

THE UNITED STATES NAVAL COMMUNICATION SERVICE.*

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MR. CHAIRMAN AND GENTLEMEN: I am sure that you will regret to know that Admiral Bullard, who was to deliver this lecture, is unable to do so on account of absence on duty in France; and as he has delegated me to substitute for him, I shall do the best I can to outline the activities of the Naval Communication Service.

The practical use of radiotelegraphy for communication with vessels at sea, in the development of which the United States Navy was one of the pioneers, resulted in the erection and operation, by the Navy, of a chain of stations along the coasts of the United States for communicating with Naval and merchant vessels. For several years the development was restricted mainly to material features with the result that no progress was made toward utilizing the radio facilities that were available in a well-thought-out plan, except, of course, for tactical uses in the Atlantic Fleet where its development was fostered and great improvements were made in the fleet itself so far as related to the tactical operation of naval units. There were a number of coast stations which, individually, were excellent so far as range and operation were concerned, but we had no organization to co-ordinate their operation with that of the fleet.

In 1912 the so-called Naval Radio Service was established, with Captain Bullard as the first superintendent. It was apparent that the material progress made in radio was at that time much further advanced than the administrative and operating features, so that efforts were concentrated immediately on a plan for the establishment of a service of communication that would serve the needs of our fleets and merchant marine to best advantage, both in time of war and in time of peace. We had a number of stations along our coast that were individually very good, and materially good, and, so far as their operation was concerned, were very good; but they were not connected up in such a way as to serve the interests of the fleet to the best advantage.

The plan outlined provided for continuous communication with our fleets and among the various sub-divisions of the fleets, as well as for the co-ordination of all naval communication facilities so as to provide a rapid and reliable interchange of information between all naval organizations afloat and ashore.

The advisability of combining all naval communication activities—that is, telegraph, telephone, cable, etc., and radio—under one head was soon appreciated by the Navy Department, and the name of this office of the department was changed from the "Naval Radio Service" to the "Naval Communication Service," and it was placed under the Chief of Naval Operations where, logically, it belonged. It consists of three main divisions, *viz.*, Atlantic, Pacific and Philippines, and each division is subdivided into districts.

The Director of Naval Communications exercises his authority through the division heads (coast superintendents), who, in turn, direct the district superintendents. So far as is practicable, the communication districts coincide with the naval districts, and all matters of an administrative nature within a district are handled through the Commandant of the district, to whom the district communication superintendent is directly responsible for the operation and administration of naval communications within the district.

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The distribution of orders or instructions and the dissemination of information from the Navy Department, or from the heads of the various naval units, is thus provided for automatically. As an illustration of how this works, it is only necessary for the Secretary of the Navy to write one message, and if he wishes the entire naval service to receive it, that is automatically taken care of by the Communication Service. Each distributing office knows to whom it should send this message and from whom to expect acknowledgment. The acknowledgments are gathered in to the coast superintendents, and eventually to the communication office in Washington, and the acknowledgment is delivered directly to the Secretary. This same procedure may be followed by the commander of any naval unit for the distribution of messages through his forces.

I want to call your attention especially to the importance that other countries have attached to communications, because we feel that the people in the United States do not appreciate the importance of a satisfactory system of American world-wide communications; certainly not so much as is done in foreign countries. The British have two routes to the East by radio in addition to their cables running out through the Mediterranean. The Dutch have undertaken a very elaborate program. They hope to have their radio station on the Island of Curacao communicate across to the Dutch East Indies. The French have also elaborated their plans, and the Belgians have in process of erection a radio station in Belgium that will communicate direct with the United States and with their possessions in the Belgian Congo. This, of course, is in addition to the cables that are largely controlled by the various countries. England has been especially active in extending her communications, and wherever her communications go trade follows.

A very valuable experiment was carried out by the Navy Department in May, 1916, in which all the naval stations within the continental limits of the United States were connected up to a central telephone switchboard in the Navy Department, and by means of which instant telephonic communication could be had between the various naval stations and the Navy Department, and also among the stations themselves. This was made possible through the assistance of the American Telephone and Telegraph Company, and its value later on, when this country declared war against Germany, was clearly proven. It was during this test that the Commandant of the Navy Yard, Mare Island, California, talked by telephone to the commanding officer of the battleship *New Hampshire*, which was then at sea off the Virginia Capes. The Commandant's remarks came by long-distance telephone from Mare Island to Arlington, where the transmitting station was installed, and from there out to the *New Hampshire* off the Virginia Capes. The greatest value derived from this experiment, aside from the knowledge that such rapid communication by telephone was available to the Navy Department, was the fact that all of the apparatus necessary was specially marked and could be placed in operating condition on twenty-four hours' notice. As a result, the interior communications of the country, so far as naval needs were concerned, were, on the outbreak of war, in excellent operating condition, and made the task of the Navy Department, in communicating its instructions and orders to the various naval stations, a comparatively simple one at the time of the declaration of war.

We have one cable running from the United States direct to the continent of Europe that does not touch foreign soil between the United States and the European country, and that is a direct French cable from Cape Cod to France. All other cables touch in British territory or in the Azores. In the Pacific—we have one cable to the Philippines—all American; but the British have a cable running down from Vancouver to Australia by way of the Fanning Islands. The communication situa-

tion in the Pacific is a very serious one. The British control the cables on the east coast of Brazil from Buenos Aires up north. The Americans control them on the west coast and across to Buenos Aires. Every British possession practically is connected by some means of rapid communication with the mother country.

On January 1, 1917, the Naval Communication Service operated fifty-five radio stations, distributed along the coast of the United States and its possessions. Naval vessels were equipped so that they could receive only one message at a time. Not all of the American merchant vessels were equipped with radio apparatus, some were equipped with poorly designed radio apparatus, and none of their radio operators was proficient in the procedure of communications during war. The Navy had only 1,031 radio operators in its service.

The radio technical equipment of the Navy was as good as any in general use in the United States at the time, but the demands for communication proved that the technical equipment would have to be increased and improved to conduct all of the necessary communication demanded in time of war.

At the beginning of the war the demands for quick communication increased by leaps and bounds. It was found necessary to communicate with ships in all parts of the world, while at the same time to maintain long-distance communications between the Navy Department and our outlying possessions and expeditionary forces. It was necessary to maintain continuous and rapid communication between the Navy Department and Europe, South America, Central America, West Indies, Pacific Coast, Hawaiian Islands, Guam, Tutuila, and the Far East. The most important centers of communications were at Cavite, P. I.; Hawaiian Islands, Canal Zone, Washington, D. C., and the capitals of the Allied nations in Europe.

To meet the demands for communication, the Navy's facilities were greatly and rapidly increased, and means were provided for collecting and disseminating information to every part of our coast and to naval vessels in Europe, South America, and the Far East.

The Navy took over and operated fifty-nine commercial stations. At the same time the several privately owned stations were closed, including all the stations operated by the amateurs, which were not necessary nor desirable for use during the war. Sixty-seven land radio stations were built by the Navy during the war, all equipped with the best apparatus, thus more than doubling its radio facilities on shore.

Naval vessels were equipped with improved apparatus, so that when the armistice was signed, battleships were able to receive four messages simultaneously and transmit three. The Commander-in-Chief of the fleet could talk to the captains of vessels in the fleet; while, at the same time, the various ships of the fleet could communicate with one another. In addition, and at the same time, airplanes could communicate with their respective battleship units. None but a naval officer can appreciate the value of such a system or how much such a system facilitated the freedom of movement of the fleet.

The Navy Department equipped all American merchant vessels with modern apparatus and furnished operators for them, so that these merchant ships could receive messages at any time of the day and transmit messages at long distances in case of distress.

The Navy had to train most of its radio men because the radio amateurs in this country were soon incorporated in the army and navy. These operators were trained at Harvard. In June, 1917, there were 350 students under instruction. When the armistice was signed there were 3,400 men under instruction, and operators were being graduated at the rate of about 200 a week. A total of about 7,000 operators completed their

training. In addition to the radio operators, it was necessary to train officers for communication duties on board the ships. At the time the armistice was signed, each ship of the Navy had a communication officer, and each merchant ship had a chief petty officer who performed communication duties and, therefore, relieved the master of the ship from a very vexatious duty.

The year before the war there was handled approximately 125,000 dispatches from the Navy Department. These dispatches averaged about 25 words each.

From April 6, 1918, to April 6, 1919, approximately 1,000,000 dispatches, of an average of about 30 words each, were handled from the Navy Department alone. Some of these dispatches, on account of the necessity of broad-casting, were sent twice in order to insure their delivery.

As it was assumed that the use of radio apparatus by ships at sea enabled German submarines to ascertain more or less accurately the movements of such ships, communication by radio from merchant ships was discontinued except in case of emergency. Men-of-war were cautioned not to use their radio apparatus unless necessary. However, it was very necessary that information should be received on shore regarding the movements of the enemy, and that the consequent orders to ships at sea should be transmitted expeditiously. Therefore, in order to direct the movements of convoys, and to transmit information to naval vessels regarding the enemy, and to issue orders to both merchant ships and naval vessels, a comprehensive system of transmission from shore was organized with the view of making it unnecessary for ships at sea to use their radio apparatus.

All merchant vessels listened for their orders from certain designated shore stations during certain hours of the day. These messages were sent by high-power and low-power stations, depending on the distance of the ship from shore. Naval vessels intercepted messages from shore stations at all hours of the day. In order to send a message to a naval vessel at sea, it was necessary only to transmit from certain shore stations on a designated wave-length. It soon became evident that this was a very sure means of communication. Many times, fifty or sixty messages were transmitted to sea simultaneously, all destined for different classes of vessels, and they were received by ships in accordance with the plan.

The foregoing system demonstrated that ships at sea could be warned of mines and submarines, and their movements directed without the necessity of their using their own radio apparatus. The system was automatic to such an extent that it was almost certain that a vessel could be reached at any time.

In order that errors in this system might be eliminated and in order that the Navy Department might be informed of the movements of vessels, there was established a Shipping Information Service. A confidential bulletin was published showing the movements of all United States vessels and as many foreign vessels as could be obtained. This information was collected from all the important ports of the world and the data printed in a booklet. This service grew to such an extent that the booklet now contains the names of approximately 12,000 vessels, their arrivals and departures, character of cargo, and destinations, and is of much value to shipping and business interests. It is the present plan to have the Naval Communication Service continue this publication until Congress makes other disposition for its publication.

In order to check the radio work of merchant vessels, a comprehensive system of inspection was organized, both in the United States and abroad. Every merchant vessel that came into port received a thorough inspection of its radio apparatus, and the radio operators were examined and thoroughly instructed. Any mistake indicated in the log-books was investigated

and the operator instructed as to the correct method of handling such cases.

Besides inspections, the Navy maintained a comprehensive system both at home and abroad of radio repair stations. Any radio apparatus on board ship which had broken down was repaired when the ship came to port.

It soon became evident that if the commander of the United States forces in Europe was to maintain close touch with all of his forces, it would be necessary to establish and control a complete system in Europe. To this end cables were laid and land wires and radio stations constructed in France, England and in Italy. The Navy used a great many of these land wires and cables that were constructed by the Signal Corps of the Army. Close co-operation was maintained with the Allied communication services with the view of utilizing their systems whenever possible and with the view of avoiding duplication of effort.

During the war it was found necessary to maintain radio communication between the United States and our naval and military forces in Europe and in other parts of the world. In October, 1917, the Allied military and naval officials had a conference to determine the best methods of operations that were to be used in maintaining communication between the United States and Europe in case the cables were either cut by the enemy or otherwise placed out of commission.

It was decided that the United States would use the radio stations at New Brunswick, Annapolis, Tuckerton and Sayville for transmission purposes; but at this time none of these stations was in reliable communication with Europe at all times of the day and year. Therefore, it was necessary to increase the power of Tuckerton and Sayville and to place more modern apparatus in New Brunswick. The radio station at Annapolis had not been completed, and orders were given to rush the construction. There were only two transatlantic receiving stations, *viz.*, one at Chatham, Mass., and one at Belmar, N. J.

In Europe the only radio stations available for use in transoceanic communication were those at Rome, Italy; Lyons, France, and Carnarvon, Wales. Of these stations, the one at Lyons, France, was the only one able to communicate satisfactorily with the United States.

None of these stations was equipped with high-speed apparatus, and none was equipped in such a way as to avoid intentional interference from radio stations in Germany and the systems of operation and control were not such that large volumes of traffic could be handled.

At first it was decided that all messages from Europe destined to the United States would be sent during certain hours of the day from Lyons, and if possible from Rome and Carnarvon. Messages from the United States destined for Europe were to be transmitted from New Brunswick, Sayville, Tuckerton, and as soon as possible from Annapolis during the remaining hours of the day. In the beginning this system was capable of handling only a comparatively few important messages. Later, when it became evident that the Germans were making some attempt to cut cables off the coast of the United States, it was decided to erect another high-power station in France. In the meantime, improvements were being made at Lyons and Rome. The key was in the Navy Department for transmission from Sayville, Tuckerton, New Brunswick and Annapolis.

New improvements in organization and operating methods were made both in the United States and in Europe, resulting in a centralized control of four United States high-power radio stations from the Navy Department. A receiving station was constructed at Bar Harbor, Maine, which proved to be one of the best receiving stations in the United States. The receiving stations at Chatham and Belmar were not used, as they were not necessary. The power of the radio stations at Tuckerton, Sayville and

New Brunswick had been increased. At the time the armistice was signed, the United States system was capable of handling several thousand words per hour, and the whole transoceanic system was able to transmit and receive messages simultaneously without fear of intentional interference from Germany's high-power radio stations. Also, just before the armistice was signed, experiments in high-speed transmitting and photographic reception had begun. Had it been necessary, the transatlantic radio service would have been capable of handling all of the Government traffic between Europe and the United States.

When the United States entered the war it was noticed that the Central Powers were conducting a comprehensive scheme of propaganda by wireless. Counteracting this were the systems operating from France and England. The United States had no means of distributing American news throughout the world. Therefore, it was decided to use the transoceanic system of the Navy to distribute news of a reliable nature from the United States. The transatlantic stations transmitted this press news to Europe and South America. Naval vessels in South America received the press and distributed it to the local papers in those countries. The European news was distributed by Admiral Sims' headquarters and redistributed to the various capitals of Europe, including points in Russia. The Central American news was broadcasted from the Navy's high-power station in the Canal Zone, and was received in the northern part of South America and Central America and Mexico. News was distributed to the Philippines, Japan, China and Siberia, through the Navy's transpacific high-power stations. These reports were received in the Philippines, Shanghai, Vladivostok and Japan, and distributed to the local papers in those countries.

During the war it was found exceedingly difficult to locate persons in the United States who were using radio apparatus unlawfully. Also, when the German submarines began operations off the United States in June, 1918, it was found that, although the radio signals of the submarines were intercepted by naval radio stations along the coast, there were no efficient devices by which the exact location of the submarines could be ascertained from their radio signals.

It was found that enemy submarines used their radio apparatus promiscuously, and that they operated in pairs in order that they could fix the position of their prey by means of bearings. Such procedure necessitated the use of radio.

In order to counteract the foregoing situation, the Navy developed a comprehensive system of radio compasses, by means of which the bearing or direction of the enemy's signals could be obtained. Also, all signals were copied so that every time a message was sent the Navy could trace it. Shortly afterwards, it was noted that the submarines did not use their radio, and it is believed that the Navy's shore radio compass system robbed the enemy of a vital weapon, as the radio compass not only made it dangerous for the enemy to use their radio for communication purposes between one another, but also prevented them from using it for sending decoy distress messages.

Later the Secretary of the Navy "in a plan to hasten the progress of troopships" authorized the construction of fifteen additional radio compass stations, making a total of thirty-four on the Atlantic and Gulf Coasts. These radio compass stations were at harbor entrances and enabled ships at sea to enter port without consequent delays due to thick weather and fog. This was a very important item in the war as every minute counted in a ship's voyage.

After the armistice was signed, the Secretary authorized the construction of twenty-four more radio compass stations, which made a grand

total of fifty-eight in the United States, and which are to be used as aids to navigation during time of peace.

The technical bureaus of the Navy Department kept pace with the operating departments in their advance in the art of radio communication and in co-operation with the radio engineers of the country accomplished some remarkable developments in radio during the war.

Efficiency in high-power transmission was increased from 30 to 90 per cent. Not only was greater efficiency arrived at with lower cost, but the power of transmission was increased. For example, the radio station at Bordeaux, France, which is being constructed under the auspices of the Navy Department, has an input of 1,000 kilowatts. Its range is estimated to be 12,000 miles. It has eight 820-foot towers.

There was an increase in speed of transmission from about 30 words a minute to 100 words a minute in actual practice, and to about 300 words a minute in prearranged tests. One of the difficulties in high-power stations was the sleet on the antennæ. Methods have been arrived at by which sleet is now prevented from accumulating on the wires of the antennæ.

The valve has been developed from a non-oscillating detector to an oscillating transmitter. It is possible to receive radio signals by the beat method and to transmit signals from the valves at comparatively long distances. The valve is used also in the transmission of speech, and is very efficient for this purpose.

Another feature of valve transmission is that it permits of very sharp tuning, which in turn permits simultaneous transmissions from a great many stations. It is believed that it will be developed in the future to such an extent that it will replace most of the existing low-power transmitters.

Another feature of the valve is that its life has increased from 5 hours to over 5,000 hours, which is a very important item in the expense.

Great improvements have been made in receiving apparatus in that they are more selective, and directive receiving has increased in efficiency from 0 to 75 per cent. The old type of overhead antenna is being rapidly replaced by the use of balanced loops and underground wires, radio phase changers, and low horizontal wiring.

It is now possible to receive signals on submarines while submerged at depths of 20 feet, from shore stations, aircraft overhead, and ships afloat. This system was used to advantage in directing our submarines off our coast when they were hunting for enemy submarines.

Another improvement has been made in the radio compass, which was used at first for detecting the positions of enemy submarines, but is now developed into an aid for navigation. With properly trained personnel, the Navy is now able to give ships their positions without any large error. This will be a great boon to our merchant marine because it eliminates the delays caused by fog and thick weather, besides making navigation generally more safe along the coast.

An interesting experiment was carried on in San Francisco from the naval station at Goat Island during a recent visit of the Pacific Fleet to that port. A radio telephone was installed on Goat Island, in San Francisco Harbor, and connected by land wire to the telephone company's switchboard in San Francisco. A man on board ship was thus able to talk to his friends on shore in any part of the city. Also, this friend on shore could call up the ship from his home. This means of communication with the fleet became a popular fad in San Francisco during the stay of the fleet.

The foregoing developments are just an indication of the possibilities of the use of radio communication in the future.

If the general public of the United States is to receive the best sort of service in radio communication, it will be necessary for some central controlling agency to regulate the matter. There are so many different private services that naturally wish to have radio communication that the only solution is to have it regulated by some central authoritative agency. For example, we have heard that a man in Waco, Texas, desires to build a radio station to communicate with another radio station in Boston. This service is for his private use. Another man desires to communicate between Detroit, Mich., and Los Angeles, California. This is also a private service. Another man wishes to communicate between Philadelphia and New York. This is a private service. Another man wishes to communicate between Chicago and St. Louis. This is a private service. Multiplicity of such private service will soon demonstrate to the public that the best use of radio communication is being handicapped. The man who has the circuit from Waco, Texas, to Boston may receive interference from the man who has a circuit from Detroit to Los Angeles. The man who has the service from Chicago to St. Louis may receive interference from the man who has a service from Detroit to Los Angeles. Unless there is some central regulating body which has the power to regulate the use of radio in accordance with the development of the art, it is believed that the future demand for radio communication will be limited, and in consequence the art will not progress as much as it would if it were properly fostered and regulated. The extensive use of radio in European countries by the Allied armies and navies with the consequent experience gained has demonstrated this fact.

To illustrate how a naval communication district acts, I should like to take as an example the Third Naval District, which extends from Rhode Island to Barnegat Inlet, and in which there are eight coastal radio stations which are located as follows: Montauk, L. I.; Fire Island, L. I.; Rockaway Beach, L. I.; Sea Gate, N. Y.; Bush Terminal, N. Y.; Navy Yard, N. Y.; Mantoloking, N. J., and New London, Conn. There are also five radio compass stations located as follows: Montauk Point, L. I.; Fire Island, L. I.; Rockaway Beach, L. I.; Sandy Hook, N. J., and Mantoloking, N. J. These radio and compass stations are all controlled from one Central Control Station, located at No. 44 Whitehall Street, New York City, at which place are also the offices of the District Communication Superintendent. Direct wires from each of these stations lead into the Central Control Station, and by means of a plug-board arrangement similar in type to that used by the telephone companies, any one of these stations may be used as a transmitter by the operator on watch at the control station.

The control station is divided into a number of booths which are magnetically shielded from one another and which contain receiving apparatus of the most up-to-date type. Each booth is given a wave-length which the operator on watch must guard. There is no transmitting apparatus at this control station, all transmitting being done by means of distant control through one of the other stations mentioned above. Therefore, if the operator on watch at 600 meters receives a call and desires to answer, he promptly plugs in on a wire to any station he may decide to use and transmits via that station. He is listening all the time to what he is sending and should he hear a distress signal, he could instantly stop and give his attention to the distress call.

A chief electrician (radio) is on duty at this control station as supervisor of traffic. On his desk he has a receiver which enables him to listen in and keep check on the traffic being handled on the various wave-lengths, and, from time to time, gives orders to the various operators and stations so as to avoid interference. Such a system of supervision was found necessary in order to overcome some of the difficulties brought about

by the large increase in radio traffic about the port of New York. The excellent manner in which this system functions locally about the port of New York is another illustration of the necessity of radio supervision by one central controlling agency.

All the stations in the Third Naval District, however, are not at all times controlled from the Central Control Station. If traffic warrants it, some outlying station, such as Montauk or Fire Island, is given orders by the supervising electrician to handle traffic independently. At such times, the outlying stations are practically acting as agents for the control station.

The great advantage, besides regulating radio traffic and cutting down the amount of interference, is that should any of the stations in the district, or the control station, hear a distress call, or any other emergency arises, the control station can immediately notify all stations to stop sending, which will leave the air clear so that the emergency may be taken care of. The ability to stop all stations in the district instantly is an absolute necessity in time of war and proved itself of much value during the time the German submarines were active along the American coast.

The radio compass stations are controlled in a manner similar to the radio transmitting stations in the Third Naval District. Each compass station in the district is connected with the Compass Control Station at No. 44 Whitehall Street, New York City (which is in the same room with the Radio Control Station) by means of direct wires. The compass stations are not equipped with transmitters, and, therefore, never work independently of the Control Station, but forward all their bearings to the supervising operator. The procedure followed by a vessel which desires her position is as follows:

The vessel calls "NAH," the call letters of Navy Radio New York, signing off with the ship's call letters, followed by the international radio abbreviation "QTE," meaning, "What is my true bearing?" or with "QTF," meaning, "What is my position?" When this signal is heard by the radio operator on watch, the compass supervisor is immediately informed and he, by means of a master key which controls all wire circuits to the compass stations simultaneously, notifies the compass stations that the ship is calling for bearings and gives the wave-length by which the ship will transmit. The radio operator in the meanwhile has acknowledged the ship's call and instructed the ship to transmit by sending dashes on whatever wave-length he may specify. The compass supervisor, who also listens in to the radio signals, gives a signal on the wires leading to the stations when the ship commences to send dashes, or, in other words, tells all stations, "There he is now." All five stations in the district then take bearings on the ship which is transmitting, and when the supervisor calls for same, forward them to the Control Station on the wire. The supervising operator enters upon a specially prepared radio blank the bearings obtained, and before transmitting these bearings to the vessel plots them on a chart specially prepared for this purpose, noting whether a good fix was obtained. If the bearings obtained were good, he turns over the radio blank with bearings on it to one of the radio operators, who, in turn, transmits it to the vessel. If the bearings obtained are poor, as shown by plotting them on the chart, the compass supervisor informs the radio operators, who request the vessel to repeat, in order that a new set of bearings may be obtained.

The average time required to obtain the bearings and forward them to a vessel is between three and four minutes. In thick weather there are many calls for radio bearings, and the five stations in the Third Naval District are kept busy. It is always the desire of the supervising compass operator to obtain bearings from as many stations as possible, in order to note whether they all check. If bearings can be obtained from three or

four stations and these bearings all intersect at one point, he is then reasonably certain that the bearings obtained are accurate.

A means of checking radio compass stations has been devised in the Third Naval District and placed in operation there. By close co-operation with the Navy Route Office, Custom House, New York, where all masters of vessels call for information regarding shipping, much data has been obtained which has proven itself useful in compiling efficient curves and records of the behavior of the radio compass stations. This system has been developed in order to be able to tell at a glance how each station behaves and what the average error is in 20-degree sectors. It has been found that in some sectors the compass may read minus, while in another sector it may read normal or plus. With such data on hand it is comparatively easy to make tests and recalibrate stations, as it is already known in what directions and by how much the station is off. Such a system is especially valuable in view of the ease with which a radio compass may be influenced either by change in a position of the apparatus, slipping of the compass dial, or due to disturbing influences in the vicinity of the station, such as telephone wires, etc.

I just want to say a word in regard to the personnel employed at these radio compass stations. You have seen a photograph of the kind of place they have to perform their duties in, and most of the stations are in similar isolated places. In the winter time, especially, there is quite a strain on the operator, and they deserve much credit for the service they have rendered. They have to sit quietly in a small hut on some lonesome beach, listening continually for vessels on which to obtain bearings, in order that navigation may be made less dangerous and life and property at sea be safeguarded. One of the greatest drawbacks to the present radio compass installations is that so much depends upon the human element. What is badly needed, and which will undoubtedly be developed in the very near future, is an indicating instrument for use in connection with loops. When such an instrument has been devised, it will be quite simple and more accurate to obtain bearings on any radio station. At present very much depends upon the operator's acuteness of hearing and judgment, and as long as such is the case, absolutely perfect bearings cannot be guaranteed.

I want to call attention to the flexibility of the Naval Communication Service and cite as an instance the flight of the NC-4. A message was transmitted from the Navy Department to the plane during its transatlantic flight, a reply was received from the plane, and this reply was transmitted to London, Paris, San Francisco and the Canal Zone, and an acknowledgment received from those stations, all within three minutes of the time of beginning the first transmission to the plane from the Navy Department. Of course, every one was very much interested in the flight and the stations were all very keen to give the very best service, but this remarkably rapid operation was even a little better than we had anticipated.

During the Peace Conference the Naval Communication Service handled all of the radio communication for the American delegation. During the past summer, at the request of the American Relief Association, the commander of our naval forces in European waters put the Naval Communication Service personnel on land lines, handling the Relief Association messages throughout certain countries in Europe, and they are now handling that service and will continue to handle it until peace is finally proclaimed. This involves a complete communication system in central Europe, and gives the Navy, as well as the American Relief Association, a communication system between its London headquarters and Paris, Germany, Poland, Belgium, Italy, Austria-Hungary and Turkey.

The Communication Office of the Navy Department has handled during the last year the following messages :

Sent to Europe by Navy Department.....	16,910
Sent to Europe by other Departments	3,645
Sent to home waters by Operations	22,870
Sent to home waters by bureaus and other departments.....	351,516
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Received from Europe by Navy Dept. for Navy.....	23,034
Received from Europe by Navy Dept. for other depts.....	3,893
Received from home waters to Operations.....	49,950
Received from home waters to bureaus and other depts.....	717,313
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Total.....	794,190
Grand Total	1,189,131
Grand Total number words at 60 words per dispatch.....	71,347,860

The foregoing total was handled as follows :

By Costal Radio	1,621,542
By High Power Radio, Transatlantic and Continental.....	16,215,423
By Leased Wire, Western Union and Postal	53,500,895

The above figures are exact, except the Bureau dispatches, which are approximate and are based on the daily ratio of bureau dispatches to others during the last five months since an accurate record has been kept.

You will note that there were approximately 71,350,000 words handled by the Naval Communication Service. The high-power radio handled approximately 16,000,000. The leased wires handled approximately 53,000,000, and the coastal stations handled about 1,500,000.

During the period of demobilization a very large commercial business was done with returning transports, some of the larger transports handling fifteen hundred messages in a single month, the men wishing to send messages to their friends at home. In order to encourage this use of radio by returning troops, free service was accorded military personnel and civilian employees of the Government in so far as the ship's sending charges were concerned. Of course, this served to increase the traffic and afforded the men a chance to communicate with their families.

During the period of the war and until April 1, 1919, practically no revenue was obtained from traffic with foreign ships. This was due to the fact that up until that time no personal messages were allowed and Allied countries, with one exception, had agreed to handle messages for Allied ships free of cost as regards shore station tolls. Pre-war charges were placed in effect for United States shore stations on April 1, 1919, and foreign ships were charged regular shore station tolls.

Owing to the congestion of the Pacific cables, the Naval Communication Service reopened the transpacific circuit to Japan and the Philippines on December 19, 1918. This service, so far as Japan was concerned, took the place of the service inaugurated by the Marconi Company about three months previous to the outbreak of the war, the Navy carrying out the agreement as to tolls between San Francisco, Pearl Harbor, and Japan. Owing to the large volume of Government business this traffic was restricted to full-rate business only.

In November, 1918, the telegraph and telephone division was in charge of a lieutenant-commander, with five officers, twelve chief petty officers and an enlisted personnel of about one hundred and thirty. The telegraph system of the Navy Department at that time included wires from Galveston, Texas, to Bar Harbor, Maine. The leased telephone wires of the Navy Department extended from Norfolk, Virginia, to Portsmouth, N. H., there

being seven private telephones from the Department to New York alone. The telegraph office of the Navy Department was handling 4,000 messages a day and the Navy telephone exchange was handling 18,000 telephone calls per day.

At the time of the armistice, the Daily Shipping Bulletin, which I think I referred to previously, was being printed on a hand press and about 300 copies a day were being distributed. It was very roughly made up and had not assumed any permanent form. The personnel consisted of three officers and about 100 enlisted men.

By July 1, 1919, the circulation of the Daily Shipping Bulletin had grown to nearly 2,000 copies a day. It was being printed on a power press and had assumed a standard form. Of its total circulation nearly 1,400 were commercial firms, such as shipping companies, marine underwriters, ship brokers, exporters and importers, press associations, etc. The Bulletin contained the names of 12,500 ships with news of their latest movements and the record of nationality, register, tonnage and cargo. The popular demand for the Bulletin is growing daily and its success as a government activity is assured. Arrangements are under way to establish a permanent civil service personnel for the operation of the Bulletin to replace the enlisted personnel whose enlistments will expire or whose service in the reserve force will terminate.

The censorship of all cables was controlled from this office through the following branch offices:

	<i>Personnel</i>	
	<i>Nov. 11, 1918</i>	<i>June 30, 1919</i>
Brazil	9	0
Guam	5	0
Guantanamo Bay	3	0
Galveston	17	0
Honolulu	17	0
Cape Haitien	1	0
Key West	9	0
Lisbon	1	0
New Orleans	12	0
New York	760	78
Paris	1	0
Ponce	3	0
Panama	8	0
San Antonio	7	0
St. Croix		
Havana		
San Domingo and Puerta Plata	5	0
San Diego	1	0
San Juan	9	0
San Francisco	151	0
St. Thomas	3	0
Seattle	5	0
London	1	0
Chief Cable Censor	103	4

On April 18, 1919, by executive order, the censorship on all cables was removed from all messages except those addressed to or from German territory. This act greatly reduced the activities of the section and all branch offices except Washington and New York were closed. On July 23, 1919, all censorship of cables was removed and this section rapidly completed its most important duties.

In closing, I would like to say that we are trying to get the people in the United States to appreciate the value of communications, and we

feel that every foreign country of consequence—England, Germany, France, Italy, Belgium, and Holland—appreciate the great importance of communications and of having a system of communications over which they have control; but it seems that the people in this country have not fully realized the benefits to commerce that will naturally follow if we do have an efficient communication service with foreign countries, or such a service to those countries with which American commercial interests wish to do business.

In the Pacific, one of the most vital considerations at present is getting reliable news from the Far East into the United States, and from the United States into the Far East. The attitude in China toward Americans is one that could not be better; their feeling, as expressed to me by people who have recently been in China, is one of the deepest friendship for us, and the question of establishing communication with them and of getting reliable and recent news to and from China is one of the most important questions of the day, and I wish to emphasize the point that if there is any way of impressing upon every American the necessity for communications and the interest that the United States should take in it and in its development, and in fostering the development of high-power radio or cables, it is a patriotic duty to do so.—“Journal of the Franklin Institute.”

THE ACCIDENT TO SUBMARINE K. 13.

Mr. Hillhouse's Account, released by the Admiralty, of the Accident in the Gareloch in January, 1917.

K. 13 was one of two vessels of the double-hull type ordered from the Fairfield Company late in 1915. She was noticeable on account of her size and method of propulsion, being over 330 feet in length, of 2,600 tons displacement, and fitted with water-tube boilers and steam turbines for surface propulsion. For underwater work she had the usual storage batteries and electric motors.

On Monday, January 29, 1917, she proceeded to Gareloch to carry out her acceptance trials and made a successful dive to 83 feet, remaining submerged for about two hours. The ship was duly accepted, but as the boiler room had been too hot during the dive to enable the watertightness of the funnel covers and boiler-room ventilators to be checked, another short dive of about a quarter of an hour's duration was asked for and decided upon.

On board at the time of diving there were 55 naval officers and ratings, 11 Admiralty and sub-contractors' men, and 14 Fairfield officials, standing-by only, the ship being worked entirely by her own crew. The day was fine and the vessel lay near the shore a short distance from Shandon Hydropathic. The hatches were all closed and so reported, and the illuminated signal “Engine Room Closed,” signifying that hatches, funnels and ventilators had been closed down, was seen to be so set by those in the control room. Capt. Herbert, after a last look around, closed down the coning-tower hatch and ordered half-speed ahead on both motors. When a suitable position had been reached, opposite Shandon Hydro, he gave the order to submerge, the hydroplanes were set to diving angles and the vessel gradually sank below the surface. Almost immediately those in the control room became aware that something was wrong, as the depth gauges showed that the vessel was sinking much more rapidly than was intended. Orders were at once given to blow all tanks and come to the surface. In spite of this the vessel continued to sink rapidly. Mr. Hepworth, the Admiralty Boiler Overseer, was in the boiler-room passage when submergence began and, through the bull's-eye in the side of the