CHAPTER 1

The United States Coast and Geodetic Survey

11. GENERAL STATEMENT

The United States Coast and Geodetic Survey performs public services essential to the safety and advancement of marine and air commerce, to science and industry, to surveying and mapping and other engineering work, and to the economic development of the country's natural resources. The early leaders of the Nation wisely considered such services as elements of the constitutional power of the Nation to promote and develop trade and commerce between the several states and with foreign nations. Through the years the wisdom of this undertaking has become increasingly evident from the benefits that have accrued to industry and to science, engineering, and other related fields.

As a leading maritime nation, the United States must have a continually expanding knowledge of the sea around it, its coasts, the location of dangerous reefs and shoals, the extent of fishing banks and submerged lands, the rise and fall of the tide, the direction and strength of sea currents, and the magnetic changes affecting navigation and communications.

As a leading nation in commerce and industry generally, the United States must have continually increasing knowledge of its natural resources, of the details of the topography and geology of its lands, and of the potentials for development of structures to further trade and commerce.

Directly or indirectly the work of the Coast Survey affects the daily lives of all Americans. The ships that bring coffee and sugar to the United States use the nautical charts of the Survey for their safe navigation; the air pilot who carries passengers, mail, or cargo uses its aeronautical charts to guide him safely to his destination; the surveyor who locates the boundaries of farms and city lots, and the engineer who plans hydroelectric, superhighway, flood control, and other construction projects use the markers it has established throughout the

land; and the safety engineer who establishes building codes against earthquake hazards uses its information to determine the stresses and strains that buildings must withstand.

The work program of the Survey, continuous by nature, is planned to satisfy the needs of new and future developments in transportation and communications. It is performed so far as possible at an overall rate of progress calculated to make the services available when and where needed.

Safety of life and property frequently depends directly upon the reliability of the Survey's charts and publications; and the geodetic control of the country is the foundation of all topographic and geologic mapping, land surveys, and many extensive engineering projects. It is therefore the policy to stress accuracy and dependability in all field observations and publications for which the Survey is responsible.

12. ORIGIN AND HISTORY

The history of the Coast and Geodetic Survey goes back to the early days of the Republic. Fifteen states or territories comprised the coastal area of the newly formed Union. Land transportation was difficult and commerce between the states was largely by coastwise shipping. Foreign trade—indispensable to the life of the Nation—was entirely by sea. With many ships plying the coast and entering harbors, shipwrecks were common. The founding fathers recognized a responsibility of the central government in this field and provided that Congress shall have the power "To regulate Commerce with foreign nations, and among the several States, and with the Indian Tribes."[1] This national obligation and constitutional power was given force and effect on February 10, 1807, when Congress, acting on the recommendation of President Jefferson, adopted a resolution for a "Survey of the Coast."

121. The Organic Act of 1807

The Act of February 10, 1807, authorized the President "to cause a survey to be taken of the coasts of the United States, in which shall be designated the islands and shoals, with the roads or places of anchorage, within twenty leagues of any part of the shores of the United States; and also the respective courses and distances between the principal capes or head lands, together with such other matters as he may deem proper for completing an accurate chart of every part of the coasts within the extent aforesaid." Section 2 of the act further

1. Art. I, sec. 8, cl. 3 of the Constitution (the commerce clause).

authorized "such examinations and observations to be made, with respect to St. George's bank, and any other bank or shoal and the soundings and currents beyond the distance aforesaid to the Gulf Stream, as in his opinion may be especially subservient to the commercial interests of the United States."[2] This was the inception of what today is the Coast and Geodetic Survey.

1211. *Legislative History of Act*

The Act of 1807 was not of sudden origin. As far back as February 27, 1795, during the Third Congress, a special committee submitted a report which began with the statement that "the sea coast, not only of Georgia, but also of South Carolina, North Carolina, and Virginia," had never been surveyed with the requisite accuracy, and concluded with a recommendation for the adoption of resolutions which should request and authorize the President to cause a survey to be made of the coast between Chesapeake Bay and St. Mary's River.[3]

A similar report was made late in 1795, and on May 14, 1796, during the Fourth Congress, a report was submitted by the Committee of Commerce and Manufactures of the House of Representatives recommending the procurement of "such accurate charts of the Atlantic coast of the United States, including the bays, sounds, harbors, and inlets thereof, as have been made from actual observation and surveys; and that, in all those parts, of which no actual survey has been made . . . to employ proper persons to survey and lay down the same."

The language of these recommendations was broad enough to have resulted in the immediate establishment of a national survey, but apparently other factors required crystallization before the country was to commit itself to such a major undertaking. But partial surveys of particular parts of the coast seem to have been authorized.[4]

When Thomas Jefferson became President, the matter of a survey of the coast gained momentum. A man of science himself, he had a wide acquaintance among scientific men of the day. One of these was Professor Robert Patterson, a distinguished scholar and then Director of the Mint. Patterson is credited

2. 2 Stat. 413 (1807). To carry into effect the provisions of the act a sum not exceeding $50,000 was appropriated. *Id.* at 414. The full text of the act is given in Appendix C.

3. The report was in response to a petition of certain individuals who as a private enterprise had previous to 1795 undertaken a survey of the coast of Georgia from St. Mary's River to Savannah. Having exhausted their funds in the field work they petitioned Congress for a grant of $3,000 to cover the cost of engraving the proposed map.

4. In 1802, Congress authorized a survey of Long Island Sound. The work called for was actually carried out and a map made, though no very definite information in regard to the execution or value of the map is available. Also, in 1805, another act provided for a survey of the coast of North Carolina, between Cape Hatteras and Cape Fear. The work was actually done by a party using one of the revenue cutters, but the vessel was wrecked by a severe storm and the records lost except for a map made in the field.

with having contributed to the idea of a trigonometric survey of the coast of high precision,[5] and appears to be one of the men chiefly responsible for having the need for a survey of the coast brought to the attention of Congress.

On December 15, 1806, in the House of Representatives, Mr. Dana, of Connecticut, addressed the House upon the need for a survey of the whole extent of the coast of the United States. He referred to the recent surveys of Long Island Sound and the North Carolina coast (*see* note 4 *supra*), and made the following remarks:

> The surveys, which have thus been authorized, were perhaps of the most urgent necessity; but other surveys of the coast are desirable. What has already been done may be regarded as introductory to a general survey of the coasts of the United States under authority of the Government. With a correct chart of every part of the coast, our seamen would no longer be under the necessity of relying on the imperfect or erroneous accounts given of our coast by foreign navigators. I hope the lives of our seamen, the interest of our merchants, and the benefits to the revenue, will be regarded as affording ample compensation for making a complete survey of the coasts of the United States at the public expense.
>
> The information which may be obtained will also be useful in designating portions of territorial sea to be regarded as the maritime precincts of the United States, within which, of course, the navigation ought to be free from the belligerent searches and seizures.
>
> It is proposed to extend the survey to the distance of twenty leagues from the shore. This distance is mentioned with a view to the second article of the treaty with Great Britain in 1783, which describes our boundaries as "comprehending all islands within twenty leagues of any part of the shores of the United States." [6]

Mr. Crowninshield, of Massachusetts, agreed with the proposal but felt that the survey should be more extensive. He believed there were many shoals off the coast at distances greater than 20 leagues and thought it important to have them surveyed. He therefore moved to strike from the resolution 20 leagues and insert 50 leagues.[7]

Mr. Dana agreed with Mr. Crowninshield on the utility of an accurate survey of the shoals or banks that had been mentioned, but was opposed to including in the resolution any islands at a greater distance than 20 leagues from shore. He believed that if any shoals at a greater distance are to be surveyed, special provision for such purpose may be made in the details of a bill rather than in a general resolution of inquiry.[8]

5. Smith, *Ferdinand Rudolph Hassler,* 13 UNION WORTHIES 7 (1958).

6. 16 ANN. OF CONG. 151–153 (1806). Mr. Dana proposed the following resolution: "Resolved That the Committee of Commerce and Manufactures be instructed to inquire into the expediency of making provision for a survey of the coasts of the United States, designating the several islands, with the shoals and roads or places of anchorage within twenty leagues of any part of the shores of the United States." *Ibid.*

7. *Ibid.* Mr. Cook, of Massachusetts, doubted whether all of St. George's Bank was within even 50 leagues of the shore, and he proposed to substitute 70 leagues. (George Bank, as it is now known, actually extends for a distance of 60 leagues from the nearest point on the mainland.)

8. The resolution previously proposed by Mr. Dana (*see* note 6 *supra*) was agreed to but with the following provision added: "And that the committee be further instructed to inquire into the expediency of surveying St. George's bank, or any other shoals or banks, which may be deemed dangerous to vessels approaching the shores of the United States." *Id.* at 165.

On January 6, 1807, a bill was reported to the House, by the Committee of Commerce and Manufactures, for surveying the coasts. After amendment, it was enacted and approved as the Act of February 10, 1807 (*see* 121).[9]

1212. *Interpretation of Act*

This legislative history of the 1807 act is an important facet in its interpretation. It has been stated in connection with the seaward boundary of Louisiana under the Submerged Lands Act (*see* Volume One, Part 2, 153), that "When Congress defined Louisiana's boundary in the Act of its admission into the Union as being three leagues from coast into the Gulf of Mexico, Congress must be taken to have intended that the three league boundary line into the Gulf was from the coast line to be designated and defined by the agency of the federal government provided by said Act of Congress of February 10, 1807." [10] It has also been stated that "In the second article [Treaty of 1783, 8 Stat. 80, 82] the State boundaries were also definitely described as a line drawn east in the Atlantic Ocean, comprehending all islands within 20 leagues of any part of the shores of the United States" and that "By act of Congress approved February 10, 1807, the President was authorized and requested to have this 20 leagues line surveyed and charted." [11]

These quotations carry the implication that the 20-league reference (60 nautical miles), in the Act of February 10, 1807 (*see* 121), was meant to establish that distance as the *coast line* of the United States which the Coast Survey was to survey and chart. This conclusion does not appear to be supported by the legislative history of the act nor by subsequent action of Congress.

The legislative history shows no intent on the part of Congress to establish a specific line in the water at 20 leagues or at any other distance from shore. The act merely calls for a survey of the *coasts* of the United States and a designation of the *islands, shoals, roads,* and *anchorages* "within twenty leagues of any part of the shores of the United States." It was to be a survey of the land area (with no defined limits) and of the water area to a distance of 20 leagues from shore, but no mention was made of surveying or charting a boundary line at that distance.[12] This is borne out by the discussion in the House of Repre-

9. The measure passed the House on Jan. 20, and the Senate, with amendments, on Jan. 30. The Senate amendments were accepted by the House on Feb. 5, 1807. 16 ANN. OF CONG. 50, 373, 456 (1807).

10. Brief of the State of Louisiana in Opposition to Motion for Judgment on Amended Complaint by the United States, 81–82, United States v. Louisiana et al., Sup. Ct., No. 10, Original, Oct. Term, 1958.

11. From *Hearings before Committee on Interior and Insular Affairs on S. 1901,* 83d Cong., 1st sess. 672, 673 (1953).

12. The term "coasts" appears to be used in the act in a very broad sense to cover both the land and the water areas. Modern usage confines "coast" to a zone of land of indefinite width (perhaps 1 to 3 miles) bordering the sea; the land extending inland from the shore (*see* Volume One, Part 2, 1548(*d*)).

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sentatives on December 15, 1806, by Mr. Dana, the proponent of the measure for a survey of the coasts, by such phraseology as "other surveys of the coast are desirable," "introductory to a general survey of the coasts of the United States," and "a correct chart of every part of the coast" (*see* text following note 5 *supra*).

It is also of interest that Mr. Dana noted that the distance of 20 leagues was mentioned because the treaty with Great Britain in 1783, which settled the Revolutionary War, "describes our boundaries as 'comprehending all islands within twenty leagues of any part of the shores of the United States.' " [13] This correspondence in distance in the two documents, together with the wording of the Treaty of 1783, has been advanced as having "fixed the boundaries of the Atlantic Coastal States as 20 leagues offshore," and that the Act of February 10, 1807, authorized the surveying and charting of that 20-league boundary line.[14]

Insofar as the Treaty of 1783 is concerned, the Supreme Court has held that the words "comprehending all islands within twenty leagues of any part of the shores of the United States" were not intended to establish United States territorial jurisdiction over all waters lying within 20 leagues of the shore. The Court noted that Secretary of State Jefferson's proposal only 10 years later (in 1793) that a 3-mile limit should be placed upon the extent of territorial waters bears out the conclusion that "language claiming all islands within a certain distance of the coast is not meant to claim all the marginal sea to that distance." [15] And it was Jefferson who as President was instrumental in having Congress pass the Act of 1807 calling for a survey of the coast (*see* text at note 5 *supra*). This would seem to be subject to the same limitation which the Court placed on the wording of the Treaty of 1783, and negatives the theory that Congress intended to establish a 20-league boundary line.

This is further substantiated by the provision in the Plan of 1843 (*see* 122) that "soundings shall be made along the whole line of the coast, as far inland as the ports and harbors for commerce, and as far seawards as to soundings of

13. Proposals were also made for substituting 50 leagues and 70 leagues for the 20-league provision based on the belief that there were many shoals off the coast at distances greater than 20 leagues, particularly St. George's Bank (*see* note 7 *supra* and preceding and following text). This indicates that the purpose of the provision was to make certain that the survey would include all islands, shoals, and banks of importance to vessels approaching or leaving our shores, rather than the establishment of a boundary line at that distance. The reference to the 20-league provision in the Treaty of 1783, was merely a convenient figure to tie up to and carried no special significance, especially in the light of the Supreme Court's interpretation of the language of that treaty (*see* text following note 14 *infra*).

14. This has been stated as indicating a repudiation by President Jefferson of the letter he wrote as Secretary of State on Nov. 8, 1793, to the minister of Great Britain, provisionally setting forth the distance of 3 miles from shore as the limit of the territorial seas of the United States. 104 Cong. Rec. A894 (Jan. 30, 1958). Yet one week prior to the passage of the Act of Feb. 10, 1807, President Jefferson's Secretary of State, Mr. Madison, reiterated Mr. Jefferson's position with respect to the 3-mile limit. MOORE, I DIGEST OF INTERNATIONAL LAW 718–721 (1906).

15. *United States* v. *Louisiana et al.*, 363 U.S. 1, 68–69 (1960).

120 fathoms depth." This is a definite modification of the 20-league provision in the Act of 1807, and is a varying rather than a constant distance.[16]

But over and above these considerations is the overriding one that the Coast and Geodetic Survey has never interpreted the 20-league provision to require it to establish a boundary line at that distance from shore nor to chart such a line, and no such line has ever been charted. The Act of August 6, 1947 (*see* 14(*a*)), which specifically defined the functions and duties of the Bureau placed no distance or depth limitation on its offshore surveys. This has been further broadened by the Act of April 5, 1960, which removed certain geographical limitations on the Bureau activities contained in the 1947 act (*see* 14(*b*)).

122. The Plan of 1843

A significant milestone in the history of the Coast Survey was reached when Congress passed the Act of March 3, 1843 (5 Stat. 630, 640). This provided that future appropriations should be "expended in accordance with a plan of reorganizing the mode of executing the survey" to be formulated by a board of officers from the Coast Survey, Navy, and Army.[17] The board submitted its report to the President on April 9, 1843, in the form of a plan for reorganization of the Survey and a recommendation that the work be kept in the Treasury Department. The plan adopted was based on Hassler's paper of March 21, 1843, which was in many respects a refinement and enlargement of his original proposal in 1807, as dictated by the needs of a growing America.

The plan defined the requirements for triangulation, astronomic, topographic, and hydrographic work, and provided for the first time the making of magnetic observations "as circumstances and the state of annual appropriations may allow." Hydrographic surveys were extended seaward to include soundings of 120 fathoms depth.[18] The board recommended that the Survey be kept in the Treasury Department on the ground that the object and purpose of the survey of the coast refers principally to the commercial interests of the country. President Tyler approved the plan of reorganization on April 29, 1843, includ-

16. Along the Atlantic coast, it varies from a maximum of 64 leagues east of Cape Cod to a minimum of 2 leagues off Miami Beach; in the Gulf of Mexico, it extends to a distance of 37 leagues off Tampa and 40 leagues at the boundary between Louisiana and Texas. The wording of the provision as to 120 fathoms depth in the Plan of 1843 also bears out the interpretation placed on the word "coasts" in the Act of 1807 that it referred to land and water areas rather than to a boundary line at a distance of 20 leagues from shore (*see* note 12 *supra* and accompanying text).

17. The act also stipulated that the plan of the board should provide for the employment of "the officers of the navy . . . on the hydrographical parts, and the officers of the army on the topographical parts."

18. This depth approximates the conventional edge of the continental shelf, which is taken as 100 fathoms. Along the northeast Atlantic coast and along the Gulf coast, this depth is considerably at variance with the 20-league belt contained in the Act of 1807 (*see* note 16 *supra*).

ing the recommendation that the work be continued in the Treasury Department.[19]

Although the responsibilities of the Survey were vastly increased during the ensuing years, the Act of March 3, 1843, and the plan of organization adopted pursuant thereto, governed its operations for more than a century until passage of the Act of August 6, 1947 (*see* 14(*a*)).[20]

123. Early History—A Pioneering Effort

In implementing the Act of 1807 (*see* 121), President Jefferson, through his Secretary of the Treasury Albert Gallatin, sought the advice and assistance of the American Philosophical Society—the leading scientific body of the period—as to the best method of approaching the task. A circular was issued setting forth a project of a survey of the coast and inviting the attention of scientists to it, and requesting plans for carrying it into effect.[21]

Among those who responded to this invitation was Ferdinand R. Hassler, a Swiss geodesist and scientist of outstanding reputation, then serving as professor of mathematics at West Point.[22] Hassler's fundamental plan provided for a division of operations into three great branches—the geodetic, the topographic, and the hydrographic. Of these, he considered the geodetic operation to be the most important, for it affected the accuracy of the other two. This plan was recommended for adoption by the Philosophical Society and was accepted by the President. Hassler later became its directing head.

The early work of organizing the Survey was indeed a pioneering effort. There were no American precedents to follow. The work had to be planned

19. The Bureau remained in the Treasury Department until July 1, 1903, when it was transferred to the newly created Department of Commerce and Labor by the Act of Feb. 14, 1903 (32 Stat. 825, 826, 830). When the Department of Labor was created by the Act of Mar. 4, 1913 (37 Stat. 736), the Bureau remained in what was thenceforth designated as the Department of Commerce, where it is now located.

20. For a full recital of the Plan of 1843, and other legislative authorizations pertaining to the Coast Survey *see* Jeffers, *Legislative History of the Coast and Geodetic Survey*, 5 Journal, Coast and Geodetic Survey 123 (1953).

21. The circular set forth with remarkable clarity an understanding of the basic principles on which any great national survey must rest. This was disseminated not for the purpose of pointing out any one plan in preference to another, but only in order to show the view that was taken of the subject and the degree of accuracy it was desirous of attaining. The plan provided for "ascertainment by a series of astronomical observations, of the true position of a few remarkable points on the coast; . . . a trigonometrical survey of the coast between those points;" and "a nautical survey of the shoals and soundings off the coast, of which the trigonometrical survey of the coast itself, and the ascertained positions of the light houses and other distinguishable objects would be the bases." Hassler's Administration (Part I) 18. This material is in typescript form and is unauthored and undated. It is filed in the Survey library and is identified as USCGS/.091/1921–2.

22. Other plans submitted were those by Robert Patterson, Andrew Ellicott, John Garnett, Isaac Briggs, Joshua Moore, and James Madison. Wraight and Roberts, The Coast and Geodetic Survey (1807–1957) 5, Publication, U.S. Coast and Geodetic Survey (1957).

and systematized. Assistants had to be trained, and when the results of the field operations accumulated, provision had to be made for compilations and reductions and for the preparation of charts and maps. In addition, instruments, such as those necessary for a geodetic survey, were not kept in stock at the beginning of the 19th century, nor were artisans capable of making such instruments available in this country. Copper of suitable quality for the chart engravings was lacking, as were qualified engravers themselves, and these had to be brought from abroad. And it is an interesting fact that not a single working observatory existed in this country at that time for the training of astronomers, and there was not a single college that included a course in geodetic surveying in its curriculum.

For these and other reasons, actual survey work was not undertaken immediately. But in 1811 Hassler was commissioned to go to Europe to arrange for the purchase or manufacture of the needed instruments and equipment. While in London he prepared his own drawings and designs, and some of the more important instruments, such as theodolites and chronometers, eventually constructed for him, bear the impress of his own inventive genius in the shape of modifications which he devised. Among these was a mammoth (by present standards) theodolite with 24-inch circle which E. Troughton, the noted instrument maker, built for him (*see* fig. 1). He collected reference books, standards of measurement, and other necessities. Caught in the War of 1812 he was unable to depart from Europe until the latter part of 1815. Upon his return to Washington, he was named head of the Survey of the Coast with the designation "Superintendent." [23]

The first field work was begun in 1816 with reconnaissance for the measurement of two geodetic base lines—one in the vicinity of English Creek, near Englewood, N.J., and the other at Gravesend Village, Long Island. Between these a small network of triangulation was extended over the bay and harbor of New York in 1817 (*see* fig. 2).[24] But the work was scarcely begun when it was suspended because of the failure of Congress to provide further funds for its continuance under the Acts of 1807 and 1816, and the Survey of the Coast was eclipsed for a period of 14 years thereafter.[25] On July 10, 1832 (4 Stat. 570),

23. The name "Superintendent" was changed to "Director" by the Act of June 5, 1920 (41 Stat. 874, 929).

24. WRAIGHT AND ROBERTS (1957), *op. cit. supra* note 22, at 7.

25. Dissatisfaction in Congress with the progress of the Survey—brought about by a failure to comprehend the enormity and scope of the undertaking—caused a modification of the 1807 law and took the Survey out of the Treasury Department and placed it under the Navy. On April 14, 1818 (3 Stat. 425), so much of the Act of 1807 "as authorized the employment of other persons in the execution of said act than by persons belonging to the army and navy" was repealed. The effect of this was to exclude Hassler and other civilian personnel from the work. It is an interesting but ironical commentary that within 7 months after Hassler took charge of the Survey he was requested to state "the probable time which will be required for the execution of this survey." HASSLER'S ADMINISTRATION, *op. cit. supra* note 21, at 30.

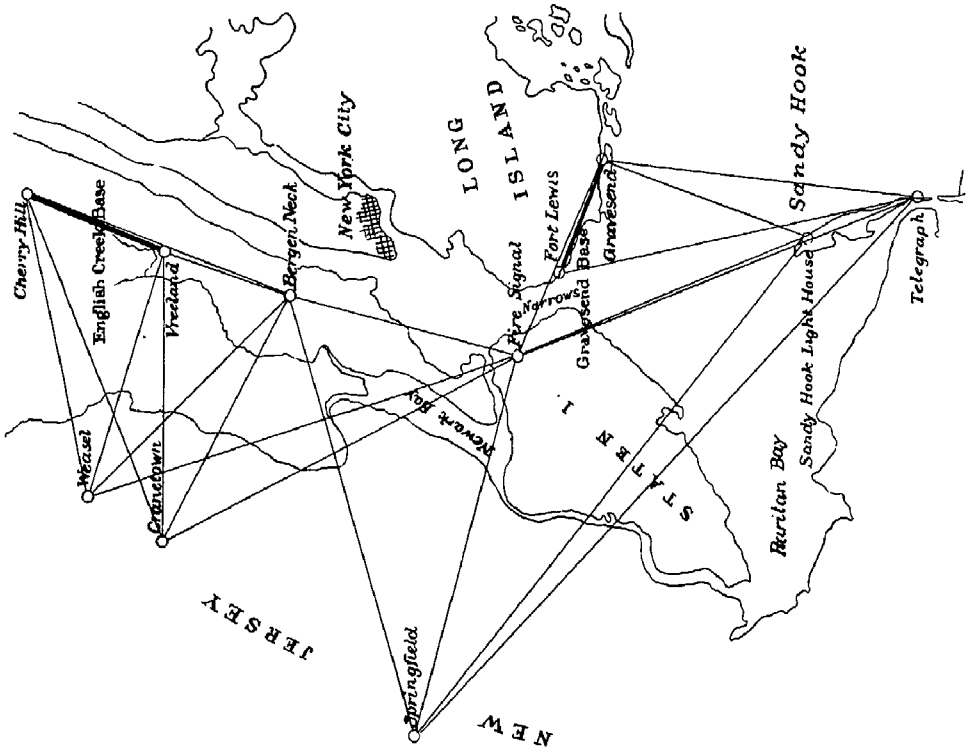

FIGURE 2.—Earliest Coast Survey triangulation, 1816–1817.

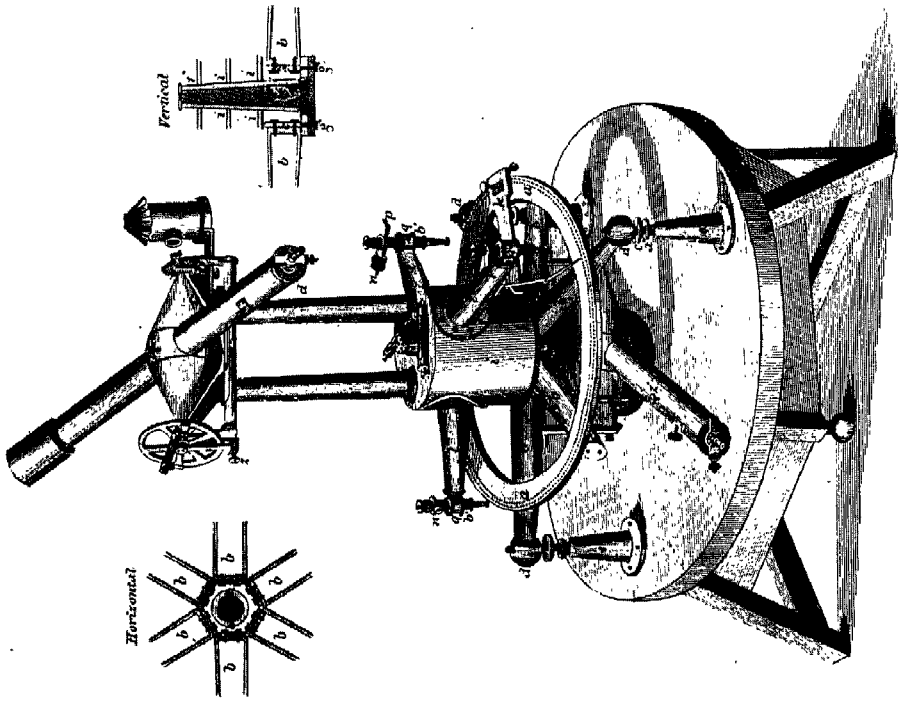

FIGURE 1.—The 24-inch theodolite used by Hassler.

Congress revived the original act and the work was extended to specifically include the coasts of Florida. Hassler was again named to the superintendency and the Bureau placed under the Treasury Department.[26]

The first topographic and hydrographic surveys were completed in 1834 and covered the area of Great South Bay, Long Island (*see* Part 2, 43, 52). The earliest nautical chart (issued in 1835) was of Bridgeport Harbor, Conn. (*see* Part 2, 127). It was probably produced commercially on contract, and Congress had the engraving done.[27] In May 1839, the first actual steps towards copper engraving were taken in the initiation of measures for procuring plates of Hungarian copper from Vienna.[28] By 1842, a copper-plate printing press was obtained, and a chart of "New York-Bay and Harbor and the Environs" was issued in 1844 and showed the fine detail that was possible from a copper-plate engraving.

1231. *Early Pioneers*

When one peruses the early reports of the Coast Survey, he finds a veritable bibliography of the most advanced scientific thought and achievement of the day. The names of many men of high talent and ability grace its pages—men who in one field or another have helped push forward the frontiers of science and engineering. Mention should be made of all those personalities who in their respective fields broadened the horizons of the Survey—men such as George Davidson, who authored the Pacific Coast Pilot of 1889, the most complete record of the coast ever to be published for the use of the mariner; Rollin Harris, who pioneered in the field of tidal research, and published a voluminous Manual of Tides in which a new and comprehensive theory was formulated; Henry Whiting, who served the Bureau with distinction for 59 years and whose pro-

26. On Mar. 11, 1834, President Jackson directed its retransfer to the control of the Navy Department, but this change was short lived and on Mar. 27, 1836, it was returned to the Treasury Department. Sometime between 1832 and 1845 the name of the Bureau was changed from "Survey of the Coast" to "Coast Survey." While published statements have appeared that suggest the name was changed in 1836 (*see* for example, WEBER, THE COAST AND GEODETIC SURVEY (Service Monographs of the United States Government No. 16) 4 (1923) and WRAIGHT AND ROBERTS (1957), *op. cit. supra* note 22, *at* 9), no specific directive could be found pin-pointing the year 1836 as the date of change. What seems to be rather positive is that until the Act of July 10, 1832 (4 Stat. 571) was passed, reviving the Act of Feb. 10, 1807, the name was definitely the "Survey of the Coast." Beginning with 1832, references to the name "Coast Survey" appear in official correspondence to and from Superintendent Hassler, but not consistently so (*see* HASSLER, REPORTS 1816–1843). In Nov. 1844, A. D. Bache signed his report to Congress as "Superintendent Survey of the Coast," but in his Nov. 1845 report his designation appears as "Superintendent United States Coast Survey." The latter date appears to mark a definite break with the name "Survey of the Coast."

27. Adams, *Engraved Charts*, 10 FIELD ENGINEERS BULLETIN 93, U.S. COAST AND GEODETIC SURVEY (1936).

28. Hassler wrote to the Secretary that he knew the Hungarian copper to be the best, and that it was very important to obtain plates free from any admixture of iron, which would ruin the plates by oxidation. It was not until about 1844 that the great deposits of native copper in the United States were developed for commercial use. HASSLER'S ADMINISTRATION, *op. cit. supra* note 21, at 108.

fessional excellence as a topographer was internationally recognized; Charles Sanders Peirce, who pioneered in the development and use of pendulums in gravity measurement, and who laid the foundation for the philosophy of pragmatism; Charles Schott, who for 50 years directed all the intricate computations and adjustments of field observations required in the geodetic, magnetic, cartographic, and tidal operations; and John Hayford, whose investigations of the size and shape of the earth resulted in the derivation of a new figure—the International Ellipsoid of Reference. These are only a few in a long roll—a roll of honor in the annals of the Survey.[29] But particular mention should be made of two early leaders—Ferdinand Hassler and Alexander Bache—who stand in the front rank of those who left the greatest impress on the Bureau's work during its difficult, formative period, and under whose direction the Survey evolved from a mere concept into an organizational entity with a fully developed plan of execution that became easily adaptable to a developing and expanding America. Both bequeathed to the Coast Survey a heritage of zeal and singleness of purpose that has been an inspiration to those who have followed them. The tradition of accuracy which they inaugurated has been steadfastly maintained through more than a century and a half of progressively increased activity.

A. FERDINAND RUDOLPH HASSLER

Ferdinand Hassler (*see* Frontispiece) may rightly be regarded as the "Father of the Coast Survey," for it was to him that President Jefferson first entrusted the important task of directing the "Survey of the Coast." It was fortunate for the country in general, and for the Bureau in particular, that so farseeing a person as Professor Hassler, with the indomitable will and courage of the pioneer, was chosen to organize and direct the operations of the Survey. A student of mathematics and geodesy under Professor Tralles at the University of Bern, and associated with him as cofounder of the Geodetic Survey of Switzerland, Hassler numbered among his many friends and associates such leaders of geodetic thought in Europe as Bohnenberger, the father of the Austrian precise surveys; Gauss and Bessel, formulators of modern geodesy; and Delambre, a principal in the triangulation upon which the metric system is based.

Hassler immigrated to the United States in 1805, at the age of 35, after filling a number of the most important official positions in Switzerland, among

29. For a more extended account of these and other personalities who served with distinction in the Coast Survey and their specialized contributions, *see* Colbert, *Pioneer Personalities in the Coast and Geodetic Survey*, 3 JOURNAL, COAST AND GEODETIC SURVEY 25 (1950).

which were the office of Attorney General and member of the Supreme Court. Disturbed by the turbulent political conditions which existed in his country at the time, he organized a colony of 120 of his native countrymen, chartered a vessel for their transportation, and sailed for the United States, landing in Philadelphia in September 1805. He brought with him a remarkable collection of instruments and standards of precision, together with a mathematical and scientific library of over 3,000 volumes.

Hassler's early association with President Jefferson, Secretary Gallatin, Professor Patterson, and other distinguished scholars who composed the American Philosophical Society, gave strong impetus to the idea of a comprehensive coastal survey as an aid in the development of the country's waterborne commerce. The plan for the survey of the coast, which he submitted (*see* 123), met with the approval of eminent scientists of Europe and this country. It is a tribute to his farsightedness and his genius that his original plan of organization, broadened and thoroughly worked out in succeeding years, is still the fundamental directing plan of the Bureau.

The difficulties that faced Hassler would have completely discouraged one of less strength and fortitude. Besides those inherent in organizing so vast and pioneer an undertaking, he had to withstand much criticism heaped upon him by some politically minded men of the day who could see no need for elaborate base measurements and triangulation systems. To them, a triangulation scheme was still a "scheme" to be guarded against, and they could not understand why the survey of the coast could not be accomplished by a few astronomic determinations along salient points tied together by means of topographic surveys.

Although the need for results was urgent, the level-headed Hassler fortunately did not allow himself to be stampeded into haphazard decisions. Instead, he approached the great task scientifically and never deviated from the high standards he set for the work. He knew that the survey of the coast, if it were to have a lasting value, could not be attacked as a problem in ordinary surveying. The operations were to be bound together by a trigonometric survey, with long lines, and executed by the most accurate instruments and the most refined methods. The best of foundations was thus laid for the geodetic operations of the Bureau and for all other phases of the Survey of the Coast. Standards established by him a century and a half ago are in keeping with the exacting scientific demands of 1963. This was Hassler's great contribution. Had he planned to meet only the needs of his time, he would have effected only a negligible saving, and his work would have had to be done over at greater expense in later years. Instead, the first Hassler surveys, still form part of the primary network of the country.

Administratively, Hassler exhibited impatience with what he considered unnecessary hampering and imposing of restrictive measures in connection with the supervision and auditing of the accounts of the Survey. Consequently, much of his energy during the last years of his life was taken up with controversies over details regarding financial procedures. But Hassler's personality made an intense impression on his contemporaries. The thoroughness of the training he had received, the broad scope of his learning, and the wide range of scientific applications and employments in which he had demonstrated expert mastery, left no doubt of his uniqueness in his day and generation. This uniqueness was fittingly summed up by Rear Admiral Karo, the present Director of the Coast and Geodetic Survey, in the following words: "He [Hassler] represented that element of scientific inquiry which is eminently spiritual in nature. It is one of the few pursuits in life which gains momentum from pure intellectual expression, from a love of seeking out the truth. It is the spirit of man insisting upon squaring himself accurately with his environment." [30]

B. ALEXANDER DALLAS BACHE

When Hassler died in 1843, the foundation for the Survey of the Coast had been laid, and the detailed surveys of the ports and harbors were begun with a survey of the approaches to New York Harbor. The building of the superstructure fell to his successor in office, Alexander Dallas Bache (*see* fig. 3). Bache was the great-grandson of Benjamin Franklin and a grandson of Alexander Dallas, Secretary of the Treasury under President Madison.

During his lifetime, Bache held many responsible positions, any one of which might have been considered the successful culmination of a life's work and ambition. As a West Point cadet, he distinguished himself by his scholastic excellence, graduating at the head of his class at the age of 19. At 22 he was named to the faculty of the University of Pennsylvania as professor of natural philosophy and chemistry. In addition to his 8 years at the university, his service to American education included the presidency of two of the country's then foremost schools (Girard College and the Central High School of Philadelphia), the general superintendency of a city school system, and the publication of a monumental work on European education resulting from 2 years of intensive study abroad.

The crowning achievement of Bache's career came on December 12, 1843, when President Tyler named him to the superintendency of the Coast Survey,

30. Karo, *Fifteen Decades of Scientific and Engineering Progress*, 13 UNION WORTHIES 13 (1958). For a comprehensive biography of Hassler, set in the context of his impact on early science in America, *see* CAJORI, THE CHEQUERED CAREER OF FERDINAND RUDOLPH HASSLER (1929).

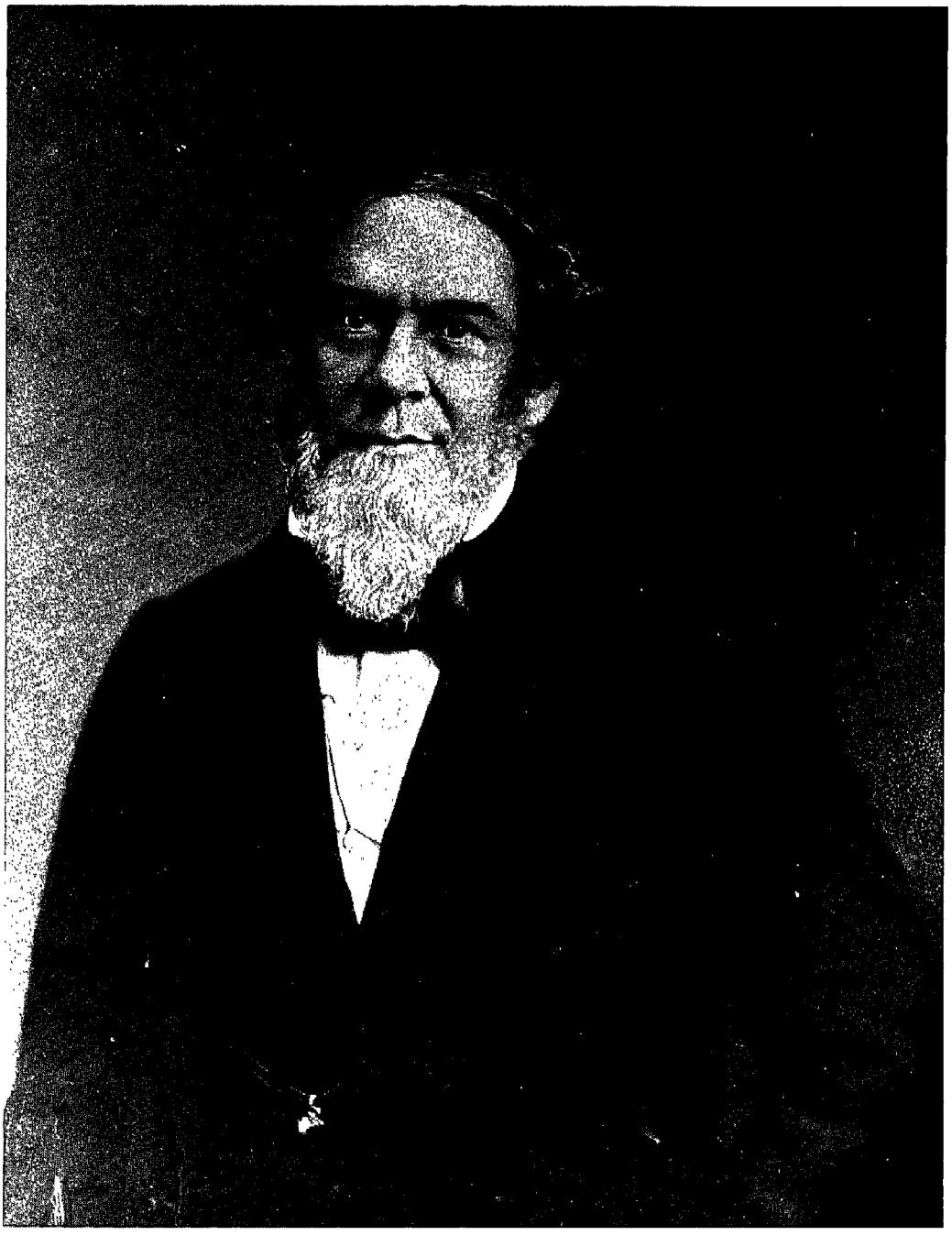

FIGURE 3.—Alexander Dallas Bache—Second Superintendent of the Coast Survey.

upon the death of Hassler. His selection had the concurrence of all the principal scientific and literary institutions of the country, and of many in Europe. It was said that no such weight of commendation was ever brought at any time in support of a candidate for office on purely intellectual grounds. Bache attained preeminence while serving as head of the Survey. He possessed by nature those qualities most conducive to success in the management of widely extended public interests. An orderly and scientific mind, combined with administrative ability of a high order, enabled him to cope successfully with the many organizational problems that faced his administration, and to govern and guide the diverse elements of the vast undertaking with tact and skill.[31] Bache's conciliatory and magnanimous nature won for him the respect and cooperation of those with whom or under whom he had to work.

But Bache too had his difficulties. More than once he was sorely beset by committees of Congress demanding to be furnished a date when the operations of the Survey would "cease and determine." Bache weathered many attacks on the floor of Congress, some of which bordered on the grotesque.[32] Congressional uneasiness was allayed with the report of the "Committee of Twenty," appointed in 1857, by the American Association for the Advancement of Science, to examine into the character and progress of the Coast Survey. The committee, consisting of leading scientists and educators, was highly laudatory of the management, progress, and outstanding achievements of the Survey. Two of the findings held special significance for the Bache administration:

> 5. This work has conferred many valuable benefits upon science, indirectly and incidentally, in the invention or perfection of instruments, in the improvement of methods of observation or of computation, in the development which it has given to special subjects of interesting inquiry, and in the stimulus which it has furnished to the scientific talent of the country, especially in the field of astronomical observation and investigation.
>
> 6. A careful study of the progress made from year to year, especially since the enlargement of the scale of operations under the present superintendent, affords ample evidence that the work has been expeditiously prosecuted, and that the amount accomplished up to the present date is materially greater than has ever been accomplished in any other country in the same length of time, and with the same means.[33]

In original concept, the plan for the Survey of the Coast was Hassler's, but Bache gave it form and direction. He adapted Hassler's plan to an expanding and developing America. The 10-year period following Bache's appointment saw more land added to the United States than in any other decade of American

31. In this characteristic, Bache was almost the antithesis of his predecessor, which perhaps accounts for his success and for Hassler's administrative difficulties.

32. One of the charges against the Coast Survey was that making astronomical observations for latitude, longitude, and azimuth at various field stations violated the provisions of the Act of 1832 against the establishment of a national observatory by the Survey.

33. COMMITTEE OF TWENTY (American Association for the Advancement of Science), REPORT ON THE HISTORY AND PROGRESS OF THE AMERICAN COAST SURVEY 121 (1858).

history. (Texas and the whole Pacific region were added during his tenure.) Early in his administration, Bache saw that by working north and south from New York as a center, as Hassler had done, there would be a limit put on progress. His first major move therefore was to divide the Atlantic and Gulf coasts into nine sections, in each of which the essential operations were to be performed simultaneously by separate parties. This arrangement had both practical and political advantages. It permitted the production of charts of important southern harbors, in advance of the tedious process of surveying the long stretches of intervening coastline, and thus opened these ports to commerce. But of even greater benefit at the time was the support it gained from these states in Congress who hitherto had difficulty in relating the operations of the Survey to their particular needs. Before the close of the forties, field parties worked in every state along the two coasts, and the first geodetic party set out with instruments on the long journey to the Pacific coast.

Under Bache's careful guidance and sympathetic understanding, the Coast Survey not only kept pace with the progress of art and science but also made many notable and original contributions in the fields of practical astronomy, hydrography, and cartography. The whole intellectual resources of the country were made tributary to its usefulness, and Bache enlisted, either as officers of the Survey or as temporary assistants for some special assignment, such men as Agassiz, Mitchell, Walker, Peirce, Bond, Gould—all in the forefront of scientific thought. From the Army and Navy he recruited the ablest officers. These not only attained distinction in the Coast Survey, but distinguished themselves later as military and naval officers. Among them were Humphreys, Stevens, Hunt, Johnston, and Hill of the Army, and Porter, Davis, Rodgers, Alden, Craven, and Luce of the Navy.

Bache's outlook was so broad, and his interest so universal, that any aspect of the work of the Survey received his enthusiastic encouragement and support. The Horrebow-Talcott method of latitude determination with the zenith telescope received great impetus toward worldwide use through its adoption and refinement by Professor Bache. The accuracy of the results obtained was superior to that of every other field method and compared favorably with the results obtained with the largest observatory instruments. It became so intimately identified with the work of the Survey, that it was known abroad as the Coast Survey method. And within a few months after Morse flashed his first telegraphic message over the wires between Baltimore and Washington, Bache began experiments for an application of the telegraph to longitude determinations. For fixing the longitude of the United States with respect to Greenwich, the Coast Survey, during the years 1849 to 1855, instituted expedi-

tions to exchange chronometers between Cambridge, Mass., and Liverpool, England; and upon the completion of the first transatlantic cable in 1866, a project was organized to make use of the cable to measure the difference in longitude between the two continents.[34]

The adoption and perfection of these methods of determining latitude and longitude placed this country well in the forefront of astronomic achievement, and it was freely stated at the time that geographical values of the positions of the principal astronomic stations of the Coast Survey were determined with greater accuracy than the values known for any European observatory. But astronomy and geodesy were not the only gainers of these new methods and researches. Other sciences were similarly promoted and their advancement stimulated. The range of the Survey was made to cover almost the whole range of the physical sciences. Bache's determination that the maps and charts of the Coast Survey should be carried to every man's door having an interest in commerce, navigation, geography, or science is an indication of his broad vision of the scope and purpose of the Survey.

Many studies in oceanography were undertaken. Special attention was given to an investigation of the Gulf Stream and its structure. Louis Agassiz—the great naturalist—was twice sent to Florida to study the coral reefs, their method of formation, and the laws which promote and restrict their growth. Tides and currents also received much attention, leading to the adoption of new methods and instruments. A self-registering tide gage was designed to record automatically the rise and fall of the tide. This gave the first strong impetus to the systematic study of tidal phenomena in the United States, with the result that the first published tables of tidal predictions were brought out by the Survey in 1853 (*see* 2322).

Hydrographic operations were extended and our coastal charts became fringed with soundings. The first surveys of the important Georges Bank were begun by Stellwagen; and James Alden began his surveys along the Pacific coast, following the discovery of gold in California. In nautical charting and related fields, studies were made of map projections, an electrotype process was experimented with for reproducing the original engraved copper plates, and toward the end of Bache's administration an attempt was made to print charts in color.

Nor were history and geography overlooked. Bache fostered several studies of the history of the early discoveries and explorations along both the Atlantic and Pacific coasts, notably those of Kohl (*see* Part 2, 6561).

34. Knox, *Precise Determination of Longitude in the United States*, 47 The Geographical Review 555, 561 (1957).

In short, as Superintendent of the Coast Survey, Bache was able to give full scope to his rich scientific background and to his extraordinary administrative talents in charting the course of the Survey for many years ahead. No finer tribute, in this respect, could be paid him than what was said by Benjamin Peirce, foremost American mathematician of his time, on his succession to the superintendency of the Coast Survey upon the death of Bache in 1867: "This important service originated with Hassler; but it received its efficient organization from Bache . . . . It is only necessary to conscientiously and faithfully to follow in his footsteps, imitate his example, and develop his plans in the administration of the Survey. To describe what the Superintendent should do is to simply describe what Bache actually performed . . . . I have before me the inspiration and example of my friend Bache. It is his organization. I have only to administer as he showed the way."

During the 24 years of his superintendency, Bache left an indelible impress on the Coast Survey. Both science and education have been enriched by his impact on them. His life has become an inseparable part of the history of America.[35]

124. Expansion and Growth

When the Survey of the Coast was first authorized in 1807, the tidal shoreline of the country comprised about 30,000 statute miles (25,000 along the Atlantic coast and 5,000 along the Gulf coast) (*see* Table 4). The activities of the Survey grew with the Nation's territorial expansion. When Florida was acquired, over 8,000 miles of shoreline were added. By the middle of the 19th century, the Texas accession was consummated, as were the cessions along the Pacific coast which later became the States of California, Oregon, and Washington, all of which added another 11,000 miles to the country's shoreline. This was followed by the purchase of Alaska in 1867 which added 34,000 more miles of tidal shoreline. The acquisition of Hawaii and of other island possessions at the beginning of the 20th century, together with the stewardship which we assumed over the Philippine Islands, further increased the shoreline to be surveyed to a total of over 110,000 miles. Bordering this extensive coastline was a belt of over 2,500,000 square miles of coastal waters that required surveys in the interest of waterborne commerce and navigation.

A major extension of the field operations of the Bureau occurred when Congress passed the Act of March 3, 1871 (16 Stat. 495, 508), authorizing a geodetic connection between the Atlantic and Pacific coasts. This was the

35. An evaluation of Bache as scientist and educator is contained in Odgers, Alexander Dallas Bache (1947).

beginning of a survey control system that eventually was to provide starting data for federal and state surveys in the interior of the country, as well as for private surveys and engineering undertakings. Originally, the geodetic surveys were made for the control of the topographic and hydrographic work along the coasts and to provide a proper tie for the nautical charts. The new authorization resulted in a great transcontinental arc of triangulation along the 39th parallel, one of the most famous arcs in the history of geodesy and at the time the longest in the world, extending over a 2,500-mile distance. This transcontinental triangulation joined the many separate systems, that had been established, into one continuous system and paved the way for the adoption of a single geodetic datum for the country (*see* fig. 4) and eventually for the whole continent—the North American 1927 Datum (*see* Part 2, 225).[36]

When Alaska was ceded to the United States, a major area of operation was opened up for the Coast Survey. This was the largest single land acquisition since the Louisiana Purchase in 1803, and represented about one-sixth the area and two-thirds the shoreline of conterminous United States. Work in Alaska was truly a pioneering effort and a constant challenge to the ingenuity of Bureau personnel (*see* fig. 5). Surveys in this northernmost outpost were begun soon after its purchase. The coastal area and the numerous intricate inland waterways were known only to a few explorers and trading vessels. Its vast interior was almost completely unknown. During the first 15 years or so of our ownership, only sporadic surveys were undertaken, aimed chiefly at tying together the positions of the various sketches of the early explorers. In 1882, the first comprehensive survey was begun. From that time on, the Bureau's work in Alaska has progressed continuously but with fluctuating tempo responding to the wax and wane of discovery and development—the discovery of gold near Juneau, the opening of the gold fields in the Klondike region, the discovery of copper in Prince William Sound and Southeast Alaska, the development of the salmon fishing industry, the beginning of the Alaska railroad in Resurrection Bay, and finally the emergence of Alaska as an important strategic region.

The last major extension of Coast Survey responsibilities occurred towards the close of the 19th century, when Spain ceded the Philippine Islands to the United States. The production of nautical charts for the islands then became the official responsibility of the Bureau. Although many maps had been produced in the years following Magellan's first visit to the islands in 1521, the

36. This added responsibility of providing geodetic control for the interior of the country was formalized by the Act of June 20, 1878 (20 Stat. 206, 215), which changed the name of the Bureau to "Coast and Geodetic Survey."

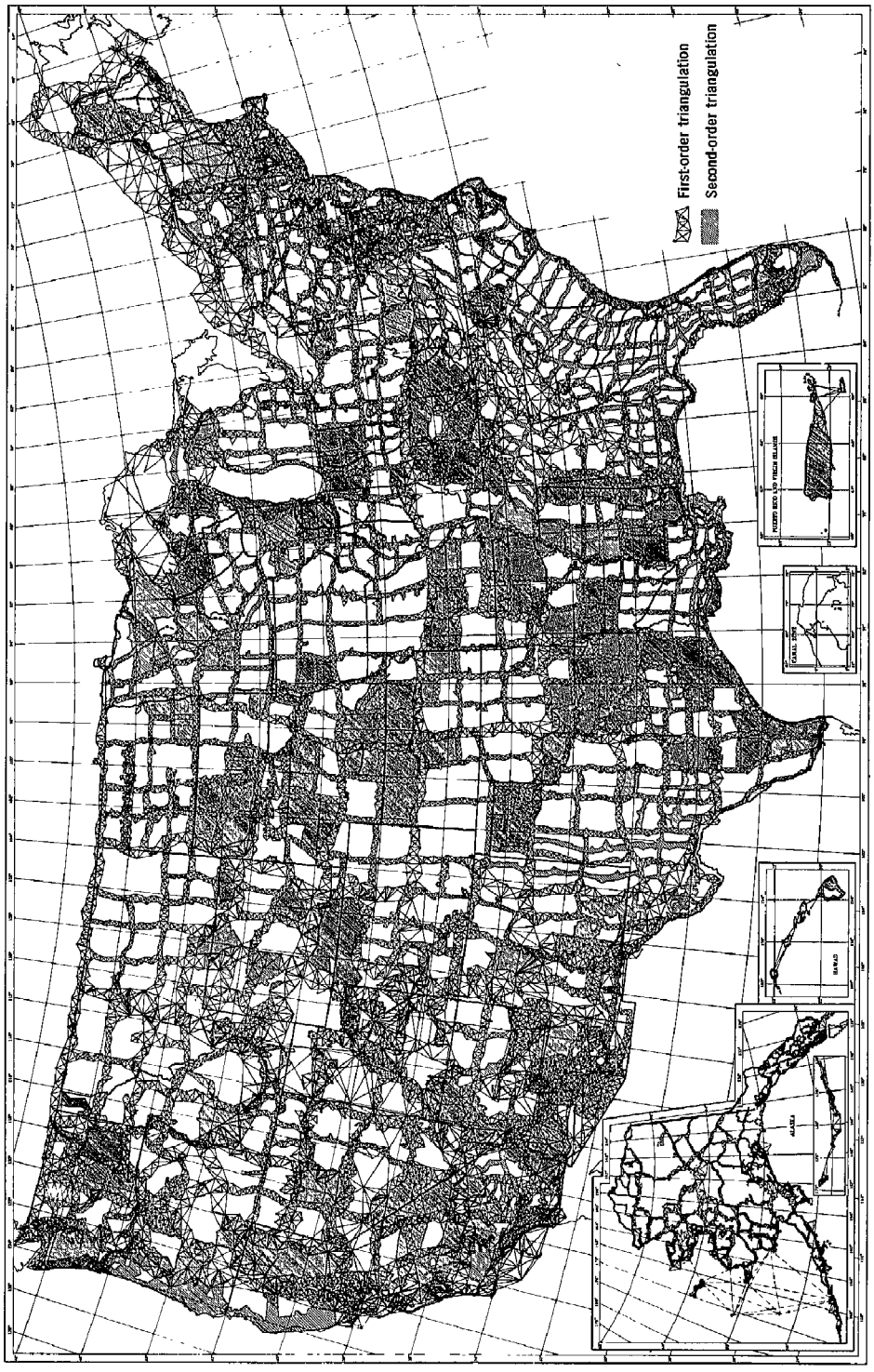

FIGURE 4.—A continuous network of triangulation provides control for mapping and engineering projects. As of May 1963, there were 170,400 permanently marked or otherwise identifiable stations in the United States.

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FIGURE 5.—Triangulation observer on Alaska mountain peak.

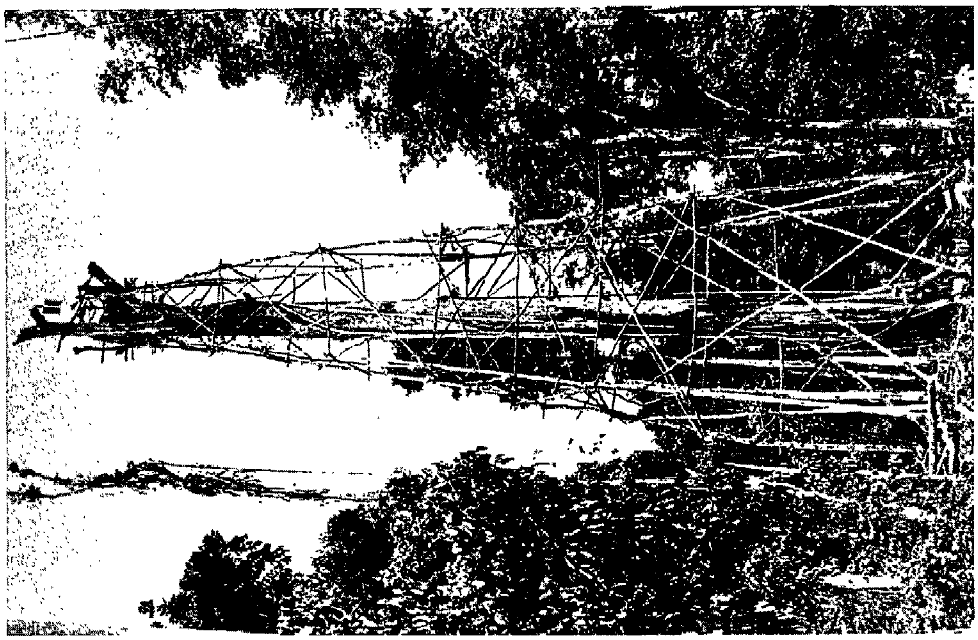

FIGURE 6.—Survey tower in the Philippine interior.

available nautical information was far from complete.[37] The magnitude of this undertaking is emphasized by the existence of 7,000 islands and rocks above water in the archipelago, comprising a tidal shoreline of 21,000 statute miles. Remote areas in the interior had to be explored for the first time in order to establish the necessary geodetic control for the surveys and charts (*see* fig. 6). It took four full decades, a considerable force of men, and a number of surveying vessels to bring the task to near completion. When the United States relinquished its stewardship over the islands, surveys of approximately 98 percent of the water and coastal areas had been completed, and the 136 Spanish charts had been replaced by a modern series of 12 general sailing charts and 152 coast and harbor charts. These had benefited the merchant marine and the Navy and advanced the economy of the Republic through the protection and aid which this work afforded for the exchange of products of the islands with the world, particularly with our own country.

13. SCIENTIFIC BYPRODUCTS AND SIGNIFICANT ACHIEVEMENTS

Throughout its history the Coast Survey has contributed directly and indirectly to the advancement of science and engineering. It has provided leadership in the various areas of its competence. New surveys into previously unexplored areas and continuous explorations for precision and efficiency have resulted in technical and scientific discoveries. For example, the theory that the earth was in isostatic compensation was given a quantitative test in the Bureau by a study of the differences between astronomic and geodetic determinations at numerous triangulation stations and comparing these differences with the attractive force of the surrounding topography on the plumb line. This condition of approximate equilibrium was later used to determine a more accurate figure of the earth—the International Ellipsoid of Reference (*see* Part 2, 211).[38]

A contribution of major significance to mapping and engineering was the establishment by the Bureau of systems of plane coordinates for the country. Until 1933, triangulation data were expressed in terms of geographic coordinates (latitudes and longitudes)—a universal system, especially convenient where extensive areas are involved. The Bureau recognized, however, that

37. This was contained in a collection of 136 Spanish charts of various dates and in the *Derotero del Archipielago Filipino*, or Spanish Coast Pilot. This had last been published in 1879 and was very much outdated. Deily, *The Coast and Geodetic Survey in the Philippine Islands*, 7 JOURNAL, COAST AND GEODETIC SURVEY 4 (1957).

38. This is of practical value in obtaining the highest precision in determining distances between points on the earth's surface, and in geophysical prospecting by gravity methods.

engineers and surveyors, unfamiliar with the computational methods involved, hesitated to use geographic coordinates for surveys of smaller areas, such as those performed within a state, county, or city. Considering the desirability of having all surveys, no matter how localized, tied into the federal network of geodetic control, the Coast Survey devised systems of plane coordinates for each state and developed the formulas for the transformation of geographic coordinates to their corresponding X and Y values. By these systems, surveys between points on the surface of the earth can be treated as though accomplished on a plane instead of a spheroidal surface (*see* 2113 B).

In the field of tides, a comprehensive theory of the nature of tidal phenomena was formulated during the latter part of the 19th century. This theory, developed in the Bureau and known as the stationary wave theory, replaced an older theory of a single world phenomenon, and substituted the idea of local responses in the different ocean basins to the tide-producing forces as the origin of the dominant tides in each basin. The accumulation of tidal knowledge has borne out the correctness of that assumption.

The Bureau has pioneered in the development of methods and equipment for use in hydrographic surveying at great distances from shore. These improvements have made it economically feasible to extend coastal surveys seaward to the continental shelf and beyond. This has brought to light submarine features of major physiographic significance (*see* 22), and gave a new concept of the configuration of the ocean floor. This important discovery laid the foundation for a new design in nautical charts so as to make these features available to the mariner as an aid in locating the position of his vessel (*see* Part 2, 6241). Perhaps an even more far-reaching result of extending these surveys offshore has been the discovery near the outer edge of the shelf in the Gulf of Mexico of numerous shoals bearing strong resemblance to some of the buried salt domes along the coastal plains of Louisiana and Texas, where some of the rich oil reserves are located. These preliminary indications stimulated interest among prospecting companies in search of new potential oil fields and culminated in actual exploration many miles from shore.

In the development of the Radio Acoustic Ranging (R.A.R.) method for locating a survey vessel's position far offshore (*see* fig. 7), it was discovered in the early 1930's that certain depth layers exist where the combined factors of temperature and pressure cause a velocity inversion, resulting in a channeling effect that conserves energy and sends the sound signals almost undiminished over great distances. Although the R.A.R. method was abandoned during World War II for security reasons and was later superseded by electronic methods of position determination, the basic phenomenon of a minimum-

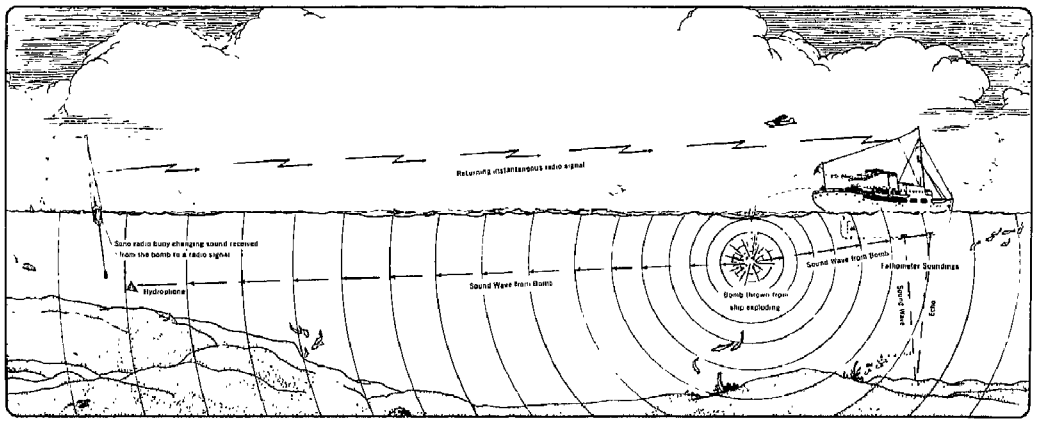

FIGURE 7.—Measuring depths and distances by sound. Radio Acoustic Ranging (R.A.R.) was a method used prior to World War II for locating a survey vessel's position far offshore.

velocity layer in the ocean was employed during the War by the U.S. Navy to develop and make operational its *Sofar* signaling system for distress calls at sea.[39]

14. PRESENT FUNCTIONS AND ORGANIZATION

(*a*) *Act of August 6, 1947.*—The Act of August 6, 1947 (61 Stat. 787), was the first of the recent legislation to define the functions and duties of the Coast and Geodetic Survey. It did not change previous authorizations to any great extent but eliminated a number of obsolete statutes and assembled into one place various items of substantive legislation which had been enacted at different times since 1807. The language is clear and concise and, in general, provides exact limitations. Section 1 sets forth the purpose of the act and the authority conferred upon the Director, under direction of the Secretary of Commerce, to conduct the following activities *in the United States, its Territories, and possessions:* [40]

(1) Hydrographic and topographic surveys *of coastal water and land areas (including surveys of offlying islands, banks, shoals, and other offshore areas)*;

(2) *Hydrographic and topographic surveys of lakes, rivers, reservoirs, and other inland waters not otherwise provided for by statute;*

39. For other scientific byproducts and significant achievements, see WRAIGHT AND ROBERTS (1957), *op. cit. supra* note 22, at 56–66.

40. The italicized words here and in the items that follow identify the language deleted from the 1947 act by the Act of April 5, 1960 (*see* (*b*), below).

(3) Tide and current observations;

(4) Geodetic-control surveys;

(5) Field surveys for aeronautical charts;

(6) Geomagnetic, seismological, gravity, and related geophysical measurements and investigations, and observations for the determination of variation in latitude and longitude.

Section 2 of the act provides for the processing and dissemination of the field data resulting from the activities authorized in Section 1, specifically the compilation, printing, and distribution of nautical and aeronautical charts and related navigational publications.

Section 5 authorizes such cooperative agreements with any state or subdivision thereof, or with any public or private organization or individual and authorizes the Director to receive and expend funds made available by any of them.[41]

(*b*) *Act of April 5, 1960.*—The Act of April 5, 1960 (74 Stat. 16), has for its purpose the removal of geographical limitations on activities of the Bureau, as contained in the Act of August 6, 1947 (*see* (*a*), above), in recognition of the fact that science has no boundary and in line with the new emphasis placed on worldwide oceanographic research.[42]

The full texts of the Acts of August 6, 1947, and April 5, 1960, are set out in Appendix C.

In consonance with the 1960 act, the Bureau underwent a major reorganization both in its emphasis in the areas of scientific research and oceanography and in the realignment of functions to provide for greater unity in the field of administration. These changes streamline and strengthen the organizational structure of the Bureau and are designed to meet the needs of modern science and technology.

The new organization arranges functions into logical and reasonable groups with clear-cut lines of responsibility and authority for achieving an objective. Five Offices were established, each headed by an Assistant Director, as follows: Oceanography, Physical Sciences, Cartography, Research and Development, and

41. The Coast Survey has entered into many such arrangements, one of the most recent being the low-water line survey of the Louisiana coast in cooperation with the State of Louisiana and the Bureau of Land Management (*see* Volume One, Part 2, 17).

42. In 1959, a Committee on Oceanography, working under the sponsorship of the National Academy of Sciences, submitted its report stressing the importance of an oceanwide, ocean-deep survey program through international cooperation in which the United States share would be about 30 percent. *Oceanography 1960 to 1970, 1-Introduction and Summary of Recommendations,* National Academy of Sciences—National Research Council (1959).

Administration (*see* fig. 8).[43] The following is a digest of the functions of these Offices as of March 26, 1963:

The Office of Oceanography conducts a broad and comprehensive program of collecting and analyzing oceanographic data to obtain a better understanding of the static and dynamic properties of the ocean and to disseminate such knowledge for application in charting, scientific, and defense endeavors. It plans, coordinates, and directs oceanographic surveys and supervises the analysis and processing of the resulting data; compiles and publishes tide and tidal current tables, tidal current charts, coast pilots, sea water temperature and density summaries, and other related reports, for charting, navigation, engineering, and scientific purposes; operates, jointly with the Office of Physical Sciences, the seismic sea wave warning system; studies and investigates the interrelationship of oceanic environment and meteorological phenomena; and provides the operating facilities, including ships and smaller vessels, ships' bases, and tide stations, required for the collection of oceanographic data.

The Office of Physical Sciences provides geodetic, geophysical, and cartographic data for charting, engineering, scientific, and defense purposes. It plans, coordinates, and directs the maintenance, adjustment, observations, and extension of the geodetic control network including astronomic observations and gravity surveys, and makes investigations relating to astronautics and astrophysics; plans and directs the recording and investigation of geomagnetic and seismological phenomena; operates, jointly with the Office of Oceanography, the seismic sea wave warning system; operates the latitude observatories, geomagnetic and seismological observatories and laboratories, and seismological stations; directs the photogrammetric field activities and the compilation of planimetric and topographic maps and airport obstruction charts; and plans and directs the operation of automatic data processing facilities, and office processing and analysis of survey data, including compilation, publication, and distribution of geodetic control data, and geomagnetic and seismological reports.

The Office of Cartography provides charts and related data for marine and air navigation to meet civil requirements and defense needs. It plans, coordinates, and directs the compilation and maintenance of nautical and aeronautical charts, the operation of a chart reproduction plant, and the administration of chart distribution facilities.

The Office of Research and Development plans, coordinates, and directs the Bureau's overall basic and applied research and development program in fields of interest to or within the Bureau's competence. This includes—but is not limited to—research and development in cartography, oceanography, geodesy, geomagnetism, seismology, photogrammetry, gravimetry, astronautics, and related supporting fields. It develops, applies, and disseminates resulting findings, theories, and hypotheses.

The Office of Administration provides administrative and technical services for all Bureau activities. It plans, coordinates, and directs budget and fiscal activities; civil service personnel activities; organization, management, and internal audit activities; procurement and supply activities; construction and maintenance of instruments and equipment; and library and map reference services.

Besides these operational and administrative functions, certain other functions are performed on a staff level under the Director and the Deputy Director, such as program planning and coordination, new ship design, officer personnel activities, international technical cooperation, and scientific and technical publications.

43. This is based on Department Order No. 87 (Revised July 11, 1960), entitled "Organization and Functions of the Coast and Geodetic Survey," which became operational in the Bureau on Oct. 1, 1960. Annual Report, U.S. Coast and Geodetic Survey 1 (1961). Figure 8 reflects some further changes made as a result of Department Order No. 87 (Revised Mar. 26, 1963), and other Bureau memoranda.

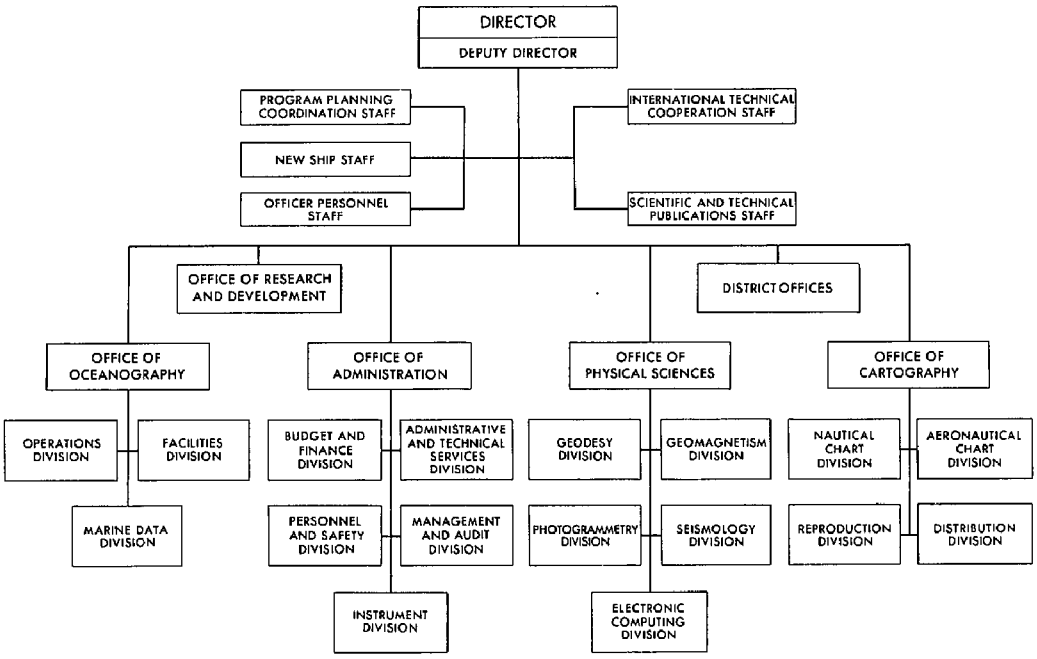

FIGURE 8.—Organization chart of the United States Coast and Geodetic Survey (to the Division level) as of July 1, 1963.

15. SUPERINTENDENTS AND DIRECTORS

The following is a list of all the Superintendents and Directors that have served the Bureau since its inception. The Title "Superintendent" was changed to "Director" by the Act of June 5, 1920 (41 Stat. 874, 929), during the administration of E. Lester Jones. Until the appointment of Raymond S. Patton as Director, in 1929, only three heads of the Bureau were appointed from the ranks—Carlile Patterson, Julius Hilgard, and Otto Tittmann; the other eight came from outside the Bureau. Following the establishment of a commissioned status for the field engineers, the Act of June 4, 1920 (41 Stat. 812, 825), required the Superintendent (Director) to be selected from the list of commissioned officers of the Survey not below the rank of Commander. It was also provided that while serving as Director his rank was to be that of Captain in the Navy. His present rank of Rear Admiral (upper half) was established by the Act of March 18, 1936 (49 Stat. 1164).

Superintendent or Director	*Period of Service*
Ferdinand R. Hassler	June 18, 1816—April 29, 1818
	August 8, 1832—November 20, 1843
Alexander D. Bache	December 12, 1843—February 17, 1867
Benjamin Peirce	February 26, 1867—February 16, 1874
Carlile P. Patterson	February 17, 1874—August 15, 1881
Julius E. Hilgard	December 22, 1881—July 23, 1885
Frank M. Thorn	September 1, 1885—June 30, 1889
Thomas C. Mendenhall	July 9, 1889—September 20, 1894
William W. Duffield	December 11, 1894—November 30, 1897
Henry S. Pritchett	December 1, 1897—November 30, 1900
Otto H. Tittmann	December 1, 1900—April 14, 1915
E. Lester Jones	April 15, 1915—April 9, 1929
Raymond S. Patton	April 29, 1929—November 25, 1937
Leo O. Colbert	April 8, 1938—April 7, 1950
Robert F. A. Studds	May 16, 1950—July 31, 1955
H. Arnold Karo	August 13, 1955—to date