, 522-531.

Thomson (Thomas): Gregory (O.). Dissertations and letters by — regarding the survey of England.
London, 1815.
Title in full under GREGORY (O.).

Thorel (J.-B.-A.). Arpentage et géodésie pratique. Ouvrage à l'aide duquel on peut apprendre le système métrique dans sa perfection, l'arpentage et la division des terres, avec instruments, ou sans autre instrument que le mètre; la trigonométrie rectiligne, etc.
4°, Paris, 1853, pp. iii, 228, 12 plates. (Paris, National.)
Trigonometric surveying.

Thuillier (H. R.) *and* Smyth (R.). A manual of surveying for India, detailing the mode of operations on the trigonometrical, topographical and revenue surveys of India. Prepared for the use of the survey department of India, and published under the authority of the Government of India.
1st ed., 8°, Calcutta, 1851.
Revd. in Calcutta Rev., XVI, 1851, 321-328.
3d ed., revised and enlarged, Calcutta, 1875, pp. xxi, 623, ccviii. (Southampton, Ordnance Survey.)
Trigonometrical surveying, pp. 466-492.

——— Harachi longitudinal series.
India, Trig. Survey, III, 1876, xiii, 135, 148, 7 plates.

——— North-west Himalaya Series.
India, Trig. Survey, III, 1876, xii, 61, 42, 3 plates.

——— *and* **Haig (C. T.).** Auxiliary tables to facilitate the calculations of the survey of India. Third edition, revised and extended under the direction of Lieut.-Colonel Thuillier, by Col. C. T. Haig.
4°, Dehra Dún, 1887, pp. lxxxvi, 124, 4 plates. (Washington, Geological Survey.)
1st ed., by SIKDHAR, 1851; 2d, by HENNESSEY, 1868.

Thuillier (H. R.)—Continued.

——— Synopses of the results of the Great Trigonometrical Survey of India.
4°, Dehra Dún, 1879 (1 vol.).

Thury (C.-F. de). *See* **Cassini de Thury (C.-F.).**

Tiarks (John). On Mr. Dalby's method of finding the difference of longitude between two points of a geodetical line on a spheroid, from the latitude of those points and the azimuths of the geodetical line at the same.
Phil. Mag. (Taylor), IV, 1828, 364–370.
The theory is: The sum of the three angles of any spheroidical triangle formed by geodetical lines is a function of the latitudes of the angular points and their differences of longitude only, and is altogether independent of the eccentricity of the spheroid. This sum is the same as the sum of the three angles of a spherical triangle whose angular points have the same relative situation to a particular diameter; that is, the same latitude and difference of longitude. As used on the survey, two of the geodetical lines are meridians, and one of the angular points is the spheroid.

——— On the longitudes of the trigonometrical survey of England.
Phil. Mag. (Taylor), V, 1829, 52–53.
A defense of the method employed on the survey.

Tidblom (A.V.). Pendel-bestämnigar under den svenska Artisca expeditionen.*
Lunds Univ. Arsskrift, XIV.

Tillman (Samuel E.) *and* **Kampf (F.).** Geodetic computations.
U. S. Eng., Rep., 1878, Appendix NN, Washington, 1878, 28–37.
The entire appendix is known as Wheeler's annual report upon the geographical surveys of the United States west of the 100th meridian.

Tilly (J.-M. de). Note sur le principe de la moyenne arithmétique et sur son application à la théorie mathématique des erreurs.
Nouv. Corr. de Math., I, 1875, 137–147.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 107.

Timmermans (Jean Alexis). De figura terræ hydrostaticæ.*
4°, Gandæ, 1822.

Tinter (William Robert). Die europäische Gradmessung in ihrer Beziehung zu den früheren Gradmessungsarbeiten.
Allg. Bauzeitg. (Förster), XXXV, 1870, 150–173, 195–209.

——— Der Zweck der europäischen Gradmessung.
K. k. geogr. Ges., Mittheil., XIV, 1871, 81–90.

——— Vorträge über höhere Geodäsie.*
Fol., Wien, 1872.
Lithographed.

——— Mathematische, geodätische und astronomische Instrumente.
8°, [Wien, 1874], pp. 32-43. (Gore.)

——— *und* **Ganahl.** Bericht über die für die europäische Gradmessung ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1875, 181–189.

——— *und* **Kalmár (A. von).** Bericht über die Gradmessungs-Arbeiten des k. k. militär-geographischen Instituts im Jahre 1887.
Int. Geod. Cong., Gen.-Ber., 1887, viii, 1–18.

Tisserand (F.). Sur la théorie de la figure de la terre.
Acad. d. Sci. Paris, Comp. Rend., XCIX, 1884, 577–583.

Tissot (A.). Notice sur l'appareil du gouvernement égyptien pour la mesure des bases géodésiques. Extrait du Cosmos, 2e série, 1er volume.
8°, Paris, n. d., pp. 16. (Paris, Observatory.)

——— Dilatation des métaux (du platine et du laiton) employés à la construction des instruments géodésiques.
Les Mondes, VI, 1864, 317.

Tittmann (Otto Hilgard). Relative expansion of bronze and Low Moor iron.
U. S. C. and G. Survey, Rep., 1877, 166–171.

——— On a method of readily transferring the underground mark at a base monument.
U. S. C. and G. Survey, Rep., 1881, 357–358.

——— On the relation of the yard to the meter.
U. S. C. and G. Survey, Bull., 1889, IX, 45–50.

Todhunter (Isaac). On the method of least squares.
L., E., D. Phil. Mag., XXX, 1865, 378; Phil. Soc. Camb., Trans., XI, 1869, ii, 219–238.

——— On the arc of meridian measured in Lapland.
Phil. Soc. Camb., Trans., XII, 1873, 1–26.
Revd. in Jahrb. üb. d. Fortschr. d. Math., V, 1875, 597–598, by GLR. [GLAISHER].

——— On a history of the mathematical theories of attraction and the figure of the earth, from the time of Newton to that of Laplace.
London, 1873, I, pp. xxxvi, 476; II, pp. 508. (Gore).

——— On the arc of the meridian measured in South Africa.
Roy. Astron. Soc., Month. Not., XXXIII, 1873, 27–34.

——— On the equation which determines the form of the strata in Legendre's and Laplace's theory of the figure of the earth. [Mécanique céleste, livre III, 530.]
Phil. Soc. Camb., Trans., XII, 1873, 301–318.
Revd. in Jahrb. üb. d. Fortschr. d. Math., V, 1873, 596–597, by GLR. [GLAISHER].

Topping (M.). Measurement of a base-line upon the sea beach, near Porto Novo, on the coast of Coromandel.
Roy. Soc. London, Phil. Trans., 1792, 99–114.

Tortolini (Barnaba). Sulla determinazione della linea geodesica descritta sulla superficie di un ellissoide a tre assi inequali secondo il metodo del cav. Jacobi, da esso dato nelle sue lezione di meccanica all' Università di Koenisberg.
Accad. d. Lincei, Atti, IV, 1850–'51, 287–324.

——— Sulla espressione dei raggi delle due curvature di una linea geodesica tracciata sulla superficie di un' ellissoide.
Ann. di Mat. (Tortolini), II, 1851, 345–357.

Tóth (Agaston Rafael). Az európai nemzetközi fokmérés es a Körébe tartozó geodätia munkálatok.*
Pest, 1870.

——— Die Geschichte und der gegenwärtige Stand der Topographie und der geodätischen Vermessungen.*
Pest, 1872.

——— Ueber europäische Gradmessung und die dazugehörigen geodätischen Arbeiten.*
Pest, 1876.

Toussaint (F. W.). Das Vermessungswesen und der Staat.*

Tralles (Johann Georg). Ueber die Landes-Vermessung der Schweiz.
Allg. geogr. Eph., I, 1798, 267–280.

——— Ueber eine eigenthümliche Methode, die Ausdehnung der Körper durch die Wärme zu bestimmen.
Ann. d. Phys. (Gilbert), XXVII, 1807, 241–260.

——— Behandlung einiger Aufgaben, die bei grösseren trigonometrischen Messungen vorkomenen.
K. Ak. d. Wiss., math. Cl., Abhandl., 1804, 11–27.

——— Algebraische Bestimmungsmethode der Länge, Breite und Azimuthe bei geodätischen Vermessungen.
K. Ak. d. Wiss., math. Cl., Abhandl., 1818–'19, 49–56.

Trechsel (Friedrich). Nachricht von der im Jahre 1811 angefangenen trigonometrischen Aufnahme des Canton Bern.
Ak. zu Bern, litter. Arch., III, 1812, 424–463.

——— Notice sur la triangulation exécutée dans le canton de Berne.
Bibl. Univ. Genève, X, 1819, 77–89.

Trepied (Ch.). Sur le calcul des coordonnées géodésiques.
Acad. d. Sci. Paris, Comp. Rend., LXXX, 1875, 36–40.
Revd. in Jahrb. üb. d. Fortschr. d. Math., VII, 1875, 698, by B[RUNS].

Tresca (H.). *and* **Barnard (F. A. P.).** Comparison of metres.
U. S. C. and G. Survey, Rep., 1867, 134–137.

——— Note sur la forme qu'il convient de donner aux mètres que la commission internationale doit construire.
Acad. d. Sci. Paris, Comp. Rend., LXXV, 1872, 1223–1230.

Trew [Treu] (Abdias). Disputatio de immobilitate terræ contra Copernicum.
Altdorf., 1636.
POGGENDORFF, II, 1133.

——— Geodæsia universalis, das ist, Bericht vom Land- und Feldmessen.*
8°, Nürnberg, 1641; 3d ed., *Doppelmayr*, Nürnberg, 1718.
POGGENDORFF, II, 1133.

TRIANGLES, ADJUSTMENT OF. *See* **FIGURE ADJUSTMENT.**

TRIANGLES, COMPENSATION OF.
ADAN (E.-H.-J.). La compensation d'une chaîne de triangles géodésiques.
Acad. de Belgique, Bull., L, 1880, 260–265; Journ. Frank. Inst., CXII, 1881, 314.
BARRAQUER (J. M.). La compensacion general de los errores de la red geodésica de España.
Madrid, 1874.
FERRERO (A.). Sur la compensation d'un réseau trigonométrique.
Int. Geod. Cong., Gen.-Ber., 1877, 217–224.

TRIANGLES, GEODETIC. *See* **GEODETIC TRIANGLES.**

Triesnecker (Francisco de Paula). Dissertatio de figura telluris e solis eclipsibus deducta.
Eph. Astron. (Hell et Triesnecker), 1791, 307–412.

Troughton (Edward). Comparison between the length of the seconds pendulum, as determined by Mr. Whitehurst and Captain Kater.
Edinb. Phil. Journ., I, 1819, 75–76.

Trowbridge (W. P.). Foreign geodetic surveys.
U. S. C. and G. Survey, Rep., 1858, 251–270.

——— Progress of the United States Coast Survey.
U. S. C. and G. Survey, Rep., 1858, 270–273.

Tübinger Blätter, *for* Tübinger Blätter für Naturwissenschaften und Arzneikunde.
8°, Tübingen, 1815–'17. (Oxford, Bodleian.)

Tutschkow. Memoirs of the army topographical department of Russia.
Vols. 10–18, 1847–'56.

Ulffers (D. W.). Praktische Anleitung und Tafeln zur Berechnung von Dreiecks-, Vierecks- und Polygon-Netzen ohne Logarithmen.
8°, Coblenz, 1854; vierte Auflage, 8°, Koblenz, 1870, pp. xv, 283, 1 plate. (Berlin, Royal.)

Ulloa (Antonio de) *y* **Juan (Jorge).** Relacion histórica del viaje á la América meridional.
Madrid, 1748.
English translation by ADAMS (J.), London, 1760, 1772, 1806, 1807; French translation by MONVILLON, Paris, 1752; German translation, Leipzig, 1751; Dutch translation, Goes, 1771.
Title in full under JUAN (J.).

——— ——— Observaciones astronómicas y físicas en los reinos del Perú.
Madrid, 1773.
Title in full under JUAN (J.).

———: **Grenus (T.).** Resultate einer Vergleichung der Werke von —.
Mon. Corr. (Zach), XVI, 1807, 238–256.

Unferdinger (Franz). Neuer Beweis des von Herrn Grunert in der Abhandlung: Das sphärische Dreieck, mit seinem Sehnendreieck verglichen, mit besonderer Rücksicht auf Geodäsie. Neuer merkwürdiger Lehrsatz.
Arch. d. Math. (Grunert), XXXIII, 1859, 89–91. *See* Arch. d. Math. (Grunert), XXV, 1855, 197.

——— Die allgemeine Formel für die Summe der Winkel eines Polygons.
K. k. Ak. d. Wiss., Sitz.-Ber., LVII, 1868, ii, 627–632.

——— Ueber die Bestimmung der Abplattung der Erde aus den gleichzeitigen Angaben eines Quecksilber- und eines Aneroid-Barometers.
Arch. d. Math. (Grunert), XLII, 1864, 443–452.

——— Aufstellung einer neuen Pendelformel und Darlegung einer Methode aus der Länge des Secundenpendels in verschiedenen Breiten die Flichkraft und die Form und Grösse der Erde zu bestimmen.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Sitz.-Ber., XLIX, 1864, ii, 210–219.

——— Vergleichung der Pendelformel mit den Beobachtungen.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Sitz.-Ber., XLIX, 1864, ii, 220–228.

——— Das Pendel als geodätisches Instrument.
Arch. d. Math. (Grunert), XLIX, 1869, 309–331.
Reproduction of two articles in Wiener Akad. papers.
Revd. in Jahrb. üb. d. Fortschr. d. Math., I, 1868, 391–392, by B[RUNS].

Unger (Ephraim Salomo). Anleitung zum Feldmessen und Aufnehmen.
8°, Gotha, 1821, pp. xiii, 536; und Gotha, 1828, vi, 216. (British Museum.)
Simple surveying.

UNITED STATES COAST SURVEY.

First report from Superintendent Hassler to the Secretary of the Treasury upon the survey of the coast. 8°, 3 pp., 1816.

Message on the Coast Survey. Transmitting a report of the Secretary of the Treasury upon the progress made in the Coast Surveys; instructions to Mr. Hassler, superintendent of the work, and his report to the Secretary of the Treasury. State Papers, No. 143, 15th Congress, 1st Session, vol. 2, 21 pp., 1818.

Report upon the works executed for the survey of the coast of the United States, upon the law of 1832, and their junction with the works made in 1817, by and under the direction of Ferdinand Rudolph Hassler. 23d Congress, 1st Session, Doc. No. 1, 17 pp., 1834.

Fourth Report. House Document No. 1, 24th Congress, 1st Session, 6 pp., 1835.

Report for 1836. House Document No. 13, 24th Congress, 2d Session, 60 pp., 1836.

For 1837. House Document No. 14, 25th Congress, 2d Session, 7 pp., 1837.

For 1838. Senate Document No. 4, 25th Congress, 3d Session, 7 pp., 1838.

Eighth annual report. Senate Document No. 15, 26th Congress, 1st Session, vol. 2, 8 pp., 1839.

Ninth annual report. Senate Document No. 20, 26th Congress, 2d Session, vol. 2, 8 pp., 1840.

Report of F. R. Hassler, showing the progress made up to the present time. House Document No. 28, 27th Congress, 2d Session, 18 pp., 1842.

Report for 1843. House Document No. 97, 28th Congress, 1st Session, 8 pp., 1844.

This was the last report of Mr. Hassler.

Report of A. D. Bache, Superintendent of the Coast Survey, for 1844. House Document No. 25, 28th Congress, 2d Session, 22 pp., 1844.

This was the first report that had accompanying progress and other sketches.

Report for 1845. Senate Document No. 13, 29th Congress, 1st Session, 44 pp., 1845.

For 1846. Senate Document No. 3, 29th Congress, 2d Session, 74 pp., 3 charts, 1846.

For 1847. Senate Document No. 6, 30th Congress, 1st Session, 88 pp., 1847.

For 1848. Senate Executive Document No. 13, 30th Congress, 2d Session, 120 pp., 1848.

For 1849. Senate Executive Document No. 5, 31st Congress, 1st Session, 98 pp., 1849.

For 1850. Senate Executive Document No. 7, 31st Congress, 2d Session, 134 pp., 1850.

For 1851. 8°, Washington, 1852.

This was the first report published separately, and is the only separate report that appeared in octavo.

Report of the Superintendent of the Coast Survey, showing the progress of the survey. 1852–'77, 26 vols., 4°, Washington, 1853–'80.

Report of the Superintendent of the U. S. Coast and Geodetic Survey, showing the progress of the work, 1878–'87. 10 vols., 4°, Washington, 1881–'89.

UNITED STATES COAST SURVEY—Continued.

The following papers relating to geodesy occur in the above reports:

BACHE (A. D.). Comparison of the reduction of horizontal angles by the method of least squares. 1854, pp. 63–70.

—— Epping-base, Maine. 1857, pp. 302–305.

BARNARD (F. A. P.). Comparison of metres. 1867, pp. 134–137.

BOUTELLE (C. O.). Primary base apparatus. 1855, pp. 64–267.

—— Description of tripod and scaffold. 1855, pp. 361–363.

—— Geodetic night signals. 1880, pp. 96–109.

—— Observing tripods. 1882, pp. 199–208.

—— Connection of the Coast Survey triangulation with that of the Lake Survey. 1884, pp. 387–390.

—— On geodetic reconnoissance. 1885, pp. 469–481.

CUTTS (R. D.). Field-work of a secondary triangulation. 1868, pp. 109–139.

—— Field-work of the triangulation. 1882, pp. 151–197.

DAVIDSON (G.). Clamp for theodolite telescopes. 1874, p. 153; 1877, p. 182.

—— Measurement of the Yolo base. 1882, pp. 139–149; 1883, pp. 273–288.

—— The run of the micrometer. 1884, pp. 377–385.

DOOLITTLE (M. H.). Closing of a circuit of triangulation. 1875, pp. 282–292.

—— Solution of normal equations. 1878, pp. 115–120.

GOODFELLOW (E.). Descriptive catalogue of publications relating to the Coast and Geodetic Survey and to standard measures, 1883, 121–135.

—— General index to the progress sketches and illustrations, maps and charts published in the annual reports from 1844 to 1885. 1887, 217–268.

GORE (J. H.). A bibliography of geodesy. 1887, 313–512.

HILGARD (J. E.). Triangulation of the Mississippi Sound. 1856, pp. 291–292.

—— Theodolite test. 1856, pp. 310–316; 1860, pp. 357–361.

—— Description of base apparatus. 1856, 308–310; 1857, pp. 395–398; 1862, pp. 248–255.

—— Geodetic signals. 1867, p. 145.

—— Use of railways for geodetic surveys. 1867, pp. 140–144.

—— Intervisibility of stations. 1873, p. 137.

—— Comparison of standards of length. 1876, pp. 402–406.

—— Examination of theodolites. 1877, pp. 114–147.

—— Comparison of American and British standard yards. 1877, 148–181.

HUNT (E. B.). Description of base-measuring apparatus. 1854, 103–108; 1873, 132–136.

—— Contact base apparatus. 1880, pp. 341–344.

LANE (J. H.). Coefficient of expansion of the British standard yard, bronze No. 11. 1877, pp. 155–166.

PEIRCE (C. S.). Errors of observation. 1870, pp. 200–224.

—— Measurements of gravity. 1876, pp. 202–337.

—— On the flexure of pendulum supports. 1881, 359–441.

—— Ellipticity of the earth from pendulum experiments. 1881, pp. 442–456.

—— Method of observing coincidence of the vibration of two pendulums. 1881, pp. 457–460.

—— Value of gravity at Paris. 1881, pp. 461–463.

—— Determinations of gravity at Alleghany, Ebensburg, and York, Pa. 1883, pp. 473–487.

—— The effect of flexure of a pendulum on its period of oscillation. 1884, 483–485.

—— The use of a noddy . . . 1884, 475–482; 1885, 509–510.

—— Effect of temperature upon a reversible pendulum. 1885, pp. 511–512.

UNITED STATES COAST SURVEY—Continued.

PRESTON (E. D.). Determination of gravity . . . 1883, 379–381.

—— Determinations of gravity for the Hawaiian Government. Bull., XI, 137–142.

SANDS (B. F.). Observing signal. 1855, p. 364.

SCHOTT (C. A.). Adjustment of horizontal angles. 1854, pp. 70–86.

—— Probable error of observation. 1854, pp. 86–95.

—— Solution of normal equations. 1855, pp. 255–264.

—— Probable error, from the German. 1856, pp. 307–308.

—— Epping-base computation. 1864, pp. 120–144; 1866, p. 141.

—— Primary triangulation of the Atlantic coast. 1866, pp. 49–54.

—— Length of the Kent Island base. 1866, p. 140.

—— Adjustment of the Long Island Sound triangulation. 1868, pp. 140–146.

—— Measurement of an arc of the meridian. 1868, pp. 147–153.

—— Connection of the Kent Island and Craney Island bases. 1869, pp. 105–112.

—— Local deflection of the zenith near Washington. 1869, pp. 113–115.

—— Adaptation of triangulations to the configuration of the country. 1871, 185–188; 1876, pp. 391–399.

—— Peach Tree base. 1873, pp. 123–136.

—— Closing of a circuit of triangulation. 1875, pp. 279–292.

—— Pamplico-Chesapeake arc of the meridian. 1877, pp. 84–95.

—— Connection of the Maryland and Georgia base lines. 1878, pp. 92–120.

—— Local deflection of the plumb-line. 1879, pp. 110–123.

—— Description of a new base apparatus. 1882, pp. 107–138.

—— Results for the length of Yolo base. 1883, 273–288.

—— Connection of Coast Survey and Lake Survey Triangulations. 1884, pp. 387–390.

—— Geographical position of Borden's Massachusetts points. 1885, pp. 285–302.

—— Yolo base triangulation. 1885, pp. 441–467.

SINCLAIR (C. H.). General index of scientific papers, methods and results contained in the appendices of the annual reports from 1845 to 1880, inclusive. 1881, 91–123.

SMITH (E.). Determination of gravity at various places. 1884, pp. 439–473.

TITTMANN (O. H.). Relative expansion of bronze 12, and Low Moor iron. 1877, pp. 166–171.

—— Transferring under ground mark at a base monument. 1881, pp. 357–358.

—— On the relation of the yard to the meter. Bull., IX, 45–50.

TRESCA (H.). Comparison of metres. 1867, 134–137.

TROWBRIDGE (W. P.). Foreign geodetic surveys. 1858, pp. 251–270.

—— Progress of the U. S. Coast Survey. 1858, pp. 270–273.

ANON. Subsidiary base apparatus. 1856, pp. 308–310.

—— Formulæ for computing latitudes, longitudes, and azimuths. 1860, pp. 361–391; 1875, pp. 315–368; 1884, 323–375.

—— Locating a point by intersections. 1864, pp. 116–119.

—— Triangulation of the coast of New England. 1865, pp. 187–203; 1866, p. 141.

—— Measurements of subsidiary base lines. 1868, pp. 133–139.

—— Report of a conference on gravity determinations. 1882, 503–516.

—— Tables for the projection of maps on the Clarke spheroid. 1884, pp. 135–321.

UNITED STATES COAST SURVEY—Continued.

Papers regarding the Survey.

B. (B.). The Coast Survey.
N. d.

BACHE (A. D.). Survey of the coast.
Sid. Mess., I, 1848, 98–99; II, 1848, 55–56.

—— Progress of the survey of the coast.
A. A. A. S., Proc., 1849, 162–178; Am. Journ. Sci., XII, 1851, 158–164.

BESSEL (F. W.). Ueber die von Herrn F. R. Hassler, zur Vermessung der Küste der Vereinigten Staaten ergriffenen Maassregeln.
Astron. Nachr., VI, 1828, 349–356.

BOUTELLE (C. O.). What has the Coast Survey done for science?
Science, VI, 1885, 558–562.

—— On a geodetic survey of the United States.
Science, VII, 1886, 460–461; Van Nostrand's Mag., XXXV, 1886, 38–40.

DAVIS (C. H.). The Coast Survey of the United States.
Cambridge, 1849; Washington, 1851.

DAVIS (J.). Speech on the subject of the Coast Survey.
[1849].

DYER (G. L.). The survey of the coast.
U. S. Naval Institution, Proc., XII, 1886, ii, 199–240.

F. Report of the Superintendent of the Coast Survey, showing progress of the work for 1847.
Journ. Frank. Inst., XLV, 1848, 213–217; for 1848, XLVII, 1849, 141–144; for 1849, L, 1850, 72; for 1850, LI, 1851, 359–360.

GORE (J. H.). The geodetic survey.
Phila. Press, Sept. 9, 1884, 7.

—— U. S. Coast and Geodetic Survey.
Railroad and Eng. Journ., LXI, 1887, 247–249, 299–300, 350–352.

H. Documentary publications and science in the Coast Survey report for 1853.
Am. Journ. Sci., XVIII, 1854, 200–212.

HASSLER (F. R.). Papers on various subjects connected with the survey of the coast of the United States.
Am. Phil. Soc., Trans., II, 1825, 232–419.

—— Principal documents relating to the survey of the coast of the United States.
New York, 1834, 1835, 1836.

—— Bericht über die Küsten-Vermessung in Nord-Amerika.
Astron. Nachr., XIX, 1842, 353–368, 377–384.

HENRY (J.). The Coast Survey.
Princeton, 1845.

HILGARD (J. E.). Letter on the proposed transfer to the Navy Department.
Washington, 1883.

—— Inquiry of the National Academy of Sciences concerning the Coast Survey.
Washington, 1884.

J. Survey of the coast of the United States.
Hunt's Merchant's Mag., 1849, 131–149.

KANE (J. K.). Report on the history and progress of the American Coast Survey.
A. A. A. S., Proc., 1850, 27–150.

LAMB (M. J.). The Coast Survey.
Harper's Mag., LVIII, 1878, 506–520.

M. (M.). The United States Coast Survey.
Christian Examiner, LII, 1852, 77–96.

OGDEN (H. G.). The survey of the coast.
Nat. Geogr. Mag., I, 1888, 59–75.

PEARCE (J. A.). Speech on the subject of the Coast Survey.
Washington, 1849.

PEIRCE (B.). A report upon the results of the United States Coast Survey.
A. A. A. S., Proc., II, 1848–'52, 124–128.

S. Nordamerikanische Vermessung.
Astron. Nachr., X, 1833, 385–388.

UNITED STATES COAST SURVEY—Continued.

SÉDILLOT (L.-A.). Notice historique sur le Coast Survey des États-Unis.
Soc. Géogr., Bull., I, 1851, 41-51.

SPENCER (J. C.). Plan for reorganization of the Coast Survey.
Washington, 1843.

TROWBRIDGE (W. P.). Progress of the United States Coast Survey.
U. S. C. and G. Survey, Rep., 1858, 270-273.

VOSE (G. L.). The United States Coast Survey.
Van Nostrand's Mag., XIII, 1875, 1-13.

WELLS (H. P.). The United States Coast and Geodetic Survey.
Harper's Weekly, XXXII, 1888, 805-808.

ANON. A review of Hassler's principle documents, executive congressional documents since 1832, and the report for 1844.
Princeton Rev., XVII, 1845, 321-344.

—— Review of the Annual Report of the U. S. Coast Survey (1847).
Am. Journ. Sci., V, 1848, 307-318.
A short review of the year's work.

—— Report of the committee on science and the arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the mechanic arts, to whom was referred for examination and report the subject of the progress of the survey of the coast of the United States.
Journ. Frank. Inst., XLVII, 1849, 209-214.

—— Notice of the visit of the American Association for the Advancement of Education to the Coast Survey Office.
Am. Journ. Ed., I, 1855, 103-106.

—— The United States Coast Survey.
Putnam's Monthly, VI, 1855, 449-458.

—— Review of the operations and results of the United States Coast Survey.
Am. Journ. Sci., XXV, 1858, 75-83, 249-258.
A popular account of the work of the Coast Survey to date.

—— The Coast Survey, by one who has examined public documents. Reprint from New York Times.
N. d., pp. 18.

—— The Coast Survey; its costs, abuses, and power. From the New York Times.
Journ. Frank. Inst., LXVII, 1859, 63-68.
A defense of the Coast Survey, in reply to the above-named article.

—— Coast Survey.
Appleton's Cyclo., V, 1859, 394-401.

—— Report on the history and progress of the American Coast Survey.
A. A. A. Sci., Proc., 1859, 27-150.

—— Report of the Secretary of the Treasury, communicating in answer to a resolution of the Senate a report showing the amount expended and the progress made in the Coast Survey.
Senate, 35th Congress, 2d session, Ex. Doc. No. 6.
Revd. in North Am. Rev., XC, 1860, 249-260.

—— Letters from Government officers, including commanders in the Army and Navy, relative to the field and office work of the Coast Survey.
8°, Washington, 1863, pp. [17].

—— Coast Survey.
Am. Cycl., IV, 1883, 754-765.

—— The late attacks upon the Coast and Geodetic Survey. Reprinted from the October and November numbers of the United Service, 1884.
8°, Philadelphia, 1884, pp. 52.

—— The geodetic survey of the United States.
Nature, XXIX, 1884, 573-575.
A review of the Report for 1882.

—— Determination of gravity at stations in Pennsylvania, 1879-1880.
Nature, XXXII, 1885, 572.
A review of the above.

UNITED STATES COAST SURVEY—Continued.

—— U. S. Coast and Geodetic Survey for the year ending with June, 1885. Rev. of.
Am. Journ. Sci., XXXIII, 1887, 129-431.

—— What the Coast Survey has done for the War. Reprinted from U. S. Service Mag., June and July, 1865.
8°, New York, 1865, pp. 24.

—— Message from the President of the United States transmitting a report from the Secretary of State relating to an invitation from the Imperial German Government to become a party to the International Geodetic Association.
50th Cong., 1st Sess., Ex. Doc. 164, pp. 18.

U. S. C. and G. Survey, Rep., *for* Report of the Superintendent U. S. Coast Survey.
8°, Washington, 1816-'51; 4°, 1852-'77.
Report of the Superintendent U. S. Coast and Geodetic Survey.
4°, Washington, 1878+.

U. S. Eng. Rep., *for* Report of the Chief of Engineers of the U. S. Army.
8°, Washington, 1868+.

UNITED STATES LAKE SURVEY.

BLAIR (H. W.). The Lake Survey.
Science, I, 1883, 174.

BOUTELLE (C. O.). Connection of the triangulation of the Coast Survey with that of the Lake Survey.
U. S. C. and G. Survey, Rep., 1884, 387-390.

COMSTOCK (C. B.). Annual report of the United States Lake Survey.
U. S. Eng. Rep., 1871, 982-1026; 1872, 1031-1108; 1873, 1169-1202; 1874, 402-476; 1875, 852-918; 1877, 1105-1206; 1878, 1355-1419; 1879, 1891-1972; 1880, 2365-2458; 1881, 2781-2803; 1882, 2785-2820.

—— Report upon the triangulation of the Lake Survey.
Washington, 1882.

GORE (J. H.). The United States Lake Survey.
Railroad and Eng. Journ., LXI, 1887, 200-203; Zeits. f. Vermes., XVII, 1888, 385-395.

KERSCHBAUM (G.). Die nord-amerikanische Basismessung von Chicago.
Zeits. f. Vermes., XIII, 1884, 533-547.

R. (S. W.). U. S. survey of the north and northwest lakes.
Journ. Frank. Inst., LXXXIV, 1867, 399-401.

RAYNOLDS (W. F.). Annual report on the survey of the north-west lakes.
U. S. Eng. Rep., 1867, 553-864; 1868, 925-1187; 1869, 549-648; 1870, 535-613.

SCHOTT (C. A.). Connection of Lake and Coast Survey triangulations.
U. S. C. and G. Survey, Rep., 1884, 387-390.

U. S. Naval Institution, Proc., *for* Proceedings U. S. Naval Institution. (Washington, Congress.)

V. (le S. C. de). Recherches curieuses des mesures du monde.
16°, Paris, 1636, pp. 48. (Gore.)

Vacossaint (Charles-Nicolas). Traité de géodésie pratique, contenant des méthodes nouvelles, simples et exactes pour la division des superficies agricoles.
8°, Oisemont, 1863, pp. ii, 109, 2 plates. (Berlin, Royal.

Valentiner (W.). Beiträge zur kürzesten und zweckmässigsten Behandlung geographischer Ortsbestimmungen, mit Hülfstafeln.
4°, Leipzig, 1869, pp. 88. (Gore.)

Van Diemen's Land, Roy. Soc., Proc., *for* Proceedings of the Royal Society of Van Diemen's Land.
8°, Hobart Town, 1849-'59 (3 vols.). (Washington, Congress.)

Van Nostrand's Mag., *for* Van Nostrand's Eclectic Engineering Magazine.
8°, New York, 1869+.

Vásárhely (P.). Auflösung einiger Aufgaben als Beittrag zum geometrischen Triangulirung.*
Ofen, 1827.

Vaugondy (Didier Robert de). *See* **Robert de Vaugondy (Didier)**.

Vecchi (E. de). Istruzioni sulle riconoscenze geodetiche.
Fol., Roma, 1872, pp. 44. (Vienna, Geographic Institute.)
Lithographed.

——— Norme per l' esecuzione de' calcoli da compiersi per determinare gli elementi geodetici necessarii alla formazione di una carte topografica.
Fol., Roma, 1872 (?), pp. 9, 10 plates. (Vienna, Geographic Institute.)
Lithographed.

——— Relazione annuale sui lavori eseguiti nel 1873 e su quelli progettati pel 1824. (Italy.)
Int. Geod. Cong., Gen.-Ber., 1873, 5.

——— Relazione sui lavori geodetici eseguiti dalla commissione italiana [for 1874].
Int. Geod. Cong., Gen.-Ber., 1874, 26–30.

——— Relazione sui lavori eseguiti nel 1876 dalla commissione italiana per la misura dei gradi in Europa.
Int. Geod. Cong., Gen.-Ber., 1876, 100–105.

Veech (James). Mason and Dixon's line. A history, including an outline of the boundary controversy between Pennsylvania and Virginia.
8°, Pittsburg, 1857, pp. iv, 58. (Washington, Congress.)

Veltmann (W.). Ausgleichung der Beobachtungsfehler nach dem Principe symmetrisch berechneter Mittelgrössen.*
Marburg, 1886.

——— Bestimmung der Unbekannten einer Ausgleichungsaufgabe mittelst der Gauss'schen Transformation der Summe der Fehlerquadrate.
Zeits. f. Vermes., XVI, 1887, 345–356.

Verdam (Gideon Jan). Verhandeling over de methode der kleinste kwadraaten.
4°, I Croningen, 1850, pp. xiii, 214, 1 plate; II Groningen, 1852, pp. xxi, 215–409. (British Museum.)

[**Verdet.**] Étalon fixe des poids et mesures, ou mémoire pour servir à la solution d'un ancien problème, renouvelé par l'assemblée constituante, sur le choix d'un étalon fixe, perpétuel et universel, pris dans la nature, pour servir de base aux mesures de toutes les nations.
8°, Paris, 1815, pp. 46. (Paris, Observatory.)

Verhulst (Pierre-François). Sur l'intégration de quelques équations différentielles relatives au problème des oscillations du pendule simple dans un milieu résistant.*
Quetelet's Corr. Math., V, 1829.

Verrier: Faye (H.-A.-E.-A.). Rapport sur la conférence géodésique tenue à Berlin. · Remarks by —.
Acad. d. Sci. Paris, Comp. Rend., LVI, 1863, 28–34.

Versamml. deuts. Nat. u. Aerzte, Ber., *for* Bericht der Versammlung der [Gesellschaft der] deutschen Naturforscher und Aerzte.
8°, 1828+. (Berlin, Royal.)

Villarceau (A.-J.-F. Yvon). *See* **Yvon-Villarceau (A.-J.-F.)**.

Vincent (Alexandre-Joseph-Hidulphe). Sur la mesure de la terre, attribuée à Ératosthène.
Acad. d. Sci. Paris, Comp. Rend., XXXVI, 1853, 317–321.
Revd. in Geogr. Mittheil. (Petermann), 1857, 455.

Vita (Gaetano de). Relazione sul procedimento del calcolo della base geodetica misurata presso la foce del fluvio Crati.
Int. Geod. Cong, Gen.-Ber., 1872, 6–15.

Vogler (Ch. August). Genauigkeit einiger nahe zum Zerlegen mittlerer Beobachtungen Fehler in mehrere Glieder.
Zeits. f. Vermes., VI, 1877, 396–412.

——— Grundzüge der Ausgleichungsrechnung.*
Braunschweig, 1882, 1883.

——— Ueber Stationsbeobachtungen in symmetrischer Anordnung.
Zeits. f. Vermes., XIV, 1885, 49–59.

——— Die Methode der kleinsten Quadratsummen als Bildnerin bestgewählter Mittelgrössen.
Zeits. f. Vermes., XVI, 1887, 142–147.

Voight (W.) *and* **Woodward (R. S.)**. Results of some experiments made to determine the variations in length of certain bars at the temperature of melting ice.
Am. Journ. Sci., XXV, 1883, 448–459.

Voiron. Histoire de l'astronomie, depuis 1781 jusqu'à 1811, pour servir de suite à l'histoire de l'astronomie de Bailly, par M. Voiron.
4°, Paris, 1810, pp. ix, 383. (Washington, Observatory.)
Figure de la terre, 174–176.

Voit. Bericht über die Thätigkeit des geodätischen Instituts, 1870.
Title in full under BAEYER (J. J.).

Vorländer (J. J.). Geographische Bestimmungen im königlich preussischen Regierungsbezirke Minden vermittelst des trigonometrischen Netzes zur Aufnahme des Grundsteuer-Katasters.
4°, Minden, 1853, pp. vi, 130, 1 chart. (British Museum.)

——— Ueber die Genauigkeit der Längen-Messungen mit der Messkette auf verschiedener Bodenarten.
Zeits. f. Math. (Schlömilch), I, 1856, 142–159.

——— Ueber das geographische Vorwärts-Einschneiden.
Zeits. f. Math. (Schlömilch), II, 1857, 299–316.

——— Ausgleichung der Fehler polygonometrischer Messungen.
8°, Leipzig, 1858, pp. 55. (British Museum.)

——— Bemerkungen über das numerische Eliminiren bei geodätischen Operationen.
Zeits. f. Math. (Schlömilch), III, 1858, 16–22.

——— Zur praktischen Geometrie.
Zeits. f. Math. (Schlömilch), III, 1858, 189–193.
On the adjustment of a quadrilateral having measured sides and diagonals.

——— Anleitung zum Feldmessen, mit besonderer Rücksicht auf die Anwendung des metrischen Maasses, nebst einem Anhang über die Flächenbestimmung mit Hülfe des Amsler'schen Polarplanimeters.
8°, Berlin, 1871, pp. iv, 173. (Cambridge, University.)

Vorländer (**J. J.**)—Continued.

——— Ueber die Genauigkeit der Längenmessung mit Kette und Latten.
Zeits. f. Vermes., I, 1872, 154–162.

——— Ausgleichung der Fehler unmittelbar gemessener Längen in einfachen Linienverbindungen.
Zeits. f. Vermes., II, 1873, 145–171.

——— Bericht über die Vergleichung eines aus gemessenen Längen und Wilkeln hergestellten Liniennetzes mit einem Dreiecksnetze.
Zeits. f. Vermes., III, 1874, 65–83.

——— Ueber die Fehlerausgleichung der Liniennetze.
Zeits. f. Vermes., III, 1874, 390–401.

——— Ueber das Wiederfinden verlorener trigonometrischer Punkte.
Zeits. f. Vermes., IV, 1875, 81–85.

——— Zur Fehlerausgleichung der Liniennetze aus gemessenen Längen und Winkeln.
Zeits. f. Vermes., V, 1876, 155–174.

Vose (**Geo. L.**). The United States Coast Survey.
Van Nostrand's Mag., XIII, 1875, 1–13.

Voss (**A.**). Ueber diejenigen Flächen, auf denen zwei Schaaren geodätischer Linien ein conjugirtes System bilden.
K. bayer. Ak. d. Wiss., math.-phys. Cl., Sitz.-Ber., 1888, 95–102.

W. (**B.**). The Ordnance Survey.
Dublin University Mag., II, 1838, 353–357.

Waege (**W.**). Die Mängel des preussischen Vermessungswesen und Ansichten über deren Abhilfe.
8°, Görlitz, 1850, pp. vi, 63. (Berlin, Royal.)

Wagner (**Johann Christian August**). Ueber die neue astronomisch-trigonometrische Landes-Vermessung der batavischen Republic vom Obersten von Krayenhoff.
Mon. Corr. (Zach), VIII, 1803, 501–506.

——— Ueber die sogenannte Pendel-Versuche des Prof. Knoch in Braunschweig.
Ann. d. Phys. (Gilbert), LIX, 1818, 328–332.

Wagner (**Hermann**). Die Dimensionen des Erdsphäroids nach Bessel's Elementen, im metrischen Maasse, mit besonderer Berücksichtigung der Bedürfnisse des Kartographen.
Georgr. Jahrb. (Behm), 1870, i–lxi.

——— Ueber die Massvergleichungen für die europäischen Gradmessung.
Fol., Gotha, 1868, pp. 20. (Berlin, Geodetic Institute.)
Lithographed from manuscript.

Walbeck (**Henric Johann**). Dissertatio de forma et magnitudine telluris ex dimensio arcubus meridiani definiendis.*
4°, Aboæ, 1819.
POGGENDORFF, II, 1243.

——— [Vergleichung der Secundenpendel-Beobachtungen Kater's unter sich selbst nach der Methode der kleinsten Quadrate.]
Astron. Nachr., I, 1823, 253–256.

Walch (**Alb. Georg**). De dimensionibus nonnullis terræ per antiquos factis.
4°, Schlesingæ, 1740, pp. 12. (Dresden, Royal.)

Walckenaer (**C. A.**): **Dicuilus.** De mensura orbis terræ.
Parisiis, 1807.
Title in full under DICUILUS.

Walker (**John**). The Great Trigonometrical Survey of India.
Calcutta Rev., IV, 1845, 6–395; XVI, 1851, 514–540; XXXVIII, 1863, 26–62; Asiatic Soc., Journ., XXXI, 1862, 32–48.

Walker (**James Thomas**). Extracts from a report on the Great Trigonometrical Survey.
Asiat. Soc., Journ., XXXII, 1863, 111–163.

——— Report of the operations of the Great Trigonometrical Survey of India during 1862–'63.
Indian Eng. (Medley), I, 1864, 180–200; Asiat. Soc., Journ., XXXV, 1866, ii, 77–89.

——— Letter to the president [of the Royal Society] on the Indian pendulum observations.
Roy. Soc. London, Proc., XV, 1866–'67, 254–255.

——— Preliminary notice of results of pendulum experiments made in India.
Roy. Soc. London, Proc., XV, 1867, 318–319.

——— Pendulum and standard-bar operations of the Great Trigonometrical Survey in 1866–'67.
Indian Eng. (Medley), V, 1868, 305–314.

——— Account of the Great Trigonometrical Survey of India. Vols. I–IX.
Dehra Dún, 1870–'83.

——— [On the Indian pendulum observations.]
Roy. Soc. London, Proc., XIX, 1871, 97–104.

——— Description of the method of comparing and the apparatus employed.
India, Trig. Survey, I, 1870, i, 1–2.

——— *and* **Hennessey** (**J. B. N.**). Cape Comorin base-line.
India, Trig. Survey, I, 1870, x, 1–35.

——— ——— Great Indus series.
India, Trig. Survey, III, 1873, pp. xxix, 211, 136, 6 plates.

——— Synopses of the results of the Great Trigonometrical Survey of India.
4°, Dehra Dún, 1874–'80 (13 vols.); 1883 (5 vols.).

——— ——— Jogi-Tila meridional series.
India, Trig. Survey, IV, 1876, xxvi, 65, 35, 2 plates.

——— On the observations of terrestrial refraction at certain stations situated on the plains of the Punjab.
India, Trig. Survey, II, 1879, iii, 77–93.

——— Introductory account of the triangulation embraced by the north-east quadrilateral, with the details of its simultaneous reduction.
India, Trig. Survey, VII, 1882, 1–276.

——— *and* **Hennessey** (**J. B. N.**). The details of the observations and the final results of the triangulation of five of the component series included in the north-east quadrilateral.
India, Trig. Survey, VII, 1882, i–xvi, 1–204, 1 plate.

——— On the theoretical errors generated respectively in side, azimut, latitude and longitude in a chain of triangles.
India, Trig. Survey, VII, 1882, 87–106 (App.).

——— The survey of India.
Van Nostrand's Mag., XXXIV, 1887, 65–79.
Abstract of address before geographical section of British Association for the Advancement of Science, Aberdeen, 1885.

Wallace (William). Hindoo astronomy and mathematics, with an account of Lambton's trigonometrical survey of India.
N. d.
Title taken from a sale catalogue.

——— Geometrical theorems and formulæ particularly applicable to some geodetical problems.
Phil. Soc. Camb., Trans., VI, 1836, 107–140.

——— Geometrical theorems and analytical formulæ, with their application to the solution of certain geodetical problems. And an appendix, containing a description of two copying instruments.
8°, Edinburgh, 1839, pp. xi, 155, 3 plates. (British Museum.)
Revd. in Calcutta Review, IV, 1845, 62–95.

Waller (Richard). The measure of the earth; being an account of several observations made for that purpose by divers members of the Royal Academy of Science at Paris. Translated by —.
Fol., London, 1688, pp. 40, 5 plates. (Washington, Congress.)
With memoirs for a natural history of animals.

———: **Picard (J.).** The measure of the earth. Revd. by —.
Acta Eruditorum, 1688, 578–586.

Walling (H. F.). Co-operation between National and State Governments in topographical surveys.
Van Nostrand's Mag., XXXI, 1884, 331–342.
Read before the American Society of Civil Engineers at the Buffalo meeting.

Walterhöffer (Otto). How the earth is weighed.
Pop. Sci. Month., XIX, 1881, 743–749.

Wangenheim (von). Instruction für die Vermessung des Herzogthum Gotha beauftragten Geometer.
8°, Gotha, 1851, pp. 24. (Gore.)

[**Wanka von Lenzenheim (Josef).**] Mittheilungen des kaiserl. königl. militär-geographischen Instituts. Herausgegeben auf Befehl des k. k. Reichs-Kriegs-Ministeriums, III, 1883, mit 11 Beilagen.
8°, Wien, 1883, pp. 177. (Gore.)

Wargentin (Pehr Wilhelm). Om jordens skapnad och storlek.
K. Svenska Veten. Acad. Handl., X, 1749, 233–245; XI, 1750, 1–11, 81–94.

Warren (John). An account of experiments made at the observatory near Fort St. George, for determining the length of the simple pendulum beating seconds of time at that place; to which are added comparisons of the said experiments with others made in different parts of the globe, and some remarks on the ellipticity of the earth, as deduced from these operations.
Asiatic Researches, XI, 1810, 293–308.

Wartmann: Dufour (W. H.). Sur les déviations apparentes du plan d'oscillation du pendule. De concert avec —.
Acad. d. Sci. Paris, Comp. Rend., XXXIII, 1851, 13–15.

Wastler (J.): Hartner (J.). Handbuch der niederen Geodäsie. Vermehrt von —.
Wien, 1885.
Title in full under HARTNER (J.).

Watson (J. C.). Method of least squares, theory of combination of observations, and determination of the most probable system of elements from a series of observations.
Theoretical Astronomy, Philadelphia, 1869, 360–425.

Watts (William). A rigorous investigation of the length of the seconds pendulum in the latitude of Plymouth, being 50° 22′ 28″.
Ann. Nat. Phil. (Thompson), VIII, 1816, 284–288.

——— Remarks on Captain Kater's paper, containing experiments for determining the length of the seconds pendulum in the latitude of London.
Edinb. Phil. Journ., I, 1819, 325–337.

——— On the length of the pendulum.
Edinb. Phil. Journ., III, 1820, 27–32.

——— On the ellipticity of the earth.
Edinb. Phil. Journ., III, 1820, 288–293.

[**Waugh (Andrew Scott).**] On the Great Trigonometrical Survey.
Calcutta Rev., IV, 1842, 62–95.

——— Report on the progress of the Great Trigonometrical Survey of India.
Indian Eng. (Medley), II, 1865, 285–300, 398–407; III, 1866, 94–108, 305–318, 402–413; IV, 1867, 303–316; 413–422.

Webb. Trigonometrical survey of India.
Phil. Mag. (Tilloch), LIII, 1819, 146.

Weber (W.). Ueber Construction des Bohnenberg'schen Reversionspendels zur Bestimmung der Pendellänge für eine bestimmte Schwingungsdauer im Verhältniss zu einem gegebenen Längenmass.
Ann. d. Phys. (Poggendorff), XXII, 439–449; K. Ges. d. Wiss. Leipzig, Ber., XXXV, 7–17.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XVI, 1884, 809, by LP. [LAMPE].

Weidler (Johann Friedrich). Bibliographia astronomica temporis quo libri vel compositi vel editi sunt ordine servato ad supplemendam et illustrandam astronomiæ historiam digesta accedunt historiæ astronomiæ supplementa.
8°, Wittenbergæ, 1755, pp. iv, 126; supplement, pp. 44. (British Museum.)
Contains numerous references to early works treating of geodetic operations.

Weierstrass (Karl): Jacobi (C. G. J.). Gesammelte Werke. Edited by —.
Berlin, 1882.

——— Ueber die geodätischen Linien auf dem dreiachsigen Ellipsoid.
K. Ak. d. Wiss., Monatsber., II, 1861, 986–997.

Weingarten (Julius). Allgemeine Untersuchung über die geodätischen Linien und die verticalen Schnitte auf krummen Oberflächen.
Pp. 87–93 of BAEYER (J. J.). Das Messen auf der sphäroidischen Erdoberfläche, Berlin, 1862.

——— Ueber eine geodätische Aufgabe.
Astron. Nachr., LXXIII, 1868, 65–76.
Regarding the reduction of the angles of a geodetic triangle to a plane triangle.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869–'70, p. 840, by BRUNS.

Weingarten (**Julius**)—Continued.

——— Ueber die Reduction der Winkel eines sphäroidischen Dreiecks auf die einer ebenen oder sphärischen.
Astron. Nachr., LXXV, 1869, 91-96.
Revd. in Jahrb. üb. d. Fortschr. d. Math., II, 1869-'70, p. 841, by BRUNS.

——— Ueber die Verschiebbarkeit geodätischer Dreiecke in krummen Flächen.
K. Ak. d. Wiss., Sitz.-Ber., XLII, 1882, 453-456.

——— Ueber die Differentialgleichung der Oberflächen, welche durch ihre Krümmungslinien in unendlich kleine Quadrate getheilt werden können.
K. Ak. d. Wiss., Sitz.-Ber., XLIII, 1883, 1163-1166.

——— Ueber die Eigenschaften des Linienelements der Flächen von constantem Krümmungsmaass.
Journ. f. Math. (Crelle), XCIV, 1883, 181-202.

Weinstein (**B.**). Handbuch der physikalischen Maasbestimmungen, in zwei Bänden. Erster Band: Die Beobachtungsfehler, ihre rechnerische Ausgleichung und Untersuchung.*
8°, Berlin, 1887, pp. 524.
Revd. in Zeits. f. Vermes., XVI, 1887, 603-604; XVIII, 1889, 27-29, by J.

Weisbach (**Julius**). Auszug aus dem Bericht der k. sächs. Commission der mitteleuropäischen Gradmessung an das k. sächs. Finanzministeriums vom 31 December 1863.
Int. Geod. Cong., Gen.-Ber., 1863, 26-27.

——— Die Biegung eines in zwei Punkten unterstützten homogenen prismatischen Messstabes, sowie durch dieselbe hervorgebrachte Verkürzung seines Längenmaasses, auf möglichst einfache weise ermittelt.
Civ.-Ing., XII, 3-26, 1 plate.

——— Bericht über die im Jahre 1865 ausgeführten geodätischen Arbeiten im Königreich Sachsen im Interesse der mitteleuropäischen Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1865, 32-35.

——— Bericht über die im Jahre 1866 im Interesse der mitteleuropäischen Gradmessung von Seiten des Königreiches Sachsen ausgeführten geodätischen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1866, 43-45.

——— *und* **Bruhns** (**C.**). Bericht über die im Interesse der europäischen Gradmessung von Seiten des Königreichs Sachsen ausgeführten geodätischen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1868, 49-53.

——— Bericht über die im Jahre 1869 im Interesse der europäischen Gradmessung von Seiten des Königreichs Sachsen ausgeführten geodätischen Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1869, 58-60.

——— Vorträge über mathematische Geographie, gehalten an der königlich sächsischen Bergakademie zu Freiburg von —, als Anhang zum Abriss der Markscheidkunst. Herausgegeben von Oscar Choulant.
8°, Freiburg, 1878, pp. 35, 2 plates. (British Museum.)
Die Erde, 11-20.

Weiss (**Edmund**). Ueber Geschichte der Gradmessung mit besonderer Beziehung auf den Zweck der mitteleuropäischen Gradmessung.
Verein z. Verbreitung naturwiss. Kenntnisse, Schriften, IV, 1863-'64, pp. 83-134.

Wells (**Henry P.**). The United States Coast and Geodetic Survey.
Harper's Weekly, XXXII, 1888, 805-808.

Weltmann *und* **Koll** (**A.**). Formeln der niederen und höheren Mathematik, sowie der Theorie der Beobachtungsfehler und der Ausgleichung derselben nach der Methode der kleinsten Quadrate. Zum Gebrauch bei geodätischen Studium und in der geodätischen Praxis zusammengestellt von —.*
Bonn, 1886.
Revd. in Zeits. f. Vermes., XV, 539; Vereinsschrift des hannov. Landmesser-Vereins, II, 1886, 54; Zeits. d. rheinisch-westf. Landmesser-Vereins, 1886, 91.

Wendt (**Amandus Theodor August**). Zur Theorie der geodätischen Linie auf einer Fläche des zweiten Grades. Inaugural-Dissertation zur Erlangung der Doctorwürde von der philosophischen Facultät der Friedrich-Wilhelms-Universität zu Berlin.
4°, Berlin, 1880, pp. 21. (Gore.)
Lithographed from manuscript.

Werneburg (**Johann Friedrich Christian**). Ueber die zeitherige Bestimmung der Dauer eines Pendelschlags und die Fallhöhe in einer Secunde.*
Eisenach, 1817.
POGGENDORFF, II, 1299.

Werner (**Wilhelm**). Ueber die Beziehung der bei der Stations-Ausgleichung gewählten Nullrichtung.
4°, Berlin, 1880, pp. 28. (Gore.)
Publication des königl. preussischen geodätischen Institutes.
Published with WESTPHAL (ALFRED). Winkel- und Seitengleichungen.

——— Ueber die Methode der "Coast and Geodetic Survey" zur Auflösung von Normalgleichungen.
Civ.-Ing., XXIX, 1883, 115-126.

——— Die Winkelmessungen bei Tage und bei Nacht. Zusatz von H. Bruns.
Zeits. f. Instrumentenkunde, III, 1883, 225-237.

Westphal (**Alfred**). Winkel- und Seitengleichungen.
4°, Berlin, 1880, pp. 5-18.
Publication des königl. preussischen geodätischen Institutes.
Published with WERNER (W.). Ueber die Beziehung, etc.

——— Der Basisapparat des General Ibañez und sein Verhältniss zum älteren spanischen Apparat.
Zeits. f. Instrumentenkunde, I, 1881, 173-183.

——— Die Ausdehnungscoefficienten der Küstenvermessung.
4°, Berlin, 1881, pp. 13. (Gore.)
Publication des königl. preuss. geodätischen Institutes.

——— Die geodätischen und astronomischen Instrumente zur Zeit des Beginnes exacter Gradmessungen.
Zeits. f. Instrumentenkunde, IV, 1884, 152-166, 189-202.

——— Basisapparate und Basismessungen.
Zeits. f. Instrumentenkunde, V, 1885, 257-274, 333-345, 373-385, 420-432; VIII, 1888, 189-236, 337-346.
The most elaborate and accurate discussion of this subject ever published.

Weyer (**Georg Daniel Eduard**). [Eine geodätische Aufgabe.]
Arch. d. Math. (Grunert), V, 1844, 223-224.

Weyprecht (Carl). Astronomische und geodätische Bestimmungen der österreichisch-ungarischen arctischen Expeditionen 1872-'74.
K. k. Ak. d. Wiss., math.-naturwiss. Cl., Denkschr., XXXV, 1877, 47-71, 1 chart.

Wheeler (E. S.) *and* **Woodward (R. S.).** Results of some experiments made to determine the variations in length of certain bars at the temperature of melting ice.
Am. Journ. Sci., XXV, 1883, 448-459.

Wheeler (G. M.): Gannett (H.). The geodetic work of the — survey.
Science, II, 1884, 447-448.

White (T. Pilkington). The Ordnance Survey of the United Kingdom.
8°, London, 1886, pp. x, 174. (Oxford, Bodleian.)

Whitehurst (John). An attempt towards obtaining invariable measures of length, capacity, and weight from the mensuration of time, independent of the mechanical operations requisite to ascertain the centre of oscillation or the true length of pendulum.
4°, London, 1887, pp. viii, 34, 3 plates. (Oxford, Bodleian.)

Whitney (J. D.). Geographical and geological surveys.
North American Rev., CXXI, 1875, 37-85, 270-314.

Wiegand (August). Der geodätische Messapparat und sein Gebrauch. Nebst Nachrichten über die Realschule im Waisenhause zu Halle aus dem Schuljahre 1847-'48, vom Inspector Ziemann. Halle, 1848.
8°, Halle, 1848, pp. 24. (Gore.)

Wiener (Christian). Die Berechnung der Veränderungen in einem veränderlichen Dreiecksnetze.
Zeits. f. Math. (Schlömilch), XIV, 1869, 62-65.
The development of an expression for the change in the computed parts of a chain of triangles when some of the vertices have undergone a slight displacement.

——— *Zusatz zu der elementaren Begründung des Fundamentalsatzes* über die geodätische Linie auf einer Umdrehungsfläche von Prof. Jordan.
Zeits. f. Vermes., IX, 1880, 337-338.
See JORDAN. Elementare Begründung, etc.
See HELMERT. Nochmals, etc.

Wijkander (August) *and* **Tidblom (A. V.).** Pendelbestämmingar under den Svenska arktiska expeditionen 1872-'73.
Acta Universitatis Lundensis, XIV, 1877-'78, pp. 1-32, 1 plate.

Wild (Heinrich). Bericht über die Arbeiten zur Reform der schweizerischen Urmaasse, Abgefasst im Sommer 1868.
4°, Zürich, 1868, pp. 170, 3 plates. (Southampton, Ordnance Survey.)

——— De la détermination de la dilatation absolue et spécialement de celle du barreau normal du bureau fédéral des poids et mesures.
Arch. Sci. Phys. Nat., Genève, XL, 1871, 373-393.

Williams (E.) *and* **Mudge (W.).** Account of the trigonometrical survey carried on in 1791.
Roy. Soc. London, Phil. Trans., 1795, 414-591.

Williams (J. Butler). Practical geodesy, comprising chain surveying and the use of surveying instruments, leveling and tracing of contours, together with trigonometrical, colonial, mining, and maritime surveying. Adapted to the use of surveyors and of students in civil and military engineering.
8°, London, 1842.
2d ed., with new chapters on railway, parish, and estate surveying.
8°, London, 1846, pp. xx, 330, with a plate of conventional signs. (Gore.)

Williams (Thomas). An entire new work, and method of proceeding to discover the variation of the earth's diameters, with evidence laid down, amounting to a demonstration, that its true ratio is not less variable than as 45 is to 46, and shortest in its pole's axis 174 miles; and that no degree of gravity given by the quadrant on its superficies is attached to the curvature found there, but are such *mean proportions* between the curvature and the centre of the spheroid; that each meridional degree at the surface will form equal areas to the common centre of gravity, the earth's centre. Offered to the consideration of those who are judges of this important problem.
4°, London, 1786, pp. 16, 2 tables. (British Museum.)

Wilsing (J.). Ueber den Einfluss von Luftdruck und Wärme auf die Pendelbewegung.
Berlin, 1880, pp. 40. (Berlin, Observatory.)

——— Bestimmung der mittleren Dichtigkeit der Erde mit Hülfe eines Pendelapparates.
Publicationen des astrophysikalischen Observatoriums zu Potsdam, VI, 1887, ii, 35-127; K. Ges. d. Wiss., Sitz.-Ber., XVII, 1887, 327-334.
Density = 5.594 ± 0.032.

Wilski (F.). Einführung in die trigonometrischen bezw. Ausgleichungsrechnungen der Anweisung IX vom 25 Oktober, 1881, für die trigonometrischen und polygonometrischen Arbeiten bei Erneuerung der Karten und Bücher des Grundsteuerkatasters mit elementarer Entwickelung der dabei in Betracht kommenden Differenzialformeln.
8°, Liegnitz, 1883, pp. viii, 100. (Berlin, Royal.)

Wilson (Charles W.). The Ordnance Survey jubilee book.
Fol., Southampton, 1887.
Only three copies printed. All work done at Survey Office.

——— *and* **Palmer (H. S.).** Ordnance survey of the peninsula of Sinai, made with the sanction of the Right Hon. Sir John Pakington, Bart., secretary of state for war, under the direction of Col. Sir Henry James. Folio in three parts. Pt. 1. Account of the survey, pp. iv, 323, 19 plates; Pts. 2, 3. Illustrations.
Southampton, 1869. (British Museum.)

Wilson (O. S.). Night signals for geodetic work.
Science, I, 1883, 70-71.

——— Method of reconnoissance, signal building, and naming of stations.
Final Results N. Y. State Survey, 1887, 115-122.

——— Final results of the New York State Survey, together with a description of the methods employed.
4°, Albany, 1887, pp. 214.
See Science, I, 1883, 267-209.

Winckler (Anton). Bemerkungen über einige Formeln der Geodäsie.
Journ. f. Math. (Crelle), L, 1855, 32-40.

——— Ueber einige in trigonometrischen Messungen vorkommende Aufgaben.
Zeits. f. Math. (Schlömilch), II, 1857, 334-338.
Reduction to center.

——— Ueber den mittleren Fehler der Kettenmessungen.
Zeits. f. Math. (Schlömilch), VI, 1861, 109-119.

Wing (Vincent). Geodætes practicus redivivus. The art of surveying, shewing the whole art of surveying by a new instrument called the imperial table.
Fol., London, 1700, pp. vi, 384, 134.
Simple surveying.

Winnecke (A.): Maclear (T.). Verification and extension of Lacaille's arc of meridian, London, 1866. Revd. by —.
Astron. Ges., Vierteljahrs., v, 1870, 44-87.

Winsheim (C. N. de). Determinatio exactior graduum parallelorum æquatoris et meridiani, in figura telluris hypothetice sphærica aut sphæroide.
Acad. de St.-Pétersbourg, Com., XII, 1740, 222-231.

Winterberg (C.). Ueber die geodätische Linie.
Astron. Nachr., LXXXIX, 1876, 103-110, 112-128; XCI, 1877, 113-120; XCV, 1879, 223-228, 238-250, 271-280.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 776, by B[RUNS].

——— Ueber die Abweichungen des Lothes von der Normalen des homogenen Erdsphäroids, erzeugt durch lokale Unregelmässigkeiten der Massenvertheilung.
Astron. Nachr., XCI, 1877, 97-108.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IX, 1877, 778, by B[RUNS].

——— Ueber den Einfluss vulkanischer Erscheinungen auf geodätische Operationen.
Civ.-Ing, XXVIII, 1882, 473-479.

——— Ueber die Anziehung von Massenpunkten insbesondere mit Rücksicht auf die Lotstörung.
Arch. d. Math. (Grunert), LXV, 1880, 113-160.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XII, 1880, 852-853, by B[RUNS].

Winterberg (Nicolaus). Disputatio de præcipuis globi terrestris affectionibus, quæ tam sub mathematici, quam physici contemplationem veniunt, nimirum de figura, positu, magnitudine et quiete terræ.
8°, Luneburg., 1596, pp. [18]. (British Museum.)

Wittstein (Theodor Ludwig). Bericht über die hannoverische Gradmessungs-Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1864, 8-11.

——— Bericht über die hannoverische Gradmessung.
Int. Geod. Cong., Gen.-Ber., 1865, 10.

——— Bericht über die in Hannover ausgeführten Arbeiten.
Int. Geod. Cong., Gen.-Ber., 1866, 29-30.

——— Die mittlere Fehler, und die preussische Landestriangulation.
Astron. Nachr., LXIX, 1867, 289-298.

——— Die Ausgleichung beobachteter Richtungen und die königlich preussische Landestriangulation.
Astron. Nachr., LXIX, 1867, 321-328.

Wittstein (Theodor Ludwig)—Continued.

——— Bericht über die Thätigkeit des geodätischen Instituts, 1869, 1870.
Title in full under BAEYER (J. J.).

——— Ueber die Ablenkung der Lothlinie in grossen Höhen.
Astron. Nachr., LXXIV, 1869, 251-254.

——— [Abplattung des Erdsphäroids.]
Int. Geod. Cong., Gen.-Ber., 1870, 40.

——— Die Methode der kleinsten Quadrate. [Appendix to LOUIS NAVIER. Lehrbuch der Differential- und Integralrechnung, Hannover, 1875.]
8°, II, 309-394. (Gore.)

——— Ein Zusatz zur Methode der kleinsten Quadrate.
Astron. Nachr., CII, 1882, 339-342; Zeits. f. Math. (Schlömilch), XXVII, 1882, 315-317.
Revd. in Jahrb. üb. d. Fortschr. d. Math., XIV, 1882, 157-159, by Ls. [LAZARUS].

Woldringh (C.) *und* **Oudemans (J. A. C.).** Die Triangulation von Java.
Haag, 1878.
Title in full under OUDEMANS (J. A. C.).

Wolf (C. I. E.). Les étalons de poids et mesures de l'observatoire de Paris et les appareils qui ont servi à les construire, leur origine, leur histoire et leur état actuel.
Acad. d. Sci. Paris, Comp. Rend., XCII, 1881, 1202-1204; XCIII, 1881, 297-299.

——— Histoire des étalons du mètre.
Acad. d. Sci. Paris, Comp. Rend., XCIV, 1882, 1503-1505.

——— Recherches historiques sur les étalons de poids et mesures de l'observatoire et les appareils qui ont servi à les construire.
Ann. d. Phys. Chim., XXV, 1882, 5-112; 2e éd., Ann. Obs. de Paris, XVII, 1883, c, i-c, 78.

——— Sur l'authenticité de la toise du Pérou.
Acad. d. Sci. Paris, Comp. Rend., CII, 1886, 567-574.

———: **Foerster (W.).** Sur la toise du Pérou. Lettre à M. —.
Acad. d. Sci. Paris, Comp. Rend., CIII, 1886, 122-124.

——— Résultats des deux comparaisons de la toise du Pérou au mètre international, exécutées par Benoit, présentés par —.
Acad. d. Sci. Paris, Comp. Rend., CVI, 1888, 977-982.

Wolf (Rudolph). Verschiedene Bemerkungen. Ueber sphärischen Hohlspiegel, geodätischer Satz.
Arch. d. Math. (Grunert), III, 1843, 444-446.

——— Notizen zur Geschichte der Vermessungen in der Schweiz.
Naturf. Ges. Bern, Mittheil., 1844, 111-117, 185-196.

——— Notiz zur Geschichte der Gradmessungen.
Naturf. Ges. Bern, Mittheil., 1848, 93-95.

——— Note zur Methode der kleinsten Quadrate.
Naturf. Ges. Bern, Mittheil., 1849, 140-144.

——— Versuche zur Vergleichung der Erfahrungswahrscheinlichkeit mit der mathematischen Wahrscheinlichkeit.
Naturf. Ges. Bern, Mittheil., 1849, 97-100, 183-185; 1850, 85-88, 209-212; 1851, 17-36; 1853, 23-28.

Wolf (Rudolph)—Continued.

——— Taschenbuch für Mathematik, Physik, Geodäsie und Astronomie.
2d ed., Bern, 1856; 5th ed., 12°, Zürich, 1877, pp. xviii, 434. (Gore.)

——— Rapport der für die Gradmessung niedergesetzten Kommission.
Schweizer naturf. Ges., Verhandl., 1862, 52–89.

——— Ueber die Bedeutung der sogenannten mitteleuropäischen Gradmessung für die Kenntniss der Erde im Allgemeinen und für die Schweiz im Besondern.
Naturf. Ges. Zürich, Vierteljahrs., vii, 1862, 337–345.

——— Auszug aus dem Circularschreiben des Präsidenten Herrn Professor Wolf an die Mitglieder der geodätischen Commission.
Int. Geod. Cong., Gen.-Ber., 1863, 31–32.

——— Handbuch der Mathematik, Physik, Geodäsie und Astronomie.
8°, i, pp. vii, 492, Zürich, 1870; ii, pp. viii, 495, Zürich, 1872. (Gore.)

——— Geschichte der Vermessungen in der Schweiz als historische Einleitung zu den Arbeiten der schweiz. geodätischen Commission.
4°, Zürich, 1879, pp. vi, 320. (Gore.)
Revd. in Zeits. f. Vermes., ix, 1880, 367–370, by Jordan.

——— Europäische Gradmessung. Das schweizerische Dreiecksnetz, herausgegeben von der schweizerischen geodätischen Commission.
4°, i. Die Winkelmessungen und Stationsausgleichungen, Zürich, 1881, pp. xxiv, 262; ii. Die Netzausgleichung und die Anschlussnetze der Sternwarten und astronomischen Puncte, Zürich, 1884, pp. xxiv, 204. (Gore.)

Wolfers (Jacob Philipp). Nachricht von der Vollendung der Gradmessung zwischen der Donau und dem Eismeere.
Arch. d. Math. (Grunert), xxiii, 1854, 225–230.

——— Ueber die Gestalt und Grösse der Erde nach Bessel.
Ges. Erdkunde, Monatsber., iii, 1842, 197–199; Zeits. f. allg. Erdkunde, xi, 1861, 1–6.

——— Ueber die Grösse der Erdoberfläche.
Zeits. f. allg. Erdkunde, xiii, 1862, 413–415.
9,261,963.2 square miles.

Wood (C.) *and* **Hennessey (J. B. N.).** Karara meridional series.
India, Trig. Survey, vii, 1882, i–x, 1–61, 1 plate.

——— ——— Amua meridional series.
India, Trig. Survey, vii, 1882, i–xiii, 1–43.

——— ——— Rangir meridional series.
India, Trig. Survey, vii, 1882, i–xvii, 1–46, 1 plate.

——— ——— Hurilaong meridional series.
India, Trig. Survey, viii, 1882, i–ix, 1–59, 1 plate.

——— ——— Calcutta meridional series.
India, Trig. Survey, viii, 1882, i–x, 1–70.

——— ——— North Maluncha meridional series.
India, Trig. Survey, viii, 1882, i–viii, 1–50, 1 plate.

Wood (C.) *and* **Hennessey (J. B. N.)**—Continued.

——— ——— North Parasnath meridional series.
India, Trig. Survey, viii, 1882, i–vi, 1–39.

——— ——— Assam longitudinal series.
India, Trig. Survey, viii, 1882, i–xiv, 1–92, 2 plates.

Woodward (Robert Simpson), Wheeler (E. S.), Flint (A. R.) *and* **Voigt (W.).** Results of some experiments made to determine the variations in length of certain bars at the temperature of melting ice.
Am. Journ. Sci., xxv, 1883, 448–459.

——— On the diffusion of heat in homogeneous rectangular masses, with special reference to bars used as standards of length.
Ann. Math., iv, 1888, 101–127.

——— On the form and position of sea level, with special reference to its dependence on superficial masses symmetrically disposed about a normal to the earth's surface.
Bulletin United States Geological Survey, No. 48, 8°, pp. 88, Washington, 1888. Ann. Math., ii, 1886, 97–103, 121–131; iii, 1887, 11–25.

Wrangell (B. W. von): Struve (F. G. W.). Beschreibung der Breitengradmessung mit Beihülfe's.
Dorpat, 1831.
Title in full under Struve (F. G. W.).

Wrede (F.). Några anmärkningar rörande minsta kvadratmetoden.
K. Vetens. Ak., Oefvers., xxx, 1873, viii, 3–34.

Wright (Edward). Certain errors in navigation detected.
London, 1599; London, 1610.
A determination of the radius of the earth is given by measuring the distance from a mountain of known height, the earth being regarded as a sphere, 224–228.

Wright (T. W.). On the computation of probable error.
Analyst, ix, 1882, 74–78.

——— On the application of the method of least squares to the reduction of comparisons of line-measures and to the calibration of thermometers.
Analyst, x, 1883, 33–41.

——— On the adjustment of condition-observations in the method of least squares, with its application to geodetic work, and with special reference to American methods of the adjustment of a system of triangulation.
Van Nostrand's Mag., xxviii, 1883, 419–436, 473–505.
Afterwards enlarged and published in book form.
See Wright (T. W.). Treatise on adjustments, etc.

——— A treatise on the adjustment of observations, with application to geodetic work and other measures of precision.
8°, New York, 1884, pp. 437. *Van Nostrand.* (Gore.)
Revd. in Nature, xxxi, 1885, 167.

——— New form of base apparatus.
Am. Journ. Sci., xxviii, 1884, 479–480.
Revd. by Kerschbaum, Zeits. f. Vermes., xiv. 1885, 251.

Würdemann (William): Bache (A. D.). Description of a base apparatus planned by —.
Am. Phil. Soc., Proc., iv, 1847, 368–370.

Wurm (**Johann Friedrich**). De ponderum, nummorum et mensurarum, ac de anni ordinande rationibus apud Romanos et Græcos.
8°, Stutgardiæ, 1821, pp. viii, 274. (British Museum.)

WUERTEMBERG.

BAUR (C. W.). Bericht über den Stand der Arbeiten für die europäische Gradmessung in Württemberg.
Int. Geod. Cong., Gen.-Ber., 1866, 49–51; 1868, 54–56; 1869, 66–69; 1870, 70–72; 1873, 32–33.

HAMMER. Bericht über die geodätischen Arbeiten in Württemberg.
Int. Geod. Cong., Verhandl., 1884–'86, 238–239.

KOHLER (C.). Die Landesvermessung in Württemberg.
Stuttgart, 1858.

SCHODER. Bericht von der württembergischen Landesvermessung.
Int. Geod. Cong., Gen.-Ber., 1874, 85; 1877, 313; 1881–'82, 141–143.

ZECH (P.). Bericht über die geodätischen Arbeiten in Württemberg pro 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 222–223.

Yates (**James**). On the unit of the length.
Journ. Frank. Inst., XLII, 1861, 348–351.

Yolland (*Capt.*). Account of the measurement of the Lough Foyle base in Ireland, with its verification and extension by triangulation, together with the various methods of computation followed on the Ordnance Survey and the requisite tables.
4°, London, 1847, pp. xix, 154, 117, 14 plates. (British Museum.)

—— An elementary course of mathematics prepared for the use of the Royal Military Academy. (Oxford, Bodleian.)
Geodesy, including practical astronomy, III, London, 1853, 375–622, 1–13.

Young (**Michel.**). Théorie de la terre.
Acad. d. Sci Paris, Comp. Rend., XCIX, 1884, 226.

Young (**Thomas**). Calculation of the direct attraction of a spheroid and demonstration of Clairaut's theorem.
Journ. Nat. Phil. (Nicholson), XX, 1808, 114–117.

—— Appendix to Captain Kater's account of experiments for determining the length of the pendulum vibrating seconds in the latitude of London.
Roy. Soc. London, Phil. Trans., 1818, 95.
Miscellaneous works of THOMAS YOUNG, II, London, 1855, 1–7.

—— Remarks on the probabilities of errors in physical observations and on the density of the earth considered especially with regard to the reduction of experiments on the pendulum.
Roy. Soc. London, Phil. Trans., 1819, 70–95.
Miscellaneous works of THOMAS YOUNG, II, London, 1855, 8–28.

—— Remarks on Laplace's latest computation of the density and figure of the earth.
Quart. Journ. Sci., IX, 1820, 32–34; Journ. de Phys., XC, 1820, 463–465.
Criticising the assumptions of Laplace regarding the density of the superficial strata of the earth, which he takes as 2½, and the internal only 5½, which the writer of this thinks too small. The article is signed S. B. L.

—— The resistance of the air, determined from Captain Kater's experiments on the pendulum.
Quart. Journ. Sci., XV, 1823, 351–356.
Miscellaneous works of THOMAS YOUNG, II, London, 1855, 93–98.

Young (**Thomas**)—Continued.

—— A brief investigation of the properties of the geodetic curve. (Signed T. Y.)
Quart. Journ. Sci., XXI, 1826, 136–137.
Miscellaneous works of THOMAS YOUNG, II, London, 1855, 111–112.

—— A simple rectification of the geodetic curve. (Signed T. Y.)
Quart. Journ. Sci., XXI, 1826, 153–155.
Miscellaneous works of THOMAS YOUNG, II, London, 1855, 113–115.

—— Considerations on the reduction of the length of the pendulum to the level of the sea.
Quart. Journ. Sci., XXI, 1826, 167–168.
Miscellaneous works of THOMAS YOUNG, II, London, 1855, 99–101.

—— A table of coefficients subservient to geodetical calculations. (Signed T. Y.)
Quart. Journ. Sci., XXI, 1826, 337–345.

—— Estimate of the effect of the terms involving the square of the disturbing force on the figure of the earth. In a letter to G. B. Airy, esq.
Quart. Journ. Sci., XXI, 1826, 346–347.
The conclusion is stated that the omission of this term can not cause an error of more than $\frac{1}{887000}$.

—— Note on Professor Svanberg's reduction of the length of the pendulum.
Quart. Journ. Sci., XXII, 1827, 365–367.

—— Computation of longitudes on a spheroid.
Quart. Journ. Sci., II, 1828, 418–420.

Yvon-Villarceau (**A.-J.-F.**). Comparaisons des déterminations astronomiques faites par l'observatoire impérial de Paris, avec les positions et azimuts géodésiques publiés par le Dépôt de la guerre.
Acad. d. Sci. Paris, Comp. Rend., XLII, 1866, 804–808.

—— De la limite des erreurs que l'on peut commettre en appliquant la théorie des lignes géodésiques aux observations des angles des triangles.
Acad. d. Sci. Paris, Comp. Rend., XLII, 1866, 850–852.

—— De l'effet des attractions locales sur les longitudes et azimuts; applications d'un nouveau théorème à l'étude de la figure de la terre.
Int. Geod. Cong., Gen.-Ber., 1866, 8–11; Acad. d. Sci. Paris, Comp. Rend., LXII, 1866, 741–745; Journ. de Math. (Liouville), XII, 1867, 65–86.

—— Nouvelle détermination de la vraie figure de la terre, ou de la surface de niveau, l'exigeant par l'emploi des nivellements proprement dits.
Acad. d. Sci. Paris, Comp. Rend., LXXIII, 1871, 808–824.
Revd. in Jahrb. üb. d. Fortschr. d. Math., III, 1871, 549–550, by B[RUNS].

—— Nouveau mode d'application du troisième théorème sur les attractions locales au contrôle des réseaux géodésiques et à la détermination de la vraie figure de la terre.
Journ. de Math. (Liouville), XVIII, 1873, 393–436; Int. Geod. Cong., Gen.-Ber., 1875, 133–141; Acad. d. Sci. Paris, Comp. Rend., LXXVI, 1873, 851–859.
Revd. in Jahrb. üb. d. Fortschr. d. Math., V, 1873, 596, by B[RUNS].

Yvon-Villarceau (A.-J.-F.)—Continued.

——— Détermination astronomique des longitudes, latitudes et azimuts effectués par l'observatoire de Paris. Recherches sur les attractions locales.
Int. Geod. Cong., Gen.-Ber., 1873, i, 1–6.

——— Nouveaux théorèmes sur les attractions locales et applications à la détermination de la vraie figure de la terre.
Int. Geod. Cong., Verhandl., 1875, 111–119; Acad. d. Sci. Paris, Comp. Rend., LXVII, 1868, 1275–1281.
Revd. in Jahrb. üb. d. Fortschr. d. Math., I, 1868, 390, by B[RUNS].

——— Troisième théorème sur les attractions locales et seconde détermination de la vraie figure de la terre obtenue sans le concours des nivellements proprement dits.
Int. Geod. Cong., Gen.-Ber., 1875, 120–123.

——— Remarques concernant l'emploi des séries trigonométriques dans la représentation des effets des attractions, et l'intégration de l'équation différentielle des surfaces de niveau.
Int. Geod. Cong., Gen.-Ber., 1875, 142–143.

——— Rapports sur les travaux géodésiques et topographiques exécutés en Algérie, par M. Roudaire.
Acad. d. Sci. Paris, Comp. Rend., LXXXIV, 1877, 1002–1014.

——— Note sur le pendule á reversion.
Int. geod. Cong., Gen.-Ber., 1879, 65–69.

——— Mémoire sur les effets du roulement dans la théorie du pendule à réversion.
4°, Paris, 1880, pp. 39.

——— Expériences sur l'emploi der régulateurs isochrones à ailettes dans la détermination de la pesanteur relative, faites à l'observatoire de Paris.
Int. Geod. Cong., Gen.-Ber., 1881–'82, 151–155.

——— Recherches sur la possibilité d'utiliser les réguteurs ischrones à ailettes dans la measure de l'intensité de la pesanteur.
Bur. d. Long., Ann. II, 1882.

——— Exposé concernant les régulateurs isochrones à ailettes. Rédigé en prenant pour base les notions les plus élémentaires de la science. Extrait du Bulletin de la Société archéologique, scientifique et littéraire du Vendômois, tome XXI.
8°, Vendôme, 1883, pp. 26, 1 plate.
An investigation concerning the possibility of determining by this means the force of gravity.

[**Zach (Anton von)**.] Méchain's Verlängerung der französischen Grad-Messung bis auf die balearischen Inseln.
Mon. Corr. (Zach), VII, 1803, 568–569.

——— Trigonometrische Vermessung des ehemaligen venetianischen Staates.
Mon. Corr. (Zach), VII, 1803, 49–56, 134–147, 210–220, 281–293, 544–550.

——— Gedanken über die Figur der Erde.
Mon. Corr. (Zach), XIII, 1806, 222–255.

Zach (Franz Xaver von). Beschreibung einer Vorrichtung, Pendellängen zu bestimmen.
Astron. Jahrb. (Bode), Suppl. Band., I, 1793.

——— Beweis, dass die österreichische Gradmessung des Jesuites Liesganig sehr fehlerhaft und zur Bestimmung der Gestalt der Erde ganz untauglich sey.
Mon. Corr. (Zach), VIII, 1803, 507–527; IX, 1804, 32–38, 120–130.

——— Allgemeine Tafeln zur Berechnung der geographischen Längen und Breiten aus Abständen vom Meridian und der Perpendiculare eines Orts in der Hypothese eines $\frac{1}{334}$ abgeplatteten Erdsphäroids.
Mon. Corr. (Zach), VII, 1803, 522–528; VIII, 1803, 81–89.

——— Ueber die königl. preussische trigonometrische Aufnahme von Thüringen und dem Eichsfelde und über de herzogl. sachsen-gothaische Gradmessung zur Bestimmung der wahren Gestalt der Erde.
Mon. Corr. (Zach), IX, 1804, 1–26, 89–120, 189–220, 269–295, 437–471; X, 1804, 1–26, 97–132, 193–209, 289–320, 389–411, 485–506.
In this volume, 2 is put for 3 in hundreds place; 300 and following to 388.

——— Schwedische Gradmessung.
Mon. Corr. (Zach), XII, 1805, 421–449, 513–541; XIII, 1805, 3–20, 330–345; XIV, 1806, 210–224, 327–332.

——— Ost-indische Gradmessung der Länge und Breite.
Mon. Corr. (Zach), XII, 1805, 488–494.

——— Nachricht von der königl. preussischen trigonometrischen und astronomischen Aufnahme von Thüringen und dem Eichsfelde und von der herzogl. sachsen-gothaischen Gradmessung zur Bestimmung der wahren Gestalt der Erde.
4°, Gotha, 1806, pp. 295. (British Museum.)

——— Ueber die Fortsetzung der französischen Gradmessung bis zu den balearischen Inseln.
Mon. Corr. (Zach), XVI, 1807, 434–442; XXI, 1810, 450–457.

——— Astronomische und geodätische Bestimmungen im Golfo della Spezzia.
Mon. Corr. (Zach), XVIII, 1808, 362–363.

——— Darstellung einiger bey geodätischen Messungen vorkommenden Correctionen. Nach Tome II, Base du système métrique décimal.
Mon. Corr. (Zach), XVII, 1808, 536–550.

——— Ueber die Möglichkeit, die Gestalt der Erde aus Gradmessungen zu bestimmen.
Mon. Corr. (Zach), XX, 1809, 3–9.

——— Ueber Reduction geneigter Winkel auf den Horizont.
Mon. Corr. (Zach), XIX, 1809, 317–330.

——— Considération sur l'aplatissemant de la terre d'après les nouvelles observations.
Bibl. Brit. Genève, XLIV, 1810, 295–302; Giorn. di Fis. (Brugnatelli), III, 1810, 429–434.

——— Ueber Densität der Erde und deren Einfluss auf geographische Ortsbestimmungen.
Mon. Corr. (Zach), XXI, 1810, 293–310.

——— Oesterreich'sche Gradmessung.
Mon. Corr. (Zach), XXIII, 1811, 151–168.

——— Le degré du méridien mesuré en Piémont par le père Beccaria.
Accad. Sci. Torino, Mem., 1811–'12, 81–116; Mon. Corr. (Zach), XXVII, 1813, 272–281.

Zach (Frank Xaver von)—Continued.

——— Remarques sur la mesure du degré du méridien au Pérou.
Bibl. Brit. Genève, L, 1812, 95–126.

——— Resultate der im Jahre 1802 beendigten neuen englischen Gradmessung.
Mon. Corr. (Zach), XXV, 1812, 497–513; XXVI, 1812, 109–130, 213–219.

——— Versuch, die Ellipticität der südlichen und nördlichen Erdhalbkugel aus Malaspina's Pendel-Beobachtungen zu bestimmen.
Mon. Corr. (Zach), XXV, 1812, 569–575.

——— Ueber die Gradmessung am Aequator.
Mon. Corr. (Zach), XXVI, 1812, 39–66.

——— Ueber die Berechnung der Längen und Breiten aus gemessenen Abständen vom Meridian und Perpendikel eines Orts.
Mon. Corr. (Zach), XXVIII, 1813, 489–501.

——— L'attraction des montagnes et ses effets sur le fil plomb ou sur les niveaux des instruments d'astronomie, constatés et déterminés par des observations astronomiques et géodésiques, faites, en 1810, à l'ermitage de Notre-Dame des Anges, sur le Mont de Mimet, et au Farral de l'Isle de Planier, près de Marseille; suivis de la description de la ville de Marseille et de son territoire.
Avignon, 1814, I, pp. xix, 354, 3 plates; II, pp. 355–715. (Washington, Observatory.)
Extracts in Bibl. Brit. Genève, LVI, 1814, 301–317; LVII, 1814, 3–28.
Revd. by GERGONNE (J.-D.). Acad. du Gard, Aperçu des travaux, 1812–'22, 150–155.

———: **Gregory (O.)**. Dissertations and letters by — regarding the survey of England.
London, 1815.
Title in full under GREGORY (O.).

——— Entwurf zu einer Längen- und Breiten-Gradmessung in Ober-Italien.
Zeits. f. Astron. (Lindenau), II, 1816, 329–345.

——— Ueber eine in mehreren Rücksichten merkwürdige Triangulation im Grossherzogthum Toscana.
Zeits. f. Astron. (Lindenau), V, 1818, 211–234.

——— [Triangulation in Italy.]
Corr. Astron. (Zach), I, 1818, 17–28.

——— [Sur la jonction géodésique de Strasbourg à Lyon.]
Corr. Astron. (Zach), I, 1818, 205–223, 224–226.

——— [Observations géodésiques à Boulogne, Lyon, Florence et au golfe de la Spezzia.]
Corr. Astron. (Zach), II, 1819, 3–44.

——— [Notices sur les opérations géodésiques en Italie de Riccioli et Grimaldi, de Manfredi et Stancari.]
Corr. Astron. (Zach), II, 1819, 115–126.

——— [Sur les nouvelles opérations géodésiques en France.]
Corr. Astron. (Zach), III, 1819, 3–21.

——— [Opérations géodésiques faites à Gap.]
Corr. Astron. (Zach), III, 1819, 113–134.

——— [Observations géodésiques et astronomiques sur le Mont S.-Victoire, près Aix.]
Corr. Astron. (Zach), III, 1819, 425–459.

Zach (Frank Xaver von)—Continued.

——— [Observations astronomiques et géodésiques faites à Nuremberg.]
Corr. Astron. (Zach), VII, 1822, 3–25.

——— [Sur la mesure des petites bases.]
Corr. Astron. (Zach), VII, 1822, 201–218.

——— [Sur les signaux de feu.]
Corr. Astron. (Zach), VII, 1822, 272–273.

——— [Sur les mesures de degré en Autriche et en Hongrie.]
Corr. Astron. (Zach), VII, 1822, 309–318, 401–421.

——— [Sur les petites bases préférables aux grandes.]
Corr. Astron. (Zach), VII, 1822, 501–508.

——— [Sur les grandes bases astronomiques.]
Corr. Astron. (Zach), IX, 1823, 217–236, 237–239.

——— [Manière de déterminer des bases terrestres par des observations célestes.]
Corr. Astron. (Zach), IX, 1823, 321–328, 417–431.

——— [Méthode de calculer les longitudes et les latitudes par les distances.]
Corr. Astron. (Zach), IX, 1823, 509–516.

——— Différence entre la longitude astronomique et géodésique à l'abbaie de St.-Matthieu en France.
Corr. Astron. (Zach), I (1818), 2e éd., 1825, 59–70.

——— Doutes sur les latitudes, attraction et répulsion du pendule.
Corr. Astron. (Zach), I, 2e éd., 1825, 35–38.

——— Sur la figure de la terre.
Bibl. Univ. Genève, XLIV, 1830, 1–11.

——— On the geographical latitude and longitude of a place on the terrestrial spheroid, the geodesic distances of which from the meridian and perpendiculars of a given point are known.
Roy. Astron. Soc., Mem., VI, 1833, 137–146.

Zachariae (G.). De mindste Kvadraters Methode.
8°, Nyborg, 1871, pp. viii, 234.
Revd. in Jahrb. üb. d. Fortschr. d. Math., III, 1871, 95.

——— Note betreffend die Bestimmung des mittleren Fehlers.
Astron. Nachr., LXXX, 1872, 67–70.
Reply by JORDAN, the same, 189–190.
Revd. in Jahrb. üb. d. Fortschr. d. Math., IV, 1872, 577–578.

——— Ueber die Bestimmung des mittleren Fehlers einer in Mehreren Theilen doppelt gemessenen Grundlinie.
Astron. Nachr., LXXXI, 1873, 225–228.
In reply to JORDAN. Ueber die Berechnung, etc.

——— De geodætiske Hovedpunkter og deres Koordinaten. Til Brug ved Undervisningen i Officerskolens Stabsafdeling.
8°, Kjøbenhavn, 1876, pp. ix, 276, 5 plates. (Southampton, Ordnance Survey.)

——— Die geodätischen Hauptpunkte und ihre Coordinaten. Autorisirte deutsche Ausgabe mit Anmerkungen und Zusätzen von Ernst August Lamp.
8°, Berlin, 1878, pp. 331. *Oppenheim.* (Gore.)
Revd. in Zeits. f. Vermes., VIII, 1879, 52–58, by JORDAN; Nature, XIX, 1879.

——— [Bericht über die geodätischen Arbeiten in Dänemark in den Jahren 1884–'86.]
Int. Geod. Cong., Verhandl., 1884–'86, 122–123.

Zachariae (G.)—Continued.
——— De mindste Kvadraters Methode. Til Brug ved Undervisningen i Officerskolens Stabsafdeling.
8°, Kjøbenhavn, 1887, pp. xv, 270. (Berlin, Geodetic Institute.)

Zanotti-Bianco (Ottavio). Il problema meccanico della figura della terra. Parte prima.
8°, *Firenze*, 1880, pp. xii, 302.
Parte seconda: Figura d' equilibrio delle masse fluide rotanti e metodi per la determinazione della densità della terra.
Firenze, 1885, pp. viii, 186.

Zanotti (E.). De angulo positionis et ejus usu in determinanda telluris figura.*
Com. Bonon., v, 1767.

Zantedeschi (F.). Recerche fisico-mathematiche sulla deviazione del pendolo dalla sua tragettoria.*
Padua, 1852.

Zech (Julius). Zur Methode der kleinsten Quadrate.
In: Einladung zur akademischen Feier des Geburtsfestes Seiner Majestät des Königs von Württemberg, 25. Sept. 1857, 4°, Tübingen, 1857, pp. 43. (British Museum.)
The first exhaustive discussion of the adjustment of indirect observations subject to conditional equations. — MERRIMAN, 203.

Zech (Paul Heinrich). Das württembergische Längenmass und die Messstangen der württembergischen Landesvermessung.
Württemberg. Jahreshefte, XXVII, 1871, 51–58.

——— Schreiben an die Gradmessungs-Commission, 1866, 1868, 1869, 1870, 1873.
Title in full under BAUER (C. W.).

———, **Bauer** *und* **Schoder.** Bericht über die geodätischen Arbeiten in Württemberg, pro 1875.
Int. Geod. Cong., Gen.-Ber., 1875, 222–223.

——— Himmel und Erde. Eine gemeinfassliche Beschreibung des Weltalls.*

Zeits. f. Astron. (Lindenau), *for* Zeitschrift für Astronomie und verwandte Wissenschaften (Lindenau).
8°, Tübingen, 1816–'18 (6 vols.). (Washington, Observatory.)

Zeits. f. Berg-, Hütten- u. Salinenwesen, *for* Zeitschrift für das Berg-, Hütten- und Salinenwesen in dem preussischen Staate.
4°, Berlin, 1854+. (Washington, Patent Office.)

Zeits. f. Instrumentenkunde, *for* Zeitschrift für Instrumentenkunde.
8°, Berlin, 1881+. (Washington, Patent Office.)

Zeits. f. Math. (Schlömilch), *for* Zeitschrift für Mathematik und Physik (Schlömilch).
8°, Leipzig, 1856+. (Washington, Observatory.)

Zeits. f. Vermes., *for* Zeitschrift für Vermessungswesen.
8°, Stuttgart, 1872+. (Gore.)

Zeller (Alaricus) : Maupertuis (P. L. M. de) Figura telluris determinanda per observationes Maupertuis. Translated by —.
Lipsiæ, 1742.
Title in full under MAUPERTUIS (P.-L.-M. DE).

Zenger (K. W.). Das Stereomikrometer.
Architekten- und Ingenieur-Verein, Mittheil., x, 1888, 1–3.
An instrument for measuring angles, using both eyes.

Zeune (August). Erdansichten, oder Abriss einer Geschichte der Erdkunde vorzüglich der neuesten Fortschritte in dieser Wissenschaft.
8°, Berlin, 1815; 2d ed., 8°, Berlin, 1820, pp. iv, 188, 6 charts. (British Museum.)
Messkundige Zeit., 41–43.

Zinger (N.). Uebersicht der neuerdings in Russland ausgeführten Arbeiten über terrestrische Refraction. Aus dem Russischen übersetzt von Lindemann.
Int. Geod. Cong., Gen.-Ber., 1883, 6–12.

Znaczekski (A. A.). De figura et magnitudine terraquæ. (H.)
Cracow, 1776.

Zoéga. Expérience du pendule faite à Beauvais en 1851.
Soc. Acad. Oise, Mém., II, 1852–'54, 145–147.

Zollmann (Joh. Wilhelm). Vollständige Anleitung zur Geodäsie oder praktischen Geometrie zum Gebrauch deren Judicorum in Entscheidung deren darüber entstehenden Streitigkeiten enthalten sind. Mit einer Vorrede von Christian Wolfs.
Fol., Halle, 1744, pp. [iv], [viii], 102, 19 plates. (Berlin, Royal.)

Zrzavý (F.). Einfache Formel zur Berechnung der Meridianconvergenz aus rechtwinkligen sphärischen Coordinaten mittelst einer Hilfstafel.
K. böhm. Ges. Prag, Sitz.-Ber., 1877, 278–281.

Züge (Eduard Heinrich). Ueber die Anziehung eines homogenen Ellipsoids.
8°, Halle, 1875, pp. 24, 1 plate. (Heidelberg, University.)

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National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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