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CHARLES SAWYER, SECRETARY

COAST AND GEODETIC SURVEY
ROBERT F. A. STUDDS, *Director*

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OF THE
DIRECTOR OF THE COAST AND GEODETIC SURVEY
FOR THE
FISCAL YEAR ENDED JUNE 30, 1950

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Annual Report of the Superintendent of the Coast Survey

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Annual Report

OF THE

U. S. Coast and Geodetic Survey

1950

U. S. C. and G. S. ship *Pathfinder* leaving Seattle. This vessel has a displacement of 2,000 tons. Its over-all length is 229.3 feet, beam 39.0 feet, and draft 15.5 feet.

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U. S. Coast and Geodetic Survey

ROBERT F. A. STUDDS, Director

GENERAL REVIEW

The Coast and Geodetic Survey performs a wide variety of essential services for the promotion of commerce, for the development of our natural resources, and for the compilation of certain basic engineering and scientific data. It surveys the coasts of the United States and its possessions to insure the safe navigation of coastal and intracoastal waters; it determines geographic positions and elevations in the interior of the country to provide the framework for mapping and other engineering work; it makes tide and current surveys to furnish datum planes to engineers and tide and current tables to mariners; it compiles and publishes nautical and aeronautical charts to meet the needs of marine and air navigation; it makes observations of the earth's magnetism to furnish magnetic information essential to the navigator, aviator, land surveyor, and others; and it makes seismological observations and investigations to supply data required in the design of earthquake-resistant structures.

Survey functions are performed by a field organization under the administrative direction of 10 divisions in the Washington office where computation and analysis of field observations are made and the results are compiled in the form of charts and other publications.

Normal functions of the Bureau play an important part in the protection of life and property at sea and in the air. Its activities are further aimed to meet the public needs involved in large peacetime projects for the multiple use of waters in our main river basins and for the acceleration of the national mapping program.

During the year, major emphasis was given to the extension of hydrographic surveys in Alaska in view of its strategic importance. Seven of the nineteen Bureau survey vessels operated in southeast Alaska, in Prince William Sound, along the south coast of the Alaska Peninsula, in the Aleutians, in Bristol Bay, and along the Arctic coast.

Other hydrographic surveys were carried on at various places along the Atlantic, Gulf, and Pacific coasts as part of a program of modernizing our nautical charts. Wire-drag surveys for locating sunken wrecks and other dangers to navigation were continued off the Maryland and Delaware coasts.

Aerial photographs, as a preliminary to the compilation of topographic maps, were taken of coastal areas along the Atlantic and Gulf coasts and in Alaska and of 44 airports in the United States, using the Bureau's 9-lens camera. Photogrammetric field surveys were in progress or were completed along the coasts of the United States and in Alaska. Original or revision surveys were completed for 120 airports for use in compiling instrument approach and landing charts and airport obstruction plans.

The basic networks of horizontal and vertical control were extended in the interior of the country and in Alaska. Major field activities were carried on in the Missouri River Basin for flood control and reclamation studies and in western Alaska. Several special geodetic field projects were in progress to provide data for studies of: horizontal earth movement in earthquake regions; deflection of the vertical from gravimetric observations; and settlement in the Long Beach, Calif., area. Progress was made in adjusting the triangulation of the United States and Alaska and of the western European net.

The program of tidal observations was advanced during the year. Observations were made at the principal seaports in the United States and possessions and in foreign areas to provide data for prediction of tides and studies of mean sea level. The comprehensive tidal current survey of Tampa Bay, Fla., was completed and the compilation of tidal current charts for the area was begun. The collection of temperatures and densities of sea water at tide stations was continued and a number of new stations were added to the network.

Continuous recordings of the magnetic elements were obtained at seven magnetic observatories, and the regular program of reobservations of magnetic conditions was carried on at selected stations. Compilation of the world isogonic chart was completed, and the Bureau continued its assigned function as the central repository for world magnetic information.

The chain of seismograph stations maintained by the Bureau and in cooperation with universities and private institutions furnished data for further mapping of seismic areas and for the development of safe building-construction methods. Through national and international cooperating agencies, the Bureau received 8,500 earthquake messages and announced the locations of 570 earthquakes.

A total of 911 nautical charts was on issue at the end of the year and nearly a million copies were distributed. New series of large-scale charts of the coast of Maine and of Chesapeake Bay were in production. The new series gives special attention to the needs of fishermen and small-boat operators. Loran lines of position have been added to many of the offshore charts and this program is being extended to the larger-scale charts for use in inshore and coastwise navigation.

At the end of the year the Bureau had on issue 914 aeronautical charts in several series to meet the needs of civil and military aviation. The Sectional Chart series was modified to include omnirange data on the face of the chart and a tabulation of airport and other navigational information on the reverse side. Four of a new series of seven aeronautical route charts to cover the United States were completed. These charts are specially designed for long-range navigation to meet the requirements of high-speed air carriers operating at high altitudes. Twenty-six million aeronautical charts of all types were distributed during the year.

A number of improvements were made in instruments and techniques that will result in higher accuracy and greater efficiency in the work of the Bureau. Notable among these were the design of a new master controller for the electronic position indicator for use in offshore hydrographic surveying; the refinement of photogrammetric techniques for accelerating topographic mapping of difficult terrain; the development, in cooperation with the Naval Ordnance Laboratory, of a new induction-type magnetometer adapted to aircraft use; and the wider application of automatic computing machines to the voluminous computations and tabulations required in the work of the Bureau.

Cooperation was continued with national agencies and with foreign governments and international organizations through new and continuing interagency projects, cooperative agreements, liaison, exchanges of information, and training of personnel, as provided by existing law.

The program of broadening the technical services of the Bureau progressed during the year. The keynote of this program is to develop a better understanding, a more effective distribution, and a greater utilization of the products of the Bureau's activities. The data collected by the Bureau have application in many scientific and engineering endeavors. This availability of information and services is being stressed by the Bureau in a number of ways, such as through the issuance of special publications, pamphlets, and press releases; the preparation of special exhibits; the publication of articles in technical and trade magazines; and the presentation of talks before scientific and engineering societies. The effect of these information activities is being reflected in a marked increase in the number of requests being received for specific survey data.

A more detailed statement of activities carried on during the fiscal year 1950 follows:

NAUTICAL AND AERONAUTICAL CHARTS

Production and distribution of nautical and aeronautical charts and related publications continue to be major activities of the Bureau.

Improvements are constantly being made in both classes of charts in the interest of the navigator. Developments in navigational aids and methods have increased the demand for new types of charts and for modernization of existing charts.

The facility with which soundings can now be obtained in deep water, by the use of echo-sounding machines, has made the mariner more conscious of submarine relief as an aid to navigation. The more faithfully the nautical chart portrays this relief, the better is the mariner able to relate his depth readings to the chart and the more certain will be his position. The advent of echo sounding in navigation gave rise to the development of a type of chart on which curves of equal depth, or submarine contours, form a major part of the hydrography. This treatment brings into prominence many characteristic features of the ocean floor which the navigator can use to determine his position or to base his future course. Such depth curves are being added to the nautical charts wherever complete modern hydrographic surveys have been made.

World War II added two electronic methods for navigational use—Loran and radar. Both of these methods have necessitated certain adaptations in the nautical charts to facilitate their use with these navigational systems. Loran lines of position have been added to many of our offshore charts along the Atlantic and Pacific coasts and this program is being extended to the larger-scale Coast Charts. For use with radar a few experimental charts along the Pacific coast have been prepared to bring into prominence the land relief which the navigator sees on the radarscope.

The Bureau's service to aviation is of relatively recent origin. The aeronautical charting program was initiated 24 years ago under authority of the Air Commerce Act of 1926. The Bureau compiles and prints aeronautical charts of the United States and possessions for the defense agencies as well as for civil aviation and also for international airways that are required primarily by United States civil aviation.

The first complete chart coverage of the terrain of the United States on a uniform scale was provided by the sectional aeronautical chart series published by the Bureau in 1935. As aviation progressed other series of charts were published to meet the different needs of the aviator.

Charts of the United States now in use include 87 sectional charts at a scale of 1:500,000; 43 world aeronautical charts at a scale of 1:1,000,000; direction-finding charts at a scale of 1:2,000,000; and route, local, instrument approach and landing, radio-facility, and aircraft-position charts at various scales.

Developments in air navigational techniques and changes in infor-

mation shown on aeronautical charts require continued revisions of and additions to the information shown on existing charts and the addition of specialized types of charts for use with newly developed aids and navigational facilities. The improvement of aeronautical charts through research and development is essential to our rapidly expanding air commerce.

Nautical Charts

A total of 911 nautical charts was on issue at the end of the fiscal year. To produce the 888,661 copies distributed, 433 printings were necessary, as follows: 15 new charts, 29 new editions, 375 new prints, and 14 reprints.

Throughout the year numerous items regarding dangers, which required hand corrections to the charts, and other navigational information were reported to the Coast Guard and the Hydrographic Office for publication in the weekly Notice to Mariners. Over 8,000,000 hand corrections were necessary to keep the charts up to date.

The new series of large-scale charts being compiled to furnish detailed coverage of the Gulf Intracoastal Waterway was more than half completed at the end of the year. Eighteen of these charts, covering 471 nautical miles of the waterway from Carrabelle, Fla., to the Vermilion River, La., have been published. Seven of the fifteen remaining charts of the series, covering 442 miles of the waterway from the Vermilion River to Brazos Santiago, Tex., are near completion.

Four of a new series of 1:40,000 scale charts of the coast of Maine were published during the year. This series is being compiled from recent surveys, and chart limits are established for greater convenience in navigation.

A new series of large-scale charts of Chesapeake Bay is also in production. In compiling this series, special attention is being given to the needs of fishermen and small-boat operators who make extensive use of these waters. Two charts of this series were published during the year.

New editions of the 1200 series charts of the Atlantic coast, based on new compilations and with chart limits revised where necessary for better coverage, are in process of production. Bottom relief is portrayed by black depth curves in the inshore areas and by blue curves in the offshore areas.

During the year a program was initiated to add Loran curves to the Coast Charts of the Atlantic and Pacific coasts, for use in inshore and coastwise navigation. At the end of the year four such charts of the Atlantic coast and five of the Pacific coast were nearing completion.

Field inspection for the revision of the Atlantic Coast Pilot, Sections A and B, was completed, and field inspection for the revision of the Pacific Coast Pilot progressed northward to the Umpqua River, Oreg.

Aeronautical Charts

At the end of the year, 914 aeronautical charts were on issue. These included 271 standard and auxiliary charts, 555 instrument approach and landing charts, and 88 radio facility charts. New charts published totaled 67, including 5 route charts, 1 auxiliary chart, and 61 instrument approach and landing charts.

An instrument approach and landing chart is issued for each principal airport in the United States. Of the approach and landing charts produced during the year, 43 were for automatic direction-finding procedures which have now been established at 59 airports by the Civil Aeronautics Administration.

Two important improvements were made in the sectional areonautical charts: the addition of omnirange data and a special back-up. The omnirange station and all VHF (very-high-frequency) navigational information, including VAR (visual-aural radio-ranges) with conventional course symbols, are printed in blue to contrast with the low-frequency radio information which is printed in magenta. The reverse side of each chart contains a tabulation of airport information and text providing details pertaining to the use of omniranges, instrument and visual flight rules, search and rescue procedures, emergency code distress signals, weather broadcasts, and other subjects.

A new series of aeronautical route charts was planned to cover the United States in seven sheets at the scale of 1:2,000,000. At the end of the year, four of the series were published and the remaining three were nearing completion. These charts are specially designed for long-range navigation to meet the requirements of high-speed air carriers operating at high altitudes. This series will make available omnirange data for the entire United States.

Route charts are compiled on an oblique Mercator projection, which is proving to be a valuable asset for great-circle navigation. This projection is developed by adapting the mathematical theory of the Mercator projection to a transverse axis, thereby supplying elements of strength and control to a given zone. An interesting variation of the route charts is the elimination of contours to simplify base detail for better emphasis of navigational data. The conventional gradient tints are retained to portray vertical detail.

A route chart corresponding to the United States series which covers western Europe from Ireland to Italy was produced for the International Air Transport Association. This chart was urgently needed by

United States commercial air carriers operating over that area. It covers many international air routes and fields in western Europe and includes the fields in the British Isles and along the European coast which serve North Atlantic flights.

An experimental chart for use in air traffic control and omnirange navigation was compiled as a result of conferences with the CAA. The final specifications for an operational omnirange chart remain to be determined when air space and air traffic control questions are finalized by the CAA. According to present information, a new series of charts will be needed for use during the period when both low- and high-frequency aids are in operation. The full impact of the need for new-type charts will be more apparent when DME (distance-measuring equipment), search radar, and similar new electronic aids are put into general use.

Chart Distribution

During the year, the number of nautical charts issued showed an increase of approximately 72,000 copies, whereas the total issue of regular aeronautical charts of the Bureau showed a marked decrease. The decrease in the latter, however, was more than offset by the large increase in demand for instrument approach charts, of which the total issue was over 17,000,000. There was also a marked increase in the demand for foreign aeronautical charts.

Nautical and aeronautical charts are sold to the public from the Washington office, through field offices, and through authorized agents located in major cities and at airports in the United States, Alaska, Canada, Hawaii, the Philippines, the West Indies, and Europe. Chart distribution centers, to supply charts to the agents in their areas, are maintained at New York, Kansas City, Los Angeles, and San Francisco.

Strict supervision is maintained over the distribution of charts to prevent the issue of those which have been designated obsolete by the Bureau. Agents and distributing centers are notified without delay when a chart becomes obsolete and therefore hazardous for use in navigation, and the unsafe chart is withheld from sale. For this reason all marine and aeronautical charts of the Bureau should be obtained from officially designated distributors or offices of the Coast and Geodetic Survey.

The Bureau continued to act as a distributing agency for the Aeronautical Chart Service of the Department of the Air Force.

During the year 23 new nautical chart agents were appointed and 10 agencies were canceled, bringing the total number at the end of the year to 226. Inspections were made of 118 agencies. Authorized agents for the distribution of aeronautical charts totaled 370.

The following table shows the number of charts and related publications issued during the past 4 years:

Charts and related publications issued

Type of chart or publication	1947	1948	1949	1950
Nautical charts	1,225,639	1,178,346	816,759	888,661
Aeronautical charts	7,988,426	6,581,130	7,077,366	6,917,902
Airport and radio facility charts	4,885,703	6,533,924	9,260,048	17,063,470
Coast Pilots	15,993	17,171	20,541	19,330
Tide Tables	65,767	43,481	55,137	59,076
Current Tables	45,778	39,051	32,687	21,314

The distribution of nautical and aeronautical charts during the year was as follows:

Distribution of nautical and aeronautical charts in 1950

NAUTICAL			
Free issue:		*Percent*	
Department of the Navy	348,213	39.2	
Coast Guard	5,513	.6	
Department of the Army	13,936	1.6	
Coast and Geodetic Survey	43,261	4.9	
Other Departments	8,176	.9	
	419,099	47.2	
Sales	378,560	42.6	
Condemned	91,002	10.2	
	888,661	100.0	888,661
UNITED STATES AERONAUTICAL			
Free issue:			
Department of the Air Force	3,964,893	57.3	
Department of the Army	45,339	.6	
Department of the Navy	792,643	11.5	
Civil Aeronautics	30,397	.4	
Coast and Geodetic Survey	62,967	.9	
Other Departments	20,477	.3	
	4,916,716	71.0	
Sales	1,124,446	16.3	
Condemned	876,740	12.7	
	6,917,902	100.0	6,917,902
UNITED STATES AIRPORT AND RADIO FACILITY			
Total issue			17,063,470
SPECIAL AND FOREIGN AERONAUTICAL			
Total issue			1,588,450
Total			26,458,483

SURVEYS OF COASTAL WATERS

Surveys of coastal waters furnish basic data essential for the compilation of nautical charts, which are produced to meet the needs of the mariner in the safe navigation of his ship.

Coastal surveys are accomplished by ships and shore-based parties

engaged on combined operations along the coasts and inland waterways of the United States and possessions. These operations comprise various activities, including hydrography, topography, and triangulation; tide, current, and magnetic observations; oceanography; and the collection of diversified data needed in compiling ond correcting nautical charts and Coast Pilots.

Approximately 90,000 statute miles of tidal shoreline, fringed by over a million square miles of coastal waters, covering the continental United States, Alaska, the Hawaiian Islands, Guam, Puerto Rico, the Canal Zone, and the Virgin Islands, constitute the operating area of the Bureau.

To keep the navigator informed of changes in the shoreline and ocean bottom, resulting from both natural and artificial causes, periodic resurveys are made. Other areas, though unchanged, must be resurveyed to modernize charts which lack the detail needed for use with modern navigational devices. The problem of surveying our coastal waters is, therefore, a continuing one.

During the year, coastal surveys were carried on under the normal peacetime program in areas of importance to commercial shipping and undeveloped regions containing oil, fishing, and mineral resources, and

Reading fathogram on deep-sea recording fathometer aboard survey vessel. Ship is also equipped with nonrecording fathometer (upper right), and 808 type fathometer for recording soundings in shoal water (lower right).

were also extended into areas of strategic importance at the specific request of the armed services.

Eighteen ships and two shore-based parties were in operation along the Atlantic and Pacific coasts, in the Gulf of Mexico, and in Alaska. Two ships accomplished hydrographic surveys in the Philippine Islands under the Philippine Rehabilitation Program. The surveys accomplished are summarized in the following table:

Statistical summary of coastal surveys

Locality	Hydrography				Topography		Triangulation		
	Sounding lines	Area	Wire drag	Area	Shoreline	Area	Length of schemes	Area	Geographic positions
	Miles	*Square miles*	*Miles*	*Square miles*	*Miles*	*Square miles*	*Miles*	*Square miles*	*Number*
Coast of Maine	2,478	79					1	2	6
Massachusetts to Cape Charles	1,942	47	356	25					6
Chesapeake Bay	4,087	161							8
Gulf of Mexico	19,187	7,412	2	1					
California, Oregon, and Washington	2,282	42			64		19	40	72
Alaska	50,826	18,144			282	244	120	445	143
Philippine Islands	4,567	79	71	3	90	17	3	10	12
Total	85,369	25,964	429	29	436	261	143	497	247

Along the Atlantic coast and in the Gulf of Mexico parties aboard the survey ships *Cowie*, *Gilbert*, *Hilgard*, *Wainwright*, *Parker*, *Bowen*, *Stirni*, *Hydrographer*, and *Sosbee* accomplished hydrographic, current, wire-drag, and coast-pilot surveys.

Combined operations were continued by the ship *Cowie* in Tangier Sound, Chesapeake Bay, Md. Hydrography in the Big Annemessex and Manokin Rivers was completed. A special investigation was made of the *San Marcos* wreck in Chesapeake Bay.

The ship *Gilbert* resumed combined operations around Long, Marshall, and Swans Islands and in Penobscot Bay, in the vicinities of Rockland and Camden, Maine. A special hydrographic investigation of indications of a submerged rock and shoal area in the vicinity of Gloucester, Mass., was also made. A measured-mile course was established in the Sheepscot River.

Coast-pilot inspection for the revision of the United States Coast Pilot, Atlantic Coast, Section B, was completed by the ship *Hilgard* in the general area of Buzzards Bay, along the north shore of Long Island Sound as far west as City Island, and in the east-central portion of Long Island westward from Montauk Point. Hydrographic surveys were also accomplished in Lower New York Bay. A special survey in the vicinity of False Hook Channel was completed.

Hydrographic surveys in Hempstead Bay, Long Island, N. Y., were accomplished by the party of the *Wainwright*. The vessel was placed

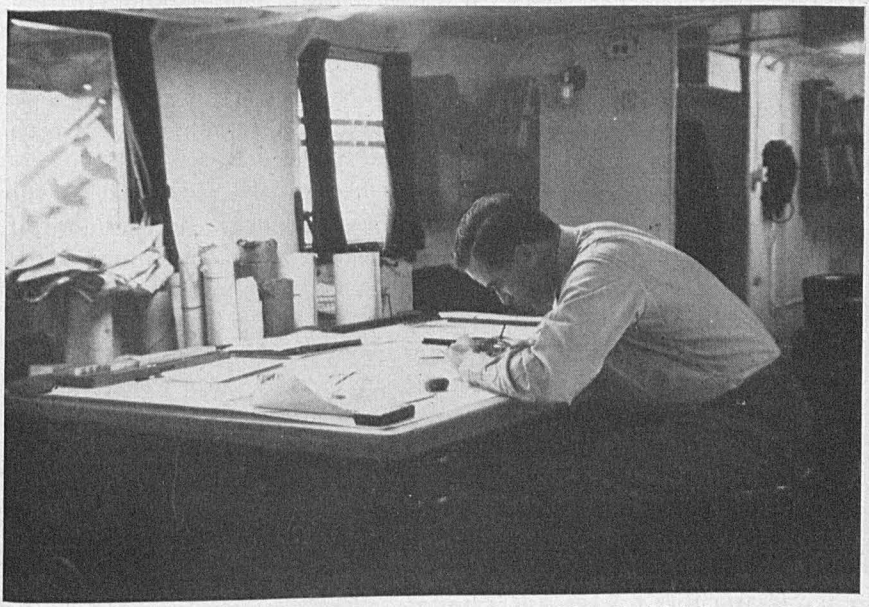
on an inactive status on January 30, 1950, because of insufficient operating funds.

The personnel of the *Parker*, *Bowen*, and *Stirni*, operating as a unit, executed hydrographic surveys in lower Chesapeake Bay in the vicinities of Old Point Comfort, Fishermans Island, and Cape Charles, Va. Visual and Shoran-controlled wire-drag investigations to locate sunken wrecks were continued along the coasts of Maryland and Delaware.

Offshore hydrographic surveys were continued by the ship *Hydrographer* in the northeastern Gulf of Mexico west of Tampa Bay and in the vicinity of Cape San Blas, Fla., using the specially designed Electronic Position Indicator. The ship also assisted the party of the *Sosbee* on inshore hydrographic surveys between Tampa Bay and Tarpon Springs, Fla.

A tidal current survey of Tampa Bay, Fla., was completed by the party of the *Sosbee*. Work was continued on new basic inshore hydrographic surveys along the west coast of Florida, in the vicinity of Clearwater. A special hydrographic survey in the vicinity of Booth Point, Fla., was also accomplished.

On the Pacific coast and in Alaska the survey ships *Bowie*, *Hodgson*, *Explorer*, *Pioneer*, *Pathfinder*, *Derickson*, *Surveyor*, *Patton*, and *Lester Jones* were used on combined operations. The *Surveyor* was reactivated on February 1, 1950, and began field operations on May 1, 1950. On May 15, 1950, the Coast Guard ship *Spruce*, a 180-foot,



Plotting room on survey vessel. Officer is drawing in shoreline detail on preliminary survey sheet.

twin-screw, Diesel-powered, steel vessel, was transferred by Executive Order from the Coast Guard to the Coast and Geodetic Survey, for use as a supply and survey ship in Alaska. The *Spruce* was renamed the *Onward.*

Combined operations were continued in Suisun Bay and Carquinez Strait, Calif., by the party of the *Bowie.* A special hydrographic investigation was made of a shoal in the vicinity of the entrance to the Marine Municipal Yacht Harbor in San Francisco.

Hydrographic surveys were continued in the Columbia and Willamette Rivers, Oreg., by the party of the *Hodgson.*

Visual and Shoran-controlled hydrographic surveys were continued by the ship *Explorer* in the Aleutian Islands, Alaska, in the vicinities of Kiska and Amchitka Islands. All hydrography surrounding Amchitka Island was completed, and was extended across Amchitka Pass to the Delarof Islands on the northeast and to latitude 50°40.5′ N., longitude 179°29.5′ W., on the southeast. A junction was made with the 1944–45 work in the vicinity of Unalga Pass. Triangulation control on Amchitka Island was completed. Deep-sea sounding lines were run across Bering Sea from Adak Island to Nome, Alaska; and across the North Pacific from Adak Island, Alaska, to Yaquina Head, Oreg., and thence to Tatoosh Island, Wash.

Visual and Shoran-controlled hydrographic surveys in the Aleutian Islands, Alaska, were extended eastward from Little Sitkin Island by the *Pioneer.* Inshore hydrography on the west coast of Kiska Island, the east coast of Little Sitkin Island, and entirely around Semisopochnoi Island was completed. Offshore hydrography north of the area between Little Sitkin Island and the east side of Amchitka Pass was also completed. Deep-sea sounding lines were run across Bering Sea from Adak to Nome, Alaska, and in the North Pacific Ocean from Chugul Pass, Alaska, to Point Reyes, Calif.

Combined operations were accomplished by the personnel of the *Pathfinder* in Bristol and Nushagak Bays, Alaska. At the close of the season's work, a deep-sea sounding line was run from Unimak Pass, Alaska, to Cascade Head, Oreg., and thence to Cape Flattery, Wash.

Combined operations were begun by the *Derickson* in Prince William Sound, Alaska, in the vicinities of the Naked, Peak, Storey, Lane, Eleanor, and Smith Islands; Perry Passage; and Perry Island. A deep-sea sounding line was run from Cape St. Elias to Yakutat sea buoy and thence to the vicinity of Cape Spencer Light, Alaska. The ship was placed on inactive status on December 1, 1949, because of insufficient operating funds.

Tidal current surveys were made by the ship *Surveyor* in the Aleutian Islands Passes, Alaska, and in Rosario Strait, San Juan Islands, Wash.

Combined operations were continued in southeast Alaska by the

Crew of U. S. C. and G. S. ship *Pioneer* landing camp gear from LCVP on beach of one of Aleutian Islands.

Hydrographic launch being hoisted aboard U. S. C. and G. S. ship *Pathfinder*.

party of the *Patton* in Krestof Sound, Nakwasina Passage, and Katlian Bay. A tag-line survey in the vicinity of the White Pass and Yukon Railroad wharf at Skagway was accomplished. Hydrography and triangulation of Krestof Sound were completed, as well as hydrography, graphic control, and air photo inspection of Katlian Bay. A tidal current survey of Grays Harbor, Wash., was also accomplished during spring of 1950.

Along the south coast of the Alaska Peninsula, in Kukak and Chignik Bays and in the vicinity of Mitrofania Island, combined operations were accomplished by the *Lester Jones*. In addition, ship support was furnished to geodetic parties operating in Chignik Bay and on Mitrofania Island. Hydrographic surveys in Kukak Bay were completed during the year. A reconnaissance survey for a power-cable crossing in the San Juan Islands, Wash., was also accomplished.

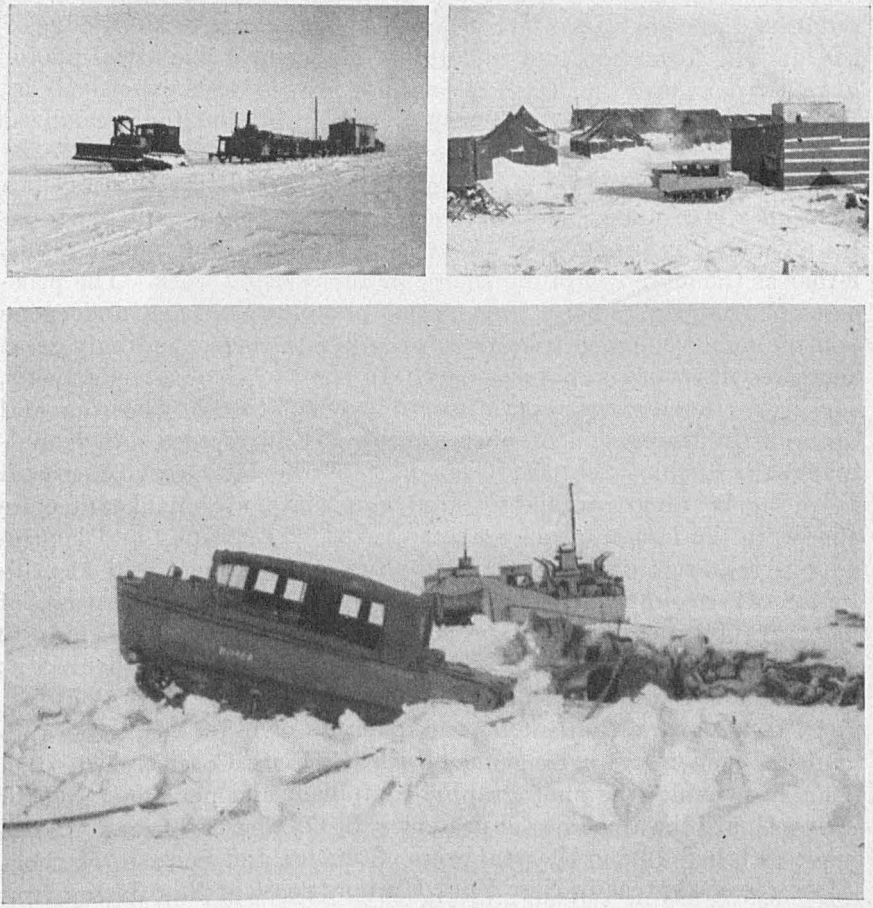
Operations were continued along the Arctic coast of Alaska by the Arctic Field Party.

A shore-based party extended basic hydrographic surveys in Hempstead Bay, Long Island, N. Y.

In the Republic of the Philippines, the Manila office of the Bureau, under the direction of the Director of Coast Surveys of the Philippine Islands, continued survey work, training of Filipinos, and assistance in the organization of the Philippine Bureau of Coast and Geodetic Survey. Three commissioned officers and five civilian employees were on duty in the Manila office to assist in field operations, revision of charts, and training. The parties of the *Tulip* and *Hornet* completed hydrographic surveys in Cebu Harbor and approaches; triangulation observations and hydrographic and wire-drag investigations in Manila Harbor; hydrography in Bacoor Bay; wire-drag investigations in Canacao Bay; and reconnaissance up the Pasig River and Laguna Bay.

District offices were maintained during the year at the following ports: Boston; New York; Norfolk; New Orleans; Los Angeles; San Francisco; Portland, Oreg.; Seattle; and Honolulu. These offices render valuable service in supplying information for the correction of charts, in assisting the field parties of the Bureau in obtaining supplies and personnel, in planning field work of the parties operating in their respective districts, and in disseminating nautical and engineering data in response to requests from official sources and from the public.

Processing offices continued in operation at the two principal bases of the field parties—Norfolk and Seattle—to expedite the application of field surveys to the finished nautical charts and to permit close cooperation between the field engineers and the office cartographers.



The Arctic party of the U. S. Coast and Geodetic Survey has transportation and housing problems. Upper left, "cat train"; upper right, survey camp; below, "cat" assists in unloading supplies from LSM.

PHOTOGRAMMETRIC SURVEYS

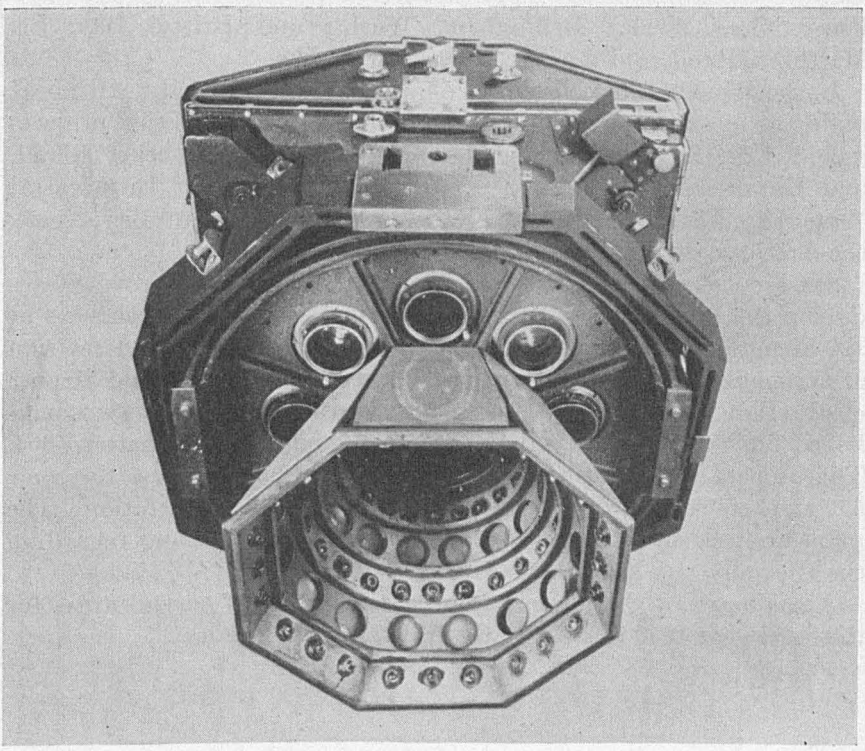
The construction and maintenance of nautical charts require accurate and up-to-date detailed topographic maps of the coastal regions. Because of the changes, both natural and artificial, that are constantly taking place in the coastal area, the topographic work of the Bureau is a continuing operation. Repeat surveys at frequent intervals are necessary in important harbor areas where new development renders topographic surveys obsolescent in a fairly short time. Photogrammetric methods have proved to be the most efficient and economical means for executing basic topographic surveys and especially for revising obsolescent surveys. The topographic maps not only furnish information for nautical charts but also provide data for engineering construction, conservation, city and regional planning, and other

public and private work which requires a comprehensive knowledge of the land, its formation, and cultural development. The aerial photographs from which the maps are compiled are also used extensively by governmental and private agencies for planning and for specialized studies.

Aerial photography for mapping has been used by the Bureau since 1920 on a constantly increasing scale. Today, practically no topographic map is produced without some use of aerial photographs, either as the main compiling source or for revision work. The processes of compiling maps from aerial photographs have undergone continuing development and improvement with correspondingly great increases in accuracy and economy. In spite of these developments, however, ground survey operations to provide control of position and accurate interpretation of photographic details, names, and boundaries still account for nearly one-half of the total cost of coastal mapping by photogrammetric methods. The major field and office phases in the mapping process are: Aerial photography and laboratory processing; field surveys, including establishment and identification of ground control and inspection and interpretation of photographic details with special emphasis on landmarks, aids to navigation, and alongshore features; office compilation; field edit; office review and drafting; and publication.

In recent years, the Bureau has taken its own aerial photographs under a cooperative arrangement with the U. S. Coast Guard. The Bureau provides the photographic equipment and personnel and the Coast Guard the airplane (at present, a B–17) and flight crew. Areas photographed during the year were: Cohasset and Scituate Harbors, Mass.; several areas in New York Harbor; coast of New Jersey from Barnegat to Townsend Inlet; vicinity of Philadelphia, Pa.; coastal areas in the vicinities of Ocean City, Md., and Chincoteague, Va.; vicinity of James River, Va.; Albemarle Sound and Alligator River, N. C.; vicinity of Daytona Beach and Jacksonville, Fla.; Mississippi Sound, Miss.-La.; Corpus Christi to Brownsville, Tex.; Kukak Bay and the Aleutian Islands, Alaska; and 44 airports throughout the United States.

Photogrammetric field surveys were in progress or were completed in the following areas: eastern Maine; New York City; New Jersey coast; Delaware River, N. J.-Pa.; Albemarle and Pamlico Sounds, N. C.; New River, N. C.; east coast of Florida; Corpus Christi to Brownsville, Tex.; Columbia River, Oreg.-Wash.; Bellingham, Wash.; and on the Yukon and Kuskokwim Rivers and Kuskokwim Bay, the north shore of the Seward Peninsula, Kotzebue Sound, and the north shore of the Alaska Peninsula, Alaska. The work on the Yukon and Kuskokwim Rivers and the Seward Peninsula was done by photogrammetric personnel attached to operating units engaged in geodetic



U. S. Coast and Geodetic Survey's nine-lens aerial mapping camera.

work. Photogrammetric field surveys were also accomplished by ships of the Bureau engaged in hydrographic surveys in the Aleutian Islands and by shore-based hydrographic parties on the Arctic coast in the vicinity of Wainwright.

The photogrammetric test area near McClure, Ohio, has been used extensively by the Bureau and by other government agencies and private organizations. The University of Michigan Engineering Research Institute, while working on a research project for the Department of the Air Force, financed surveys for the establishment of more than 40 additional stations to provide more closely spaced calibration points within the area.

Photogrammetric offices continued in operation at Baltimore, Md.; Tampa, Fla.; and Portland, Oreg., compiling topographic and planimetric maps of coastal areas in the vicinities of eastern Maine; Elizabeth Islands, Nantucket Island, and Martha's Vineyard, Mass.; New York Harbor and Staten Island, N. Y.; Delaware River, N. J.-Pa.; Pamlico Sound, N. C.; New River, N. C.; east coast of Florida; Vermilion Bay, La.; Gulf Intracoastal Waterway; Corpus Christi, Tex.; Humboldt Bay, Calif.; Coquille River and Coos Bay, Oreg.; Columbia

River, Oreg.-Wash.; Bellingham, Wash.; and Bristol Bay, St. Matthew Island, and the Arctic coast in Alaska.

In the Washington Office, the compilation, review, and drafting of planimetric and topographic maps were continued. Major projects included the following areas: Martha's Vineyard, Nantucket Island, and Elizabeth Islands, Mass.; York River, Va.; Gulf Intracoastal Waterway, Tex.; and Sitka and Salisbury Sounds, Bristol Bay, Nome, the Arctic coast, and the Aleutian Islands, Alaska.

Six airport survey parties operated throughout the United States during the fiscal year and completed original or revision surveys at 120 airports. These surveys are used in the production and revision of aeronautical instrument approach and landing charts and airport obstruction plans. Sixty-two airport obstruction plans were published during the year, bringing the total published to date to 363. This is part of a continuing program of preparing plans for some 550 airports requested by the Civil Aeronautics Administration. The plans are used by that agency in administering regulations regarding the allowable pay load of various types of aircraft.

A summary of the photogrammetric mapping of coastal areas for the fiscal year 1950 is given in the following tabulation:

Summary of photogrammetric mapping

Locality	Aerial photography	Photogrammetric field surveys				Compilations completed				Planimetric maps published	
		Shoreline	Interior area	Contours (plane-table)	Contours (stereoscopic)	Planimetric maps and shorline surveys		Topographic maps			
	Square miles	*Linear miles*	*Square miles*	*Square miles*	*Square miles*	*Square miles*	*Number*	*Square miles*	*Number*	*Square miles*	*Number*
Maine (Portland to Canadian boundary)		94	105			105	6	80	[1] 3	225	9
Massachusetts (Cohasset and Scituate Harbors)	55										
Massachusetts Rhode Island and Connecticut Six coastal areas						110	10				
New York, Great South Bay		114	50			114	2				
New York, miscellaneous areas for chart corrections		18	11			11	2				
New Jersey, Barnegat Inlet to a point north of Cape May	640							210	[1] 5	30	1
Delaware River	90										
Maryland, Chesapeake Bay areas for chart corrections	250										
Virginia, West Point tidewater area	400										
North Carolina	950	807	1,200	1,000				1,000	[1] 20		
Florida, East Coast		159	50	50				473	[1] 11		
Louisiana						1,320	43	280	4		
Mississippi Sound	600										
Texas	1,870	600	250	320		370	10	90	3		
California, San Francisco Bay										364	14
Washington-Oregon Lower Columbia River		225	225			225	15				
Washington, Bellingham		150	100								
Alaska:											
Sitka Sound		150	150			150	5				
Prince William Sound		70	100								
Kukak Bay	60	30	40								
Aleutian Islands	60	120	60		165			165	[2] 16		
Alaska Peninsula:											
North Shore		80	700								
Kuskokwim and Yukon Rivers		200	[3] 2,000					40	2		
North shore Seward Peninsula		220	1,800								
Arctic coast		150	750			30					
Totals	4,975	3,187	7,591	1,370	165	2,435	93	2,338	64	619	24

[1] Topographic maps compiled by this Bureau and turned over to the U. S. Geological Survey for drafting, reproduction, and publication.

[2] Topographic maps compiled by this Bureau and turned over to the Army Map Service for drafting, reproduction, and publication.

[3] Triangulation, interior inspection of aerial photographs, and identification of control on photographs, done cooperatively by the Divisions of Geodesy and Photogrammetry specifically for the Army Map Service.

GEODETIC CONTROL SURVEYS

Geodetic control surveys consist of triangulation and occasionally traverse to determine the exact positions of survey monuments and prominent natural and artificial objects and of precise leveling to determine the elevations of bench marks above the plane of mean sea level. Geodetic control surveys take into account the ellipsoidal figure of the earth and are the most accurate of all land surveys. The positions of triangulation and traverse stations are expressed in terms of latitudes and longitudes or plane coordinates and are related to a common horizontal datum—the North American 1927 datum. The elevations of bench marks are referred to the 1929 adjustment of mean sea level. Points in the network of horizontal control are, therefore, correctly related in latitude and longitude to each other no matter how far apart they may be, and all bench marks in the vertical network are correctly related in elevation to each other. As a result of this, coordination is obtained between contiguous surveys and maps—an essential in any engineering or mapping undertaking extending over a large area.

The primary purpose of establishing a geodetic network of control in the United States is to provide the basic data for carrying out the mapping and charting programs of the Federal Government. A secondary purpose, but equally important, is to provide the States with data for their geologic and topographic mapping. Besides these uses, geodetic control surveys are used extensively in the planning and construction phases of area and regional engineering undertakings, such as those for flood control, irrigation, water supply, and drainage; and for highways, railroads, tunnels, canals, and similar projects. Without geodetic control, gaps or overlaps result between contiguous surveys and errors of considerable magnitude may result.

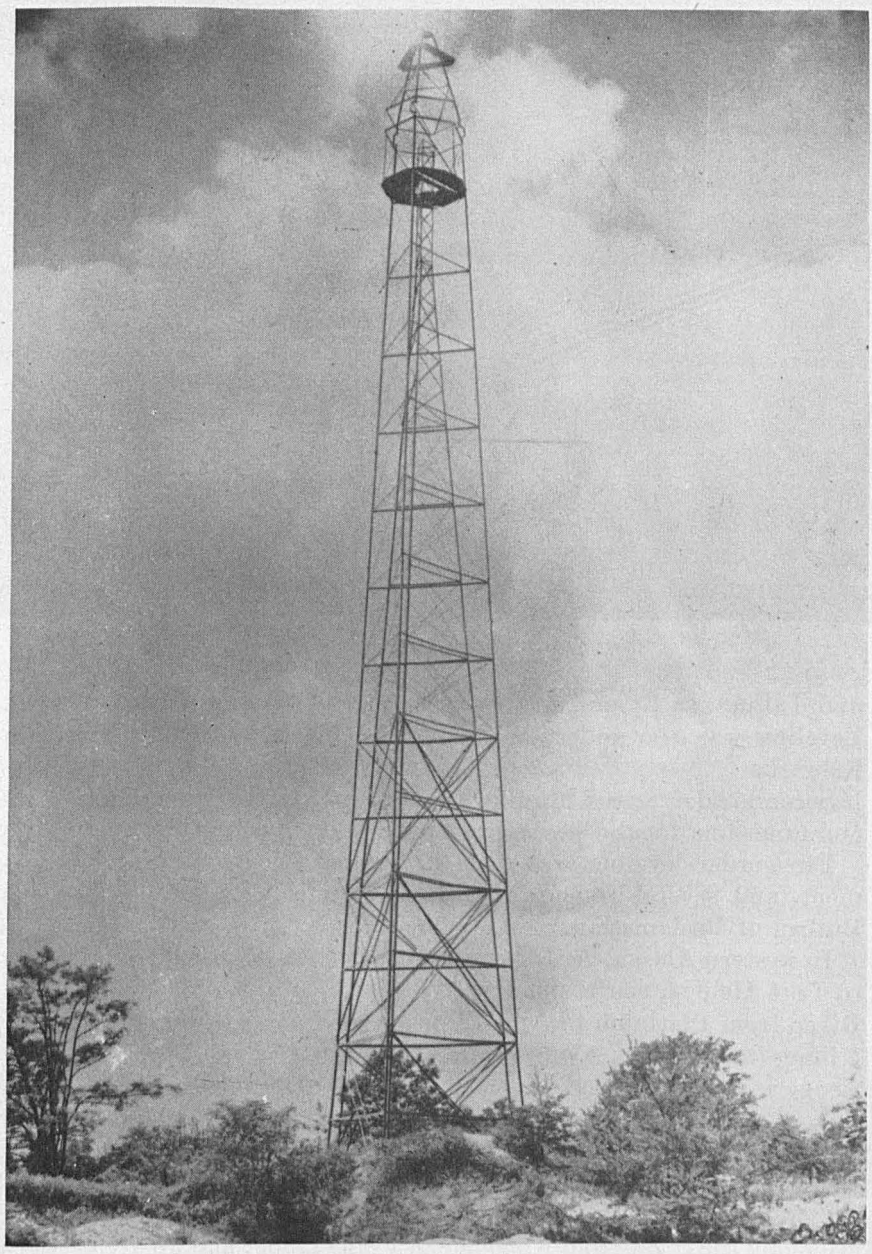
Field Work

Major field activities during the year have been in the Missouri River Basin for flood control and reclamation studies and in various parts of the United States for use of the Geological Survey in its mapping program. Another major project was in western Alaska.

Eight triangulation parties operated in the United States in the following areas: Alabama, Arizona, California, Colorado, Idaho, Iowa, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Montana, Nebraska, New Mexico, South Dakota, Texas, and Washington.

First-order releveling of old lines was accomplished in Alabama, Illinois, Indiana, Kentucky, Missouri, and Tennessee in order to strengthen the existing first-order net.

Second-order leveling was continued in California for the Forest Service. Additional lines were leveled where bench marks were set in 1935 but not leveled over at that time.



Ninety-foot portable steel triangulation tower. Note inner tower for instrument support, and outer tower which supports observer's platform.

At the request of the Corps of Engineers, first- and second-order leveling was continued along the Missouri River in North and South Dakota, Nebraska, and Iowa, and second-order "area" leveling was undertaken in Alabama, in the watershed of the Alabama, Cahaba,

Leveling unit operating in eastern Montana.

and Tallapoosa Rivers, as a continuation of leveling started in 1946. Leveling was also undertaken along the Platte and Loup Rivers in Nebraska.

Second-order "area" leveling was undertaken in Washington State and Louisiana for the Geological Survey.

First-order leveling was done in Virginia for the Navy Department, and several second-order lines were run in Oregon for the Bureau of Reclamation.

In western Alaska, arcs of triangulation were observed from Egegik to Port Heiden, south shore of Bristol Bay; along the Kuskokwim River from Platinum to Aniak, thence to Holy Cross, and from Eek Village to Kipnuk; along the Yukon River from Kaltag to Holy Cross and thence to Mountain Village; and on Seward Peninsula from Cape Prince of Wales to Kotzebue. At the end of the fiscal year triangulation surveys were underway in western Alaska on St. Lawrence Island; on Mitrofania Island, Alaska Peninsula; a cross arc on the Alaska Peninsula from Port Heiden to Chignik Bay; an arc along the coast from Kotzebue to Point Hope; and an arc between the Alaskan Railroad and Richardson Highway from Cantwell to Paxsons.

Gravity pendulum stations were established at 18 stations between Beloit, Kans., and Pembina, N. Dak. These are part of a series of 35 stations planned to extend from southern Texas to the Canadian border to provide uniform calibration of gravity meters for future

surveys in the United States and other areas. By arrangement with the Dominion Observatory of Canada, the Bureau will establish four additional stations in Canada, thereby appreciably extending the gravity range of the calibration chain.

Astronomic observations for latitude, longitude, and azimuth were made at stations in Arkansas, California, the District of Columbia, Kentucky, Minnesota, Montana, North Carolina, Oklahoma, Texas, West Virginia, and Wyoming. Three azimuths were observed in California to determine crustal shifts resulting from earthquakes. Astronomic position determinations were made at three stations in Texas and one in Arkansas in connection with the investigation of gravimetric deflections. At Wilkins Base, Tex., astronomic positions were determined at both ends of the base to obtain LaPlace corrections for corresponding azimuths observed by the triangulation party. This procedure was an experimental measure to evaluate the methods used in some foreign geodetic surveys.

First-order azimuth observations for geodetic control in the United States were made by triangulation parties. A preliminary azimuth was observed at Variak, Alaska, by the Alaska Arctic party. The party in the Hawaiian Islands observed astronomic latitude, longitude, and azimuth at a station on the Island of Maui and an azimuth on the Island of Hawaii.

The variation of latitude observatories at Gaithersburg, Md., and Ukiah, Calif., were maintained throughout the year. Original records of the observations were regularly transmitted to the Central

Geodetic field party headquarters at Rapid City, S. Dak. Two office trailers in center, with private house trailers of members of party, survey trucks, and other vehicles grouped around them. (*Photo by staff, South Dakota Journal, Rapid City, S. Dak.*)

Office of the International Latitude Service at Torino, Italy. At the Gaithersburg Observatory, 1,425 pairs of stars were observed on 188 nights, with complete sets of pairs observed on 35 nights. At the Ukiah Observatory, 2,243 pairs were observed on 197 nights, with complete sets observed on 167 nights.

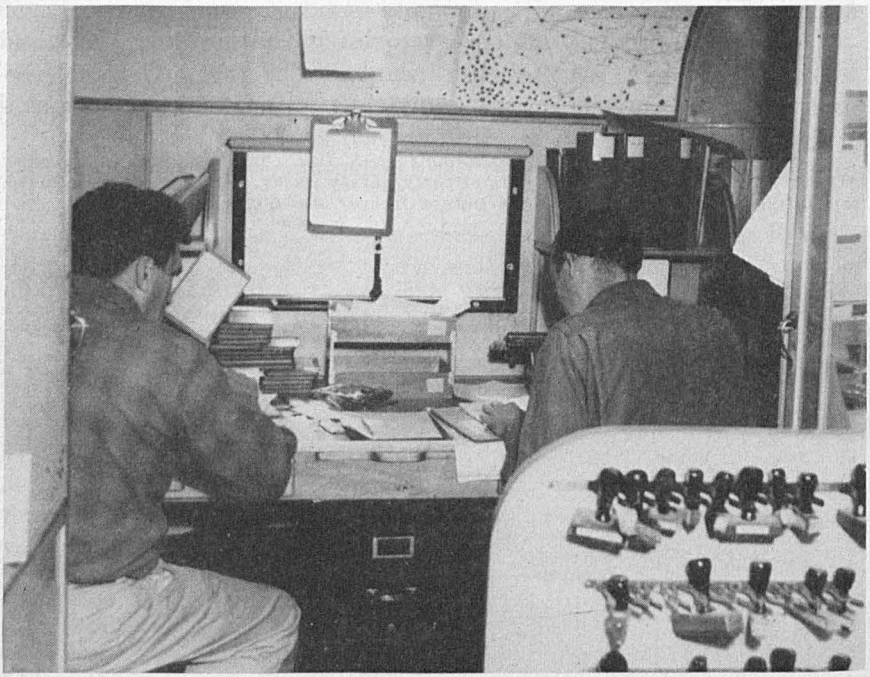
Special Field Projects

Several special geodetic field projects were undertaken or continued during the year. These included the following:

Precise surveys to detect horizontal movement in earthquake regions were accomplished at Gorman, Moreno, and Whitewater, Calif. LaPlace azimuths were also observed at specified stations across the San Andreas fault for the same purpose.

Releveling was done in the vicinity of Hoover Dam in order to determine whether settlement or change in elevation had occurred from levelings made in 1935 and 1940. Tide gages were installed in Lake Mead to provide water level connections between the level lines crossing the lake. Prior to impounding of the lake in 1935, it was possible to run levels over the roads.

For the Department of the Navy, precise surveys were established at the Naval Ordnance Test Station near Inyokern, Calif. Triangula-



Geodetic field party—interior of office trailer showing computer and assistant at work. (*Photo by staff, South Dakota Journal, Rapid City, S. Dak.*)

tion, traverse, and leveling in the vicinity of Terminal Island, Long Beach, Calif., were repeated. Settlement in this area has reached a magnitude of 11 feet, and periodic surveys are being made to determine the extent of subsidence and horizontal movement.

Gravity observations were made in the south-central United States using the Brown pendulum apparatus and the Worden gravity meter to complete the gravity coverage required for the gravimetric deflection investigation being carried out in cooperation with the Army Map Service. An area of about 14,200 square miles in southwest Kansas and one of about 3,000 square miles in southeastern Oklahoma were surveyed with the Worden meter at an average station spacing of 6 miles. For control purposes, pendulum determinations were made at six new stations in Kansas and three new stations in Oklahoma; one old station in Kansas and one in Oklahoma were reoccupied. Several gravity meter traverses provided connections between the various gravity nets obtained from commercial sources. Detailed gravity meter surveys were made in the vicinities of astronomic-geodetic stations Meades Ranch and Dirks, Kans.; Twin, Okla.; and Arcadia, Mo.

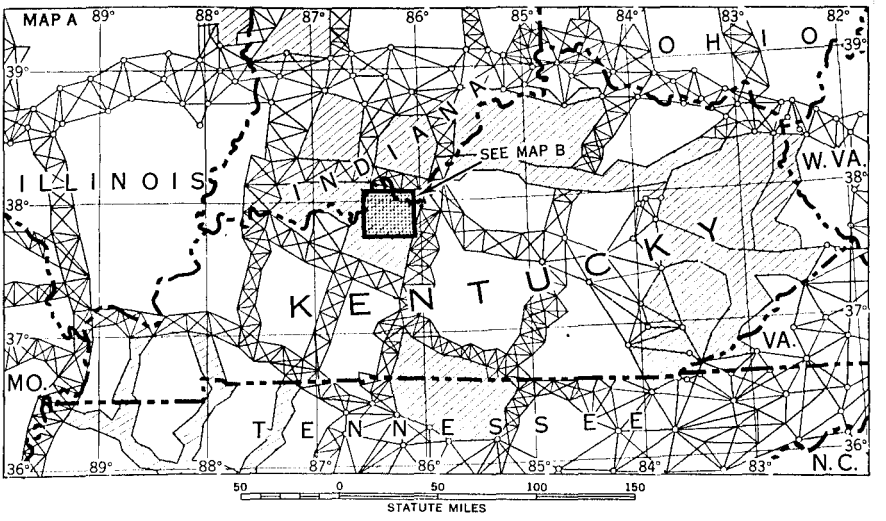
The field activities during the year are summarized in the following tables:

First order base-line measurement

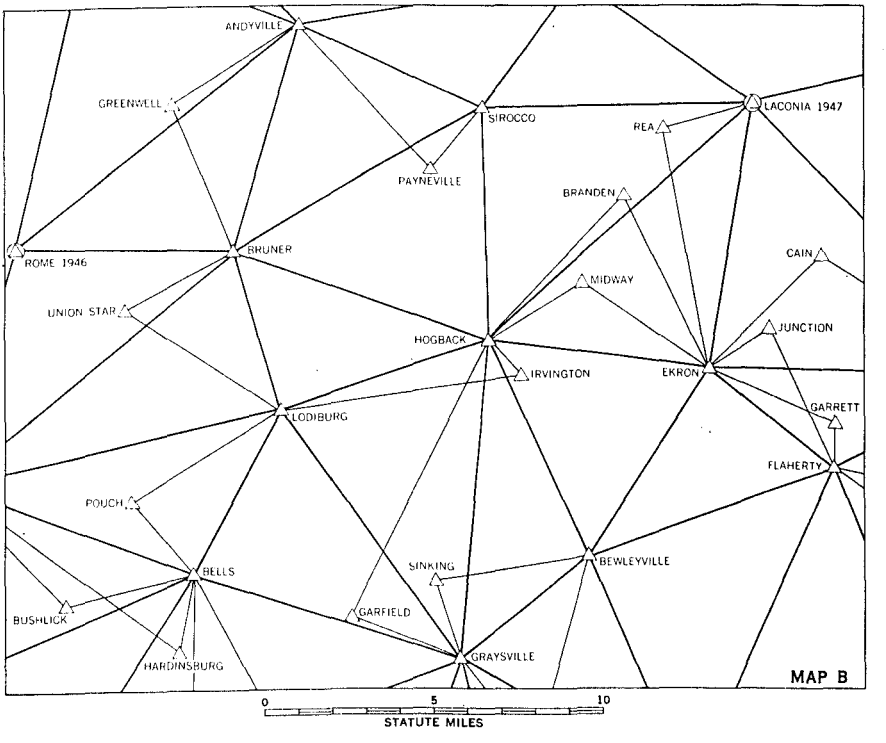
Locality	Length	Locality	Length
	Miles		*Miles*
Hilo, Hawaii	2.9	Patuxent, Md	1.9
Wailuku, Maui	4.0	Snort, Calif	11.7
Lahaina, Maui	2.1	K Range, Calif	4.8
Port Heiden, Alaska	3.2	B4 Range, Calif	3.0
Bethel, Alaska	2.9	B1 Range, Calif	2.9
Aniak, Alaska	2.4	Wilkins, Tex	5.2
Kipnuk, Alaska	1.9	Red Bay, Ala. and Miss	6.2
Pikeville, Ky	2.8	Ida Grove, Iowa	4.7
Lexington, Ky	9.5	Columbia-Wrightsville, Pa	0.7
London, Ky	5.6	McCartney, Ohio	2.2
Levy, N. Mex	4.9	Meridian, Ohio	3.0
Biddle, Mont	5.8		
Ekalaka, Mont	6.7	Total	105.5
Cherry, Nebr	4.5		

Area triangulation—first- and second-order

Locality	Number of stations	Length of scheme	Area
		Miles	*Square miles*
Kuskokwim Bay and River, Alaska	127	220	1,930
Vicinity of Chincoteague, Va	7	10	85
Yukon River, Alaska	108	270	4,560
Winifred to Great Falls, Mont	77	105	2,245
Fort Collins-Craig Area, Colo	83	120	5,030
Chariton River and Columbia areas, Mo	85	100	2,045
Plattsburg-Sedalia area, Mo	41	75	1,215
Morehead-Paintsville area, Ky	54	110	1,630
Atkison-O'Neill area, Nebr	60	75	2,960
Cape Prince of Wales to Kotzebue Sound, Alaska	80	260	3,900
Egegik to Black Lake, Alaska	63	115	1,300
Norheim to Sahara, Mont	63	140	1,820
Northeast Wyoming	62	70	4,455
Island of Hawaii, T. H	34	65	1,045
Plumas National Forest, Calif	237	140	6,465
Big Sioux River area, Iowa, S. D., and Minn	119	75	2,100
Garland, Mont., to Bowman, N. D	23	85	1,275
Vicinity Grayling, Mich	18	50	725
Vicinity Ann Arbor, Mich	4	10	60
Colorado Springs, Colo., to Palma, N. Mex	131	290	3,480
Clear Lake Area, Calif	67	60	2,275
Big Sioux River area, S. D	65	50	1,405
Cajon Pass area, Calif	43	10	55
Eminence-Falmouth area, Ky	104	90	2,280
Biddle to Mildred, Mont	48	170	2,210
Valentine-Ainsworth area, Nebr	82	75	4,390
Snake and Niobrara Rivers area, Nebr	26	50	1,600
Vicinity of Del Rio, Tex	3	20	400
Trinity River area, Tex	47	45	800
Sarita-Raymondville area, Tex	45	65	1,385
Vicinity of Moreno, Calif	52	15	65
Tompkinsville-Cookeville area, Tenn. and Ky	101	70	2,590
Brownsboro to Mount Pleasant, Tex	58	90	1,080
Plain Dealing-Haynesville area, La., and Magnolia area, Ark	121	110	3,220
New Salem, Tex., to Greenwood, La	54	85	850
Owensboro area, Ky	29	55	735
Vicinity of Whitewater, Calif	43	10	45
Vicinity of Dateland, Ariz	14	45	1,055
Vicinity of Inyokern, Calif	71	25	90
Randsburg Wash area, Calif	11	45	245
Beatty area, Nev.-Calif	66	135	6,915
Tombigbee River area, Miss.-Ala	223	90	4,065
Vicinity of Eglin Field, Fla	10	40	175
Hardinsburg-Leitchfield area, Ky	67	55	1,535
Concordia area, Kans	79	75	2,380
Vicinity of Cape Newenham, Alaska	4	30	160
Mahoning County, Ohio	113	45	905
Ilio Point, Molokai Island, T. H	4	5	5
Maui Island, T. H	70	55	720
Vicinity of Kotzebue Sound, Alaska	11	30	600
Little Sioux River area, Iowa	61	70	2,520
Fordsville to Elkton, Ky	31	60	470
Davenport-Ritzville area, Wash	159	100	5,445
Lemhi Valley, Idaho	42	95	1,260
Total	3,500	4,455	102,255
Reobservations			
Vicinity of Gorman (Tejon Pass), Calif	7	15	130
Vicinity of Long Beach, Calif	34	3	5
Vicinity of Indio, Calif	7	7	20
Mitrofania Island area, Alaska	6	30	190
Reobserved totals	54	55	345



Illustrating area triangulation which is established within the loops formed by the arcs of first- and second-order triangulation. This network of horizontal control provides for a monumented station in every 7½-minute quadrangle and 5-mile spacing along all improved highways.



First-order traverse measurement

Locality	Number of stations	Length
		Miles
Cajon Pass Area, Calif	203	5.8
Vicinity of Inyokern, Calif	147	9.0
Total	350	14.8
Reobservation		
Vicinity of Long Beach, Calif	38	9.5

Reconnaissance

[For area triangulation—first- and second-order]

Locality	Length of scheme	Area
	Miles	*Square miles*
Kuskokwim Bay and River, Alaska	195	1,605
Vicinity of Chincoteague, Va	10	85
Eminence-Falmouth area, Ky	90	2,280
Valentine-Ainsworth area, Nebr	75	4,390
Snake and Niobrara River area, Nebr	50	1,600
Kernville area, Calif	30	1,050
Fresno to Big Pine, Calif	100	5,245
Summersville to Princeton, W. Va	60	1,500
Big Sioux River area, S. Dak	80	2,485
Tompkinsville-Cookeville area, Ky. and Tenn	70	2,590
Cape Prince of Wales to Kotzebue Sound, Alaska	260	3,900
Yellowstone National Park Area, Idaho, Mont., and Wyo	120	9,880
Maui Island, Hawaiian Islands	55	720
Egegik to Black Lake, Alaska	105	1,200
Fallon, Nev., to Fillmore, Utah	350	10,620
Vicinity of Grayling, Mich	50	725
Vicinity Ann Arbor, Mich	10	60
Washington County, Ohio	75	3,025
Snake River, Twin Falls to Pocatello, Idaho	90	1,350
Ashland City area, Tenn	60	1,550
Yukon River, Alaska	240	4,075
Nevada-Idaho-Oregon	175	2,800
Vicinity of Del Rio, Tex	20	400
Rushville area, Nebr	55	1,650
Mansfield-Shreveport area, La	60	2,270
Leesville-Jasper area, La. and Tex	55	2,375
Dyersburg-Trenton area, Tenn	60	1,900
Nevada-Idaho-Oregon boundary	50	650
Concordia area, Kans	75	3,290
Beloit-Smith Center area, Kans	70	3,195
Norton-Hays area, Kans	90	4,215
Vicinity of Moreno, Calif	15	65
Canadian River area, Okla	250	12,775
Ashland-Buffalo area, Kans. and Okla	90	5,645
Dodge City area, Kans	80	5,470
Hampton area, Ark	50	1,975
Farmerville area, La	60	1,870
Clarksville-Hopkinsville area, Tenn. and Ky	80	2,050
Owensboro area, Ky	55	735
Brandenburg-Leitchfield area, Ky	50	1,655
Antlers-Clayton area, Okla	55	2,855
Smithville-Mena area, Ark. and Okla	60	2,185
Mt. Ida area, Ark	55	2,350
Murfreesboro area, Ark	80	3,150
Nevada-Oregon-California boundary	80	1,360
Eglin Field, Fla	35	250
Madisonville-Central City area, Ky	70	2,205
Cheyenne River area, S. Dak	125	5,160
Bowling Green-Russellville area, Ky	80	2,016
Cantwell to Paxsons, Alaska	40	370
La Junta area, Colo	105	5,775
Colby area, Kans	105	4,195
Island of Hawaii, T. H	65	1,045
Ilio Point, Molokai, T. H	5	5
Vicinity of Cape Newenham, Alaska	30	160
Vicinity of Kotzebue Sound, Alaska	20	400
St. Lawrence Island, Alaska	20	115
Little Sioux River area, Iowa	80	4,600
Total	4,725	153,116

Leveling

State	First-order	Second-order	State	First-order	Second-order
	Miles	*Miles*		*Miles*	*Miles*
Alabama	214	732	New York	1	282
Arizona	336	5	North Dakota	78	31
California	168	319	Ohio	21	269
Georgia	3	0	Oregon	0	251
Illinois	289	19	Pennsylvania	0	1
Indiana	127	6	South Dakota	296	246
Iowa	7	183	Tennessee	392	5
Kentucky	300	13	Virginia	49	2
Louisiana	123	657	Washington	12	583
Missouri	100	8			
Nebraska	30	905	Total	2,909	4,523
Nevada	363	6			

Astronomy

State	Determinations		
	Latitude	Longitude	Azimuth
California			1
District of Columbia	1	1	
Kentucky	2	2	1
Minnesota	1	1	1
Montana	4	4	3
North Carolina	1	1	
Oklahoma	1	1	
Texas	2	3	2
West Virginia	1	1	1
Wyoming	1	1	
Territory of Hawaii	1	1	2
Alaska			1
Total	15	16	12
	Repeat determinations		
Arkansas		1	
California			2
Kentucky			1
Montana			1
Texas	1	2	
Total determinations	16	19	16

Gravity

State	Pendulum determinations			Gravity meter determinations
	New	Reobserved	Repeat	
Oklahoma	3	1		178
Kansas	7	1	1	639
Nebraska	3	2		
South Dakota	4	1		
North Dakota	5	2		
Total	22	7	1	817

Summary of geodetic work, June 30, 1950

Work	July 1, 1949 to June 30, 1950	Total to June 30, 1950
	Miles	*Miles*
Triangulation, first- and second-order, length of arc	4,455	115,010
Leveling, first- and second-order	7,432	373,474
	Number	*Number*
First-order base lines	25	373
Second-order base lines	0	56
Latitude stations	15	1,035
Longitude stations	16	840
Azimuth stations	13	1,323
Gravity stations	839	2,912

Office Work

Processing of field records continued in the offices at Washington and New York City. Major adjustments of triangulation in the United States and in Alaska, as well as of the western European triangulation net, were completed or were in progress. In addition, many special projects involving computations of leveling data, pendulum gravity observations, and grid intersections and distances for cartographic use were performed during the year.

Triangulation adjustments in the United States were completed for the double cross arc in northern Indiana and for the area network north of Fort Wayne; for an area near Liberty and Meadville, Miss.; and for several projects in Texas. In California, readjustments were completed of triangulation along the coast south from San Francisco. These adjustments were required because of stronger connections made to the coastal arc. The area survey over Shasta National Forest was also adjusted.

At the end of the year adjustments were in progress on a large net of area triangulation in southwestern Arizona, in southwestern Arkansas, in northwestern Louisiana, and in Nebraska. Triangulation adjustments were also in progress of the surveys over Plumas, Modoc, and Fremont National Forests; of two areas north of San Francisco—Santa Rosa and Clear Lake; of two large areas in Wyoming—Casper and Laramie; and of the first-order arc along the 37th parallel crossing the Nevada-California boundary.

The triangulation network along the Trinity River, Tex., including control over Fort Worth and Dallas, was also being adjusted. About 200 points are involved in this adjustment, which will be the largest the Bureau has attempted using the variation of coordinates method. Two other large adjustments are underway in Montana—a double cross arc in the southeastern part of the state and two north-south and two east-west arcs in the north central part of the state. The latter are being adjusted simultaneously and more than 450 conditions have to be satisfied.

In Alaska, adjustment of older surveys along the Alaska Peninsula was completed during the year. The adjustment of surveys in Prince William Sound is nearing completion. There are more than 2,200 points in this area. Most of the old surveys in Prince William Sound have been adjusted to the North American 1927 datum.

The office work of computing and adjusting several special triangulation projects was in process or completed during the year. Among these were the surveys at the Naval Ordnance Test Station in the vicinity of Inyokern, Calif.; the repeat survey at Terminal Island, Calif., which gave additional information concerning the horizontal movement of the surface toward the center of the area of maximum subsidence; and surveys along the San Andreas Fault. No sharp displacement in the fault is indicated as having taken place in recent years; however, the systematic "creep" of the area to the southwest of the fault is shown in the triangulation observations and by the clockwise change in astronomical azimuths on lines crossing the fault.

The adjustment of the European triangulation net, undertaken last year in cooperation with the Army Map Service, was carried forward. The southwestern area, comprising Belgium, France, Switzerland, Austria, Italy, Spain, and North Africa, was completed. Approximately 1,300 points were involved in this adjustment and the number of conditions to be satisfied was 2,358. A simultaneous adjustment was made of the combined nets. The solution of so large a set of equations would not have been undertaken without the use of automatic computing equipment. A northern part, consisting of the triangulation nets in Denmark, Norway, Sweden, and Finland, will be adjusted to the Central European net. There are more than 800 points in this project. This work will be completed early in 1951.

Preliminary computations were made for 3,166 miles of first-order and 1,072 miles of second-order leveling; combination computations were made for 62 miles of second-order leveling; and distributions of corrections were made for 1,033 miles of first-order and 2,422 miles of second-order leveling. Fifteen projects were adjusted, requiring the solution of 228 normal equations, for 835 miles of first-order, 2,036 miles of second-order, and 210 miles of third-order leveling.

Office computations of astronomic data kept pace with field determinations. A total of 15 latitudes, 19 longitudes, and 21 azimuths were processed. When time was available, latitudes previously computed on the Boss Catalogue system were reduced to conform to the FK_3 system, on which astronomic longitude computations have been based since 1940.

Pendulum gravity observations were computed and final values obtained for 9 stations in Central and South America and 11 stations in Kansas and Oklahoma. Positions, elevations, and observed gravity and free air anomalies were computed for all gravity meter stations

observed by the Bureau during 1948 and 1949. Included were 1,438 stations in the United States and 23 stations in Central and South America. Isostatic reductions were also made for 9 pendulum stations observed in Central and South America.

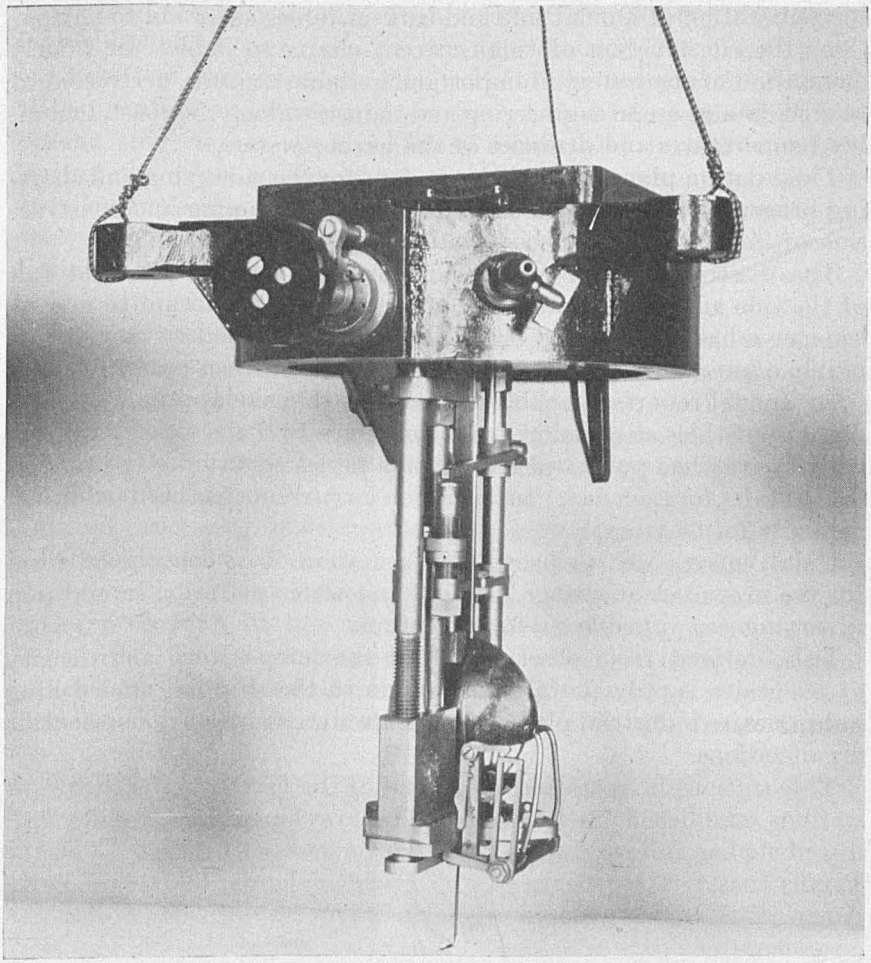
Gravimetric Deflection Project

This is an experimental project which the Bureau is conducting in cooperation with the Army Map Service to determine whether the deflection of the vertical can be obtained from a study of gravity anomalies. An interim report was submitted to the Army Map Service in August 1949. Upon completion of the 1949 field gravity observations, several gravity networks, previously obtained from commercial sources and the three areas covered by operations of the Bureau, were tied together and adjusted to the Coast and Geodetic Survey pendulum datum. All gravity data were compiled on a single Lambert conformal projection at a scale of 1:2,000,000 in the form of free-air anomaly contours at a 10-milligal interval. Additional contour maps at scales of 1:250,000 and 1:25,000 were drawn to give a more detailed picture of the gravity field in the vicinities of the deflection stations.

First results obtained using the more extensive gravity field now available bear out the preliminary finding that for areas of relatively smooth topography such as exists in the south-central United States, gravimetric deflections agree with astronomic-geodetic values within about 1 second. This agreement is obtained even when the gravity fields are limited to distances of the order of 150 kilometers from the deflection station. Contributions of the more distant zones are relatively small compared to the effect of the area within 150 kilometers from the deflection station. It has also been shown that, while the usual field determinations of astronomic longitude are sufficiently accurate for control of LaPlace azimuths and delineation of broad geoid features, close control of systematic errors in the longitudes is necessary for comparisons with gravimetric values.

Temperature Constants of Brown Pendulum Gravity Apparatus

Data obtained from the experimental swings with the Brown apparatus to determine temperature constants were processed and analyzed. This experiment was undertaken at the Washington, D. C., gravity base station to determine the static and dynamic temperature characteristics of the invar pendulums now in use. Fixed temperatures ranging from 0° to 38° C. were used for determination of the static coefficient; the dynamic coefficient was obtained by using two different rates of temperature rise and fall over the range from 10° to 32° C. The derived value for the static coefficient confirmed very closely the value previously used. The dynamic coefficient, however,



Brown pendulum gravity apparatus showing mechanism with pendulum manometer and thermometer mounting in place.

was found to be approximately twice the former value. An analysis was made of field results of recent years; this indicated that the dynamic effect at field stations is appreciably different from that obtained at the base station. Further tests will therefore be made of the dynamic factor under conditions which will more nearly approximate those in the field.

TIDE AND CURRENT SURVEYS

Tide and current surveys have as their purpose the determination of mean sea level and other tidal datum planes for surveying and engineering purposes; the calculation and correlation of data for

the publication of annual tide and current tables as an aid to navigation; the construction of tidal current charts to depict the hourly circulation of the waters in important harbors; and the derivation of related data of use to engineering and industry along the coast, including temperatures and densities of the harbor waters.

Tidal datum planes provide basic data for the surveying and charting program of the Bureau as well as for the planning and construction of industrial projects associated with coastal waters.

The dissemination of advance information on the rise and fall of the tide and the ebb and flow of the currents as an aid to marine commerce has been carried on by the Coast and Geodetic Survey for nearly a hundred years. As early as 1853 the Bureau published data in its annual reports to enable the mariner to make approximate predictions of tides as occasion arose, and since 1867 the Coast and Geodetic Survey has published annual tide tables containing the prediction of tides for each day. Information on currents has been published annually for 60 years.

Tidal current charts provide information in a convenient form for use in studies of sewage disposal and water pollution in addition to serving as a valuable aid to navigation.

Data derived from observations of the temperature and density of sea water supply useful information to the shipping and fishing industries, to industrial plants using sea water, and to various scientific organizations.

Tide stations in operation at the end of the fiscal year, exclusive of stations established for hydrographic survey operations, totaled 137, distributed as follows: 47 on the Atlantic and Gulf coasts; 18 on the Pacific coast; 12 in Alaska; 14 on Pacific Islands; and 46 in Latin America. Under the Bureau policy of carrying out tidal projects on a cooperative basis wherever practicable, 102 of the stations were maintained in cooperation with other agencies, including the governments in Central and South America; the Department of State; various units of the Department of Defense; the Coast Guard; the Civil Aeronautics Administration; and State, municipal, and scientific organizations.

The results of the comprehensive current survey of Tampa Bay, Fla., which was completed early in June 1950, are being utilized to compile tidal current charts for the area. At the request of, and in cooperation with, the Corps of Engineers, a current survey was made of the vicinity of Grays Harbor entrance, Wash. Detailed results of the observations for use in model studies have been furnished. A current survey of Rosario Strait, Wash., was begun and a number of stations were occupied in the southern part of the Strait. Current observations in a number of other waterways were obtained by hydrographic parties. Hourly current observations were continued

throughout the year at Five Fathom Bank and Frying Pan Shoals Lightships under a cooperative arrangement with the Coast Guard.

As part of the oceanographic work of the Bureau, observations of temperature and density of sea water are being obtained at most Bureau tide stations in the United States and foreign countries. During the year, instrumental equipment for these purposes was installed at 25 new stations, thereby increasing to 123 the number of places from which such data are being received. Requests for information were received from a number of public and private organizations for special purposes.

To assist in carrying out the field projects of tidal surveys, tide-station servicing parties were in operation as follows: one on the Atlantic and Gulf coasts; one on the Pacific coast; one in the Pacific Islands area; and one in Latin America. During the summer months a subparty was engaged in bench-mark recovery operations along the Atlantic coast.

Initial processing of field records has kept pace with field surveys, but a backlog of work on these records is accumulating due to a lack of personnel for final processing. Work accomplished included the initial processing of tide records comprising 1,543 station-months of records. Initial processing of tide records from hydrographic surveys was accomplished for 42 stations. Leveling records were processed for 2,373 bench marks at 449 stations. Reference datums

Aguligik tide gage on Alaska Peninsula, used for measuring rise and fall of the tide during hydrographic survey operations in the vicinity.

were verified and indexed for 1,191 volumes of sounding records for 144 hydrographic sheets. Tide notes on charts were prepared or verified for 490 places on 168 charts. Processing was completed for 1,722 days of current records for 115 locations.

The program of tidal studies for selected areas was kept up to date. Seven reports were completed during the year. Predictions of tides and currents were completed for the 1951 editions of eight tide and current tables.

Several modifications were made in the system for warning the Hawaiian Islands of an impending seismic sea wave. The tide and detector station at Palmyra was discontinued during the year and tide stations were installed on Kodiak and Wake Islands. The tide station at Balboa, C. Z., was also brought into the system so that there are now 18 tide stations in the network, four of which are equipped with seismic sea wave detectors. After a number of conferences, a Communication Plan for the Seismic Sea Wave Warning System was prepared in the Office of Naval Communications. As a result of experience gained in the use of this plan, a number of revisions have been decided upon by the various services involved and a revised plan is being prepared.

In connection with the warning system, seismic sea wave travel time charts were completed for Midway, Attu, Adak, Dutch Harbor, Kodiak, and Sitka. Computations for use in constructing the time curves were completed for five other charts. These charts show the time required for a seismic sea wave to reach the respective places from an earthquake epicenter in the Pacific Ocean.

Because of the Bureau's interest in gravity work and its technical knowledge of the highly specialized field of tidal harmonic analysis, it was called upon to participate in a world program of simultaneous gravity observations. As a part of this project, tidal mathematicians of the Bureau carried out harmonic analyses of the gravity observations at 17 stations in the United States, Hawaii, and Mexico to determine the tidal effect on gravity. A study of the results showed that the magnifying factor, or the excess of observed tidal effect over the theoretical value, was very nearly constant for the various constituents and also for the various stations. The phase angles were virtually zero, indicating that the tidal effects were practically instantaneous. In addition to this program, harmonic analyses were made of two 29-day series of gravity observations under a cooperative arrangement with the Institute of Geophysics of the University of California.

GEOMAGNETIC SURVEYS

Geomagnetic information is an essential component of navigational charts. It is also required for the use of surveyors in retracing old

property lines originally surveyed by compass bearings. Important collateral uses are in geophysical prospecting for oil-bearing structures; in the study and prediction of radio propagation affecting communications and radio navigational aids; and in the study of sunspot phenomena and auroral and ionospheric disturbances. In addition, it has certain military applications.

The magnetic survey of the United States has required the observation, over a period of many years, of magnetic declination, intensity, and dip at several thousand places in the United States and its territorial possessions. A knowledge of the magnetic declination, or deviation of the compass needle from true north, is a basic requirement for sea and air navigation and for land surveying. In the United States, declination varies from 22° west of north in the northeastern part of the country to 24° east of north in the northwestern part. To evaluate the constantly changing components of the magnetic field, repeat observations at a limited number of key stations are made on a regular schedule; continuous readings of the changing components are made at fixed observatories.

During the year, 46 new field stations were established, 41 repeat stations were reoccupied, and standard observatories were operated at Cheltenham, Md.; Honolulu, T. H.; San Juan, P. R.; Tucson, Ariz.; and at Sitka, College, and Barrow, Alaska. Secondary automatic observatories were operated at Gatlinburg, Tenn., and Logan, Utah, for declination recordings.

Close cooperation was continued with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington on several major projects. These included maintenance of the International Magnetic Standard and operation of a cosmic ray station at Cheltenham Observatory and the operation of an atmospheric-electricity recording station at Tucson Observatory.

The United States central library of world geomagnetic data was maintained. By solicitation and through exchange agreements, important data have been acquired from governmental and private scientific agencies throughout the world. Under the agreement with the Hydrographic Office of the Navy, the 1950 isogonic and isoporic world chart, an undertaking involving the use of 78,000 world-wide station values, was compiled. This chart will be published by the Hydrographic Office.

Current revisions of magnetic declination data were made on 312 nautical and aeronautical charts. Isogonic line revisions were provided for two such charts. The compilation of a new 1950 Alaska isogonic chart was 75 percent completed and that of a new 1950 United States isogonic chart 25 percent completed.

The following table shows the distribution of magnetic field observations made by field parties during the year:

Distribution of magnetic observations

Location	Repeat stations				Other stations	Total
	New		Old			
	D, H, I[1]	D	D, H, I	D	D	
California		1		1	1	3
Illinois				2		2
Kansas				2		2
Maine	1		4		1	6
Maryland	2					2
Michigan				2		2
Minnesota				1		1
Montana				4		4
Nevada				1		1
New Mexico				1		1
New York			2			2
North Dakota				2		2
Oregon				1	1	2
Rhode Island			1			1
South Dakota				2		2
Tennessee				1		1
Texas				1		1
Utah				2		2
Vermont		1	2	1		4
Virginia	1		2		1	4
Washington				2	2	4
Wyoming				3		3
Alaska					35	35
Total	4	2	11	29	41	87

[1] NOTE: D=Declination; H=Horizontal intensity; I=Dip.

SEISMOLOGY

Observations and studies in seismology are directed primarily toward mapping of seismic areas, development of safe building-construction methods, and safeguarding life and property. Secondarily, such studies constitute research into scientific problems of geophysics and contribute to the national defense program. Collateral uses are the improvement of hurricane detection and tracking, the detection and evaluation of explosions and other artificial disturbances, and the detection of seismic sea waves as part of a warning service.

Seismicity studies of regions involve the plotting of strong earthquakes over the entire earth and the determination of their magnitude and depth. For the United States and outlying territories such studies are of a very comprehensive character. Study and analysis of the earth's wave mechanics are made to improve the interpretation of the records of sensitive seismographs. Seismicity studies furnish information on the relative earthquake risk in various areas for use of engineers in determining building standards and of actuaries in setting insurance premium rates.

The seismological program involves the direct operation of sensitive seismograph stations at Washington, D. C., and at the observatories at San Juan, P. R.; Tucson, Ariz.; Ukiah, Calif.; Sitka and College, Alaska; and Honolulu, T. H. A special network of five sensitive stations has also been operated on behalf of the Bureau of Rec-

lamation for studies of local earthquakes associated with reservoir loading at Hoover, Shasta, and Hungry Horse Dams. These stations also contribute to the general seismicity work. An additional network of eight stations is operated in cooperation with universities and private institutions at nominal cost to the Government. The latter program serves to widen and extend the national interest and experience in this work. Records are also processed and results published for seven other private stations.

By cooperative measures and the exchange of information and data, the Bureau serves as a coordinating agency to improve the over-all value of several domestic networks, such as those of the Jesuit Seismological Association, the University of California, and the California Institute of Technology. Liaison and exchange with numerous foreign stations and international seismological associations are also maintained. A great many consultation services are rendered to Federal and private agencies concerned with earthquake and vibration problems.

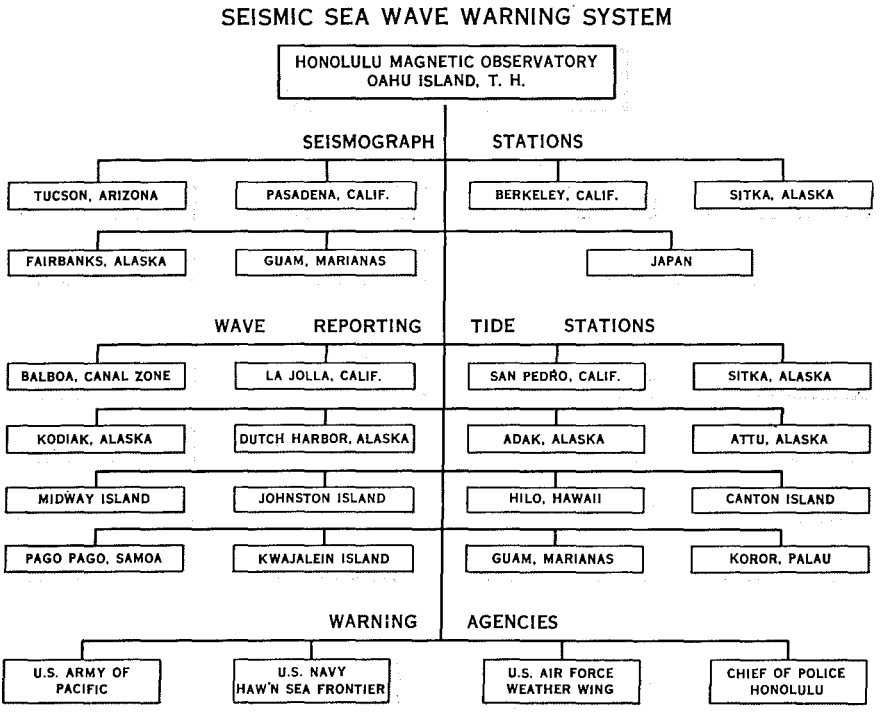
Observation and analysis of strong earth motions experienced in destructive earthquakes furnish basic data for the development of safe structural-design practices. Corollary studies involve observation of the vibrational characteristics of typical structures and of the ground at building sites and the survey of earthquake damage.

Through the use of widely expanded communications facilities provided by the Department of State, the Public Buildings Administration, and other agencies, earthquake-location activity was greatly intensified during the year, enabling receipt of 8,500 earthquake messages and announcement of 570 earthquake locations for the use of seismologists in carrying on their studies.

A field office in San Francisco operates a network of 53 strong-motion seismographs designed to record destructive earth motions experienced in the seismically active western areas. During the past year, 20 records were obtained of 8 such earthquakes. The office also conducted 18 building-vibration studies and other vibration tests, and made field surveys of 2 damaging earthquakes. The effects of three blasts were observed by instrument methods. Personnel from the Washington office measured explosion vibration effects at a naval proving ground.

With the cooperation of the Office of Naval Research, analysis of a number of strong-motion records to determine the responses of oscillating structures to complex earthquake motions was carried out on the analog computer at California Institute of Technology.

The Bureau supported the work of the Earthquake Engineering Research Institute in promoting the organization of research activities in structural dynamics.



Nearly 1,000 noninstrumental reports of 230 earthquakes in the United States were received through the cooperation of a corps of 40,000 volunteer reporters, representing business concerns, railroads, public utilities, and governmental agencies. In nine of the Western States this cooperative effort is supervised by state collaborators at universities. The most notable United States earthquake of the year was a slight disturbance that sheared off about 100 oil wells in the Terminal Island region of Long Beach, Calif., causing damage estimated at $9,000,000.

A seismic sea wave, or tidal wave, warning system was maintained. Centered at Honolulu and employing the reports of three of the Bureau's seismograph stations, two private stations, several tide stations of the Bureau, and military and civil communications networks, this system provides for the prompt detection and location of seismic sea waves and permits the broadcast of alert warnings to threatened areas in Hawaii and elsewhere. Several successful operations of the system were carried out following submarine earthquakes, although no damaging sea waves developed during the year.

IMPROVEMENTS IN INSTRUMENTS, EQUIPMENT, AND TECHNIQUES

Because of its highly specialized activities, the Bureau has from its inception recognized the importance of developing new and improved instruments, equipment, and techniques in order that better results might be obtained at reduced costs. A modern instrument shop is maintained for servicing and developing instrumental equipment and a special radio-sonic laboratory is maintained for servicing and improving electronic equipment. In addition, research is carried on in almost every field of the Bureau's activities in order to keep abreast with new developments in these fields and to adapt the current findings of science to our own needs.

In the field of hydrographic surveying, a new ship equipment for the Electronic Position Indicator, designated Mark III, Model 1, was completed and tested under service conditions. The new model, reduced in size and weight, includes a completely redesigned antenna coupling circuit to provide greater efficiency and to facilitate tuning; a new zero-check circuit; and a specially constructed frequency meter with calibrations in the vicinity of the operating frequency. Performance tests have indicated that the new model is superior in operation to preceding models and, because of the circuit stability, fewer checks at established check points are required.

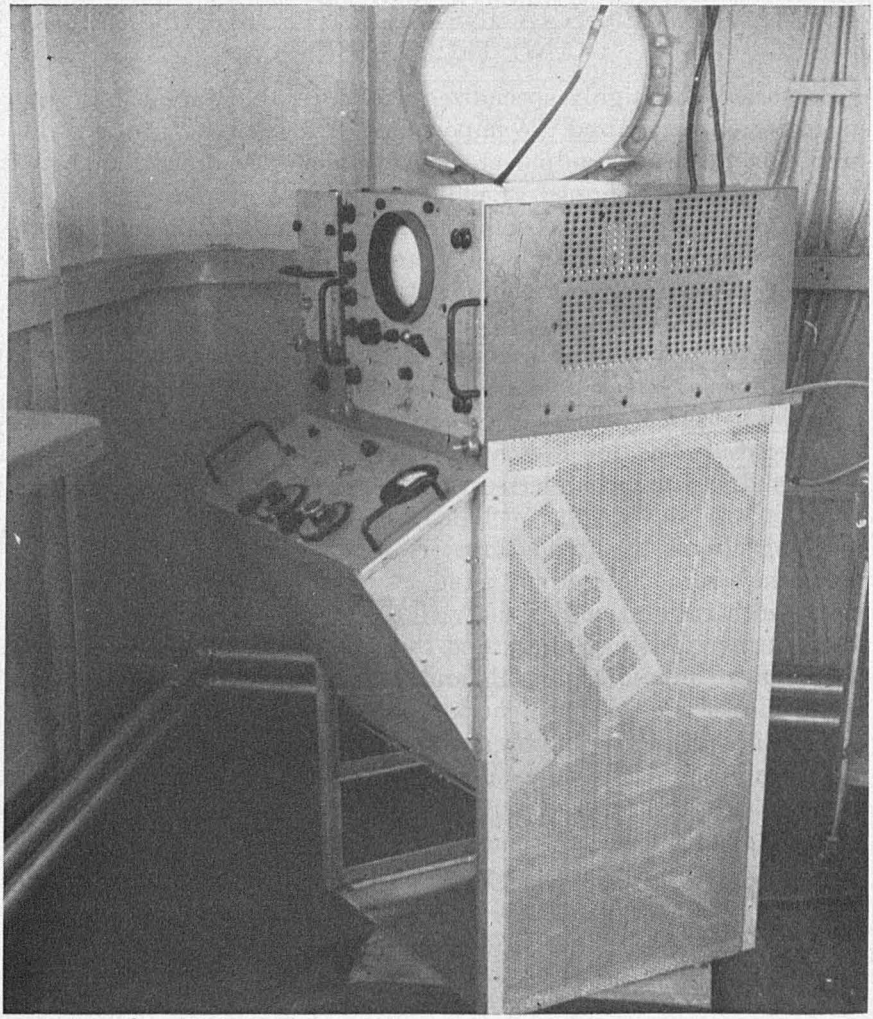
Several ship-borne Shoran equipments were modified to include a completely redesigned transmitter and indicator and to incorporate a variable delay line to permit their use at shore stations.

Mechanical and electrical modifications were also made in the NK–7 portable depth recorders to replace the 808 Fathometers. Some were modified for use in one depth range only—0 to 55 feet or fathoms.

New checking equipment was built for the three-armed metal protractors used in hydrographic surveying. In many of the protractors the arms were incorrectly positioned and were not radial. A program for correcting these instruments was begun, the design being altered sufficiently so that after reconditioning they will remain in correct adjustment under normal conditions.

In the field of photogrammetry, a continuing program to improve the quality, accuracy, and rate of progress in stereoscopic mapping with the Reading plotter has been pursued. This has resulted in the development of a number of refinements in techniques and procedures for mapping the difficult terrain of areas in Alaska, particularly in the Aleutian Islands, on a production basis. Experiments are being conducted with the use of the phototheodolite in Alaska to establish the supplemental control required for stereoscopic mapping.

A significant contribution to magnetic surveying was made during

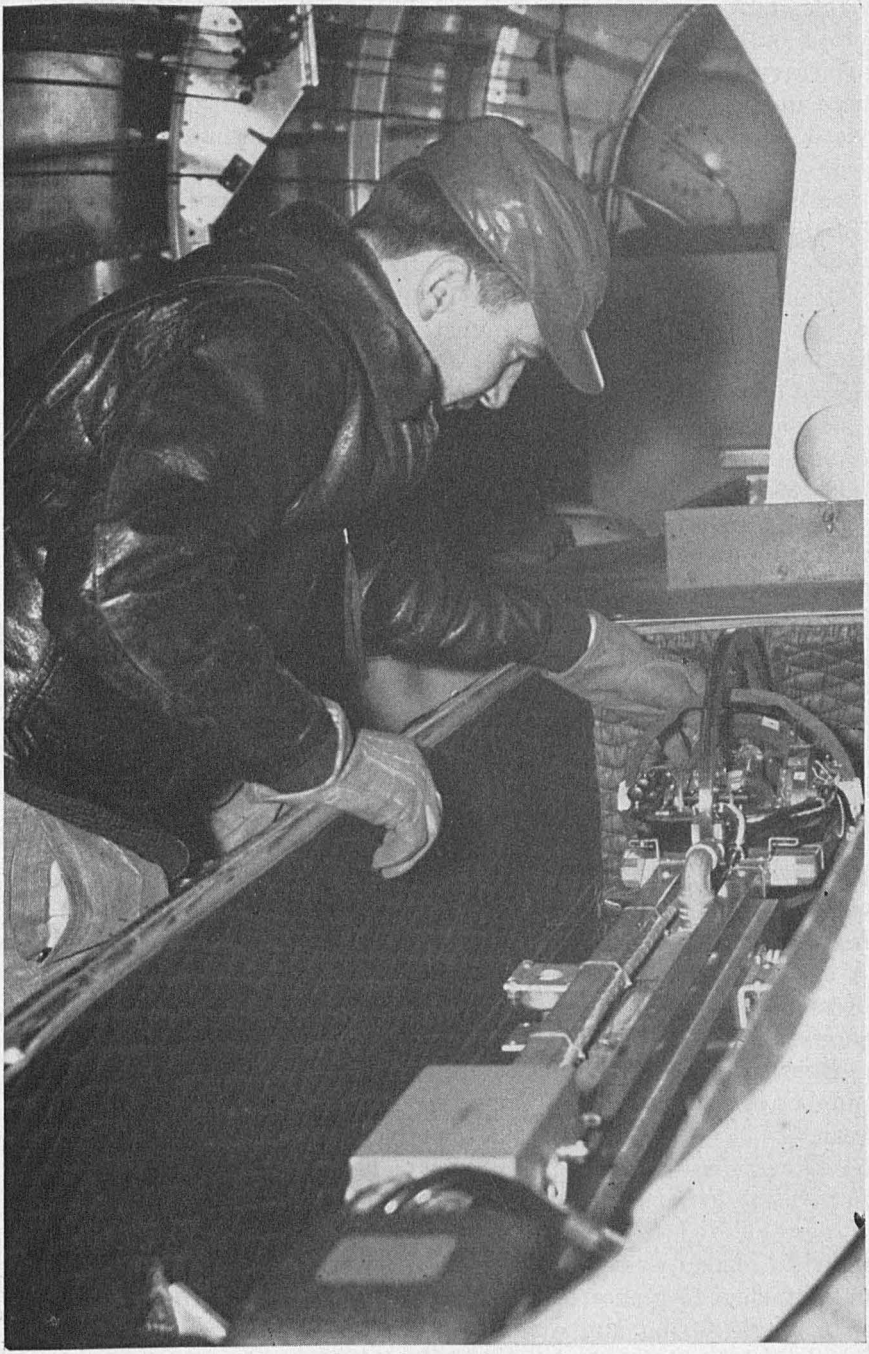


Mark III, Model 1, Master Controller for Electronic Position Indicator developed by the U. S. Coast and Geodetic Survey.

the year by the development of a new induction-type magnetometer in cooperation with the Naval Ordnance Laboratory. Its successful adaptation to aircraft use by the Bureau has opened for the first time the immediate possibilities of future airborne magnetic surveying of ocean areas and other regions inaccessible by ordinary methods.

The development of a much-needed visible-recording magnetograph for observatory use is nearly completed. A new apparatus has been devised for the drawing of quartz fibers for use in magnetic instruments.

In the field of seismology, a simplified technique for calibrating electrical-recording seismographs was developed to obtain more re-



The airborne magnetometer, developed in cooperation with the Naval Ordnance Laboratory, a device of great importance in future magnetic surveying. Installation aboard plane. (*Official photo, U. S. Air Force.*)

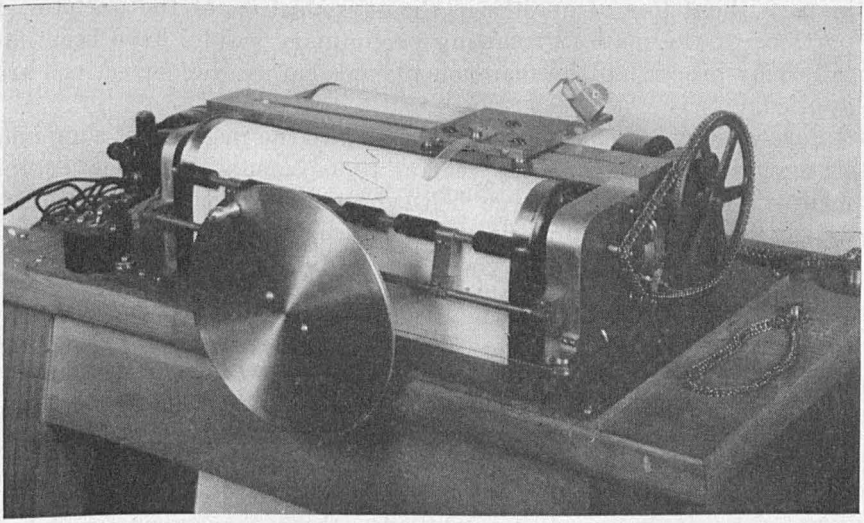
liable data on the actual ground movements; a two-drum pantograph was designed and constructed to reproduce precisely, and to arbitrary time scales, the records of destructive earthquake motions used in engineering research; a new type of measuring tape was devised, employing a variable time scale instead of a uniform distance scale, to speed up the location of earthquakes on the Bureau's 30-inch terrestrial globes; and visible seismograph recorders, of greater reliability than those formerly in use, were designed for use at stations participating in the seismic sea wave warning service.

A new three-component Benioff seismograph of high quality and a new three-component Sprengnether seismograph were purchased, and three additional vertical component Benioff seismographs obtained by conversion of surplus units.

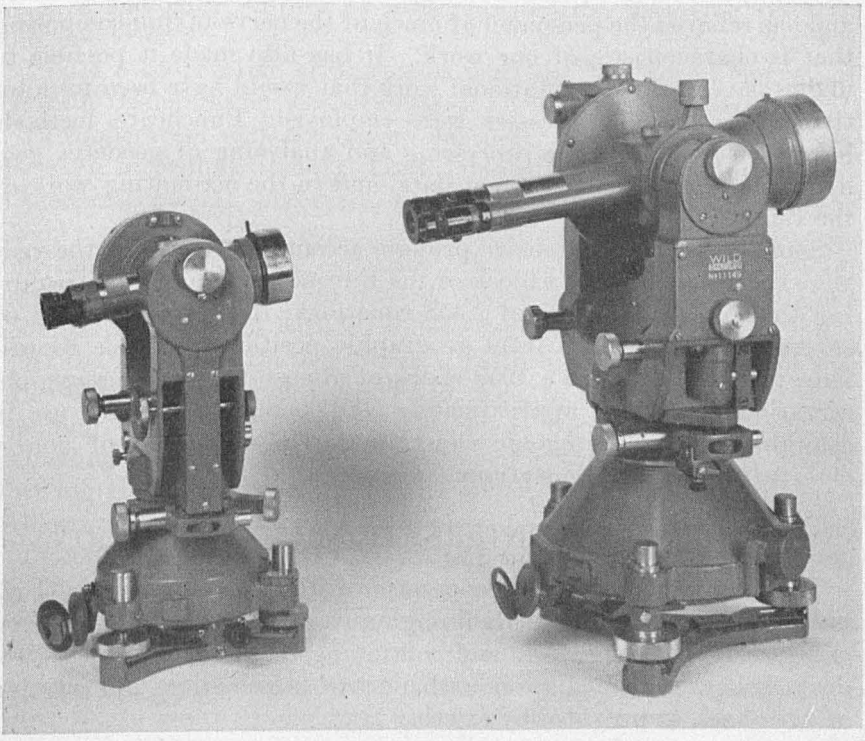
In the field of geodesy, improvements were made in the telescope trunnions of the first- and second-order theodolites to prevent the telescope from lifting in the wyes of the standard. The microscope was also redesigned to provide positive adjustments for focus and run. An improvement was effected in the 5-inch signal lamp to facilitate insertion of the centering screws when the lamps are stacked in multiple.

In the field of tides and currents, improvements have been made in the standard tide gage to overcome the occasional jamming of the lead screw bearings. Self-aligning ball bearings are now being installed. The Tide Predicting Machine, which has been in use 40 years, was decommissioned for a couple of months while it was completely overhauled and some parts were replaced. After the new Tide Predicting Machine has been acquired, it is planned to rebuild the old one and renew all worn parts. A new type of current-meter cable, insulated with plastic and more resistant to salt water, has been procured to replace the rubber-insulated cable formerly used. A new hydrometer scale was also designed for use in making density observations of sea water. The new scale is much easier to read and should improve the accuracy of the observations.

Research in cartographic reproduction methods has resulted in a number of significant improvements. Films of halftone screens have been produced of 100 lines to the inch. Ranging in size up to 38 by 54 inches, these screens have proved to be highly satisfactory for use in printing gradient tints of land areas and blue tints of water areas. A new method for processing compass roses to printing plates of nautical charts was developed. By the new method, compass roses are attached to a sheet of vinylite in proper location and processed in a single fitting and exposure. This is a considerable improvement over the old method in which each compass rose had to be processed to the plate by registering it to previously located marks. Studies have also been made of methods for revision of topographic



Two-drum pantograph developed in the Bureau to make precise reproductions of destructive earthquake motions on different time scales. This has made a substantial contribution to engineering research.



Two types of modern theodolites used in photogrammetric and geodetic surveying. They combine compactness and light weight with a high degree of accuracy in reading the angle measurements.

maps without loss of quality in the reproduction of the unchanged portions of the map. Promising preliminary results have been obtained by processing the maps on plastics before the corrections are applied.

Several items of equipment were added to the instrument shop and to the pressroom during the year as replacements or as new equipment. These include a large belt-type sanding machine, a direct-driven band saw, a precision drill-sharpening machine, a motor-driven drum for use in spraying lacquers or photo emulsion on level rods, and a new 64-inch Seybold-Harris cutter.

Use of High-Speed Calculating Machines

This was the second year of the Bureau's use of high-speed calculating machines using punchcard methods for processing field and office data. The specialized equipment now consists of two electrical key punches for numerical and alphabetical data; two small mechanical punches for numerical work only; three reproducing punches, one of which is equipped for summary punching; two sorters; one collator; three calculators; and one tabulator.

The use of this equipment has saved many man-hours of labor and has relieved the personnel of much of the nerve-taxing computing that is characteristic of our work. It has also made it possible to undertake certain computational work that would have been prohibitive if the normal processes were employed. Punchcard methods have been applied to the processing and analyzing of geodetic, geomagnetic, and tide and current data, and to the accounting work of the Bureau.

Some of the more extensive projects accomplished during the year were the adjustment of a block of the European triangulation requiring the solution of a set of 2,358 equations; the transformation of several hundred points from geographic positions to plane coordinates; the reduction to a 1950 epoch of almost 100,000 magnetic observations, involving approximately 500,000 punchcards, for use in compiling a world isogonic chart; and the summation of hourly observations for 20 tide stations.

NATIONAL AND INTERNATIONAL COOPERATION

The Bureau continued its cooperation with national agencies (both public and private) and with foreign governments and international organizations through new and continuing interagency projects, cooperative agreements, liaison, exchanges of information, and training of personnel, as provided by existing law.

In cooperation with the United States Air Force (USAF), a field organization has been developed for making airborne magnetic surveys. Flight service is contributed by the Air Force; the technical planning, direction, observational work, and analysis of results are performed by the Bureau. Instrumental techniques and flight procedures have been developed, and field operations will be carried out during the fiscal year 1951.

Revisions of magnetic declination for several thousand places, and isogonic lines for a portion of China, were furnished the Army Map Service.

Magnetic observatory information has been reported daily to the Central Radio Propagation Laboratory, National Bureau of Standards, for use in the study and prediction of radio transmission conditions.

Information on earthquake risks, the effects of blasting, and vibration problems was furnished to several Federal agencies, including the White House engineers, the Atomic Energy Commission, and the military agencies. Cooperation was also extended to a defense agency on a seismological project of high classification involving research and operation.

Under a cooperative arrangement with the Territorial Survey of Hawaii, triangulation was established on the Island of Maui.

In cooperation with the county engineer, precise leveling was undertaken in Suffolk County, Long Island, N. Y. The Bureau furnished instruments, observers, and supervisory personnel; and the County provided office space, transportation, additional personnel, and funds for operating expenses. Horizontal and vertical control surveys were also made throughout Mahoning County, Ohio, under a similar arrangement with the county engineer.

At the request of the Air Force, a pattern of geodetic control stations was established at Eglin Field, Fla., to be used for precision-bombing tests. Surveys were also made to locate guided-missile launching sites and other installations for the Joint Long Range Proving Ground Project at Banana River, Fla. Expenses for both projects were assumed by the Air Force.

In connection with the reconstruction of the White House, precise leveling was run at periodic intervals during the establishment of footings under the side walls and columns. Sixty-five bench marks were set along the side walls and at points throughout the building to detect any possible movement caused by the construction work which might require preventive action. Assistance was also given on vibration problems and information on local earthquake risk.

A base line was measured on the Columbia-Wrightsville Bridge

across the Susquehanna River at Columbia, Pa., and connected to the basic triangulation in that area. This work was undertaken in cooperation with the Pennsylvania Water and Power Company.

Upon requests from the Surveys and Mapping Division of Kentucky and the United States Geological Survey, the Bureau transformed the Geological Survey control points in that State from geographic positions to State Plane Coordinates. In addition, coordinates were computed for each 2½′ intersection within the State, involving computations for approximately 25,000 points.

First-order leveling was accomplished for the Department of the Navy in the vicinity of Chincoteague Island, Va., and elevations of 15 bench marks in the vicinity of La Plata, Md., were established at the request of the Highway Research Board of the National Research Council.

Cooperation was extended to several of the Federal agencies in the field of hydrographic surveying. Certain surveys requested by the Department of Defense were accomplished. Under an agreement with the Department of the Navy and the Coast Guard, the Bureau has assumed responsibility for erecting aids to navigation, furnished by the Coast Guard, along the Arctic coast of Alaska.

Hydrographic surveys for the Navy Department were made in the San Francisco Bay area; for the Coast Guard, in the Chesapeake Bay area and the San Francisco Bay area; for the Corps of Engineers, in the San Francisco Bay area and bank-to-bank surveys in the Columbia River from the mouth to Bonneville, Oreg.; for the Bonneville Power Administration in the area of the San Juan Islands, Wash.; and for the Bureau of Reclamation in Franklin D. Roosevelt Lake.

In cooperation with the Beach Erosion Board and Suffolk County, N. Y., hydrographic surveys were begun on the south shore of Long Island to furnish information for studies of erosion and accretion along the sandy shores of New York and New Jersey.

In cooperation with the Weather Bureau, tri-daily weather reports were furnished from the survey ship *Hydrographer* on her working grounds in the Gulf of Mexico during the hurricane season.

At the request of the Army Map Service and with the agreement of the United States Geological Survey, topographic mapping of the Aleutian Islands was continued. Aerial photography, field surveys, compilation, and smooth drafting are done by the Bureau, and reproduction and printing of quadrangles by the Army Map Service.

On a transfer of funds basis, geodetic and photogrammetric surveys were also made in Alaska for the Army Engineers along the north shore of the Seward Peninsula and along the Kuskokwim and Yukon Rivers.

Close liaison was continued with personnel of the Civil Aeronautics

Administration through Bureau officers stationed in four regional offices. This coordination of activities in matters of mutual interest to both agencies simplifies the exchange of information and services and expedites the application of important information to the charts. Chart 3066, showing airfields in the United States, was revised at the request of the CAA and a special overprint was made depicting danger areas. In addition, a special planimetric map, in four sheets, of Indianapolis, Ind., was produced for use in conducting experiments and for testing new electronic aids to air navigation.

Liaison was also maintained with the highway commissions of the various States in the exchange of publications. At the request of the Bureau of Public Roads, sectional aeronautical charts were made available to state highway commissions to provide information concerning the location and classification of airports appearing on county maps. From the many responses received, it is apparent that this service is welcomed by the States.

Under funds transferred from the Department of the Air Force, cooperation was continued with the Air Matériel Command in the development of a special coordinate setting machine for use in the construction of aircraft jigs. This project was nearly completed at the end of the fiscal year and will be ready for operational tests during the fiscal year 1951.

Cooperation was continued with the Department of Justice in connection with the submerged lands cases now before the Supreme Court. Information was furnished the Department on tidal and other technical aspects of the case relating to the demarcation of the boundary line along the California coast.

Considerable interest in Bureau reproduction methods was shown during the year by representatives of Federal agencies and commercial establishments. Technical employees from the USAF Aeronautical Chart Service and from the Bureau of Soils, Plant Industry, and Agricultural Engineering of the Department of Agriculture were given training in methods of glass-negative engraving.

American Republics

Technical Cooperation with the American Republics was continued throughout the year. This program is sponsored by the Department of State, and participation of the Coast and Geodetic Survey is financed by funds transferred from that Department.

The cooperation program of the Bureau embraces two major activities—an Exchange of Persons program under which qualified trainees from the American Republics receive training in the methods and procedures adopted by the Coast and Geodetic Survey and a Scientific and Technical program under which the Bureau sends missions of

technical experts to interested countries. These experts act in a consultative or advisory capacity to the surveying and mapping agencies of foreign governments.

Under the Exchange of Persons program, in-service training grants are offered to qualified persons in specific government agencies which are responsible for carrying on the surveying and mapping operations within those countries. Although only two types of grants are awarded, one in geodetic surveying and one in map and chart production, they are broad enough in scope to include related activities in each of these fields. Upon the arrival of a trainee, a discussion of his specific needs is held with a view to determining the type of work he proposes to undertake after returning to his country. Grants fall into three categories, namely: Type A, financed entirely by the United States; type B, financed wholly by the foreign government; and type C, financed jointly. During the year, 11 grants were awarded, as follows: In map and chart production—Argentina (1), Bolivia (1), Brazil (1), Cuba (1), El Salvador (1), Mexico (1), Peru (1), and Uruguay (1); in geodetic surveying—Bolivia (1), Chile (1), and Peru (1). Of these, 10 were of Type C, and 1 of Type B. In addition, 15 type A, 2 type C, and 1 type B trainees continued training undertaken during the previous year.

The trainee program also included 3 guest workers from the following South American countries: Argentina (1), Ecuador (1), and Venezuela (1). These guest workers were not awarded grants but were trained under the same financial arrangements as Type B trainees, in which all expenses are assumed by the participating foreign governments. The length of their stay in the United States ranged from 6 weeks to 23 months.

The period of training for students receiving the official grants awarded by the Bureau is 6 months for map and chart production and 8 months for geodetic surveying. In some instances, the trainee or his agency requests additional training beyond the official period, and, if funds are available, these requests are granted. During the year, six extensions were granted for an average period of 2 months.

In the training course, emphasis is placed on the practical application of methods and procedures, supplemented by lectures and discussions on theory, with specific reference to the manuals and special publications of the Bureau. Wherever practicable, trainees are assigned to field parties to observe methods of party operation and to gain practical experience in the use of instruments.

In addition to the training received in the Bureau, arrangements are made for the trainees to visit other governmental agencies to obtain as broad a view as possible of the surveying and mapping activities in which they are interested. Assistance is also given

Survey expert in photogrammetry (left) instructing Latin American trainee in the use of the Reading Plotter in compiling maps from aerial photographs.

trainees and foreign representatives in the purchase of scientific instruments, equipment, and related materials and supplies. Many of the trainees become affiliated with national and international professional societies and technical organizations in order to keep informed concerning the latest developments and techniques in surveying and mapping.

Under the Scientific and Technical program, two technical missions were sent to foreign countries, as follows: In tides and currents—one mission to Argentina, Brazil, Chile, Panama, Peru, and Uruguay; and in seismology—one mission to Colombia, Costa Rica, Ecuador, Guatemala, Panama, and Peru. These Bureau experts consulted with representatives of foreign government agencies and made recommendations concerning the planning and operation of broad programs in these specialized fields.

Other types of cooperation with the American Republics included special tide and current predictions for the Chilean Hydrographic Service; exchange of tide predictions with Argentina; tide predictions for Peru to assist it publishing its first tide tables; the operation of tide stations at 45 ports in Central and South America under the Information and Educational Exchange program of the depart-

ment of State and the Inter-American Geodetic Survey (IAGS) program of the Department of the Army. An officer of the Bureau served as tidal consultant to the IAGS.

In establishing the tide stations under the State Department program, the Coast and Geodetic Survey furnishes the instrumental equipment and directs the installation of the stations. The cooperating countries furnish the sites, the observers, and housing for the instruments. The tide-gage records are forwarded to the Bureau for analysis and processing, and the results distributed to the respective countries. The information gained from these observations is supplying valuable data for use in the preparation of tide tables, the construction of nautical charts, engineering construction along the coast, development of navigational aids, and studies of changes in the relation of land to sea.

In cooperation with Mexico, a connection between the United States and Mexican triangulation was made in the vicinity of Del Rio, Tex. Observations were made at the United States station by Bureau observers and at the Mexican stations by Mexican observers. This connection provides an additional supporting link between the two triangulation nets and gives increased rigidity to the coordination of data in each country.

Cooperation continued in the operation of strong-motion seismographs and the interpretation of records at the following stations: Santiago, Chile; San Jose, Costa Rica; Quito, Ecuador; Guatemala City, Guatemala; Balboa Heights, Panama; and Lima, Peru. Information on the construction and operation of seismological equipment was given to the governments of Chile, Mexico, and Peru. Seismological training was given to representatives of Peru, and advice furnished for planning a survey of the destructive Ecuadorean earthquake of August 5, 1949.

Through the Department of State, telegraphic service was continued with seismograph stations in Argentina, Bolivia, Brazil, Colombia, and Peru for the immediate location of earthquakes, and similar arrangements were made with Chile.

Technical advice on geomagnetic operations and processes was given representatives from Argentina, Colombia, Mexico, Peru, and Venezuela. Two magnetographs purchased by the National University of La Plata (Argentina) were inspected, tested, and calibrated prior to acceptance. A portable field magnetometer for Venezuela was tested, compared, and standardized against the International Standard at the Cheltenham Magnetic Observatory. Plans, specifications, and requirements for a magnetic observatory in Colombia were furnished.

Technical planning and direction were furnished the Inter-Ameri-

can Geodetic Survey (IAGS) for the accomplishment of geomagnetic field surveys in Costa Rica, Cuba, El Salvador, Guatemala, Honduras, Nicaragua, Panama, and Peru. Old repeat stations, numbering 34, were occupied, and 13 new ones established, for measurement of magnetic components.

Three officers were also assigned to liaison duties with the IAGS as technical advisers on geodetic control surveys. Forty-four pairs of geodetic level rods were graduated and otherwise completed in the Washington office and purchases made of technical supplies that were urgently needed for use in Panama and South America.

The IAGS and the Army Map Service have requested the Bureau to adjust the nets of triangulation in Mexico and Central America. At the end of the fiscal year, the observational data for about 90 percent of the Mexican net had been received. The computations for this project will be started in the near future.

The cooperation program with the American Republics continued to produce important benefits to the participating countries and to the United States. Cordial relations were established with military, naval, and civil departments of foreign governments. Valuable scientific and technical data have been exchanged, and interest has been stimulated in the development and execution of broad surveying and mapping programs in many of the participating countries. As a result of the in-service training and technical missions, Coast and Geodetic Survey methods have been adopted in a number of Latin American countries, which contributes materially to the establishment of standards of accuracy and technical procedure on a hemispheric basis. Such standards are being sponsored by the Commission on Cartography of the Pan American Institute of Geography and History at consultations of delegates from the American nations and observers from other countries of the world.

Other Governments and International Associations

In the general interest of navigation, the Bureau is participating in a program of international exchange of tide predictions. Under this program, exchange is now being carried out with Canada, England, France, Germany, India, the Netherlands, and Norway.

An officer of the Bureau completed a mission to India and Thailand in connection with tidal investigations. Daily tide predictions, together with a roll of predicted tide curves for Bangkok Bar, covering the year 1951, were also supplied to Thailand. Special tide and current predictions were made for the Canadian Hydrographic Service.

The Bureau collaborated with the International Association of Terrestrial Magnetism and Electricity in the preparation of K-indices

for the polar year 1932–33. For international use, weekly K-index reports were issued for the observatory at Cheltenham, Md.

Cooperation continued with the Pan American Institute of Geography and History for the establishment of International Standards for Western Hemisphere magnetic work.

American-manufactured magnetometers and magnetographs were inspected and approved for the Belgian Congo, New Zealand, and the Philippines. In addition, assistance was given the Afghan Institute of Technology in obtaining equipment for a seismograph station at Kabul. Advice and information regarding instrumental equipment and procedures were also given several other foreign governments.

Through exchange and use of special magnetometers owned by the International Union of Geodesy and Geophysics, comparison was made between the magnetic standard instruments of Argentina, Denmark, Peru, South Africa, and those of the United States. Bureau participation in this project, the first formal program of its kind, was designed to promote greater usefulness of international magnetic readings and better coordination of world magnetic work.

Ten guest workers from the following countries of the Eastern Hemisphere were trained in the Bureau during the fiscal year: Egypt (2), India (2), Italy (1), Sweden (2), Thailand (2), and Turkey (1). The expenses of this training were assumed by the participating foreign governments.

Technicians from Norway and Sweden were given extended training in Bureau reproduction methods, with special emphasis on glass-negative engraving. Representatives of other countries also received training in this field for brief periods.

In cooperation with the Economic Cooperation Administration, five representatives from Austria and Norway received training in Bureau methods for periods of 6 weeks to 5 months.

Under the Philippine Rehabilitation Program, authorized by the Seventy-ninth Congress, the Bureau maintained a staff of experts in the Philippines to assist in field survey operations, to aid and advise the Philippine Government in the organization of a Philippine Coast and Geodetic Survey, and to train selected groups of Filipinos. In addition, two groups of 10 trainees each received instruction and training in the United States in survey methods. At the termination of this program on June 30, 1950, all operations were transferred to the Philippine Government.

REPRESENTATION ON COMMISSIONS, BOARDS, AND PANELS

To keep abreast of scientific and technical developments, both national and international, in fields related to its work and to contribute

its specialized knowledge to the study of future national needs, the Coast and Geodetic Survey is represented on a number of panels, boards, and committees. Membership in some of these is defined by law, Executive Order, or administrative decision; in others, membership is on a voluntary basis. Among the most significant and active of these organizations are the following:

Mississippi River Commission.—Rear Admiral Leo Otis Colbert, Director of the Bureau until April 1950, is the Coast and Geodetic Survey member of the Mississippi River Commission. The Commission is responsible for the maintenance and improvement of the Mississippi River, from Cairo, Ill., to the Gulf of Mexico, through providing flood control, promoting navigation, and facilitating commerce on the river.

Research and Development Board.—Admiral Colbert is an advisory member of the Committee on Geophysics and Geography of the Research and Development Board of the National Military Establishment. The Bureau is also represented on various panels by the Chief of the Division of Geomagnetism and Seismology, the Assistant Chiefs of the Divisions of Photogrammetry and Tides and Currents, and officials of the Divisions of Geodesy and Coastal Surveys. These panels include those on Seismology; Geomagnetism and Electricity; Oceanography; and Cartography and Geodesy of the Committee on Geophysics and Geography.

Air Coordinating Committee.—The Chief of the Aeronautical Chart Branch is chairman of the Subcommittee on Aeronautical Maps and Charts of the Air Coordinating Committee, which was established by Executive Order to coordinate the aviation activities of the Federal Government. The principal objectives of the subcommittee are to facilitate United States participation in the International Civil Aviation Organization, to prevent duplication of effort, and to promote the adoption of uniform symbolization for charts produced by United States agencies.

International Civil Aviation Organization.—An officer of the Bureau, on detached service, is the United States representative on the Council of the International Civil Aviation Organization (ICAO). The chief purposes of this organization are to promote safety and encourage the development of uniform standards and procedures for international civil aviation.

Pan American Institute of Geography and History.—The director of the Bureau is a member of the United States Advisory Committee on American Cartography for the Commission on Cartography of the Pan American Institute of Geography and History. The Bureau is also represented on various technical subcommittees of the Commission on Cartography. This Commission was constituted in 1941 for

the purpose of promoting high, uniform standards of surveying and mapping and facilitating the exchange of ideas and information on cartography among the Pan American nations.

Miscellaneous representation on boards, etc.—The Bureau is officially represented on a number of other technical boards, associations, and interagency committees designed to facilitate coordinated governmental planning, procurement, and activity in fields related to the Survey's work. Among these are the United States Board on Geographic Names; National Research Council, American Committee for the Study of Paricutin Volcano; Graduate School of the Department of Agriculture, Faculty and Committee on Surveying and Mapping; Central Radio Propagation Laboratory, Executive Committee; Joint Map Photo Committee of the Joint Chiefs of Staff, Subcommittee on Standardization of Maps and Map Symbols; Navy Arctic and Cold Weather Coordinating Committee; Shipping Coordinating Committee, Working Group on Maritime Tonnage Measurement; Radio Technical Committee for Marine Services, Executive Committee; Inter-Agency River Basin Committee, Federal Inter-Agency Subcommittee on Sedimentation; American Standards Association, Committee on Photography and Sectional Committee on Building Code Requirements; Federal Specifications Board, Technical Committee for Laboratory Equipment and Supplies; Inter-Agency Map Procurement and Coordination Committee; Procurement Coordination Committee of the Central Intelligence Agency; Technical Committee No. 75 on Drafting Equipment and Supplies, operating under direction of the Bureau of Federal Supply; Civil Service Committee of Expert Examiners for the Coast and Geodetic Survey; and Committee on Information Programs of the Department of Commerce.

In addition, personnel of the Bureau hold executive positions or head technical divisions in a number of other scientific and engineering associations which it is the policy of the Bureau to encourage. A forum is thereby provided for the interchange of ideas on new developments, and a wider dissemination of information on Bureau activities is obtained. Among the associations on which representation is maintained are the following: Seismological Society of America, International Seismological Association, Earthquake Engineering Research Institute, American Geological Institute, International Society of Photogrammetry, American Society of Photogrammetry, American Society of Civil Engineers, American Congress on Surveying and Mapping, Society of American Military Engineers, Washington Society of Engineers, Washington Academy of Sciences, American Geophysical Union, International Union of Geodesy and Geophysics, International Association of Terrestrial Magnetism and Electricity, and Institute of Navigation.

ADMINISTRATION

Personnel

The number of persons in the service of the Coast and Geodetic Survey during the fiscal year averaged 2,419.

Civilian personnel actions included 837 appointments, 1,018 separations, 11 retirements, 387 line promotions, 1,135 periodic step increases, and 2 longevity step increases. Of the 837 appointments effected, 1 was an employee who returned to duty from military furlough and 288 were veterans, totaling 289 veterans placed in the Bureau during the year.

Commissioned personnel changes included 6 retirements, 1 death, 3 resignations, 1 separation due to physical disability, and promotions as follows: 12 deck officers to ensigns, 4 lieutenants (jg) to lieutenants, 23 lieutenant commanders to commanders, 2 captains to rear admirals.

At the end of the year one officer was serving as instructor in surveying at the Field Artillery School, Fort Sill, Okla., and another was serving as survey expert with the Field Artillery Test Section of Army Ground Forces Board No. 1, Fort Bragg, N. C. Two officers completed the 5-months' course at the Armed Forces Staff College at Norfolk, Va. Three officers were attached to the Inter-American Geodetic Survey for liaison duties in surveying and mapping in Central and South American countries. One officer, based at Honolulu, was assigned to a project for obtaining systematic tide observations in the western Pacific in cooperation with the Corps of Engineers.

One officer was serving as United States representative on the Council of the International Civil Aviation Organization.

One cartographer continued as liaison officer between the Bureau and the Civil Aeronautics Administration.

Three officers, two mathematicians, one cartographer, an electronic scientist, and a clerk continued on duty in the Republic of the Philippines under the Philippine Rehabilitation Program.

The following table shows distribution of the number of employees in the Bureau by regular appropriations and other funds as of June 30, 1950. Part-time fixed-fee employees and dollar-a-year men have been omitted from this table.

Distribution of personnel by appropriations, June 30, 1950

Appropriation	Commissioned	Civilian	Total
Washington office:			
Regular appropriation	20	854	874
Working funds		69	69
Philippine rehabilitation		6	6
International Informational Educational Activities		5	5
Total, Washington office	20	934	954
Field service:			
Regular appropriation	138	1,228	1,366
Working funds		62	62
Philippine rehabilitation		6	6
Total, field service	138	1,296	1,434
Total	158	2,230	2,388

FINANCES

Collections covering miscellaneous receipts, including sales of nautical and aeronautical charts and related publications, totaled $379,595 as compared with $347,218 during the preceding year.

The following funds, from the sources indicated, were made available to the Bureau during the fiscal year 1950:

Available funds

Regular appropriations:	
Salaries and expenses, departmental	$3,750,000
Salaries and expenses, departmental (Classification Act of 1949—Public Law 429)	56,000
Salaries and expenses, departmental (Pay Increase for lithographic Wage Board employees)	45,000
Salaries and expenses, field	5,900,000
Salaries and expenses, field (Classification Act of 1949—Public Law 429)	68,000
Pay and Allowances, Commissioned Officers	1,310,000
Pay and Allowances, Commissioned Officers (Career Compensation Act of 1949—Public Law 351)	80,000
Total appropriations	11,209,000
Reimbursements from other departments to credit of appropriation for:	
Salaries and expenses, departmental	175,663
Salaries and expenses, field	35,731
Total reimbursements	211,394

Available funds—Continued

Working funds received from:	
Department of the Army:	
Adjustment of triangulation net of western Europe	$28,550
Detailed current surveys of Gray's Harbor	15,000
Control surveys in western Alaska	90,000
Department of the Navy:	
Control surveys at naval ordnance test station Inyokern, California	60,000
Hydrographic Office (isomagnetic charts and other geomagnetic data)	8,200
Hydrographic Office (confidential reports)	2,900
Patuxent Naval Air Station (surveying speed course)	500
Department of the Air Force:	
Compilation and printing of special aeronautical charts	423,670
Classified project	64,459
Development and fabrication of metrology equipment for use in aircraft production	20,000
Department of Commerce:	
Bureau of Public Roads (printing and revising special maps)	55,000
Department of Interior:	
Seismological stations at Hoover, Grand Coulee, Shasta, and Hungry Horse Dams	16,000
Precise leveling and tide gages in vicinity of Lake Mead	8,400
I. A. G. S.: Continued services in support of Inter-American Geodetic Survey Operations	61,000
Total Working Funds	853,679
Transfer from: Department of State (Philippine rehabilitation)	336,076
Allotments from: Department of State (International Information Educational Activities)	51,751
Total funds received	12,661,900

Administrative Changes

Rear Adm. Leo Otis Colbert, director of the Bureau since 1938, retired from active service on April 7, 1950. He was succeeded as director by Rear Adm. Robert F. A. Studds on May 16, 1950.

Rear Adm. Jean H. Hawley, assistant director of the Bureau since 1932, retired from active service on October 1, 1949. He was succeeded as assistant director by Rear Adm. K. T. Adams on October 19, 1949.

Mr. Dudley P. Barnette, chief of the Reproduction Branch, retired on June 30, 1950, after service in the Bureau since 1907.

On June 12, 1950, the Division of Personnel and Accounts was abolished and two new divisions were created—a Division of Personnel and a Division of Finance and Special Services.

The Bureau notes with regret the untimely passing of Capt. Casper M. Durgin on March 11, 1950. Captain Durgin was first appointed to the Bureau on July 27, 1917. He was chief of the Division of Charts at the time of his death.

PUBLICATIONS AND DISSEMINATION OF INFORMATION

An important part of the Bureau's work is the dissemination of its technical information in the form of charts, maps, printed publications, and processed material. In addition, a large volume of technical data is furnished to the public in response to specific requests.

Publications

Published material available in the Coast and Geodetic Survey comprises the following categories:

Nautical Charts and Coast Pilots for use by the Navy, Merchant Marine, fishing industry, and small pleasure-craft owners.

Aeronautical Charts for use by the armed services, commercial air carriers, and private pilots.

Planimetric Maps of coastal areas for use in charting and planning engineering and other construction projects.

Geodetic Control Data (triangulation, leveling, and gravity) for use by Federal, State, and local mapping and engineering agencies, by private surveyors and engineers, and by scientific investigators.

Tide and Current Publications (Tide and Current Tables, Tidal Current Charts, and special tide and current surveys) for use in navigation, coastal construction, water-front litigation, and scientific investigations.

Geomagnetic Publications for use by Federal mapping and charting agencies, by local surveyors in boundary surveys, and by geophysical prospectors in search for oil and other minerals.

Earthquake Reports for use by construction engineers in the design of earthquake-resistant structures, by geologists and insurance statisticians in earthquake areas, and by scientists in the study of earthquake phenomena.

Nautical and aeronautical charts, which constitute the principal products of the Bureau, are sold to the public at field stations, at the Washington office, and at authorized agencies centrally located in various regions of the country. Certain related chart publications, such as chart catalogs, and processed pamphlets giving results of field surveys are distributed on request, and planimetric maps based on aerial photographs are printed and sold, from the Washington office. Manuals and other publications of the Bureau are printed and sold by the Government Printing Office.

During the year, the following new and revised publications were issued or were in process:

Coast Pilots

Coast Pilots are volumes containing a wide variety of descriptive material, published for use by navigators in conjunction with nautical charts.

New editions were published of the West Indies Coast Pilot; the Gulf Coast Pilot, covering the coastal area from Key West to the Rio Grande; and the Hawaiian Islands Coast Pilot. New editions of the Atlantic Coast Pilot, Sections A and B, were in press at the end of the year. Supplements were also issued for seven Coast Pilots.

Geodesy

In the field of geodesy the following new publications were issued:

Special Publication No. 243, Fundamental Tables for the Deflection of the Vertical.

Special Publication No. 244, Pendulum Gravity Data in the United States.

Special Publication No. 245, Equal-Area Projections for World Statistical Maps.

Special Publication No. 246, Sines, Cosines, and Tangents, Ten Decimal Places with Ten-Second Intervals, 0°–6°.

The manuscript for Special Publication No. 247, Manual of Geodetic Triangulation, was sent to the printer.

The following processed publications were also issued:

G–62, Grid Transformation Tables, New York Harbor Area.

G–118, Plane Coordinate Projection Tables for Maryland.

G–122, Plane Coordinate Projection Tables for Mississippi.

Revisions were made of processed publications G–47 and G–48, Star Azimuth Tables, to include a table of corrections based on 1950 positions.

A special lithoprinted booklet was published giving the geographic positions, plane coordinates, descriptions and sketches of all the triangulation and traverse stations established by the Coast and Geodetic Survey in Alameda and Contra Costa Counties, Calif. A similar booklet was assembled for the triangulation stations and bench marks in Baltimore County, Md.

Tides and Currents

As an aid to navigation, tide and current tables are published annually in advance, giving information on the rise and fall of the tide and the ebb and flow of the current for numerous ports and waterways throughout the world.

The following tide and current tables were published for the year 1951:

Tide Tables, Europe and West Coast of Africa (including the Mediterranean Sea).

Tide Tables, East Coast, North and South America (including Greenland).

Tide Tables, West Coast, North and South America (including Hawaiian Islands).

Tide Tables, Central and Western Pacific, and Indian Oceans.

Current Tables, Atlantic Coast, North America.

Current Tables, Pacific Coast, North America.

Tide and Current Tables, Japan and China.

Tide and Current Tables, Philippine Islands.

Daily tide predictions for the following new reference stations were included in the 1951 tide tables: Narvik, Norway; Harrington, Quebec; Miami Harbor entrance, Florida; Antofagasta, Chile; and Khor Kaliya, Persian Gulf. In the current tables for 1951 daily current predictions were included for a new reference station at Kvichak Bay, Bristol Bay, Alaska. These predictions will supply much-needed information for the fishing industry as well as for navigation.

Other publications dealing with tides and currents were printed in revised form as follows:

Special Publication No. 215, Manual of Current Observations.

Special Publication No. 228, Tide and Current Glossary.

DW–1, Density of Sea Water, Atlantic and Gulf Coasts.

DW–2, Density of Sea Water, Pacific Ocean.

Index maps of tidal bench marks and loose-leaf compilations of descriptions and elevations of tidal bench marks were completed for Louisiana, Texas, Georgia, South Carolina, North Carolina, and New Jersey and were revised for Massachusetts and the San Francisco Bay and Sacramento-San Joaquin Delta region.

Geomagnetism and Seismology

In the field of geomagnetism the following publications were issued:

Serial 667, United States Magnetic Tables and Charts for 1945.

Serial 690, Magnetic Observations in the American Republics.

Serial 717, Magnetic Declination in Texas, 1945, (with isogonic chart of Texas).

Serial 718, Magnetic Surveys.

Serial 726, Magnetic Poles and the Compass.

In addition, four of the MG series of magnetic observatory reports were published. These reports contain quarter-scale reproductions of magnetograms, each report covering a half year of observations at one observatory.

Seismological publications issued during the year included the following:

Special Publication No. 250, The Determination of True Ground Motion From Seismograph Records.

Serial 730, United States Earthquakes, 1947.

In addition, the following seismological bulletins and reports were issued: One quarterly Seismological Bulletin, through September 1945; four quarterly Engineering Seismology bulletins, through March 1950; and four quarterly Abstracts of Earthquake Reports for the Pacific Coast and Western Mountain Region, through December 1949.

Miscellaneous

The third number of The Journal of the Coast and Geodetic Survey was issued during the year. Engineering colleges are showing considerable interest in The Journal and some of them are using it to supplement the classroom work.

A new edition of chart No. 1, "Nautical Chart Symbols and Abbreviations Used by the United States of America," was published for the first time in pamphlet form. The pamphlet includes illustrations showing aids to navigation and the symbolization used on the charts.

An illustrated booklet entitled "Coast and Geodetic Survey Activities" was published for distribution to groups visiting the Bureau.

Dissemination of Information

Apart from its function of making and publishing nautical and aeronautical charts, with which mariners and aviators are familiar, the work of the Bureau touches a variety of other fields which could have application in many scientific and engineering endeavors. This availability of information and services is being stressed by the Bureau in a number of different ways.

During the year, monthly announcements were carried in the International Hydrographic Bulletin of new and revised charts and other items of interest concerning activities of the Bureau. Information relating to new publications, surveying and charting techniques, and activities of general interest were exchanged with member States of the International Hydrographic Bureau.

Material concerning aeronautical charting was furnished the State Aeronautics Commission of Wisconsin for distribution at summer sessions of teachers' colleges.

A number of specially prepared exhibits of Bureau activities were on display in various parts of the country in conjunction with meetings and expositions of national scope and importance.

Information on Bureau work was also disseminated through the mediums of news releases in the daily press; publication of articles in technical and trade magazines; and presentation of talks before scientific and engineering societies and before nontechnical groups. A closer liaison with the public is being maintained through active participation by Bureau personnel in the programs of national and inter-

national bodies, affording an opportunity for exchange of information of mutual benefit to participating agencies.

The effect of these informational activities is being reflected in a marked increase in the number of requests being received for specific Bureau survey data. As an example, 859,282 pages of geodetic data were furnished during the year in response to 11,084 requests.