U. S. DEPARTMENT OF COMMERCE

R. P. LAMONT, Secretary

RADIO DIVISION

W. D. TERRELL, Chief

ANNUAL REPORT

OF THE

CHIEF OF RADIO DIVISION

TO THE

SECRETARY OF COMMERCE

FOR THE

FISCAL YEAR ENDED JUNE 30, 1929

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RADIO DIVISION

DEPARTMENT OF COMMERCE,
RADIO DIVISION,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following condensed report of the work of the radio division during the past fiscal year, including references to related developments which have taken place during the year.

Under authority of an act of Congress approved March 4, 1929, all the powers and authority vested in the Federal Radio Commission by the radio act of 1927 are continued to be vested in and exercised by the commission until December 31, 1929. The radio division continues the inspection of all licensed radio stations, land and ship; examines and licenses radio operators; checks the frequencies of stations; measures the field strength of stations; and performs all of the field work necessary for the enforcement of the ship radio act, the radio act of 1927, and the International Radiotelegraph Convention of 1927. The radio act of 1927 limits the period of a broadcasting station license to three months and all other classes of radio station licenses to a period not exceeding one year. These licenses are issued by the Federal Radio Commission, with the exception of amateur and technical and training-school station licenses which are issued by the radio division by authority of the Federal Radio Commission.

RADIO INSPECTION SERVICE

During the fiscal year 10,715 inspections were made of radio installations on American and foreign vessels clearing from our ports as compared with 9,093 the previous year. The inspections made developed 335 cases of defective apparatus, lack of proper equipment or personnel, etc. There were 15,023 clearances of such vessels as compared with 14,305 during the previous year. There were 1,102 inspections of ship stations for license as compared with 1,139 the previous year. There were 1,154 inspections of commercial land stations and 229 inspections of amateur stations as compared with 866 and 184, respectively, the previous year. Examinations were given 3,477 applicants for commercial operators' licenses and 3,163 applicants for amateur operators' licenses. During the year offices were established at Kansas City, Mo., St. Paul, Minn., Dallas, Tex., and Los Angeles, Calif. Consideration has been given to locating offices at Denver, Colo., Hawaii, and Alaska. This can not be accomplished until additional personnel is available and some additional equipment is obtained, although there is pressing need for them. It is hoped that Denver and Hawaii can be opened this fall and Alaska next spring.

It is expected there will be a considerable increase in the duties of the inspection service during the coming year, due to the extensive use of radio in the aviation service and the operation of numerous point-to-point commercial communication stations.

RADIO TEST CARS

The division now has in service six radio test cars, one assigned to each of the following districts: Third, Baltimore; fourth, Atlanta; fifth, Dallas; sixth, San Francisco; eighth, Detroit; ninth, Kansas City. Two additional cars are urgently needed for the first district, Boston, and the seventh district, Seattle. Since the first car was purchased in 1925 the usefulness of these cars in our inspection work has been fully demonstrated. There has been no other way found to satisfactorily transport the inspection equipment and efficiently perform much of the inspection work. The cars provide a practical and satisfactory means of checking the frequency of the numerous small stations sharing the same frequencies. This can not be done from the headquarters offices when several stations are simultaneously using the same frequency. The cars also provide the only means of measuring the field strength of radio transmitters and determining the dependable service area of stations. The strength of harmonics is also measured in this manner.

MONITORING BROADCASTING STATIONS

With apparatus constructed by the field inspection service, monitoring was carried on throughout the year in all inspection districts. The use of this equipment demonstrated the need for more precise instruments, and steps have been taken to procure them. It also proved the value of frequency measurements at fixed points rather than at the station being measured as was formerly the custom. This service has been of value to the Federal Radio Commission and has been helpful to station owners. Of the 614 licensed broadcasting stations, frequency measurements were made of 374 stations. The 240 stations not measured were mostly of low power, at a considerable distance from the monitoring stations, and stations operating simultaneously on shared frequencies, or operating mostly during daylight hours. To measure the frequencies of these stations it will be necessary to make use of test cars fitted with frequency-measuring apparatus, which will be possible during the coming winter when the apparatus now being manufactured for this purpose has been installed. Fixed-point measurements will be made at Boston, New York, Baltimore, New Orleans, Los Angeles, San Francisco, Portland, Detroit, Chicago, St. Paul, Denver, and Grand Island, Nebr. At the latter point the constant-frequency monitoring station will be situated. In addition to monitoring the commercial and private stations, our service will monitor the Government stations of any department of the Government desiring our assistance. When these monitoring stations are fully equipped and manned the measurements will not be limited to broadcast stations as heretofore, but will include the frequencies in use above and below the broadcast band. During the year there were 2,451 measurements made showing a deviation of

500 cycles or more from the assigned frequency of the stations out of a total of 22,450 measurements made of broadcasting station frequencies. There were 106 measurements showing deviations of 5 kilocycles or more, and of this number there were 59 deviations of 10 kilocycles or more.

CONSTANT-FREQUENCY MONITORING STATION

The department was authorized in an act approved February 21, 1929, to purchase a suitable site and to contract for the construction thereon of a building suitable for installation therein of apparatus for use as a constant-frequency monitoring radio station, and for the construction of a suitable roadway, power, and communication facilities, at a cost not to exceed $50,000.

The site, comprising 50 acres of land, has been procured in the vicinity of Grand Island, Nebr., which is about the geographical center of the United States, where tests indicate radio-reception conditions to be favorable in all directions. The chamber of commerce at Grand Island has shown a real and helpful interest in our problem from the beginning of our effort to find a suitable site and is continuing its cooperation to the fullest extent.

The Navy Department, Bureau of Yards and Docks, prepared plans and specifications for the building and is continuing to give such assistance and advice as are needed in connection with the work.

It is expected that the building will be erected and the apparatus installed and in operation within a few months. The measuring apparatus to be installed in this station will be of such design that it will be capable of making measurements with a resulting accuracy of 1 part in 1,000,000. The primary source of frequency will be that of the earth's rotation derived through the United States standard of time, which is the Naval Observatory at Washington, from which standard time is transmitted twice daily. To further augment these standard time transmissions there will be installed at the constant-frequency station a master clock, operating in a heat-controlled chamber and under vacuum, accurate to a degree greater than one-tenth of a second. This method assures agreement with the recognized radio standard of the United States at the Bureau of Standards. This standard clock will be checked daily and kept in synchronism with the Naval Observatory clock.

An electrically driven tuning fork, controlled by the clock, serves as a basis for the establishment of the ultimate radio-frequencies to be developed. As an alternate, a piezoelectric oscillator will be supplied to perform the same service as the tuning fork. The frequency of the tuning fork which is relatively low, on the order of 5,000 cycles, is multiplied by means of harmonic multiplier circuits to radio-frequencies on the order of 30,000 kilocycles. The production of these radio-frequencies is accomplished in such a manner that harmonics are available at every 10 kilocycles throughout the radio-frequency spectrum. These standard frequencies are used as a means of measurement of unknown radio-frequencies in precisely the same fashion as described in the operation of the secondary standards of

frequency. The equipment involved in all operations is of a more precise nature due to the greater requirements of accuracy for this central station.

Three types of receivers are to be installed at this station, two of which cover the frequencies from 100 to 30,000 kilocycles; the third covers from 10 to 100 kilocycles, using both loops and antenna and having extreme selectivity and sensitivity. The arrangement of the receivers permits simultaneous use at all times. Each receiver is to be in a shielded booth. All power supplies, although generated on the premises, are to be filtered and shielded. The standards and receivers will be operated entirely from storage batteries, all provided in duplicate, and charged by means of small motor generators through suitable distribution systems connected to the main power plant.

A special antenna system, in conformity with the latest developments in this line, is to be erected. These antennæ are in the main to be of the type connected to receivers through radio-frequency transmission lines. Due to the large number of these antennæ and to the necessity of complete isolation from any device capable of causing interference with reception it has been necessary to secure at least 50 acres of land for the use of this station.

The station is to be built around a room having 2,000 square feet of floor space in which will be installed all of the standard equipment and receivers. In addition to this large room there will be rooms to be used for dormitories, kitchen, workshop, office, storage batteries, motor generators, and switchboards. An adjacent building will provide garage space and power plant. Every effort has been made to make the station complete in itself, so that 24-hour-a-day service will be insured throughout the year.

SECONDARY STANDARD OF FREQUENCY MONITORING

The secondary standards of frequency now being developed for the division obtain their fundamental source of frequency from a piezocrystal with temperature carefully controlled. This crystal is electrically connected with the 10-kilocycle oscillator and controls it. The 10-kilocycle oscillator is a device rich in harmonics, furnishing them every 10 kilocycles between the limits of 30,000 and 10 kilocycles. Since these numerous frequencies are furnished by an oscillator controlled by the crystal oscillator their accuracy is supposed to be of the same order as that of the fundamental control frequency.

The beat frequency indicator is a device which furnishes indication in a visual form between various circuits and is primarily a resonance indicator capable of use to a great accuracy.

The audio-frequency oscillator operates between the frequencies of approximately 60 and 15,000 cycles. Its use is the accurate determination of the difference between unknown frequencies such as those of the transmitting stations to be measured and the known frequencies supplied from the control oscillator.

The heterodyne frequency wave meter is an oscillating wave meter which is used for the identification of individual 10-kilocycle harmonics. It is a device having fundamentally a straight line curve permitting the standard frequency identifications to be made quickly and accurately.

The tuning-fork calibration meter furnishes a means of either calibrating or determining the state of calibration of the audio-frequency oscillator. It is really a device supplying a sufficient number of known accurate audio-frequencies by means of which the calibration curve or the audio oscillator may be either drawn or checked.

The above equipment is to be used for the measurement of frequency of any radio transmitter in the following manner: Signals are tuned in from the transmitter on the proper receiver, a description of which follows later, and are put through the following operations: The output from the receiver is heterodyned or mixed with the output of the 10-kilocycle controlled oscillator. Since this oscillator has harmonics all through the radio-frequency spectrum, one of these harmonics will beat with the output of the receiver producing an audio-frequency whose value is dependent on the difference or sum between the transmitter's frequency and the proper harmonic. The order or value of this harmonic may then be determined by means of the heterodyne frequency meter. The beat frequency produced between the harmonic of the 10-kilocycle oscillator and the transmitter may then be measured by means of the audio-frequency oscillator. This amounts to merely varying the frequency of the audio oscillator until its frequency is exactly the same as that of the beat frequency mentioned above. We now know exactly the difference between the standard frequency and the transmitter frequency. Inasmuch as the transmitter frequency may be either above or below the standard beating harmonic from the 10-kilocycle generator, it is necessary to either add or substract this difference from this harmonic. Whether it should be added or subtracted is determined by the use of the heterodyne frequency meter which is heterodyned with the incoming signal, and since it was previously heterodyned with the beating harmonic a glance at the curve of the instrument will indicate which way the transmitter frequency lies. In all of these operations each zero beat, whether between audio or radio frequencies, has been determined by means of the zero beat indicator furnishing visual indication, and also by means of a loud speaker furnishing audible indications. A brief summation of the operations outlined above would be that, to measure an unknown frequency, the unknown frequency is heterodyned with a standard known frequency. The difference between the known frequency and the unknown or transmitted frequency is measured by means of an audio oscillator exactly synchronized with the difference between the two.

The receivers to be used at the secondary standard stations consist of two units, one operating between the frequencies of 1,500 and 100 kilocycles, the other operating between the frequencies of 1,500 and 30,000 kilocycles. The receiver mentioned first consists of four stages of individually tuned radio-frequency amplification. Plug-in coils are used to cover the wide range. The selectivity of this receiver is such that it is possible to receive without interference stations on each of the 10-kilocycle channels throughout the broadcast band. The sensitivity of the receiver is such that it will respond to signals of less than 1 microvolt per meter level and furnish a good loud-speaker signal at this value. The audio-frequency section of the receiver furnishes reproduction throughout the entire audio range of frequencies up to 10,000 cycles and works in to a special dynamic type of loud speaker giving high-quality reproduction. Regeneration in the de-

tector circuit of this receiver is supplied to further increase the sensitivity of the set and to make possible the reception of continuous wave signals. This receiver operates from both loops and antenna throughout its range.

The high-frequency receiver which operates over the range of 1,500 to 30,000 kilocycles is a radio-frequency receiver having three stages of screen grid individually tuned amplification. This receiver is an extremely selective and sensitive device, furnishing loud-speaker response on radio signals of a level considerably less than 1 microvolt per meter. Regeneration is supplied in this receiver to increase its sensitivity and to make possible the reception of continuous wave signals. The audio-frequency portion of the receiver as well as its loud speaker is identical with that described above.

The power supply for the secondary standard of frequency, its associated equipment, and the receivers as outlined above, is derived entirely from storage batteries. All batteries are supplied in duplicate both for filament and plate supply. These batteries are kept in a state of charge by means of two high-voltage motor generators and one low-voltage motor generator. All charging and discharging are done through a switchboard which furnishes indications of the various rates of charge and discharge at all times.

The total secondary standard of frequency, as described above, is a complete unit for the reception and measurement of any frequency between 100 and 30,000 kilocycles. The accuracy of measurement is such that a result of at least 1 part in 100,000 may be secured.

These secondary standards are to be placed in each of the radio inspection districts. Six of them will be placed on the six test cars now in service. They will supplement the service to be performed at the central station situated in Nebraska.

RADIO FOR AVIATION

There are now 97 planes equipped with radio apparatus. Radio transmitting licenses have been issued to 34 airports; in addition there have been issued 44 construction permits for airports to be equipped with radio transmitters. From the radio standpoint, this service is just getting started and is expected to expand rapidly.

Following are some pertinent extracts from a report submitted by a commercial aviation committee on radio:

> It is anticipated that the safeguarding of life and property in aviation will be largely dependent upon radio communication, radio navigation, advising pilots regarding weather conditions, directing pilots to landing fields, guiding pilots during periods of poor visibility, and enabling pilots to land. Due to the nature of the service rendered, radio is the only means for handling communications to and from aircraft in flight. At present in the United States there are approximately 3,000 landing fields in operation or under construction and about 20,000 planes of all classes in use. Several overseas aircraft routes are projected.

Radio stations in this important and rapidly developing service must be inspected and protected from interference. Safety of life and property is largely dependent upon reliable radio communication, and the inspection service of the radio division will be relied upon to aid in protecting this service from interference. The personnel and facilities of the radio division are far from being adequate to meet the demands being made upon it. It is essential that increased facilities be made available through larger appropriations for this service;

otherwise its duties can not be performed as they should be, even though the personnel continue working overtime in the future as they have in the past.

RADIOBEACONS AND RADIO COMPASSES

For the purpose of better safeguarding navigation, particularly in foggy weather, when the greatest need for aid exists, the Bureau of Lighthouses has in operation 23 radiobeacons on the Atlantic coast, 15 on the Pacific coast, 6 on the Gulf coast, and 21 on the coasts of the Great Lakes. These beacons are located in the lighthouses and light vessels. The transmitters send out characteristic signals composed of dashes and dots which serve to identify each beacon. This service is available to ships which are equipped with radio compasses. In other countries there are a total of 57 beacons.

Interest in the installation of radio compasses on ships is increasing rapidly. Because of the value of this apparatus as a navigational aid and its demonstrated usefulness in connection with locating vessels in distress it was agreed at the Safety of Life at Sea Conference held in London in April and May of this year that all passenger ships of 5,000 tons gross tonnage and upwards shall within two years from the date on which the convention comes in force be provided with an approved direction finding apparatus (radio compass).

Under the United States flag there are 718 commercial vessels and 375 Government vessels using radio compasses or a total of 1,093. There are 1,942 foreign vessels so equipped.

AUTOMATIC ALARM SIGNAL DEVICE

The Safety of Life at Sea Convention signed at London May 31 provides for the use of the auto alarm as a means of maintaining watch. This device may be used as a substitute for an operator or a watcher where more than one operator is required on a vessel. However, all vessels which are required to be fitted with radio installations, shall, for safety purposes, carry a qualified operator. Where the auto alarm is installed it must be in operation whenever the operator or watcher is not on duty. The auto alarm must meet the specifications set forth in the International Radiotelegraph Convention of Washington, 1927. There are 5 types of auto alarm being manufactured—3 British, 1 French, and 1 German. So far, only the British types are installed on ships and all are on British ships, with few, if any, exceptions. During the fiscal year, 688 inspections were made of vessels equipped with auto alarms and in 414 cases reports were made that the device had responded to signals not intended to actuate the apparatus.

RADIO BROADCASTING

The United States was the first country in the world to have radio broadcasting. The first broadcasting licenses were issued in the fall of 1921. Prior to this time a few special events were broadcast, but this form of transmission was carried on largely for the purpose of testing radiotelephone transmitters, which was usually done under experimental licenses. One of the earliest radiotelephone tests of which this office has a record, in connection with which phonograph

records of music were broadcast, was carried on by the Wanamaker, New York, radio station during May, 1914. Different types of hydrogen arc radiotelephone transmitters were used in these tests. Government departments, commercial radio companies, and amateurs were about the only ones having radio receiving sets at that time. One of these sets was installed in the office of the radio inspector, customhouse, New York, for the purpose of observing interference between amateur stations and ships. While engaged in this work the broadcast of music was detected. No one at that time had any idea of the future possibilities of broadcasting entertainment. About five years later experiments were being made with the tube type of radio transmitter. Listeners hearing the musical programs, and learning the source of them, sent in requests for more music which subsequently resulted in the inauguration of the service through stations built for this purpose. During the early days the programs of a majority of the stations consisted almost entirely of phonograph records. The announcers usually had favorite records which they repeated numerous times during a program.

The Secretary of Commerce foresaw the danger of the stations losing public interest if a change was not made in the programs. He ordered the creation of a new class of license requiring a higher standard in equipment, studios, and programs which immediately stimulated interest in the programs and resulted in rivalry among station owners to improve their stations and obtain one of the new high-class licenses. Thus was the foundation laid for the high-class broadcasting service we have to-day, which is far in advance of any country of the world as indicated by the increase in the number of receiving sets in use, approximately 60,000 in 1922 and approximately 10,000,000 at the present time. When an event of general public interest is broadcast it is reasonable to assume that it is available to more than half of the population of this country and a large number in other countries of the world.

From the beginning it has been recognized that the basis of granting a broadcasting license should be service to the public, and in no other way can an audience be held or a station prosper. There is no financial support for the operation of broadcasting stations derived directly from the listeners through the payment of a fee, such as is the custom in many other countries. For instance, in Great Britain there is an annual tax on the use of receiving sets amounting to $2.45. In France the rate is 5 cents per annum and in Salvador it is $18 per annum. Canada charges $1 per annum.

AMATEURS

At the end of the fiscal year there were 16,829 licensed amateur radio stations, a decrease of 99 as compared with the previous year, when there were 16,928. While other countries are worrying over the problem of controlling, taxing, and discouraging the few surviving amateurs they have, this country is constantly endeavoring to keep this large and useful group of experimenters engaged in useful and interesting work. The latest proposal they have put forward is a request for permission to carry on radiotelephone communication in the 20-meter band, from 14,000 to 14,400 kilocycles. If given this

privilege, the amateurs expect to carry on international radiotelephone communication in this high-frequency band.

In order to continue satisfactory operation under the restricted frequency bands imposed by the Washington convention, intensive technical development has been carried on by the amateurs during the past year. This, the American Radio Relay League reports, has resulted in marked advances in apparatus and methods. In March, 1928, the band 28,000 to 30,000 kilocycles, 10.7 to 10 meters, made available to amateurs in the Washington convention, was opened to their use in this country. They have given particular attention to work in this band, and two-way communication has been established between amateurs in this country and in Europe, South America, and New Zealand. European amateurs have succeeded in communicating from Europe to South Africa and India on similar frequencies. On their more useful frequencies, numerous amateur stations have now been in communication with as many as 50 foreign countries. There is an increase in amateur interest in radiotelephony and many amateurs now seek an opportunity to duplicate by voice the long-distance work which they have successfully accomplished by radiotelegraphy.

The amateur again demonstrated his great value as a means of emergency communication to storm-stricken communities during the West Indian hurricane in September, 1928. At the Virgin Islands, when the Navy station was destroyed, one of the operators who maintained an amateur station put his set on the air and broadcast a warning to the United States in advance of the disturbance. As a result, amateurs in Florida and other Southern States had established emergency communication routes before the storm had reached this continent. Particular credit is due to two amateurs at Palm Beach who, although they lost their homes and personal belongings, put their amateur set into operation and for three days furnished the only means of communication with northern points from the distressed area. State, Army, and municipal authorities were high in their praise of this service.

In addition to emergency work, amateurs afforded home contact with many exploring and scientific expeditions.

INTERNATIONAL RADIO COMMUNICATION

Radiotelegraph and radiotelephone circuits now link the United States with the principal countries of the world. This service is being constantly improved and extended. Already it is far more extensive than that of any other nation. Much of this expansion and improvement are due to the successful use of short waves (high frequencies). Handling of increased traffic has been made possible by the development of directive, high-speed, short-wave apparatus.

In addition to the trans-Atlantic radiotelephone service, made available to the public January, 1927, there is soon to be inaugurated radiotelephone service between ship and shore and ship and ship. It is planned to provide a method for direct conversation between the residence or office phone and the stateroom phone on the ship.

PERSONNEL

The division is experiencing much difficulty in obtaining employees in the inspection service having the essential qualifications considered necessary for the performance of the highly technical duties required of this service. There are 18 vacancies to be filled. The Civil Service Commission held a special examination throughout the United States on January 15, 1929, which resulted in obtaining 14 eligibles from a total of 44 who took the examination for the position of assistant radio inspector. Only three of these men were willing to accept appointment. The Civil Service Commission has authorized the filling of existing vacancies by temporary appointments pending the establishment of another list of eligibles. Commercial companies are employing men with similar qualifications and are offering better salaries. The supply is not equal to the demand in this highly technical and specialized field, therefore our service will be at a disadvantage until the salaries more nearly compare with commercial salaries.

I renew my previous recommendation that the following classification of positions and salaries be made applicable to the field-inspection personnel:

Supervisor (senior)	$5,600–$6,400
Supervisor (junior)	4,600– 5,200
Assistant supervisors	3,800– 4,400
Inspectors	3,200– 3,700
Assistant inspectors	2,600– 3,100

A true indication of the need for additional personnel is shown by the number of hours overtime worked by 56 inspectors, which was 601 days during the year, and the amount of annual leave these men were able to take, which was 686 days during the year—average overtime per man 10⅞ days, average leave per man 12¼ days. The above annual leave was not given to compensate for overtime, but ordinary leave granted all employees.

INTERNATIONAL CONFERENCES

A representative of the radio division attended three international conferences during the year. The first one was held at Ottawa, Canada, in January, where arrangements were made by representatives of Canada, Cuba, Newfoundland, and the United States to use certain short waves or high-frequency channels for national services in such manner as to avoid international interference. Mexico was invited to send a representative, but it was not convenient for him to attend at the time arranged. However, the requirements of Mexico were given careful consideration and a share of the waves was provided for the use of Mexico.

The second conference was held at Prague, Czechoslovakia, in April. This conference limited its deliberations almost entirely to subjects affecting European broadcasting and particularly to a new plan of frequency assignments for European broadcasting stations. Several other subjects of technical character were discussed, but as they were of international interest it was decided that they be referred to the international technical consulting committee on radio created by the International Radiotelegraph Convention of Washington, 1927. This

technical committee will hold its first meeting at The Hague in September, 1929.

The third conference was held at London, beginning April 16 and closing May 31. This conference dealt with subjects relating to safety of life at sea, an important one of which is radio. As a result of this conference the number of vessels required to be equipped with radio is materially increased. Passenger ships of 5,000 gross tonnage and upwards, if engaged in international service, must be fitted with radio direction-finding apparatus (radio compass). Where ships in the international service carry more than 13 lifeboats, 1 shall be a motor boat, and where the number is more than 19, 2 shall be motor boats. These motor lifeboats shall be fitted with a wireless telegraph installation. The radiotelegraphy provisions of the convention apply to all ships engaged in international voyages except cargo ships of less than 1,600 tons gross tonnage. All ships covered by the convention must carry at least one licensed operator, but continuous watch may be maintained by the use of an automatic alarm, provided such device complies with the requirements specified in the International Radiotelegraph Convention of Washington, 1927.

INTERNATIONAL RADIO ACCOUNTING

Since July 1, 1924, it has fallen to the lot of the radio division to carry out the provisions of the London Radiotelegraph Convention of 1912, to which the United States is signatory, with reference to settlement of accounts for tolls arising from the exchange of radio traffic between vessels of American registry and foreign coastal and ship stations. Messages originating in the United States and addressed to vessels of any nationality via radio are also charged to the United States by foreign administrations. Collections and settlements therefor are made through the accounting section of the radio division.

The activities of the accounting section of the radio division during the fiscal year from July 1, 1928, to June 30, 1929, may be summarized as follows:

Number of accounts handled:	
On hand July 1, 1928	701
Received during year	1,100
Total	1,801
Settled and cleared	1,045
Accounts on hand and unsettled June 30, 1929	756
Financial operations required to complete activities summarized:	
Cash balance, July 1, 1928	$61,863.31
Collections	62,773.74
Total	124,637.05
Disbursements	80,117.24
Cash balance, June 30, 1929	44,519.81

Efforts of the nations signatory to the London Radiotelegraph Convention of 1912 have been directed in late years toward expediting settlement of accounts of the classes described. Special efforts have been made by the accounting section of the radio division to keep the accounts constantly moving in order that they may be held only

long enough to permit collection of charges due by American companies to foreign administrations. The cash handled represents collections only, as no appropriation account is involved in any way. The speed with which accounts may be settled with foreign administrations depends only on the completion of collections from American companies, inasmuch as no single account may be disbursed until all charges are collected. The cash balance at the end of each fiscal year represents partially collected charges on unsettled accounts.

Very truly yours,

W. D. TERRELL,
Chief Radio Division.

STATISTICAL TABLES

Submitted below are statistics covering the division's work.

SCOPE OF WORK

The following table shows the inspection and licensing work performed yearly from 1914 to 1929, inclusive, and the number of persons employed in the field force:

June 30—	American ships	American ships licensed	Inspections of American and foreign ships	Commercial operators licensed	Commercial and special land stations licensed [1]	Amateur stations licensed	Amateur operators licensed	Total field force
1914	555	203	6,484	339	83	2,137	1,172	20
1915	585	362	6,152	1,653	115	3,547	3,067	26
1916	604	444	7,236	1,278	182	4,942	4,199	28
1917	836	484	7,137	1,682	160	3,741	3,303	28
1918	1,478	392	5,575	1,616				29
1919	2,312	976	5,160	1,645				27
1920	2,808	1,158	5,419	4,652	254	5,719	6,103	25–45
1921	2,978	921	5,591	2,722	491	7,351	6,207	26
1922	2,773	1,174	6,071	3,136	1,086	9,525	8,920	35
1923	2,723	945	6,933	2,860	1,375	7,821	9,908	53
1924	2,741	1,382	7,727	3,370	1,489	8,205	9,545	53
1925	1,901	976	8,603	3,215	1,129	10,074	8,293	62
1926	1,954	1,258	9,197	3,398	1,072	8,037	8,140	65
1927	2,092	[2] 558	9,330	3,463	1,260	7,123	7,275	63
1928	2,166	([2])	9,093	3,816	([2])	12,386	8,369	78
1929	2,213	([2])	10,715	3,798	([2])	12,646	9,490	95

[1] Includes experimental, relay broadcasting, visual (television) broadcasting, and technical and training school stations.

[2] Radio station licenses, other than amateur and technical and training school station licenses, were issued by the Federal Radio Commission during the fiscal years 1928 and 1929.

DETAILED WORK OF THE RADIO SERVICE

The following statement shows the details of the work performed during the past fiscal year compared with 1928 and the total number of licensed and Government radio stations:

Work of service	1928	1929
Clearances of American and foreign vessels required by law to be equipped with radio		15,023
Inspections of radio equipment on American and foreign vessels required by law to be equipped with radio		10,715
Inspections of radio equipment on voluntarily equipped vessels		2,520
American ship radio stations inspected for license		1,102
Land stations inspected		1,154
Land stations inspected for license		29
Amateur stations licensed		12,646
Commercial operators examined		3,477
Commercial operators licensed		3,798
Amateur operators examined		3,173
Amateur operators licensed		9,490
Defects found upon inspection of ship radio stations where clearance would have been in violation of law		335
Licensed and Government radio stations: [1]		
American vessels equipped with radio		2,213
Experimental, relay broadcasting, visual broadcasting, and technical and training-school stations		228
Commercial land stations [2]		446
Broadcasting stations	[3] 1	614
Commercial aircraft stations	5	97
Geophysical stations [2]		106
Amateur stations	[3] 8	16,829
Government land stations	[3]	[4] 369
Government ship stations	[illegible]	1,211

[1] Stations in the Philippine Islands are not included.

[2] A number of stations for which construction permits have been issued but not licensed for operation up to June 30, 1929, are not included in these figures.

[3] Includes 56 radiobeacons and 53 radio-compass stations.

[4] 65 radiobeacons and 53 radio-compass stations not included.

OPERATORS LICENSED

The following table shows the number of radio operators licensed during the past two years:

Class and grade	1928	1929	Total
Commercial extra first class	17	19	36
Commercial first class	3,088	2,080	5,168
Commercial second class	711	1,471	2,182
Broadcast class	[1]	113	113
Phone class	[1]	115	115
Amateur extra first grade	[2]	72	72
Amateur first grade	4,424	5,058	9,482
Amateur (temporary)	[3] 3,945	[3] 4,360	8,305
Total	12,185	13,288	25,473

[1] Established in 1929.
[2] Discontinued in 1928; reestablished in 1929.
[3] Amateur second grade discontinued in 1928; temporary class established in 1929.

MONITORING

The following table shows the monitoring work performed by districts:

District	Stations monitored		Measurements made		Measurements showing deviation of 500 cycles or more	
	In district	Outside district	In district	Outside district	In district	Outside district
First	25	83	1,452	1,054	109	75
Second	45	97	4,292	769	603	154
Third	25	134	322	285	15	6
Fourth	55	55	99	70	23	5
Fifth	18	61	295	307	96	53
Sixth	47	50	4,561	457	417	33
Seventh	23	39	2,724	1,164	287	140
Eighth	51	81	1,387	1,049	166	108
Ninth	75	59	1,582	581	105	56
Total	364	659	16,714	5,736	1,821	630

FIELD ACTIVITIES

Following is a statement, by districts, of the work performed during the past fiscal year compared with the previous year:

Place of inspection or examination (city or town)	Stations inspected						Amateur stations licensed	Operators examined						Operators licensed						
								Commercial				Amateur		Commercial				Amateur		
	Ship, under act	Ship, voluntary equipment	Ship for license	Land [1]	Land for license [1]	Amateur		Extra, first	First	Second	Broadcast and phone	Extra, first [2]	First [3]	Extra, first	First	Second	Broadcast and phone	Extra, first	First	Temporary [4]
First district:																				
Boston, Mass.	1,313	74	56	2	----	4	1,465	3	159	70	11	11	119	3	145	112	11	6	506	311
Outside Boston office	----	1	1	12	----	40	----	----	----	----	----	2	197	----	----	----	----	2	98	----
Total, 1929	1,313	75	57	14	----	44	1,465	3	159	70	11	13	316	3	145	112	11	8	604	311
Total, 1928	1,221	81	65	55	----	12	1,181	----	259	35	----	----	364	1	257	62	----	----	638	327
Second district:																				
New York, N. Y.	2,516	367	351	4	1	21	1,397	3	418	158	16	10	374	5	533	221	14	7	607	60
Outside New York office	297	91	88	1	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total, 1929	3,813	458	439	5	1	21	1,397	3	418	158	16	10	374	5	533	221	14	7	607	60
Total, 1928	3,218	567	583	32	4	52	1,189	3	458	89	----	----	460	10	747	60	----	----	604	48
Third district:																				
Baltimore, Md.	439	43	17	----	----	2	1,138	----	49	21	1	----	30	----	77	36	1	----	324	93
Outside Baltimore office	----	----	----	5	----	2	----	----	----	----	----	----	17	----	----	----	----	----	----	----
Philadelphia, Pa.	462	7	6	11	----	12	----	----	55	27	9	8	123	----	69	42	6	4	86	----
Outside Philadelphia office	1	7	5	1	----	3	----	----	----	----	----	3	----	----	----	----	----	----	----	----
Norfolk, Va.	637	22	20	2	----	1	----	----	20	9	4	----	29	----	29	12	5	----	34	----
Outside Norfolk, office	----	1	1	1	1	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Washington, D. C.	----	----	----	1	----	----	----	1	43	22	6	2	34	4	39	27	5	2	34	----
Total, 1929	1,539	80	49	21	1	20	1,138	1	167	79	20	13	233	4	214	117	17	6	478	93
Total, 1928	1,508	68	58	42	6	15	1,121	----	145	47	----	----	189	----	273	64	----	----	488	79
Fourth district:																				
Atlanta, Ga.	----	----	----	----	----	----	659	----	18	12	16	3	16	----	43	35	17	9	112	320
Outside Atlanta office	46	4	----	41	----	----	----	----	17	26	12	7	68	----	----	----	----	----	----	----
Total, 1929	46	4	----	41	----	----	659	----	35	38	28	10	84	----	43	35	17	9	112	320
Total, 1928	2	----	----	29	----	----	622	----	74	35	----	----	198	----	86	23	----	----	69	191

[1] Other than amateur.
[2] Revived in 1928.
[3] Totals for 1928 include first and second class, second class having been discontinued in 1929.
[4] Totals for 1928 are for second class which was discontinued in 1929.

Place of inspection or examination (city or town)	Stations inspected						Amateur stations licensed	Operators examined						Operators licensed							
								Commercial				Amateur		Commercial				Amateur			
	Ship, under act	Ship, voluntary equipment	Ship for license	Land	Land for license	Amateur		Extra, first	First	Second	Broadcast and phone	Extra, first	First	Extra, first	First	Second	Broadcast and phone	Extra, first	First	Temporary
Fifth district:																				
New Orleans	583	132	101	13			832		165	75	5		23	1	281	208	23	5	179	475
Outside New Orleans office	16	51	41	162	2	29			80	123	37	7	129							
Total, 1929	599	183	142	175	2	29	832		245	198	42	7	152	1	281	208	23	5	179	475
Total, 1928	642	108	109	192		25	903		246	96			557	1	431	91			204	463
Sixth district:																				
San Francisco, Calif	1,317	370	125	11	2		881		204	89	13	12	209	5	380	177	20	14	942	370
Outside San Francisco office		5	2	67		1			49	11	6	18	123							
Los Angeles, Calif				10		1		2	39	44	6	3	81		36	63	12	5	105	
Outside Los Angeles office	213	62	32	37	1				3	9	10	2	14							
Total, 1929	1,530	437	159	125	3	2	881	2	295	153	35	35	427	5	416	240	32	19	1,047	370
Total, 1928	1,317	255	183	157		15	1,011	2	309	92			710	4	598	87			1,036	277
Seventh district:																				
Seattle, Wash	564	224	53	36	2	3	940		113	94	6	1	72		167	150	24	2	331	230
Outside Seattle office	15	16	6	108	10	5			55	73	13	4	160							
Total, 1929	579	240	59	144	12	8	940		168	167	19	5	232		167	150	24	2	331	230
Total, 1928	612	216	105	83	1	29	893		186	126			282		263	93			208	137
Eighth district:																				
Detroit, Mich	461	317	29	14	2	1	1,887		82	73	38	5	90	1	86	116	33	5	452	1,036
Outside Detroit office				26		4			12	27	5	15	218							
Buffalo, N. Y	155	249	15	91	1	4	89		16	23	12	3	32		24	31	5	4	102	22
Outside Buffalo office				25	3	17			8	4			80							
Total, 1929	616	566	44	156	6	26	1,976		118	127	55	23	420	1	110	147	38	9	554	1,058
Total, 1928	277	289	27	91		11	2,281		152	25			1,104	1	179	57			498	929

Ninth district:																				
Chicago, Ill	648	158	25	37	2	8	3,358	1	143	166	20	2	174		158	200	42	6	985	1,443
Outside Chicago office		10	7	222		26			88	81	28	13	438							
St. Paul, Minn									5	13	1		29		1	8	1		35	
Outside St. Paul office		1		104		34				1		3	19							
Duluth, Minn	32	172	52	24	2	4			9	12	1		14		7	5			15	
Outside Duluth office		136	69	11																
Kansas City, Mo				35		2			4	20	11	2	38		5	28	9	1	111	
Outside Kansas City office				40		5			3	21	19	4	83							
Total, 1929	680	477	153	473	4	79	3,358	1	252	314	80	24	795		171	241	52	7	1,146	1,443
Total, 1928	296	75	9	185	1	25	3,185	1	369	144			1,823		254	174			679	1,550
SUMMARY																				
First district	1,313	75	57	14		44	1,465	3	159	70	11	13	316	3	145	112	11	8	604	311
Second district	3,813	458	439	5	1	21	1,397	3	418	158	16	10	374	5	533	221	14	7	607	60
Third district	1,539	80	49	21	1	20	1,138	1	167	79	20	13	233	4	214	117	17	6	478	93
Fourth district	46	4		41			659		35	38	28	10	84		43	35	17	9	112	320
Fifth district	599	183	142	175	2	29	832		245	198	42	7	152	1	281	208	23	5	179	475
Sixth district	1,530	437	159	125	3	2	881	2	295	153	35	35	427	5	416	240	32	19	1,047	370
Seventh district	579	240	59	144	12	8	940		168	167	19	5	232		167	150	24	2	331	230
Eighth district	616	566	44	156	6	26	1,976		118	127	55	23	420	1	110	147	38	9	554	1,058
Ninth district	680	477	153	473	4	79	3,358	1	252	314	80	24	795		171	241	52	7	1,146	1,443
Grand total, 1929	10,715	2,520	1,102	1,154	29	229	12,646	10	1,857	1,304	306	140	3,033	19	2,080	1,471	228	72	5,058	4,360
Grand total, 1928	9,093	1,659	1,139	866	12	184	12,386	6	2,288	689			5,687	17	3,088	711			4,424	3,945

COST OF RADIO SERVICE

The following statement shows the detailed expenditures of the radio service for 1929 and the appropriation and proposed allotment for the fiscal year 1930.

	1929	1930
Salaries:		
District of Columbia	$52,103.84	$85,770.00
Field	213,932.46	297,180.00
Total	266,036.30	382,950.00
General expenses:		
Travel and subsistence	18,380.26	17,420.00
Furniture and fixtures, office	8,753.66	3,800.00
Test cars and equipment	19,955.12	6,800.00
Motor vehicles	749.19	----------
Technical instruments and supplies	108,498.66	13,200.00
General expenses—Con.		
Rents	$16,473.48	$25,800.00
Office supplies and stationery	2,859.98	3,675.00
Communications	2,735.61	3,500.00
Miscellaneous expenses	2,138.97	2,855.00
Total	[1] 446,581.23	[2] 460,000.00
Unexpended balance	29,578.77	----------
Total appropriations	476,160.00	460,000.00

[1] The total amount appropriated for the fiscal year 1929 was $476,160. This was made as follows: The regular appropriation, $320,000; second deficiency act, $140,000; and supplemental appropriation to meet salary adjustments under the Welch Act, $16,160.

[2] In addition to the regular amount appropriated, $460,000, by act of Congress $50,000 was made available for the purchase of a site and for the construction of a constant-frequency monitoring radio station.

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