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NAVY DEPARTMENT,
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SOME NOTES ON THE EARLY HISTORY OF THE RADIO DIVISION

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These notes are by Mr. Lawrence J. Haslett, Clerk, CAF–4, whose employment in the Radio Division extended from 27 July, 1903 to 31 January, 1944 when, after having rendered faithful service throughout this period, he retired. Mr. Haslett was the first full time civilian employee of the Radio Division. His duties as stenographer and clerk afforded unique opportunities for observing matters pertaining to the establishment and early growth of Navy Radio as reflected in the notes published herewith.

J. B. DOW,
Captain, U.S.N.

* * *

In order to assist in dating events listed in these notes, the Roster of Officers-in-Charge of the Radio Division for the period 1903–1944 follows:

Bureau of Equipment

Lieut A. M. Beecher	1903.
Lieut. J. M. Hudgins	1903–1904.
Lieut. J. L. Jayne	1903–1904.
Lieut. S. S. Robison	1904–1906.
Lt. Comdr. Cleland Davis	1906–1910.

Bureau of Steam Engineering
and
Bureau of Engineering

Lt. Comdr. D. W. Todd	1910–1913.
Lt. Comdr. A. J. Hepburn	1913–1915.
Lieut. S. C. Hooper	April 1915–July 1917.
Lt. Comdr. H. P. LeClair	July 1917–August 1918.
Comdr. S. C. Hooper	August 1918–July 1923.
Capt. R. W. McNeely	July 1923–March 1926.
Comdr. S. C. Hooper	March 1926–July 1928.
Comdr. E. C. Raguet	July 1928–December 1930.
Comdr. S. A. Manahan	December 1930–October 1933.
Comdr. W. J. Ruble	October 1933–June 1938.
Lt. Comdr. J. B. Dow	June 1938–January 1940.
Comdr. A. J. Spriggs	January 1940–June 1940.

Bureau of Ships

Comdr. A. J. Spriggs..June 1940–December 1941.
Comdr. J. B. Dow..December 1941–

The first naval officers detailed in the Bureau of Equipment to devote their attention to wireless telegraphy were Lieut. A. M. Beecher and Lieut. J. M. Hudgins. During the tour of duty of Lieut. Hudgins, he prepared the first naval text book on the subject, "Instructions for the Use of Wireless Telegraph Apparatus." Reference to the Bureau's files may still find a report by him detailing the efforts made and the difficulties encountered and finally overcome in accomplishing wireless communication between Washington and Annapolis, the intervening distance being 30 miles. The Annapolis and Washington test stations were established in 1902 for the purpose of testing equipment of Slaby-Arco and Braun-Siemens-Halske manufactured in Berlin, Rochefort and Ducretet manufactured in Paris, and Lodge-Muirhead manufactured in London and imported into the United States for this purpose. DeForest equipment manufactured in the United States also was used. Tests between Annapolis and a ship in Chesapeake Bay, and between two ships at sea at "a considerable distance from land" were made also. The tests were made under the supervision of a board of five naval officers. The report of the board, received in the Bureau on 23 Sept. 1903, found that the Slaby-Arco apparatus was superior to the others. Thereupon, the Bureau ordered 20 Slaby-Arco sets, to be imported into the United States from Germany, for further tests during forthcoming fleet maneuvers.

Although not named in the roster of officers detailed in the Bureau, mention should be made of Commander F. M. Barbour, U S. Navy (retired), who was residing in Paris and in October 1901 was, at the request of the Bureau, especially detailed for duty in connection with the investigation of wireless on the Continent of Europe and who contributed largely in securing the cooperation of foreign governments, notably the French, in the early developments of wireless. For a number of years, Commander Barbour kept the Bureau advised of the latest developments and inventions in Europe.

Lieut. S. S. Robison during his stay in the Bureau, where he was associated with Lieut. J. L. Jayne, prepared in 1906 his first "Manual of Wireless Telegraphy for the Use of Naval Electricians", several editions of which have since been issued. From its initial publication in 1906 it was recognized as the Navy's standard text book on the subject.

Wireless stations were established at all the navy yards and

naval stations and at many other places on both the Atlantic and Pacific coasts of the United States, including stations on a number of lightships. Wireless stations were also established at various locations in the West Indies and the Pacific Ocean area. Eventually all the larger naval vessels were similarly equipped and the smaller ones when suitable apparatus became available.

The ships and shore stations which first were fully equipped with wireless apparatus, and operators furnished for service use, are listed below:

1903

Ships		*Shore Stations*
Baltimore.	Prairie.	Cape Elizabeth, Maine.
Kearsage.	Texas.	Newport, R. I.
Illinois.	Topeka.	Montauk Point, N. Y.
Olympia.		Navy Yard, New York[1]
		Highlands of Novesink, N. J.

1904

Ships		*Shore Stations*
Alabama.	Maine.	Portsmouth, N. H.[1]
Atlanta.	Newark.	Cape Ann, Mass.
Boston.	Cincinnati.	Boston, Mass.[1]
Brooklyn.	Rainbow.	Cape Cod, Mass.
New York.	San Francisco.	Annapolis, Md.
Yankee.	Massachusetts.	Washington, D. C.[1]
Oregon.	Mayflower.	Norfolk, Va.[1]
Wisconsin.	Minneapolis.	Cape Henry, Va.
Columbia.	Missouri.	Key West, Fla.[1]
Detroit.	Solace.	Dry Tortugas, Fla.
Iowa.	New Orleans.	Pensacola, Fla.
	Raleigh.	San Juan, P. R.
		Culebra, W. I.
		Mare Island, Calif.[1]
		Yerba Buena Isl., Calif.

1905

		Light Vessels
Chicago.	Dolphin.	Nantucket Shoals Lightship Nos. 58 & 56.
Cleveland.	Tacoma.	Diamond Shoals Lightships Nos. 71 & 72.
Des Moines.	Chattanooga.	Charleston Lightship No. 34.
Maryland.	Denver.	Guantanamo, Cuba.
Whipple.	Galveston.	Colon, C. Z.
Kentucky.	West Virginia.	Cape Henlopen, Del.
Colorado.		Charleston, S. C.
		St. Augustine, Fla.

[1] In 1905, the Shore Stations marked with figure 1 began the practice of sending out noon time signals by wireless telegraph for use in comparing chronometers.

The Navy's ship and shore wireless stations in the vicinity of San Francisco were of special value during the San Francisco disaster in April 1906, by furnishing for a considerable period a means of rapid communication with the outside world.

Jupiter Inlet, Fla.
New Orleans, La.
Pt. Arguello, Calif.
Pt. Loma, Calif.
Navy Yard, Puget Sound.
Navy Yard, Pearl Harbor.
Guam, Mariana Islands.

1906

Ships		*Shore Stations*
Brutus.	Lawton.	Fire Island, N. Y.
Caesar.	Lebanon.	Beaufort, N. C.
Charleston.	Marietta.	Tatoosh Island.
Don Juan de Aistria.	Paducah.	North Head, Wash.
Dubuque.	Supply.	Cape Blanco, Ore.
		Eureka, Calif. (Table Bluff).
		Farallon Islands.
		Cavite, P. I.

In the early days, wireless apparatus was not always received on board a vessel with enthusiasm, and more than once it was heard to be classed as a "luxury". Instances were known when commanding officers were pleased if they could leave port without having on board such means of communication.

During the tour of duty of Lieut. Comdr. Cleland Davis, who succeeded Lieut. Comdr. Robison, great progress was made in the wireless art. Consideration was given to the establishment of a chain of high power stations, which eventually were located at Arlington, Va., Darien, Canal Zone, San Diego (Chollas Heights), Calif., Pearl Harbor (Navy Yard), T. H., and Cavite (Sangley Point), P. I. Close and cordial relations were established with other government agencies in furthering the common good. Efforts were made to secure the passage of legislation to afford wireless a legal status. The many inventors who appeared were welcomed and afforded every facility and encouragement in explaining their ideas and demonstrating their inventions. Experiments were conducted with wireless compasses (or direction finders) and with the submarine bell. A contract was entered into in 1909 for the 100 KW, synchronous rotary spark, transmitter for the projected Arlington Station, this transmitter being installed at Brant Rock, Mass. in 1910 for conducting preliminary experiments in conjunction with the Wireless Laboratory at the Bureau of Standards in Washington.

It has been said that the success and favorable attention gained by Navy wireless during this early period was in no small measure due to the vision and forceful personality of Lieut. Comdr. Davis, who was stated by the Chief of Bureau to be "the beau ideal naval officer."

Lieut. J. J. Hyland (now Captain and Inspector of Naval Material at Boston) was assistant to Lieut. Comdr. Davis during this period. He systematized the blanks and forms used and the reports on wireless required from the ships and stations, and was recognized as being entitled to great credit in his efforts to bring order in that line and make the results readily obtainable and of value in a study of conditions and policies to be pursued. At that time all matters pertaining to Navy wireless, including the sending and receiving of messages, were under the cognizance of the Bureau of Equipment and all messages went through the wireless station at the Navy Yard Washington. Among the records kept was that of the number of messages and words sent and received by each wireless station. The forms, including those relating to messages, originated by Lieut. Hyland, changed to meet different conditions, are still in use. Some have been called for in court proceedings.

The following table, giving the number of messages received and transmitted by each shore station, then in commission, from July 1, 1906 to July 1, 1907 illustrates the volume of traffic handled in the early days of Navy wireless:

Name	*Messages sent*	*Messages received*	*Words sent*	*Words received*
Cape Elizabeth, Maine	48	166	892	2,935
Portsmouth, N. H.	531	840	8,078	12,922
Boston, Mass.	373	1,183	14,169	17,835
Cape Cod, Mass.	2,673	2,304	56,186	53,903
Newport, R. I.	397	2,701	9,022	35,315
Fire Island, N. Y.	81	159	1,334	872
Navy Yard, N. Y.	861	1,121	22,202	31,364
Cape Henlopen, Del.	39	115	594	2,121
Annapolis, Md.	482	573	11,432	13,333
Washington, D. C.	525	786	9,335	14,577
Norfolk Va.	1,923	2,171	31,463	33,224
Cape Henry, Va.	1,465	1,289	22,149	23,120
Light Ship No. 71	247	114	3,086	1,192
Light Ship No. 72	578	169	6,570	2,813
Beaufort, N. C.	42	537	967	6,720
Charleston, S. C.	111	196	2,466	4,407
Light Ship No. 34	7	35	188	930
St. Augustine, Fla.	122	121	2,602	2,571
Jupiter Inlet, Fla.	53	273	845	2,902
Key West, Fla.	950	1,550	18,920	27,497
Dry Tortugas, Fla.	1,228	2,703	29,278	101,902
Pensacola, Fla.	110	174	2,054	2,677
New Orleans, La.	583	1,255	1,449	1,221
San Juan, P. R.	585	1,343	13,365	18,081
Culebra, P. R.	674	458	11,614	9,893
Guantanamo, Cuba	1,359	706	17,577	14,132

Name	Messages sent	Messages received	Words sent	Words received
Colon	216	140	2,130	3,551
Puget Sound, Wash.	230	237	5,735	5,073
Tatoosh Island	17	61	902	1,176
North Head	100	101	2,215	2,362
Cape Blanco	22	15	421	250
Table Bluff, Cal.	42	19	1,060	373
Mare Island, Cal.	1,898	2,334	47,735	75,687
Farallon Islands	1,889	1,221	45,338	28,768
Yerba Buena Island	1,265	1,836	30,094	42,190
Point Arguello, Cal.	1,040	978	27,533	19,962
Point Loma, Cal.	1,672	1,532	26,528	24,384
Honolulu	16	27	351	600
Cavite, P. I.	2,025	2,013	47,081	34,247
Guam	454	517	6,959	8,525
Totals	26,936	34,073	541,519	685,607

As indicated by this table, the service at this time, comprised only messages exchanged between ships at sea and coastal stations of the Navy's "Coast Signal Service."

Lieut. Hyland prepared the first edition of "List of Wireless Telegraph Stations of the World," which, on account of the meager information received and the conflicting statements regarding call letters, wave lengths, etc., was a by no means inspiring task. Several editions of this publication were issued by the Bureau before the importance of the subject was recognized by legislation which placed it under the Department of Commerce with the call letters, wave lengths, etc., covered by legal requirements.

Wireless telephony was tested on board a number of ships in 1906, but it did not prove a valuable or satisfactory means of communication. The *Connecticut* and *Virginia* were equipped with wireless telephone equipment for further experimental purposes in 1909 in connection with the round-the-world cruise of the Fleet. So important was the experiment considered that some boxes of additional accessories were despatched after the sailing of the fleet in order to intercept it at a South American port. This action did not meet with the approval of the Commander-in-Chief of the Fleet and he freely admitted to being at a loss to know what had prompted the Bureau to forward freight at a time when the Fleet's attention was fully occupied in matters of diplomatic importance and he himself was calling upon the president of a South American country. Incidentally the experiments were not very satisfactory but paved the way to successful developments.

Halley's Comet paid the earth a visit at this time and efforts were made to ascertain if, as anticipated by some scientists, its proximity affected the wireless field. No special results were noted,

but a plan of action was tentatively decided upon for use on the occasion of its next visit.

Serious consideration was given to the possible use of the Washington Monument as a base for contemplated wireless experiments. The utilization of the monument for this purpose involved only the placing of a cap on the apex and stringing wires therefrom, and the proponents of the idea referred to the similar use of the Eiffel Tower for that purpose and the value such had been to the French in their experiments. It was also put forward as an argument in favor of the project that to receive messages emanating from the memorial to the Father of his Country would appeal most agreeably to the American people. However, the idea did not strike a responsive chord among the high officials, and the matter was dropped.

On his detachment Lieut. Hyland was succeeded by Lieut. George C. Sweet, who had been associated with the Navy wireless from its beginning. He took an active part in many experiments, and, in addition to his wireless work, was the officer of the Bureau detailed to observe and report on airplane developments and their possible utilization by the Navy. On one of his early flights with one of the Wright brothers at Fort Myer the airplane crashed and he sustained a broken arm. Undeterred by this mishap, he prepared a requisition for the construction of an airplane strong enough to hold four persons, which requirement many individuals gravely stated was entirely beyond reasonable expectations. The requisition did not gain official approval, but it is not too much to state that it was at least a factor in developing and crystalizing a sentiment which finally resulted in the creation of the Bureau of Aeronautics. Ensign C. H. Maddox designed and built the first radio transmitter used in a Navy airplane and tested the equipment in flight, its effective range being about ten miles.

On a later tour of duty Lieut. Sweet (then Commander) had charge of the radio installation features of the Lafayette 1000 kw Arc Radio Station in France.

During the administration of Lieut. Comdr. Davis the Navy Department considered itself fortunate in having the cooperation of Dr. Louis W. Austin, noted physicist and international authority, then conducting tests under the auspices of the Bureau of Standards. Later, in order to devote his entire time in endeavoring to solve the many pressing problems arising in naval communications, Dr. Austin resigned from the Bureau of Standards and became attached to the Navy Department. He was head of the U. S. Naval Radiotelegraphic Laboratory at the Bureau of Standards from 1908 to 1923. He made several trips to Europe in furtherance of the Navy's interests and was a representative of this country at the International Radiotelegraphic Conference at Paris in 1921.

Dr. Austin was the author of numerous pamphlets on radio measurements and devices, and was especially active in the study of atmospheric interference, its source and causes. Many of these articles, which received world-wide acclaim, were published in the Bulletin of the Bureau of Standards, in the Proceedings of the Washington Academy of Science, and in the Proceedings of the Institute of Radio Engineers. He was a fellow of the latter organization and was its president in 1914.

George H. Clark was appointed as Subinspector of Wireless Telegraph Stations in 1908, and was stationed at the Navy Yard, Washington. The title of his position was subsequently changed to Expert Radio Aide and a number of technical assistants with similar titles were appointed at various navy yards. As originally directed when these positions were created, the time of these assistants was not to be taken up with the preparation of correspondence.

Being the first practical wireless man in the service of the Navy Department, and being stationed at the Navy Yard, Washington, Mr. Clark was in close touch with the administrative officers of the Department and was called upon constantly to assist in solving the problems that arose. He specialized in the preparation of specifications for wireless apparatus, and all Navy wireless material up to the close of World War I was purchased in accordance with these specifications. He took an active part in a number of tests between naval vessels and shore stations, and accompanied the President on several trips to the Canal Zone. He alone conducted the transatlantic acceptance tests of the Arlington Naval Radio Station (NAA). These tests required the cruiser *Salem*, on board of which Mr. Clark directed the tests, to go as far as the coast of Europe. In his report to the Department on this subject, Lieut. Comdr. Hepburn stated that Mr. Clark had very satisfactorily conducted tests which ordinarily would have required the appointment of a board of naval officers. Mr. Clark later resigned from the Navy Department to accept a position with a commercial radio company.

Lieut. Comdr. Davis was succeeded by Lieut. Comdr. D. W. Todd, under whose administration the importance of wireless became more and more recognized and great strides were made in relation to its use by the Navy; the outstanding features of which might be considered as the completion of the Arlington, Va. 100 KW rotary synchronous spark station of the Navy's chain of

high power stations Arlington, Darien, San Diego, Pearl Harbor and Cavite, and the establishment of the office of Superintendent of Radio Service. (The Arlington Station was placed in commission on 13 February 1913.)

FIGURE 1.—Photograph of personnel of the Arlington station.

The Radio Division as such was established at this time (1910) when the Bureau of Equipment was abolished and the administration of its duties concerning radio were taken over by the Bureau of Steam Engineering. At the recommendation of the Bureau the substitution of the word "Radio" for "Wireless," in conformity with international usage, was authorized and directed by the Department.

The functions of the office of Superintendent of Radio Service were designed to administer the executive details of the ever-expanding features of Navy radio previously handled solely by the Bureau, the latter retaining only the features relating to the apparatus and its installation and maintenance. At first the office of Superintendent was considered as a "field" service and was located at the Arlington Radio Station. Legislation was subsequently enacted which permitted the office to be transferred to the Navy Department Building, and the title of its head changed to Director of Naval Communications.

Several sets of portable radio apparatus were purchased in 1910 and tested on the *North Carolina, Montana* and *Chester*. These were designed for a maximum range of 20 miles and were intended for landing parties and use during battle; upon clearing ship for battle, the main aerial to be taken down, the portable set to be used with a wire hoisted to the yard arm, the operator and his small portable outfit being in any protected position.

In 1911 a working party from the Navy Yard, Mare Island, arrived in Alaskan waters on the *U. S. S. Buffalo* and established shore radio stations at St. Paul, Unalaska (later Dutch Harbor), and Kodiak. These stations were intended to serve not only the Navy but also the Departments of Commerce, Treasury and Agriculture. They also served commercial interests in Alaska by providing for the exchange of messages between outlying points and the Alaska terminal of the Washington and Alaskan military cable system.

The value of kites as supports for aerials of ships for temporary long-distance communications were tested with indifferent results.

Contracts for construction of the Darien, C. Z., high power station were awarded in 1913.

No legislation covering the use of radio was enacted until after the *Titanic* disaster, when installation of radio on all ocean-going steamers and the control of such apparatus on sea and shore was required by law. Up to that time, cooperation between the different radio companies and with the Navy was not always what could have been desired. One company refused to work with vessels and stations equipped with apparatus other than its own; even with naval vessels when requesting information regarding the whereabouts of a derelict which was being sought to be destroyed as a menace to navigation. This attitude justified the necessity for some positive law covering the humanitarian features of radio.

The notable achievements attained by the Navy in radio developments and the growing importance it assumed during this

period might properly be considered as in no small degree due to the tireless energy and devotion to duty of Lieut. Comdr. Todd. He later returned to the Department as Captain and Director of Naval Communications.

Lieut. Comdr. A. J. Hepburn succeeded Lieut. Comdr. Todd, and under his administration the radio compass (afterwards called direction finder) was largely developed. A number of experimental radio compasses were established first on ships and later on shore, and finally over fifty stations were in successful operation. Most of the stations were later turned over to the Coast Guard, the Navy retaining only those at Naval Air Stations and at strategic points.

In addition to the marked progress made in radio which characterized Lieut. Comdr. Hepburn's administration, there was established at this time the system of co-ordinating and numbering radio drawings. This system was found to greatly simplify and facilitate the work involved. In this system the Bureau and each navy yard is given an identifying letter, so that there is no confusion between the prints of one yard and those of another. The drawings of any yard can be used at any other yard without renumbering. As an example, one drawing issued by the Bureau is numbered RE 42A 125. The center figures show the class of apparatus involved, and the final figures indicate the serial number of the drawing relating to that type of apparatus. Also by use of this system, castings and parts made at any yard could be used without confusion at any other yard.

The above system of numbering, wholly originating in the Radio Division, was approved and adopted by the Navy Filing Manual Permanent Committee in its preparation of a filing manual for the Naval Establishment, which in turn was given official approval by the Secretary of the Navy.

While this system has been discarded in the Bureau of Ships with respect to classification and numbering of radio correspondence, it is still in current use for type numbers and drawing number assignments, and is being used by the Bureau of Aeronautics in connection with correspondence relating to aircraft radio.

With the question of permanency of stations being determined and owing to the fire hazards involved, the policy was established in 1914 of replacing wood lattice guyed masts with self-supporting steel towers and also replacing wood frame operating buildings with reinforced concrete buildings.

Proposals were issued in 1914 for the remaining high power stations, San Diego (Chollas Hts.) Pearl Harbor (Navy Yard) and Cavite (Sangley Point); and plans were formulated for similar stations, but of lower power, at Tutuila, Samoa and Guam, Mariana Islands. These five stations were eventually established within the statutory limit of cost of $1,500,000.

In the face of adverse reports by the world's greatest authorities, the Poulsen "Arc" continuous wave type transmitter was adopted by the Navy for its chain of high power radio stations.

Lieut. Comdr. Hepburn was succeeded by Lieut. S. C. Hooper, who came to the Bureau from duty as the Fleet Radio Officer. It should be stated that he has the distinction of being the first officer to have had this duty. He was Head of the Radio Division during the early part of the first World War. Up to the time he took charge, the Radio Division had consisted of but one or two officers and one civilian, but during his incumbency it speedily expanded and in time numbered nearly one hundred officers and civilians.

The publication now known as "Radio and Sound Bulletin" made its initial appearance during the administration of Lieut. Hooper in 1915. It was in blueprint form entitled "Semi-Monthly Radio Report" and had a limited circulation, but its importance was soon recognized and resulted in its appearance as a printed publication. Still later it was combined with the "Bulletin of Engineering Information," issued for years by the Bureau of Steam Engineering. It has since been re-established as a separate publication and issued quarterly. It is widely distributed and from its beginning has been of inestimable value in disseminating and coordinating radio information throughout the Naval Service. It has frequently been of assistance in litigation and copies of its pages have been called for by the courts.

The Darien high power station was completed and placed in commission in May 1915. The service performance of this 100 KW station on the Balboa-Washington circuit exceeded expectations and assured the success of the remaining high power stations—Chollas Heights, Pearl Harbor, Cavite. Owing to the greater distances over land-water paths, these stations eventually received Arc transmitters of 200 KW, 300 KW and 350 KW rated power respectively.

Decision was made to supplement the spark type transmitter with Arc type transmitter of from 20 to 30 KW rated power at the Charleston, Key West, Puget Sound, Mare Island and San Juan stations and to provide 30 KW Arc transmitters for the new stations at Cordova, Alaska and Pt. Isabel, Tex.

In 1915–1916 the first aircraft radio laboratory in the world was established by the Navy at Anacostia, D. C.

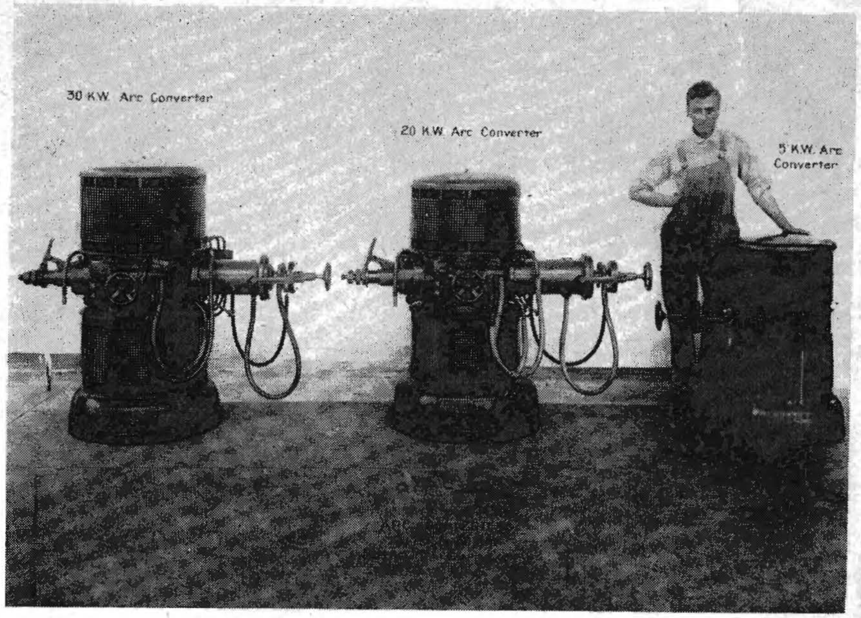


FIGURE 2.—Early arc converters.

Inventions and developments in the Radio Compass and Radio Direction Finder for naval and maritime use and also for use in aircraft were sponsored and encouraged by the Navy.

Steps were taken in 1915 to equip Naval Militia Organizations with field sets for training purposes and for use in the field.

Beginning in 1915 and for some time thereafter, some of the equipment required by the Navy was manufactured in Navy Yards from the Bureau's design and specifications in an effort to bring about standardization of Navy equipment.

In 1916, contracts were entered into for the radio equipment for the San Diego (Chollas Hts.) and Pearl Harbor high power radio stations and for both the radio and power equipment for the Cavite station. Also, distant control of stations, to permit simultaneous sending and receiving was established in connection with the Arlington, Mare Island, Boston and Navy Yard Washington Stations.

The Naval Radio Service was mobilized for tests on May 6, 7, and 8, 1916 when, in conjunction with the American Telephone and Telegraph Co., the Navy Department was connected by telephone and telegraph with all Navy Yards and naval radio stations in the United States. On 6 May, communication was established by wireless telephone between the Secretary of the Navy and the Captain of the battleship *New Hampshire,* then at anchor off

FIGURE 3.—Photograph showing Secretary of the Navy Daniels in communication with the U.S.S. *New Hampshire* by wireless telephone.

Fortress Monroe. On 7 May, communication was again carried out with the *New Hampshire* cruising between Hampton Roads and the Southern drill grounds, and the communication was extended to include Mare Island; the Commandant conversing for some time with the Captain of the *New Hampshire*. This was done by land line from Mare Island to Arlington and thence by wireless telephone to the *New Hampshire;* returning wireless telephone from the *New Hampshire* to Norfolk Radio thence by land line to Mare Island via the Navy Department. Earlier, in 1915, trans-Atlantic radio telephone experiments were carried on between the Arlington Station and the Eifel Tower Station in Paris.

On being detached from his first tour of duty in the Radio Division, Lieut. Comdr. Hooper, detailed to command the destroyer *Fairfax,* was succeeded by Lieut. Comdr. H. P. LeClair. During Lt. Comdr. LeClair's administration, the Navy definitely established the policy of equipping ships of the fleet with continuous wave type of transmitters with a view to the gradual replacement of all "spark" or "damped wave" type of transmitters, which previously had been in general use throughout the fleet. Upon learning of the Navy's intentions, vigorous protests by several manufacturers of the "spark" equipment were lodged with the Secretary of the Navy. They contended that the damped wave "spark"

type transmitter was superior to the continuous wave type for the then present and future shipboard use.

At this time the Navy Department purchased from the Marconi Wireless Telegraph Company of America at a cost of $1,450,000 all their equipments on American vessels installed on a rental basis and all of their shore radio stations situated within the United States and Alaska, the Marconi Company retaining only its high power trans-oceanic and trans-Pacific stations. All of the Marconi stations were equipped with "spark" type transmitters. During this time also all of the shore radio stations and the "Arc" patents of the Federal Telegraph Company of California were purchased for $1,600,000. All of the Federal Stations were equipped with "Arc" type, continuous wave, transmitters. This included the terminals of their trans-Pacific circuit between San Francisco and Honolulu, via., the South San Francisco and the Heeia, (T.H.) high power radio stations.

The purchase of the Marconi and Federal Radio Stations proved to be of outstanding importance. The later formation of the Radio Corporation of America which finally brought about full American ownership and control of all radio stations within the United States and its insular possessions stemmed from these purchases.

On the detachment of Lieut. Comdr. LeClair, Commander Hooper was again ordered to head the Radio Division. It was during this tour of duty that officers were assigned to duty in the field as Radio Material Officers. District Communication Officers thereafter handled only the personnel-operation features and Radio Material Officers the material features of the Naval Communication Service in the field.

The approval in principle of the Chief of Naval Operation was obtained by the Bureau prior to the assignment of officers to various Navy Yards for duty as Radio Material Officers. However, upon the issuance by the Bureau of instructions to Commandants concerning the duties and functions of Radio Material Officers, some opposition to this move developed on the ground that the District Communication Officers could readily continue to handle all material matters in addition to their supervising the personnel-operation functions of the Naval Communication Service. The Chief of Naval Operations thereupon withdrew his approval. Since, by that time, a number of officers had been detailed, and were functioning as Radio Material Officers, and as the Bureau's instructions, widely distributed ashore and afloat, were in effect, it was impracticable for the Bureau to withdraw and informal agreement was reached to let matters stand as they then were. As a consequence, Radio Material Officers are not yet fully recognized in Navy Regulations. The necessary action in this regard is now being initiated by the Bureau.

The Navy encouraged in every way possible the development of the three eleent vacuum tube, it being felt that no other generator of high frequency oscillations offered the solution to the problem of providing a sufficient number of frequency channels for intra- and interfleet communications.

On his own detachment when his tour of shore duty had expired, Commander Hooper became the Radio Officer of the United States Fleet with station on board the cruiser *Seattle.* At this juncture Captain R. W. McNeely, then commanding the battleship *Delaware,* was detailed to head the Division. He was the first officer of that rank to become its head, and his appointment was considered to be quite an asset to the Radio Division and signally enhanced its standing. Consolidation of design and research work at the new Naval Experimental and Research Laboratory, Bellevue, D. C., was effected in 1923, under the supervision of Doctor Taylor and Doctor Hays. The advent of high frequency radio in the Navy; equipping ships for simultaneous transmission and reception; and the beginning of conversion of spark, damped wave, transmitters into vacuum tube, continuous wave, transmitters occurred during this period.

Concluding his duty as staff officer, Commander Hooper, upon the detachment of Captain McNeely, returned a third time to head the Radio Division. His three administrations were replete with outstanding achievements, one of the most prominent of which being his part, together with Rear Admiral Bullard, Director of Naval Communications, and Rear Admiral Griffin, Chief of the Bureau of Steam Engineering, and other officers, in bringing about the formation of the Radio Corporation of America. This corporation acquired the remaining property of the Marconi Wireless Telegraph Company of America, including its high power trans-Atlantic and trans-Pacific radio stations. This action, together with the previous acquirement by American companies of the high power trans-Atlantic stations at Sayville (Long Island) and Tuckerton, (N. J.) eliminated from the United States and its possessions all transoceanic radio stations of other than American ownership and control.

Upon our entrance into World War I, Commander Hooper made arrangements with officials of the United States Shipping Board whereby the Navy radio organization in the Radio Division and that in the field at navy yards and stations, undertook the work of procuring and installing all radio equipment on Shipping Board vessels requisitioned or constructed, and also the maintenance of

the installations for the duration of the war. This relieved the Shipping Board of all responsibility for radio material matters in connection with their vessels, numbering approximately 1800.

The establishment by the Navy, in conjunction with the French government, of a high power (1,000 KW) arc type transmitter station (Lafayette Radio Station) at Croix d'Hins near Boreadux, was finished under the supervision of Commander Hooper. This station in conjunction with a similar station at Annapolis, Md., was intended to augment the then available meager trasn-Atlantic communication facilities between the American Expeditionary

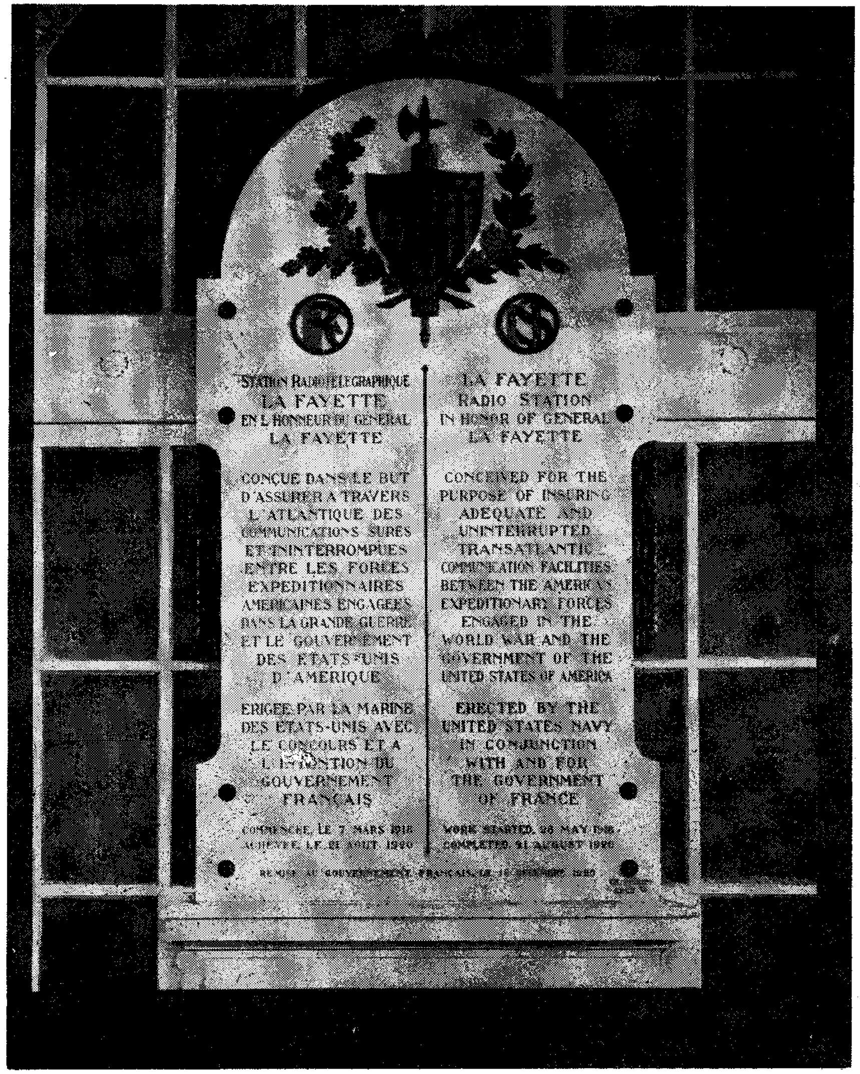


FIGURE 4.—Photograph of tablet erected on Lafayette radio station.

Force and the United States and to provide for an emergency means of communication in the event that the trans-Atlantic cables were cut by German submarines.

For his achievements during the war Commissioner Hooper was awarded the Victory Medal and Navy Cross. He was also decorated by the French government and made a chevalier in the Legion of Honor, receiving the decoration personally from General Neville of the French army at Fort Myer, December 6, 1920.

On the occasion of his second tour of duty in the Bureau, Commander Hooper's duties were greatly increased when the work of conducting underwater sound activities was transferred to the Radio Division. This was a development of the experiments conducted with the submarine bell by the Radio Division during the administration of Lieut. Comdr. Davis. Ships were fitted with microphones mounted within the hull for receiving the bell signals. The first means of calculating distances from obscure stations was by means of a submarine bell, combined with radio, in which signals were sent out simultaneously. By knowing the time of transit of the sound impulses under water, the distance was ascertained. The technique arising from the use of the submarine bell in locating a vessel's position relative to a lightship was the basis from which all of the developments of submarine detection by underwater sound sprung during the first World War.

When the German submarine menace during this period became serious, at an urgent recommendation initiated by the Radio Division, several large groups of scientists from the leading electrical companies and technical universities began work on the development of devices for submarine detection. Navy sponsored laboratories at New London and Pasadena were centers of development by these scientific groups. Full cooperation of the Radio Division engineering facilities was provided.

First developing the multi-spot sound receiver as the acceptable detection equipment for the Navy, the Radio Division, working in conjunction with the Sound Laboratory at the Washington Navy Yard and the Experiment Station at Annapolis and later with the Naval Research Laboratory at Bellevue, eventually developed an underwater sound detection equipment. This was installed at first on a limited number of ships—not exceeding thirty. Later the Radio Division embarked on a major program of equipping all new destroyers and submarines with this equipment. In 1936 the number was less than one hundred; it is now increased to approximately three thousand.

Underwater sound is now recognized as a necessary equipment for submarine detection and submarine listening. It is the only known means at the present time whereby a submarine submerged can be detected.

The Department has lately approved the use of the coined word "Sonar" as a short title covering the art of equipment for the purpose of submarine detection and navigation by United States naval vessels involving the use of underwater sound principles. This word is derived from the terms "sound," "navigation" and "ranging."

Reference to the events transpiring during Commander Hooper's regime would be incomplete without an allusion to the experiments conducted with piloting cable. As an outgrowth of wartime experiments in Great Britain and the United States, the Radio Division promoted the laying of piloting cable at the shore station entrance of New York Harbor. This was used experimentally for four years and then turned over to the Bureau of Lighthouses of the Department of Commerce. While in use by the Navy, tests were made both by surface vessels and low-flying seaplanes, and these tests showed promise for it as a piloting system.

The Army's need for radio for the transmission of their traffic increased to such an extent that they were considering the establishment of a separate station at Fort Myer, Va. Since this appeared to be a duplication of the functioning of the Arlington Radio Station, the Navy offered to supply such radio facilities as might be required under an agreement of mutual satisfaction to both the Army and Navy. This equipment was maintained by the Navy and all control of the transmitter assigned to the Army was accomplished from the Army Radio Center in Washington.

Commander Hooper reached the grade of Captain while attached to the Radio Division. He was succeeded by Commander E. C. Raguet, whose administration continued the policy of using high power low frequency service, in lieu of discarding low frequency in favor of high frequency service for long distance communications as had been done by the commercial radio companies on their point-to-point circuits. Decision was therefore made and action taken to procure and install 300 KW low frequency vacuum tube transmitters at the Cavite and Pearl Harbor stations as replacements for similar powered arc type transmitters of semi-obsolete type.

The installation of these sets definitely proved the practicability of a vacuum tube transmitter of such large outputs. The Cavite transmitter has since been destroyed by bombing by the Japanese. The Pearl Harbor transmitter later was modified for 500 KW rated power and installed at Lualualei, T. H., where it is now operating and where it has rendered valuable service. At Annapolis there is now a similar 500 KW installation.

Extensive developments in and installations of high frequency radio on the Navy's point-to-point circuits and on ships took place during this period. High speed automatic transmission and recording on the Navy's point-to-point circuits also was introduced during this period.

On his detachment Commander Raguet was succeeded by Commander S. A. Manahan, who had already served two tours of duty in the Radio Division, first in charge of Ship Installations and later as head of the Shore Station Section.

During this period there developed the need for a more extensive receiving and monitor stations than that in use at the Naval Research Laboratory at Bellevue. Cheltenham, Md., was selected as the most suitable site. The reservation comprised 550 acres. The station was not finally completed until 1939. Its facilities have been greatly increased from time to time.

During Commander Manahan's administration the cognizance of visual signaling searchlights was transferred from the Electrical Division to the Radio Division and placed in the Underwater Sound Section, where it remained until 1940. During this period of control of small incandescent searchlights and 24″ searchlights a complete modernization of all such equipment in the fleet was accomplished. The work was turned back to the Electrical Division with the design and procurement in such condition that very little work was necessary other than increasing the volume and distribution of equipment to meet the emergency. During Commander Manahan's tour of duty as head of the Shore Station Section, efforts were made to acquire, on a rental basis, the service use of the RCA Bolinas, Calif., and Kahuku, T. H. Alexanderson alternator low frequency equipment for Navy trans-Pacific communications. The rental terms proposed were unacceptable and the matter was dropped. The Navy subsequently installed the high power vacuum tube low frequency transmitters at Pearl Harbor and Cavite as previously referred to. Low frequency receivers of restricted low frequency range were developed for exclusive use on the Navy's low frequency circuits.

Commander W. J. Ruble succeeded Commander Manahan in charge of the Radio Division, and after him came Lieut. Comdr. J. B. Dow and Commander A. J. Spriggs. Commander Dow, since promoted to the grade of Captain, returned to head the Division, which now numbers over a thousand members.

While the events of the latest administrations of the Radio Division might perhaps be considered as too recent for allusion

at this time, it would still be appropriate to refer to the erection of the higher power station, Lualualei, Hawaiian Islands, and the fact that the energy with which the Division undertook in bringing this project to an early completion, while under charge of Commander Ruble, was a matter of special notice and commendation by the Department.

During the first World War the value of pigeons as a means of limited communication was recognized by the Navy, and as this comprised a material part of communications, their cognizance logically fell under the supervision of the Radio Division. Lofts were established at Pensacola, Lakehurst, Anacostia, Parris Island and other locations. The acquisition and training of pigeons continued for a number of years following the war. The Navy at the Anacostia loft bred a number of nationally known birds which established several interesting records for flights and endurance. Owing to the advance in the radio art, however, interest and the need for pigeons in the Navy diminished. Finally what remained of this branch of the communication service was transferred to the Bureau of Aeronautics and the Marine Corps, the latter retaining lofts of their own at several locations.

The Radio Division has a distinction which probably no other divisions of a Naval Bureau has attained in that two of its heads reached the grade of Admiral and became Commanders-in-Chief of the Fleet. They are Admiral S. S. Robison and Admiral A. J. Hepburn.

Following its policy of cooperation and in addition to its long period of work with the Army Signal Corps, the Radio Division has worked in close relationship with Radio officials of the Department of Commerce to facilitate the establishment and functioning of installations required from time to time by legislation; has assisted the Coast Guard (in peacetime under the Treasury Department) in the procurement and installation of apparatus; has furnished radio sets for use by the State Department in distant countries; and worked with the Agriculture Department in assisting in certain experiments conducted by the Weather Bureau and furnishing radio sets for use in fighting forest fires and establishing communications destroyed by floods.

The Arlington Radio Station as a regular Navy traffic station has since been dismantled and its towers have disappeared. The removal of the station, long a landmark of early naval radio and presenting a striking and pleasing sight across the Potomac River from Washington, with the tracery of its towers outlined against the sky, was seemingly necessitated by the hazards they presented to aerial navigation.

Among others who served in the Radio Division at different times may be mentioned the following:

Guy Hill, radio aide and later Captain, U. S. Signal Corps, who rendered notable service, particularly in design work. He made a specialty of wave changers and was a joint inventor of the Navy's standard device.

A. M. Trogner, radio aide, who deserves special mention for his work in establishing standard plans for installations on various types of vessels. Upon visiting several British warships and drawing up plans for similar equipment on American vessels, especially the acceptor-rejector and the 120-meter equipment, the ships of both navies were equipped for mutual signaling.

Radio Aide E. D. Forbes, who supervised the design of radio compasses at the Philadelphia Navy Yard, and Radio Aide Stuart Ballentine who was engaged in similar work, particularly in the mathematical study of these devices.

Haraden Pratt, vice president and chief engineer of the Mackay Radio & Telegraph Co., who served for several years as radio aide. His services were especially useful in connection with the building of the high power station at Annapolis.

B. R. Cummings, now with the Farnsworth Television Company; A. A. Isbell, formerly west coast manager of the Radio Corporation of America; T. Johnson, Jr., now with the General Electric Company and while with the Radio Division the author of 'Naval Aircraft Radio," recognized as a standard treatise on the subject; George Lewis, who served during the first World War as Lieutenant, USNR.

Comdr. William A. Eaton, USNR., who served in the Navy for years prior to the first World War and is now in the Radio Division in charge of ship radar installations and maintenance; Lieut. Comdr. A. P. Van Dyck, USNR., a radio aide during the first war and now an officer again attached to the Radio Division; Lieut. Harry Sadenwater, USNR., a member of the crew of the NC–4 on its trans-Atlantic flight; Ensign Alfred Crossley, USNR., who specialized in submarine and subterranean antenna experiments.

While not attached to the Radio Division, the list would be incomplete without including Charles J. Pannill, who was in close contact with its officers for years both before and during his service as assistant to the Director of Naval Communications. He is now president of the Radiomarine Corporation of America.

Arthur O'Brien, John M. Stewart and James E. Parker have the distinction of serving in the Radio Division during both World Wars, while Walter H. Floyd has a service record embracing the

same period, most of which was spent in the Radio Division. Any list of the older employes should also include the names of Harold Abbey and Philip T. Russell, both long identified with the development and installation of underwater sound equipment, the latter being associated with a number of inventions covering the same apparatus.

A record of the Radio Division would be incomplete without allusion to those who have passed away and who, by their attainments and example, afford an inspiration to those who have taken up the work where they left off. Among those who have died are Rear Admiral Joseph L. Jayne, head of the Radio Division in its early days and a member of the Inter-Departmental Wireless Telegraph Board appointed by the President, and later became Superintendent of the Naval Observatory; Lieut. John M. Hudgins, another of the pioneers, who left the Bureau only to meet death shortly thereafter in an explosion on board the battleship *Missouri;* Lieut. Herbert C. Rodd, remembered for his energetic work in aircraft radio and his participation in the memorable trans-Atlantic flight of the NC–4, and who died in an airplane crash at Norfolk; Lieut. Marcus H. Esterly, who perished in the ZR–2 dirigible disaster at Hull, England, in 1921; Captain William F. Grimes, USNR., who served for several years as radio aide in the Division and who died lately while holding the position of District Communication Officer of the Eleventh Naval District; Dr. Louis W. Austin, the noted physicist, whose death left a distinct void in the field of radio research; and Albert L. Young, radio aide in the Bureau since 1919 and well known to the service as an authority on ship installations.

Nor would reference to the Radio personnel be complete without mention of Frank C. Warman who was well known to all the officers and civilians who successfully were on duty in the Division, and all of whom would gladly express their appreciation of his outstanding ability and the assistance he rendered. A veritable genius in the details of filing, he was made senior member of a departmental board appointed to coordinate the various filing systems in use throughout the Naval Establishment. He was delegated to visit the several yards and stations to inaugurate a uniform system, and received tangible evidence of the Department's recognition and appreciation. There were innumerable instances of his ability in aiding the Radio officers in their search for papers involving matters then in litigation or otherwise of great importance. A man of remarkable memory, on being requested to furnish a paper from the files even twenty or more years back, he would be able to state the contents of the same before locating it, and later produce the paper to corroborate his statements. Although not himself a member of the Radio Division, any recounting of incidents relating thereto would be incomplete without a closing tribute to the memory of Frank C. Warman.

REVISED FAILURE REPORT FORM

In order to facilitate the prompt report of all failures in Naval Radio Equipment, Failure Report Form NBS 383 has been revised. The multiple-copy form has been replaced by a single card accompanied by a franked return-addressed envelope. The face and reverse of the card are reproduced in figure 1.

FAILURE REPORT
NBS-383—NAVSHIPS (250)
REVISED 4-44

NOTICE.—Read notes on reverse side. Additional forms or envelopes may be obtained from nearest RMO.

DATE

SHIP NUMBER AND NAME OR STATION USING EQUIPMENT WHEN FAILURE OCCURRED

NAME AND RANK OR RATING OF PERSON MAKING REPORT (PREFERABLY REPAIRMAN)

EQUIPMENT INVOLVED

CHECK WHICH EQUIPMENT: ☐ RADIO ☐ RADAR ☐ SONAR ☐ OTHER

MODEL NO. | NAME OF CONTRACTOR | SERIAL NO. (CONSULT NAMEPLATE)

TYPE NUMBER AND NAME OF MAJOR UNIT INVOLVED | SERIAL NO. (CONSULT NAMEPLATE)

CONTRACT NO. (CONSULT NAMEPLATE) | DATE INSTALLED (IF KNOWN)

ITEM OR PART WHICH FAILED

GIVE BRIEF DESCRIPTION OF PART

CIRCUIT SYMBOL | NAVY TYPE IF AVAILABLE | APPROXIMATE LIFE

BRIEF DESCRIPTION OF FAILURE (USE OTHER SIDE OR SEPARATE SHEET IF ADDITIONAL SPACE IS NECESSARY)

INSERT IN ENVELOPE—SEAL—MAIL

16—39322-1

FIGURE 1a.—Face of new failure report form.

1. This new simplified failure report form has been prepared to make the submission of these reports quicker and easier. Franked envelope (Form NBS 383A) is supplied for your convenience in submitting card form—if not available mail to BUSHIPS, Attn.: Code (970).
2. The purpose of this report is to inform BUSHIPS of the cause and rate of failures.
3. This report MUST be filled out and forwarded for EVERY DERANGEMENT of equipment (less tubes) whether caused by DEFECTIVE PARTS, WORN PARTS, IMPROPER OPERATION, or EXTERNAL INFLUENCES.
4. This report is not a requisition. You must request the replacement part from your Tender, Supply Officer, or Radio Material Officer.
5. This report may be filled out with TYPEWRITER, PEN, or PENCIL.
6. If CONFIDENTIAL information is included in description of failure, mail in accordance with NAVY REGS. TYPE and MODEL DESIGNATIONS ARE NOT CONFIDENTIAL.
7. This revised Form NBS 383 supersedes the old septuplicate form. No copies are required. Previous instructions pertaining to preparation and submission of the old form (including sect. VIII, part 2, of chap. 67, BUSHIPS Manual, not yet distributed, April 1944) are hereby canceled. Adjustments of contractual matters will be made between BUSHIPS, INSMATS, and CONTRACTORS.

16—39322-1 U. S. GOVERNMENT PRINTING OFFICE

FIGURE 1b.—Reverse of new failure report form.

The primary purposes of this form are:

(*a*) To advise the Radio Division of the Bureau of Ships of failures occurring in equipments under its cognizance. The information requested in NBS 383 (revised April 1944) is essential in order that new design may profit by experience gathered from the operation of similar units in the field.

(*b*) To advise the Radio Division of excessive failures of items so that immediate steps may be taken to procure needed parts in advance of requests from primary supply sources.

(*c*) To provide evidence warranting overall replacement by the contractor of parts failing in excess of 10% during the guarantee period.

As soon as any electronic failure is experienced, the person determining the failure or the individual responsible for its repair shall fill out the card and mail it directly to the Bureau of Ships. A "failure" is intended to include anything that may cause an equipment or component thereof to become inoperative or inefficient to the point of unsatisfactory performance. This includes normal wear and tear. The full advantage of the form will be realized only if the best information obtainable as to cause and nature of the failure and conditions surrounding it are included in the report. A separate failure report card should be used for each component failure and several cards may be mailed in a single envelope if desired.

It should be borne in mind that the new card is for engineering record only and is not a requisition. Replacement parts should be requested through established Naval Supply channels. Copies of the failure report need not be sent to Inspector of Naval Material by the activity reporting the failure.

Copies of the form are available from Radio Material Officers.

REPLACEMENT OF COAXIAL CABLES AND CONNECTORS FOR THE AN/FGC-1A KEYER

In order to improve the reliability and availability of coaxial cable and connectors used on and with the AN/FGC-1A Frequency Shift Keyer, a change has been made to a more standard Army-Navy type.

Whenever the cables and connectors of the older type become defective, they should be replaced with the following:

(*a*) Wherever the H. B. Jones S101 receptacle is used, the Navy type 49194 receptacle and Navy type 49193 receptacle hood should be substituted therefor.

(*b*) Wherever the H. B. Jones P101 ¼ plug is used, the Navy type 49195 plug should be substituted therefor.

(*c*) Wherever the Western Electric Company Code KS-8086 coaxial cable (Army-Navy type RG-39/U) is used, the Army-Navy type RG-8/U coaxial cable should be substituted therefor.

These new cables and cable connectors are described with assembling instructions in Bureau of Ships Radio and Sound Bulletin Number 13, dated 1 January 1944.

EFFECTIVENESS OF TYPE CKB-50142 NOISE LIMITERS

At the request of the Bureau of Ships, the Radio Material Officer at Navy Yard, Philadelphia, has investigated the effectiveness of the type CKB-50142 Noise Limiter in the Model RAS receivers. The report of this study is quoted herewith.

"One of these noise limiters has been installed in each RAS receiver in the Fourth Naval District, and decibel meter tests indicated that the relative noise level dropped from approximately 22 to 14 db in the air station control towers. Signals which were unintelligible before installation of the limiter could be understood after it was inserted, without change of volume controls. In general, the noise limiters have improved reception at each location where installed."

REQUISITIONS FOR CLASS 16 REPLACEMENTS

To insure prompt delivery of Class 16 replacement parts on requisitions, it is imperative that all items be clearly identified. Many instances have been reported where supply activities have been unable to furnish items requested because of insufficient part description:

When ordering Class 16 replacement parts as much of the following information should be given as pertains:

(*a*) Federal standard stock numbers, if any.

(*b*) Navy type number of the part itself; if not available, the equipment manufacturer's part or drawing number, together with the names of the manufacturers of the equipment and the part.

(*c*) Navy Model letter of equipment in which used, and circuit symbol describing it; or if not a Navy model, the manufacturer's type number on the whole equipment and the name of the manufacturer.

(*d*) A description of the part itself including its capacity, resistance, rating, power supply or other characteristic.

(*e*) If an equivalent item instead of an exact replacement is satisfactory, so state and indicate whether the supplied part should be equivalent as to size, weight, capacity, function, rating, or some other characteristic. This information is extremely helpful in deciding whether an available part is sufficiently close to the desired characteristics to justify sending it.

(*f*) Whether in equipment, tender or stock spares.

(*g*) Vacuum tubes should be ordered in accordance with the approved Navy designations as set forth in Vacuum Tube Catalogue, Volume 1 published by the Bureau of Ships, Radio Division.

Requests should specify the quantity required for immediate delivery and also the additional quantity required for stock. If part of the quantity must be delivered by a certain date, or direct to another supply activity, this fact should be stated.

RECOMMENDATIONS FOR LOW FREQUENCY TRANSMITTING ANTENNAS

The low frequency antennas in use at present generally consist of a flat-top about 480 feet long supported by towers or poles varying in height from 60 to 90 feet. It is proposed to replace these antennas with tower radiators 130 to 180 feet high. The following rough calculations at a frequency of 150 kilocycles may be of interest. The frequency of 150 kc. was chosen as the lowest frequency likely to be used. Since this represents the toughest problem, the comparison between a flat-top antenna and an insulated 185-foot tower was made at this frequency.

Flat Top Type.—If we assume the height of supports to be 75 feet, the effective height will probably be around 50 feet. The corresponding radiation resistance is then about 0.093 ohms. With a flat top of five #4 wires spaced 2½ feet and 480 feet long, the capacity reactance is estimtaed as about 650 ohms. If we assume a power factor of 0.2 percent for the tuning coil and down-lead inductance together, the loss resistance would be about 1.3 ohms, and the radiation efficiency would probably be around 4 percent with a good ground system.

Insulated Tower.—The radiation resistance of the 185-foot insulated tower should be about 0.32 ohms for the 150 kc. frequency. If the average effective diameter of the tower is two feet, the capacity reactance would be about 2000 ohms at the base. Assuming a tuning coil with a power factor of 0.2 percent, the loss resistance would be about 4 ohms. The radiation efficiency would then be about 7.8 percent without allowing anything for ground losses. The probable overall efficiency would be somewhere around 4 percent.

Comparison.—From the above it would seem that the two types of antennas would give about the same radiation efficiency at 150 kc., the odds favoring the tower type antenna a little. The same conclusion would apply at 300 kc. disregarding ground resistance, although the efficiency of both types of antennas would be much higher at the higher frequency. However, if the ground resistance is high, the comparison would definitely tend to favor the tower radiator since its radiation resistance is higher. The efficiency of the flat top type of antenna might be increased considerably if another support were added, so as to make possible an equilateral triangle of three flat tops. The multimast arrangement would appear to have an advantage in military application because in case of damage due to enemy action, some sort of an antenna might be arranged haywire fashion much more readily than would be possible with the mast type of radiator. It would seem that a number of smaller masts might be more readily handled in the field than a larger insulated base type of mast.

The efficiency of the mast type of radiator can also be improved by installing insulated guys at the top to form an "umbrella." This improves the current distribution in the tower radiator and increases the effective height. It would be desirable to support the ends of the umbrella wires by shorter poles around the central mast to keep the center of capacity as high as possible.

The most practical type of ground system would be a counterpoise system beyond the ends of an L or T antenna at least to a distance equal to the antenna height. The wires should probably extend at least 100 feet each side of the flat top.

If a vertical radiator is used, wires might be run out radially at least 200 feet to form a counterpoise system. The counterpoise has special advantages in instances where the antenna is to be erected over lava rock or frozen ground.

Wave Antenna.—The Wave Antenna is a simple form of directive antenna which is particularly useful for reception at low frequencies, in locations where there is sufficient space in the vicinity of the receiving station to erect it.

In its simplest form, the Wave Antenna consists of a horizontal wire, on the order of a wavelength long, pointing toward the desired transmitting station as shown in figure 1. The wave front of the signal approaching the antenna at *A* is tilted forward slightly in the direction of travel due to losses in the ground; hence, there is a horizontal component which induces a voltage in the horizontal wire. Thus, at the end, a little wave induced in the wire starts to run down the antenna toward the receiving station at *B* and, since it travels in the wire with the same velocity as the radio wave in space, the space wave follows right along with it, supplying energy to it as it goes, and building

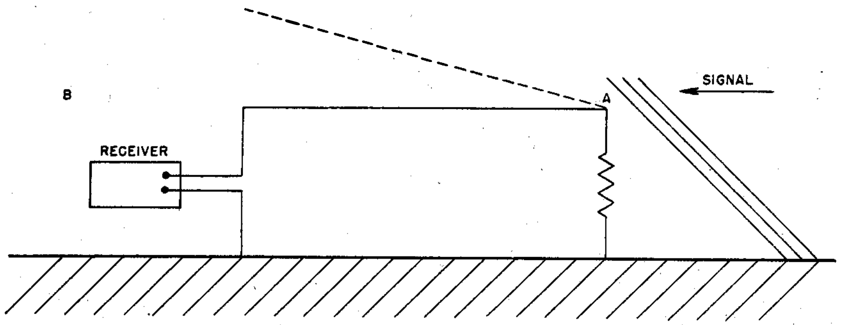


FIGURE 1.—Single wire wave antenna showing increase in signal strength from direction A to B.

it up. At the receiver at end *B*, it has reached a magnitude many times that which it had at *A*. This is illustrated in figure 1 by the dotted line which shows the signal strength building up along the wire to a maximum at the receiver. The dotted line shows the condition for a signal traveling in a direction from *A* to *B*.

A signal coming from the opposite direction to that which we have been considering, that is, traveling in the direction of *B* to *A*, will build up a wave on the wire in a similar way, from a small value at *B* to a large value at *A*. If, now, the line were open or grounded at *A*, the wave would be reflected back over the antenna to the receiver at end *B* and would be heard in the receiver. On the other hand, if we damp the end *A* in such a manner as to prevent reflections, the antenna becomes uni-directional. A non-inductive resistance having the value $R=\sqrt{L/C}$ ohms, where L and C are the inductance and capacity of the antenna per unit length, constitutes a practically perfect damper.

Figure 2(a) shows a directive diagram of an antenna one wavelength long, which has been damped at the end nearest the desired transmitting station by a resistance $R=\sqrt{L/C}$, which is equal to the *surge impedance* of the antenna. It will be noted that the antenna is uni-directional. Figure 2(b) shows the directive diagram for the case where the damping resistance at *A* is omitted and reflections are allowed to take place. The antenna is now bi-directional, but since there is some attenuation in the energy reflected at *A*, the rear lobe of the antenna is somewhat smaller than the front lobe. A similar bi-directional characteristic will be obtained if the antenna is grounded at *A* instead of being left open.

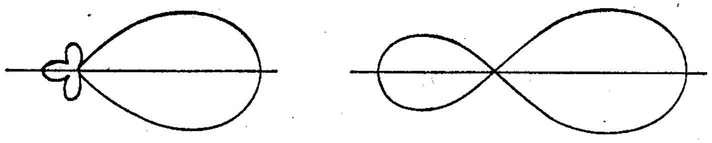


FIGURE 2(a) left.—Polar diagram of an antenna one wave length long damped at point A by a characteristic impedance.

FIGURE 2(b) right.—Polar diagram for antenna without damping the resistance.

When the antenna is terminated in a resistance equal to the surge impedance, the impedance of the antenna itself will be substantially constant over a wide band of frequencies since only traveling waves are involved. For the usual type of antenna, this impedance will be approximately 370 ohms. On the other hand, if the damping resistance is omitted and the antenna is either open or grounded at *A*, the phase relations between the induced traveling wave and the reflected wave is a function of the length of the antenna as compared to the wavelength and, consequently, the voltage at the receiver due to the reflected wave is not constant with wavelength or frequency. This is another way of saying that the impedance of the antenna is variable with frequency if the damping resistance is omitted. Consequently, in most cases, it is desirable to use the damping resistance where it is practicable to do so, even though bi-directional reception is desired.

Figure 3 shows the type of antenna that has been found to be most desirable for general use. It will be noted that, instead of a single wire, two wires have been used. This does not change the theory of the antenna. A signal traveling in the direction of *A* to *B* will build up to a strong signal at end *B*, at which point it would be desirable to place the receiver. However, by putting in a suitable transformer at end *B*, and using the two wires as a transmission line, the desired signal at *B* is sent back over the antenna itself to the end *A* where another transformer is placed between the antenna itself and a transmission line running to the receiving station. This transformer has an electrostatic shield, as shown, and the damping resistance is connected to the midpoint of the primary of this transformer. This arrangement has several advantages. In the first place, it eliminates a considerable amount of noise. At most receiving stations, the ground system is very noisy due to commutator ripple, key clicks and other man-made electrical noises at the station itself. Consequently, it is highly desirable, and essential for the reception of weak signals, to place the ground for the antenna at some distance from the receiving station and to use a separate ground for the antenna.

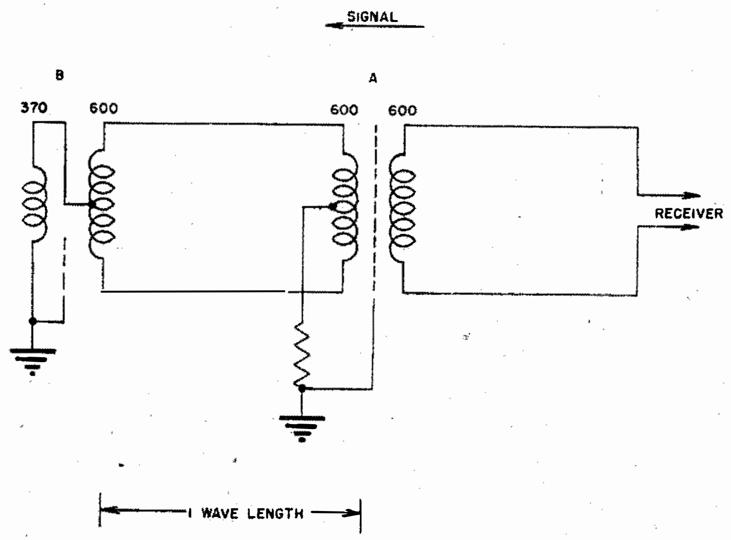


FIGURE 3.—Two wire antenna using matching transformer.

Since the attenuation of open wire transmission lines is very low, it is possible to place the antenna at any desired distance from the receiving station and to run the transmission line to the station over any desired route. Another advantage of the arrangement shown in figure 3 is that the damping resistance is at the end nearest the station, making it convenient to adjust. It also makes it possible to receive from both directions simultaneously where desired.

Figure 4 shows a possible arrangement for receiving from both directions simultaneously. As far as the reception of signals traveling in the direction of *A* to *B* is concerned, the arrangement is equivalent to figure 3. Instead of a transformer at end *B*, one wire has been grounded while the other has been left open. This is the equivalent of the transformer shown at end *B* in figure 3 since the phase of the reflection for the grounded wire is 180 degrees different than the reflection from the end of the open wire. This arrangement is satisfactory if the ground resistance is low but, in general, it is safer to use the transformer, which is not as critical to ground resistance. The signal traveling in the direction *A* to *B* is received on receiver #1. For reception of signals traveling in the opposite direction—that is, from *B* to *A*—a transformer with an impedance ratio of 370 to 600 ohms is shown in place of the damping resistance. The signal traveling in the direction *B* to *A* is received on receiver #2. If the transmission line to receiver #2 is properly terminated in 600 ohms, it will be reflected through the transformer and appear as 370 ohms on the secondary side which will properly damp the antenna. This arrangement makes it possible to receive simultaneously from both directions

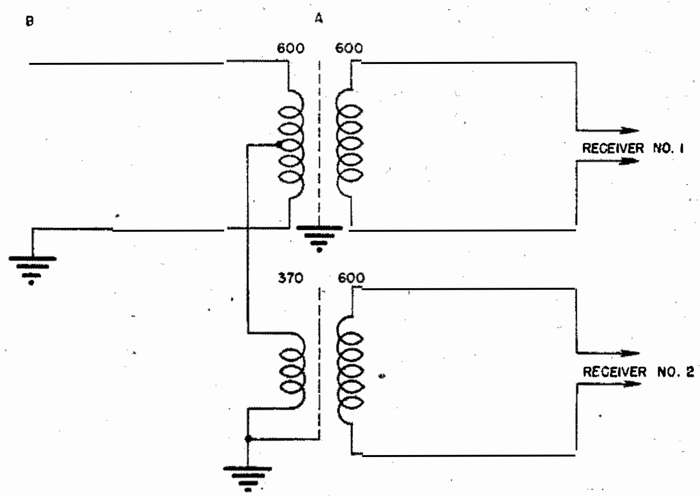


FIGURE 4.—Antenna arrangement for receiving from two directions simultaneously.

independently, but requires the use of either two receivers or the switching of one receiver from one line to the other depending upon the direction which it is desired to receive.

If a communication network is set up which uses the same frequency at all transmitters, and if it is desired to hear the transmissions from both directions on the same receiver, the arrangement of figure 3, with the damping resistance omitted and the end *A* of the antenna connected to ground, would be the most simple arrangement. The impedance of the antenna then varies with frequency as was explained above.

Figure 5 is similar to figure 4 but uses coaxial lines between the near end of the antenna and the receivers. This arrangement has the advantage of greater protection against picking up local man-made noise in the vicinity of the receiving station. A simple resistance network may be used for improving the damping at the receiver end of the line, if desired. Only a single type of transformer is required, since the antenna-to-open-wire-transmission-line ratio of 370 ohms-to-600 ohms is obtained with the windings

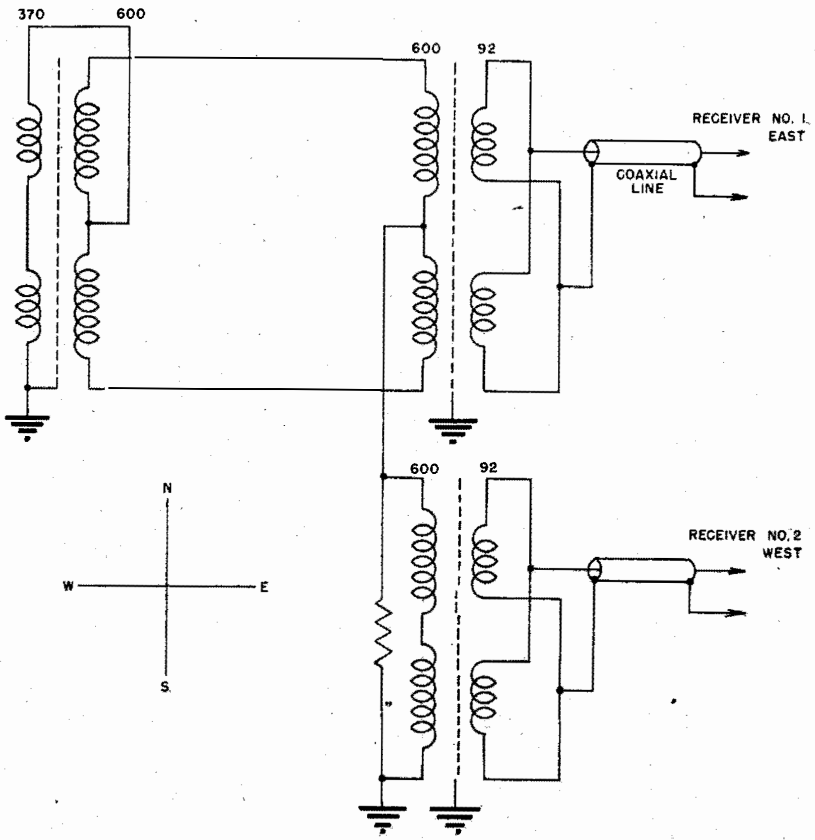


FIGURE 5.—Arrangement using coaxial lines between the antenna and receivers.

of the low impedance side connected in series, while the 600 ohm to 92 ohm impedance to match the open wire transmission line to the coaxial cable is obtained by connecting the windings of the low impedance side in parallel.

Any coaxial cable for use out of doors should be properly weather-proofed. The cable is preferably brought in under ground, but where this is impractical, it can be run in overhead if properly supported.

Practical Construction Details.—The voltage picked up by a Wave Antenna is substantially independent of the height of the wires above ground. The only theoretical requirement is to have the wires far enough above the ground to make the velocity of the currents traveling in the wire substantially equal to the velocity of light. If the wires are erected a few feet above the ground, this requirement will be met, so there is no object in placing the wires of a Wave Antenna higher than is required for security and to pass obstructions. Apart from the importance of running the antenna as straight as possible in the proper direction and avoiding proximity to other conductors, the specifications for Wave Antenna construction might be taken bodily from those written for an open wire copper telephone circuit. In other words, poles 15 to 20 feet high with regular telephone-type brackets would be entirely satisfactory. The size of the wire will be determined by mechanical considerations such that the wire will be strong enough to stand the storms which may be expected. Number 10 B & S is generally used. High grade telephone insulators should be used in order to make the balance of the two wires as good as possible.

While it is desirable to build the antenna over level ground, if the ground is rolling, the wires may follow the changes in elevation of the ground without serious detriment. It is important to have good grounds at each end of the antenna; it is recommended, for ordinary soil including sandy soil, that a radial ground be used consisting of twelve wires 100 feet long spaced radially approximately 30 degrees apart. These wires should be buried a few inches in the ground. In cases where it is very difficult to obtain a good ground as, for example, where the top soil is light or missing, it may be necessary to lay out a more extensive ground system than was recommended above since, in this case, the ground system is in the nature of a capacity rather than an actual ground. In such cases, more wires of greater length should be laid out or, perhaps, an area of chicken wire about 100 feet square should be used to obtain a capacity ground of reasonably low impedance.

It is important that the ground system be located outside of the area of man-made electrical noise which usually exists in the vicinity of the receiving station. In most cases, a distance of 400 to 500 feet should suffice; it is recommended that the antenna be terminated at this distance from the receiving station.

If open wire transmission lines are to be used between the antenna and the receiving station, the transmission line should preferably be of the same construction as the antenna itself. It is recommended that the open wire transmission line be run up to the station, at which point it would be desirable to transform from 600 ohms to 92 ohms to match coaxial cable or twisted pair running to the receiver. If high grade twisted pair is used, and its length does not exceed 50 feet, the matching transformer may be omitted; it would be necessary to use a matching network properly to terminate the transmission line to receiver #2 in the arrangement shown in figure 4. In general, the arrangement shown in figure 5 is the most desirable one electrically since it uses a minimum of transformers, all of one type, and all circuits are readily matched. Of course, the problem of matching the transmission line for preventing reflections is of far less importance when using the antenna for uni-directional reception as shown in figures 1 and 2. In this case, the damping is a simple fixed resistance. The damping problem arises when it is desired to use the same antenna for reception from two opposite directions.

The antenna should be approximately one wavelength long for the average frequency that it is desired to receive. For example, if the average frequency to be received is 300 kc., corresponding to a wavelength of 1000 meters, the antenna should be approximately 1000 meters long, or 3280 feet. This length is not critical and the antenna should be satisfactory for reception over a considerable range of frequencies. A Wave Antenna one wavelength long is down approximately 6 db at plus and minus 40 degrees from the direction of the antenna.

Recommendations.—If it is decided to install Wave Antennas for low frequency reception, it is recommended that the antennas and ground systems be installed immediately. The connections shown in figure 3 may be used temporarily. If one wire at the far end is grounded as shown at *B* in figure 4, the reflection transformer is eliminated and only the 600:600 ohm transformer at *A* in figure 3 is required. A 10-watt damping resistance of 370 ohms should be used for uni-directional reception. For bi-directional reception, the midpoint of the transformer at *A* should preferably be grounded, although equivalent results will be obtained with the ground omitted, since the back wave will be reflected in either case as has been explained. In any event, the shield of the transformer should be grounded. At a later date when transformers and coaxial cables are available it is recommended that the arrangement shown in figure 5 be installed.

REPAIR OF SWITCHES IN TBY SERIES EQUIPMENT.

It has been discovered that the contacts of the meter circuit switch "S5" in a number of model TBY series equipments become coated with some foreign material during manufacture or subsequent thereto. This coating interferes with the operation of the switch and should be removed whenever this condition is encountered. The Small TBY Service Station in the Third District recommends the following procedure:

"(*a*) Remove switch S5 from the TBY unit.

(*b*) If covered, remove rubber covering from the switch.

(*c*) Immerse switch in a small container of carbon-tetrachloride, and let soak for about 5 minutes.

(*d*) While still immersed, move the 3 position switch shaft back and forth about a dozen times.

(*e*) Remove the switch from the liquid, permit to dry, check for continuity and reinstall."

ELECTRICAL ALIGNMENT OF FILAMENT INDUCTION VOLTAGE REGULATORS IN MODEL TBC–3 TRANSMITTERS

If there is a failure of Induction Voltage Regulators (VR601, 602 and 603) in the Model TBC–3 transmitter, and any or all of them are removed, repaired, and replaced in service, it may be found that there is an unbalance of voltages between phases.

This trouble was discovered at the Naval Radio Station, Annapolis. It was found that although the nameplate data on the various TBC–3 regulators would indicate that they are directly interchangeable, this is not true. Apparently, the manufacturer has selected three matched units for each transmitter. However, providing that all three regulators are set at electrical neutral together, a spare or rebuilt regulator being used with two original regulators will cause not more than approximately 3 percent voltage unbalance between phases.

It was found that alignment of the rotor winding of a spare or repaired regulator with the other two with which it is to work in a three-phase circuit, must be done by electrical alignment. As no information concerning this is contained in the TBC–3 instruction book or the General Electric Company bulletin referred to on the regulator nameplate, the alignment procedure is given herein:

1. Disconnect motor leads for the regulator tuning motor.

2. Disconnect leads from terminal 41–6, 7 and 8 going to filament transformer primary.

3. Press transmitter start button, closing K603 by hand if regulators are not at maximum buck position.

4. By hand rotate turning motor until dial indicates regulators are near neutral position.

5. Measure voltage between terminals 43–37 and 41–7. This is the voltage that is being generated in the series winding of VR601.

6. With voltmeter across the two terminals mentioned above rotate turning motor by hand until voltage is zero volts. Leave turning motor in this position while checking neutral of VR602 and VR603.

7. Voltage being generated in series winding on VR602 can be measured between terminals 43–38 and 41–6. If this voltage does not measure zero loosen Allen set screw and turn worm gear shaft of VR602 until voltmeter does read zero, holding turning motor by hand so that it does not turn. Tighten Allen set screw.

8. Voltage being generated in series winding on VR603 may be checked by measuring voltage between terminals 43–36 and 41–8. If this voltage is not zero loosen Allen set screw and turn worm gear shaft of VR603 until voltage is zero, holding turning motor by hand so that it does not turn. Tighten Allen set screw.

9. If no mechanical movement of turning motors has occurred all three series windings will read zero volts.

10. By hand rotate turning motor to maximum buck position recording voltage between terminals 43–37 and 41–7, 43–38 and 41–6, and 43–36 and 41–8. Voltages of about 135 volts may be expected.

11. Let maximum buck position be zero degrees of rotation. At the dials on top of VR602 and VR603 measure the above three voltages at 22½, 45, 67½, 90, 112½, 135, 157½ and 180 degrees (maximum raise). Voltages by steps from zero through 180 degrees should vary from about 135 volts at maximum buck decreasing to zero at neutral and increasing to about 135 volts at maximum raise. The three voltages at any given step position should be within approximately one volt of each other. Rotate turning motor to maximum buck position.

12. If the above tests show that good tracking of voltage between three regulators is obtained remove power and replace all connections.

13. After replacing connections and reapplying power the voltages measured between terminals 41–7, 41–6 and 41–8 should be

within a volt or two of each other and should be approximately 300 volts each if the line voltage is 225 volts per phase and the filament voltage is 15 volts.

A similar procedure may be used for alignment of regulators in Model TBC–4 and TBC–5 equipment.

RADIATION FROM DIRECTION FINDER RECEIVERS

An abnormally high radiation from the sense-balance antenna of a DP–12/–13 installation was recently reported to the U. S. Navy Radio and Sound Laboratory at San Diego. The receiver was made available to the laboratory for test with the following results:

The D/F receiver chassis was explored with an OF equipment provided with a small pickup probe which could be connected either as a loop or as an open antenna. Most of the voltage reaching the sense-balance antenna terminal was being applied by way of the lead from the gang tuning condenser section which tunes this circuit. Evidently, the rotor of the tuning condenser was at a considerable RF potential with respect to other parts of the receiver chassis because of circulating currents in the chassis structure. This supposition is further supported by the fact that voltage at the antenna terminal was greatest at the low frequency end of each band (See figure 1).

The voltage at the sense-balance antenna terminal was reduced

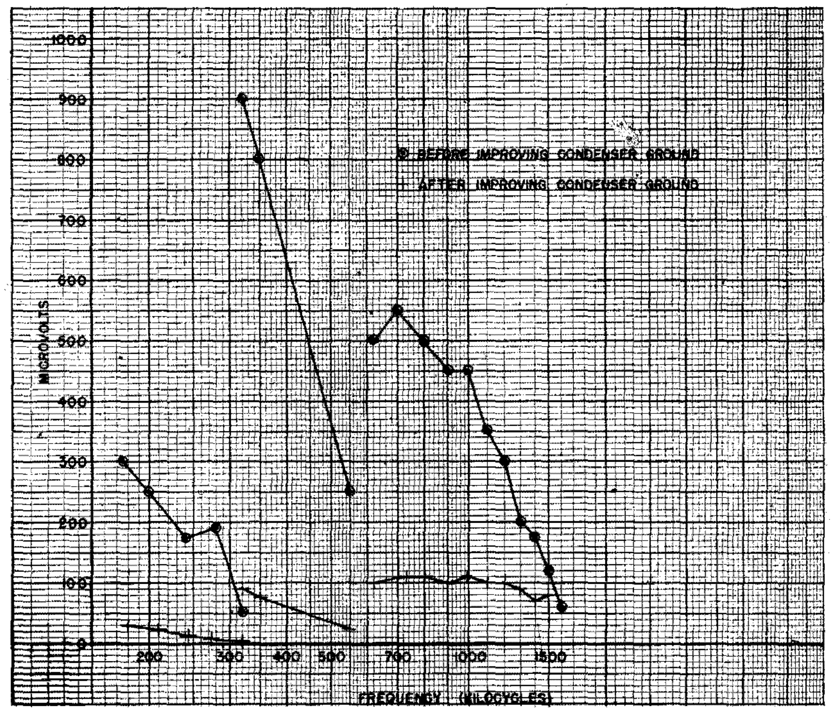


FIGURE 1.—Graph showing radiation before and after improving ground on tuning condensers.

considerably simply by tightening the bolts which secure the tuning condenser frame casting to the receiver chassis. A further reduction was obtained by installing short heavy copper braid ground bonds from approximately the center of the tuning condenser casting to the receiver chassis. The improvement effected is shown by the curves of figure 1.

MAINTENANCE NOTES ON COMMERCIAL FM RADIO EQUIPMENT MANUFACTURED BY GALVIN MANUFACTURING CORPORATION

The following notes have been compiled from field experience with the commercial FM equipment manufactured by Galvin Manufacturing Corporation, with the thought that it will be useful to Naval activities who have had limited experience with this type of equipment.

Receiver alignment.—It is very important to use a weak signal in aligning FM receivers, both mobile and fixed. A mobile transmitter may be used as a source of weak signals for this purpose providing the antenna is removed and a 32 volt lamp plugged into the antenna receptacle at the transmitter. The lamp should be soldered to an antenna plug for this purpose as shown in figure 1. After installation the final stage of the transmitter will have to be retuned, and the transmitter moved to a point where the signal to noise ratio at the receiver approximates 1:1. The discriminator should be tuned first by the following procedure. Connect a 0-50 micro-ammeter (2000 ohms internal resistance) to the METER plug and throw the METER SWITCH to position "5" (see figure 2). Now using a fairly strong unmodulated input signal, tune the discriminator transformer T8R to maximum meter reading. Then detune to 2/3 maximum reading by turning the screwdriver adjustment in the direction of the arrow. Next turn the METER SWITCH to position "4" and tune T7R to zero. This completes the discriminator adjustment.

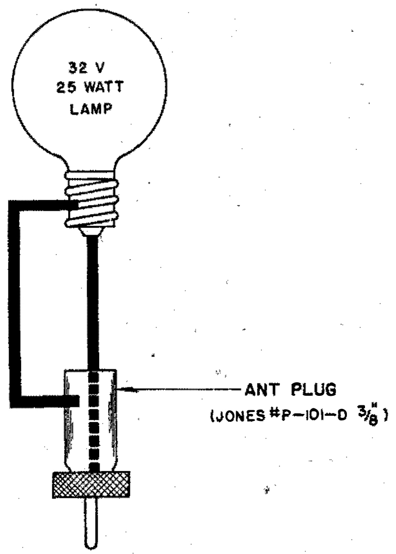


FIGURE 1.—Diagram showing 32 volt lamp connected as a dummy antenna.

After alignment of the receiver has been completed, it is possible to obtain a 6 to 10 db reduction in background noise by the following suggestion. Using a signal source so weak that it is almost lost in noise, retune T5R by ear only, until minimum noise is heard (maximum quieting effect). This procedure is applicable to all Galvin FM receivers, both DC and AC. In mobile equip-

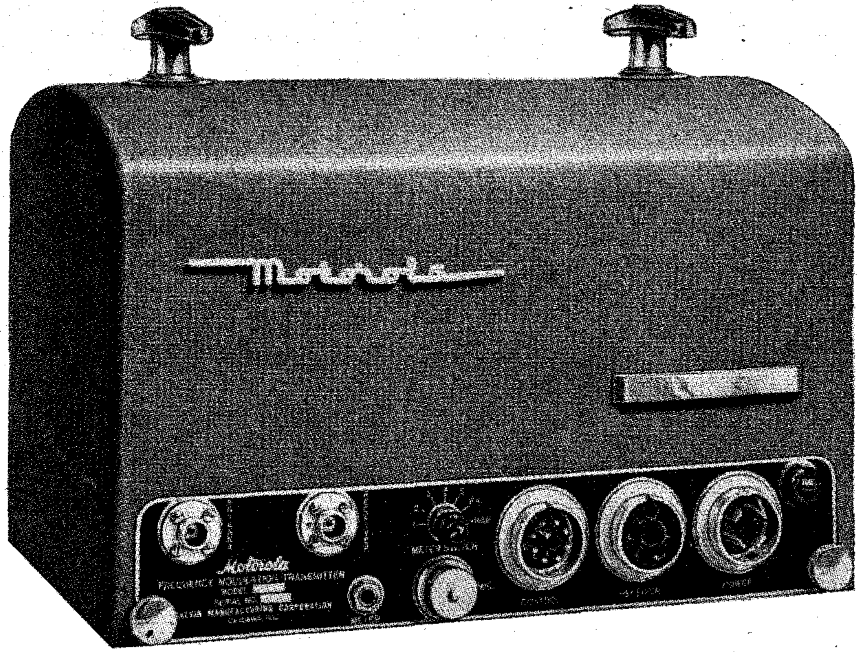


FIGURE 2.—Photograph of FM transmitter showing METER SWITCH and METER plug.

ment, the adjustment must be made with the receiver installed in the vehicle.

Tube substitution.—Additional gain can be obtained in the FMTR receivers by replacing 6SD7 tubes with 6SH7 tubes, especially in RF, first mixer, and oscillator positions. A complete substitution in all positions is desirable when sufficient 6SH7 tubes are available. No circuit changes are necessary but retuning will be required. Also 6K8 tubes vary; pick from several for best results.

Determination of transmission line length.—One of the problems in installing a fixed station is the adjustment of the length of transmission line to an exact multiple of a quarter wave length. In installations employing 7/8 inch copper coaxial line a convenient method of obtaining this resonant condition is by use of a short length of copalene line between the coaxial line and the transmitter relay box. The exact length is determined by the following procedure. Using a 70 ohm Ohmite dummy antenna in series with a 0-3 RF ammeter as shown in figure 3, adjust the antenna and tank condensers for peak RF power output. With the METERS SWITCH in the "PA" position and using a 0–50 micro-ammeter (2000 ohms internal resistance) in the test meter plug, adjust for correct loading. Now disconnect the dummy an-

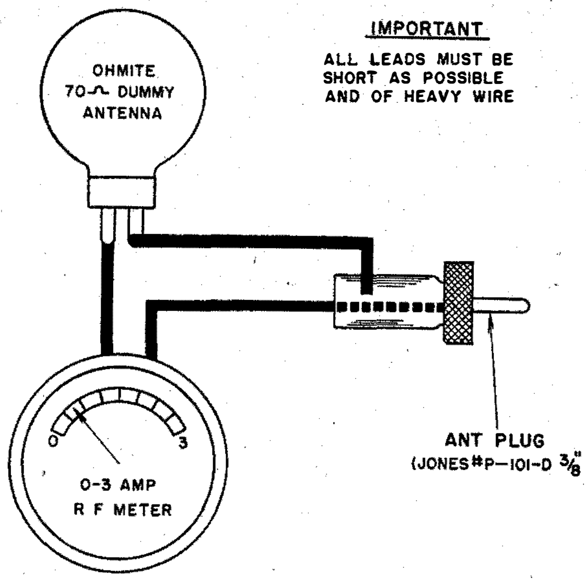


FIGURE 3.—Dummy antenna connection.

tenna and connect an eight-foot length of 70 ohm-impedance copalene line from the transmitter relay box in series with the 7/8 inch copper coaxial line, which is connected to the antenna. Without disturbing the setting of the final stage tuning condensers, observe the reading on the test meter (switch still in position "PA"). Now shorten the copalene line an inch at a time until the length giving minimum reading on the micro-ammeter has been determined. This process will result in the line having been shortened beyond the critical length. However, with the correct length determined, a permanent installation using a new piece of copalene line can be made.

Antenna adjustments.—A coaxial antenna for a fixed station represents a rather sharply tuned circuit, especially in the skirt length. The signal drops off 2 db when the length of skirt is incorrect by one-half inch, although the whip end can be plus or minus four (4) inches without affecting the field strength. Thus attention must be given to the use of an antenna which is designed for the particular operating frequency.

All antennas should be checked for "opens" or "shorts," clean insulators, and proper frequency. The skirt should be kept at least eighteen (18) inches from all extraneous objects. When an FMTR-50 transmitter is used with an RCA ground plane antenna, it may be necessary to accomplish resonance in the final stage by connecting, on the underside of the chassis, a 100 MMF, 1,000 W.V., condenser in parallel with the antenna condenser.

Miscellaneous.—All relays in FSTR-50 and FMTR-25 equipment are DC operated, and in the AC equipment the relays obtain field excitation from a copper-oxide rectifier beneath the chassis. A piece of thin bakelite should be inserted between this rectifier unit and the chassis to prevent possible shorts. In all FMTR-25 VW and FMTR-50 BR receivers, condenser C-10 (which is inside can T2R) should be replaced with a mica condenser of 100 MF, 600 WV. Coupling condensers should be checked for leakage and, in the RF sections, be replaced by mica condensers.

The Jones plug at the transmitter often breaks loose from the shielding on the transmission line and should be examined regularly.

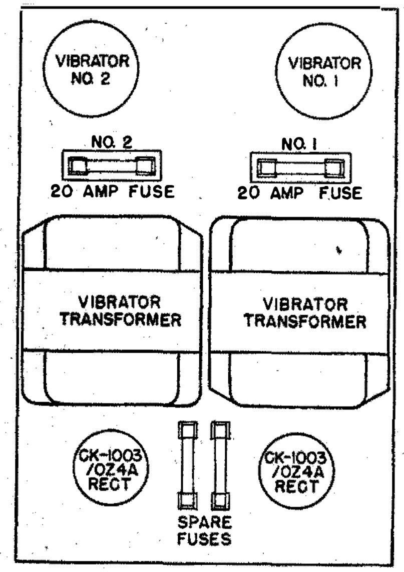
One answer to battery problems is a large capacity voltage and current regulated generator in conjunction with a 170-190 ampere hour battery. A fast engine idle also helps.

The screen resistor for the 807 tube(s) in transmitters should be 20,000 ohms; it is not necessary to unsolder this for measurement.

All 50-watt transmitters should be examined for broken leads to the two 807 tubes in the final stage. As these tubes are in parallel operation, a broken lead will permit one 807 to carry the entire load.

On mobile FM transmitters using vibrator power supplies, removing one of the fuses will permit the tuning of the final stage with only 300 volts on the plate. This will permit accurate tuning without the danger of damaging the 807 tubes. Be sure to replace the fuse when tuning is completed. See figure 4).

Tubes should be constantly under suspicion when trouble occurs and none regarded as perfect without having operated satisfactorily in another similar piece of equipment.



P-8027 VIBRATOR POWER SUPPLY

FIGURE 4.—Vibrator power supply showing location of fuses.

FACILITIES OF THE U. S. NAVY RADIO AND SOUND LABORATORY SAN DIEGO

Due to the rapid expansion of the Navy, the service in general may not be familiar with the purpose of, and the facilities offered by this Laboratory. For the information of the service the mission of the Laboratory with respect to radio and its allied fields, underwater sound and other equipment under the cognizance of the Radio Division of the Bureau of Ships, is:

(*a*) To provide expert technical assistance to Fleet or unit Commanders;

(*b*) To study, investigate, and report to the Bureau of Ships on suggestions for new or improved equipment submitted by the Fleet;

(*c*) To work on the solution of such problems as may be assigned by the Bureau of Ships;

(*d*) To provide technical experts and equipment to units of the Fleet which are assigned experimental work requiring the service of such experts or equipment;

(*e*) To install new and experimental types of shipboard equipment and to conduct tests of this equipment;

(*f*) To cooperate with the Naval Research Laboratory;

(*g*) To cooperate with engineers of civil or government laboratories engaged in Naval work in this area;

(*h*) To make repairs and alterations to equipment when such require the services of specially trained technical personnel not otherwise available;

(*i*) To provide technical assistance as may be required by Navy Yards or other shore establishments of the Navy;

(*j*) To maintain a staff of civilian and naval technical personnel and equipment and ship facilities such as may be required in order to provide the above services and facilities.

Specifically some of the more common services rendered the Fleet are:

(*a*) Checking antenna field strength patterns;

(*b*) Checking radar antenna directivity patterns; (*a*) and (*b*) require two hours to one day at selected location in harbor or offshore, possibly in connection with other operations.

(*c*) Locating uncommon interference in radio and radar equipments;

(*d*) Investigating abnormal operational troubles encountered in the Fleet in radio, radar and sound equipments;

(*e*) Measuring radiation hazard to security of receivers and other electrical equipment;

(*f*) Making noise and vibration surveys;

(*g*) Developing and testing modification or devices at the request of the Commanding Officers;

(*h*) Calibrating or repairing of surface vessel bathythermographs;

(*i*) Assisting in the location of lost submerged objects by use of underwater sound;

(*j*) Making surveys for the location of underwater devices, bottom contour surveys and tidal current measurements.

(*k*) Investigating the abnormal operation of magnetic loops and harbor detection equipment;

(*l*) Testing equipment for operation at deep submergence;

(*m*) Performing work involving the use of a high vacuum chamber for objects up to thirty inches in diameter.

Commanding Officers of vessels present in the San Diego area may make use of these services by communicating with the Director of the laboratory via the Radio Material Officer at the 11th Naval District or Destroyer Base, San Diego. Problems arising elsewhere should be submitted by letter to the Bureau of Ships with a carbon copy to the Director of the laboratory.

NOTE ON SOLDERING.

Reports have come in through the Marine Corps of the use of soldering paste on radio equipment. This has been condemned **many times as a very unwise practice, and only invites future failures of equipment. No acid, or soldering paste, should ever be used on radio equipment, or for tinning irons for this use. Rosin is the accepted flux for such work.**

THE FORUM

AN INFORMAL DISCUSSION OF COMMUNICATION MATERIAL MATTERS OF INTEREST TO THE SERVICE

The purpose of THE FORUM is to provide a means for publishing informal comments by members of the naval service on matters of interest to others in the radio field. These contributions need not have official status, and thus a medium is offered for the expression of personal opinion and observation. Comments, suggestions, experiences, difficulties, and other items concerning radio equipment are welcome at all times. Material of this kind is not only interesting to other radio personnel but is of great value to the Bureau.

Contributions may be prepared as informally as desired. They should be forwarded via the commanding officer to the Radio and Sound Bulletin, Bureau of Ships (Code 993), Navy Department, Washington, D. C.

COMMENTS ON THE TBS EQUIPMENT

Radio Electrician C. S. WEAVER, *USN*, U.S.S. *Nashville*

I. EMERGENCY TBS ANTENNAE

The TBS equipment has been subjected to several tests utilizing a straight wire antenna. The purpose of the tests were to find a feasible emergency set-up for use in case of casualty to the designed antenna and transmission line. DCP–2 cable was used—run through a stuffing tube in the weather bulkhead and attached directly to the antenna post on the transmitter.

The original length of the cable was forty (40) feet. The far end was secured to various convenient projections on the ship such as yardarm, stanchions, lifelines and even a haphazard "heap" on the deck. The cable was successfully trimmed down to a length of fifteen (15) feet.

In each case, regardless of length, horizontal or vertical position, or projection to which secured, the equipment performed every bit as well as on parallel tests made using the designed antenna system.

The only adjustment required after each antenna change was in the power amplifier tuning. The procedure of changing the tap on the power amplifier plate tank coil was discarded in favor of the much easier method of changing the position of the antenna with respect to some stanchion, bulkhead, etc. The same results were produced.

These tests were made over a period of two (2) weeks, utilizing target ships varying from ½ to 25 miles distant. The position of the ship with respect to the target ship had no effect on the signal strength in either direction.

The ship now has a thirty (30) foot length of DCP–2 cable struck down by each equipment, ready for immediate use in case of casualty to the designed antenna system. This length was chosen because it is a mechanically convenient length, not because it proved the most efficient electrical length. Electrical efficiency did not enter into the idea of these experimnts. The tests were purposely made on a non-technical basis, using the gear as it is normally used on operations and noting the effects as actually appearing to the most inexperienced of maintenance men. In this way, each man was aware of what was being accomplished and was not confused by the involved measurements necessary for a technical test.

It is realized that this arrangement can bring a storm of criticism from the theorists and it does have definite drawbacks. (The main one being increased interference with nearby receiving equipment). However, as an emergency set-up, it is much more practical than attempting to repair a concentric line during action or declaring the equipment out of commission because the designed antenna has been shot away. The advent of higher frequency equipment with the attendant "Book" designed antenna and transmission lines, impressive formulae, varying theories, have caused too many to abandon the old "Hit and Miss" method that usually has proven to be the best as far as antennae are concerned.

II. AN ARRANGEMENT WHEREBY REMOTE CONTROL UNITS FOR TWO TBS UNITS CAN BE TIED IN WITH A SINGLE UNIT

An addition to the TBS arrangement has been made that has proven invaluable to the maintenance men.

There are two (2) TBS equipments installed on the ship. One in flag radio forward, one in auxiliary CIC aft. Formerly the only station on the ship having control of both equipments was forward CIC.

The system is now modified so that the control units for each gear run to a transfer switch (Type JB-S, 10 section, 20 Pole).

During operations, both equipments are ready for use, the forward TBS normally being used. If trouble occurs with the forward TBS, the transfer switch merely has to be turned and all control units are tied in with the after TBS. This arrangement also works in reverse. This system has been in operation for approximately four (4) months.

The benefits derived from this set-up have more than paid for the time spent in installing the switch and running the additional cable.

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