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THE COMMUNICATION SYSTEM OF THE RADIOMARINE CORPORATION OF AMERICA*

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Summary—*The coastal facilities and shipboard apparatus used in the communication system of the Radiomarine Corporation of America, are described in this paper. Long-range communication obtainable from ship to shore with moderate power at high frequencies has resulted in the development of several new types of short-wave transmitters. In addition to serving the marine field as an important communication facility and safety-of-life factor, radio, through the direction finder, has become a valuable navigation aid. One of the standard Radiomarine direction finders is briefly described in this paper.*

Introduction

Radio communication as applied to the marine field, began to receive general public recognition in the year 1909 when the *S. S. Republic* sent out a distress call after a collision off Nantucket. This event clearly proved the utility of radio as a safety-of-life service. As the radio art progressed technically, improvements were rapidly made in marine apparatus until today we find a large number of services performed through marine radio.

Classes of Traffic

It is of interest to consider some of the classes of traffic now handled between coastal stations and shipboard installations. These may be listed as follows:

General public correspondence, such as message traffic by passengers.

Ship business, involving routing, cargo information, weather reports, and daily position reports. The owners and general public are kept informed of the position and arrival time of vessels through this service.

Press service, consisting of news transmitted daily to subscribing ships. The news is then printed and distributed to passengers.

Medical service which provides free emergency medical advice. This is especially valuable in cases where a doctor is not aboard ship.

Brokerage service, involving fast transmission of buying and selling orders, and also including quotation service.

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Coastal Stations

In order to provide both long- and short-distance radiotelegraph facilities to vessels communicating with the United States, the Radiomarine Corporation of America has a network of 16 coastal radiotelegraph stations throughout the country. The location of these stations is shown on the map in Fig. 1. Long-distance communication over the North and South Atlantic Oceans is furnished through the high power stations at Chatham, Mass., (WCC) and Tuckerton, N. J., (WCS). Printer circuits connect these stations to New York City and Boston through Western Union Telegraph facilities and all of the offices of Western Union are therefore available for pick-up or delivery of radio-

Fig. 1—Coastal radiotelegraph system of the Radiomarine Corporation of America.

grams. On the West Coast the station at Bolinas, Calif., (KPH) handles traffic over the Pacific Ocean. Ships in all parts of the world, which are equipped with short-wave apparatus, are able to maintain contact with one or more of these high power stations.

The primary function of the remaining coastal stations, which use medium power transmitters, is to provide service to coastal shipping or where the distances are less than approximately 500 miles. Communication facilities for vessels in the Great Lakes area are provided through the stations at Duluth (WRL), Chicago (WGO), Cleveland (WCY), and Buffalo (WBL). In New York City, harbor traffic consisting mainly of messages to incoming and outgoing transatlantic vessels is handled through station WNY.

The station at Chatham, Mass., is a typical example of one of the high power coastal installations. This is a duplex station, the receiving apparatus being located at Chatham while the transmitters are remotely controlled at Marion, Mass., approximately 50 miles from the receiving station. This arrangement, by removing the receiving antennas from the strong local field of the transmitting antennas, permits simultaneous transmission and reception.

A view of the receiving station at Catham is shown in Fig. 2. Horizontal doublets are used for short-wave reception. These are suspended

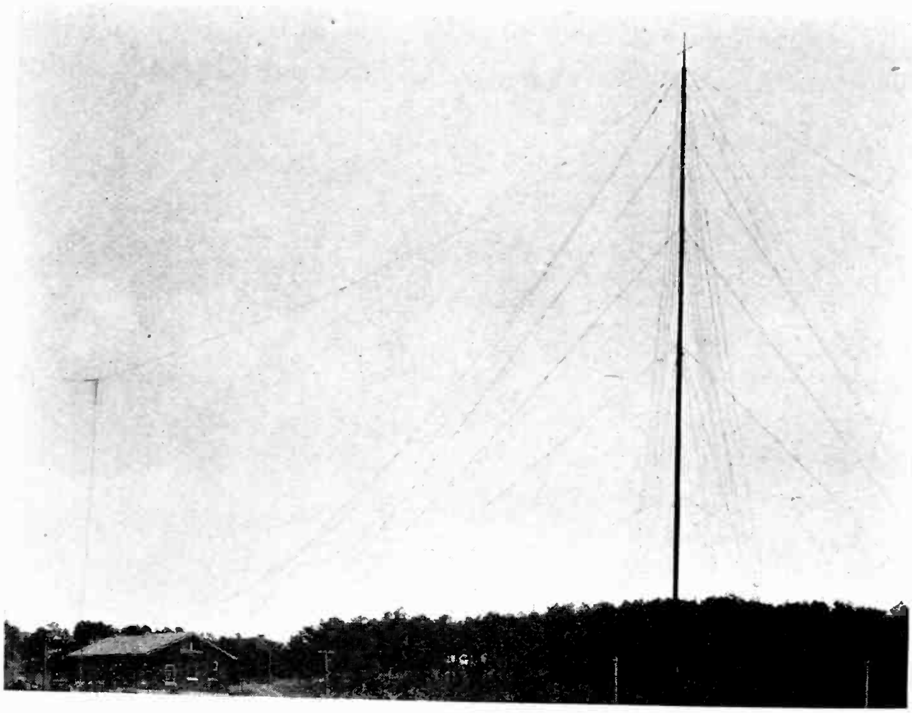

Fig. 2—Chatham receiving station.

between the high mast shown in the figure and a shorter steel tower which does not appear in the photograph. Intermediate- and long-wave reception is obtained from low Beverage antennas which are directed toward the East. A total of 15 receiver positions is available consisting of four long-wave superheterodyne units, one 600-meter superheterodyne, four intermediate-frequency receivers, and six short-wave receivers. During periods of heavy traffic 12 to 15 ships may be worked simultaneously.

The transmitting equipment at Marion is under control by the operators at Chatham for purposes of start-stop, wave-change, and switching from cw to icw in the 500-kilocycle band. Nine transmitters are available at Marion and provide the following frequencies and antenna power:

117 kc	5 kw
129 kc	5 kw
406 and 500 kc	5 kw
6360 and 11,220 kc	1 kw
5525 and 11,145 kc	200 watts
8450 kc	40 kw
16,900 kc	1 kw
6320	1 kw
12,645 kc	40 kw

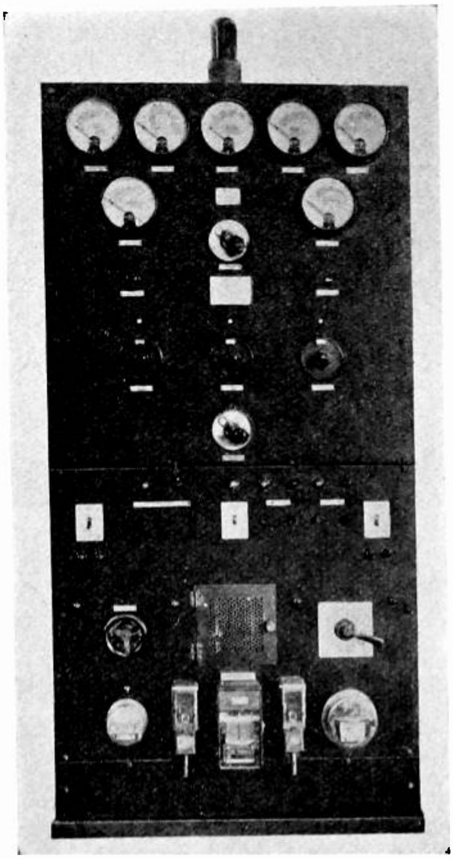

Fig. 3—40-kw power amplifier.

Both horizontal doublets and long antennas operated on their harmonics are available for the high-frequency transmitters. Quarter-wave antennas with suitable loading are employed for the intermediate and low frequencies. The high power, short-wave transmitters consist of a 1-kw crystal controlled exciter and a 40-kw power amplifier. A view of one of the 40-kw amplifier panels is shown in Fig. 3. Plate supply for the power amplifier is obtained from a 3-phase full-wave mer-

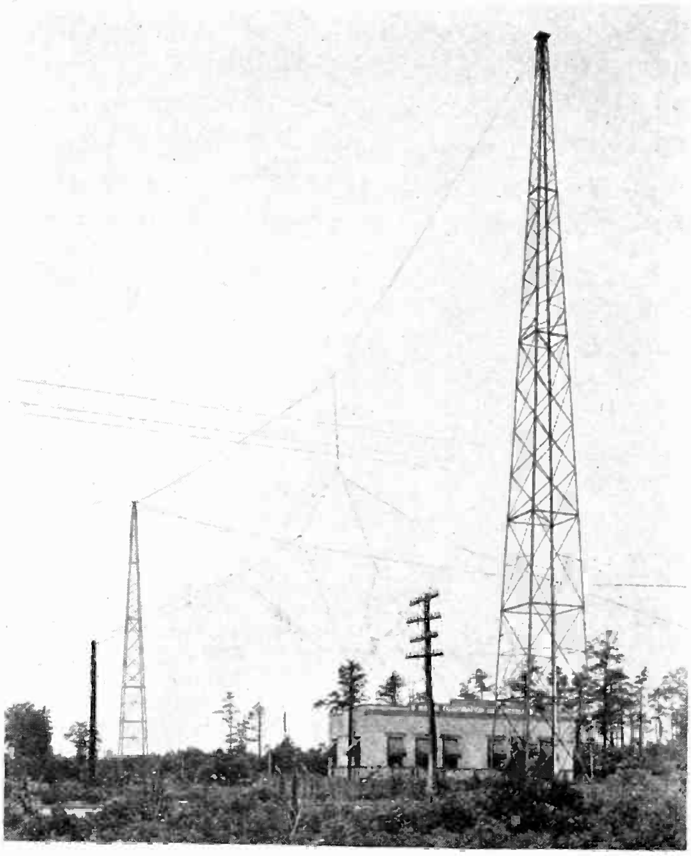

Fig. 4—Tuckerton receiving station.

Fig. 5—Tuckerton receiving station.

cury vapor rectifier which uses six UV-869 tubes, and has a full-load rating of 72 kw at 18,000 volts.

The station at Tuckerton, N. J., is in general similar to the Chatham-Marion layout and consists of complete short-, intermediate-, and long-wave transmitting and receiving facilities. The receiving station building and antennas at Tuckerton are shown in Fig. 4. The diamond-shaped antenna is a Bellini-Tosi system which is used for directive reception in the 500-kc band. An interior view of the operating room is shown in Fig. 5.

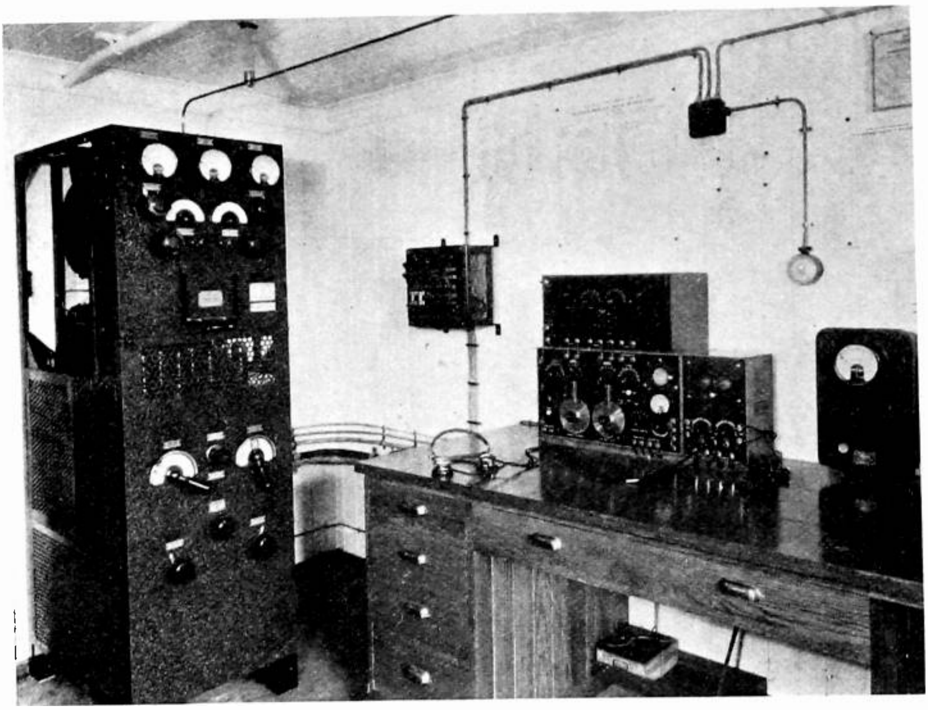

Fig. 6—ET-3626-C shipboard installation.

The transmitting station is located about five miles from the receiving station and provides eight vacuum tube transmitters as follows:

125 and 133 kc	3 kw
462 and 500 kc	5 kw
6350 kc	200 watts
8430 kc	40 kw
11,175 kc	200 watts
12,675 kc	40 kw
16,860 kc	1 kw
6340 kc	1 kw

Press is transmitted from the Tuckerton Station in the 8000-kilocycle band and also from a high-frequency alternator at 22.1 kilocycles.

Shipboard Stations

Apparatus for use aboard ship must be compact, rugged, resistant to marine weather conditions, provide good frequency stability, and permit quick wave change. A large number of types of transmitters have been developed to meet the requirements of different classes of shipping.

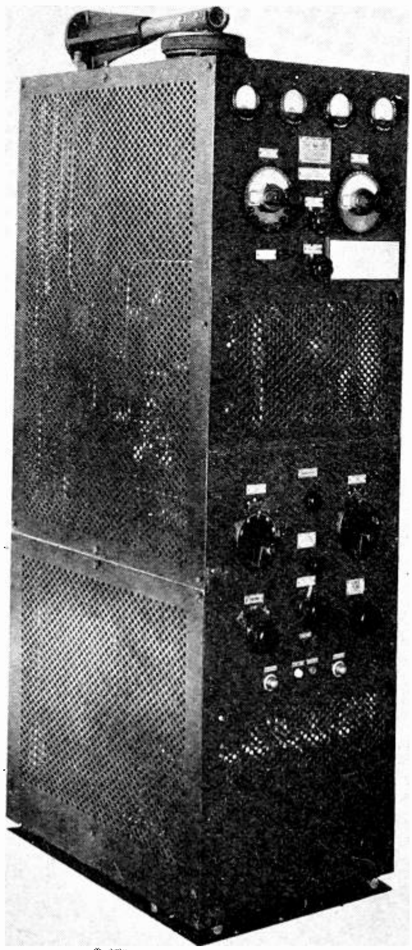

Fig. 7—ET-3674 combination transmitter.

A typical shipboard installation for operation in the intermediate-frequency bands is shown in Fig. 6. The transmitter, known as model ET-3626-C, covers the frequency ranges of 375 to 500 kilocycles and 125 to 167 kilocycles and delivers 500 to 750 watts to the antenna. The master oscillator power amplifier circuit is employed using 8 UV-211 tubes. One tube functions as a master oscillator, six as power amplifiers, and one as audio oscillator for icw. Automatic positioning devices are used on the frequency control dials to enable the operator to adjust the transmitter quickly to any of its assigned frequencies. For reception the well-known IP-501-A receiver is used, which covers a frequency range of 16 to 1200 kilocycles. The small panel mounted on the bulkhead is used for charging the receiver storage batteries. The second panel

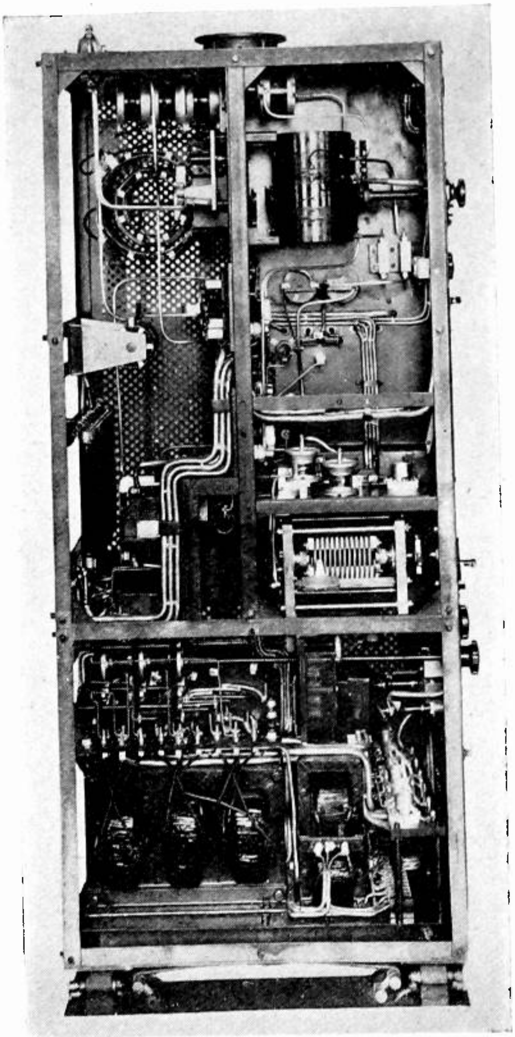

Fig. 8—ET-3674 combination transmitter.

near the operator's table provides start-stop for the transmitter 1000-volt motor generator set and control of the transmitter filament circuit.

The present standard receiver for short-wave reception on shipboard is known as the AR-1496-D. This receiver provides one stage of screen-grid amplification, regenerative detector, and two stages of audio amplification. Plug-in coils are used to cover a range of 2000 to 25,000 kilocycles.

A newly developed "combination" transmitter known as the ET-3674 is shown in Fig. 7. This transmitter provides two frequency bands, 375 to 500 kilocycles and 5500 to 17,150 kilocycles. A single compact unit of this type therefore provides medium distance transmission and the necessary distress wavelength in the 375- to 500-kilocycle band, while long-distance transmission is available through the use of high

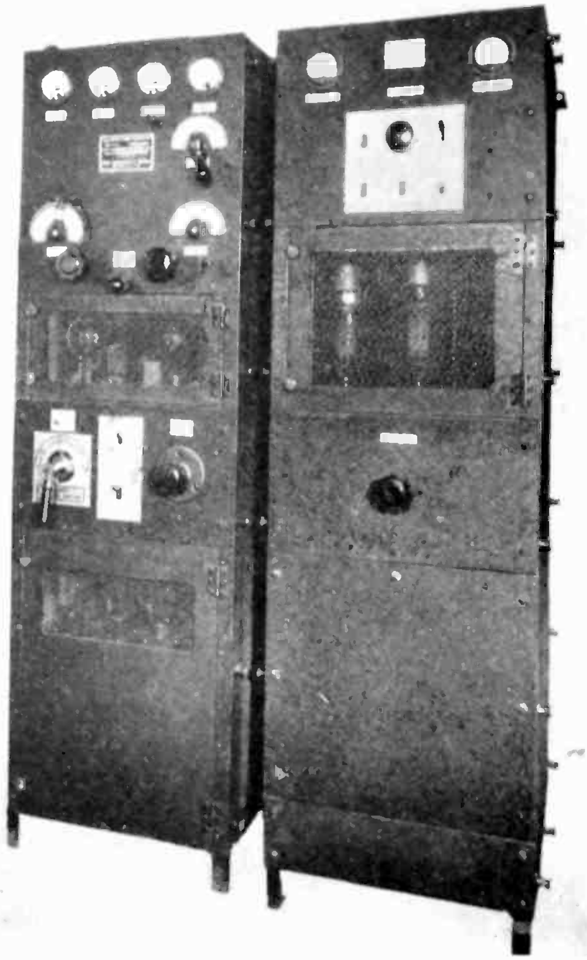

Fig. 9—ET-3666 short-wave telephone and telegraph transmitter.

frequencies in the second band. Four-element screen-grid tubes are used in the radio circuits, consisting of a UX-860 tube as master oscillator, a UX-861 tube as power amplifier, and a UX-860 tube as audio oscillator. The transmitter delivers 500 watts to the antenna.

Since the power amplifier tube in this transmitter operates at a plate voltage of 3000 volts, the transmitter is provided with a built-in rectifier. The rectifier in turn secures its power supply from a compact rotary converter which changes the shipboard d-c supply to three-phase at 60 cycles. This arrangement eliminates all high voltage wiring external to the transmitter which is a very desirable feature for shipboard installations. The rectifier uses six UX-866 tubes in a three-phase, full-wave circuit.

A view of the left side of the transmitter is shown in Fig. 8. Of interest is the automobile-type spring suspension to minimize the effects

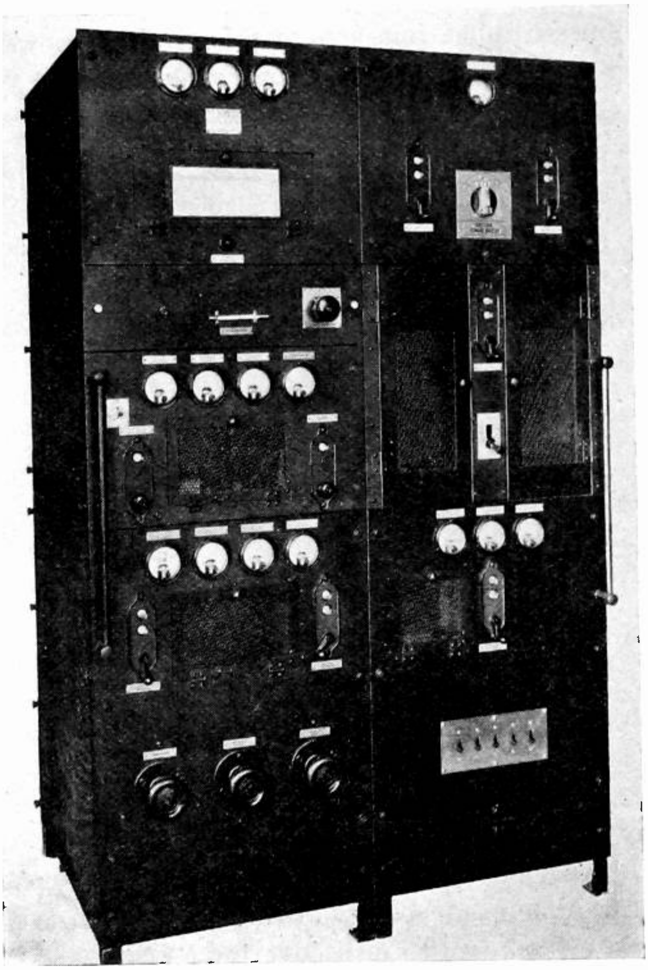

Fig. 10—ET-3656-A short-wave transmitter.

of ship vibration. The high-frequency circuits are continuously variable throughout their range through the use of the rotating coil mounted in the center section.

Large vessels handling a considerable amount of traffic are frequently arranged so that simultaneous transmission and reception in the intermediate- and high-frequency bands may be obtained. For these applications where a separate high-frequency transmitter is required the model ET-3666, shown in Fig. 9, is provided. This unit has an output rating of 200 to 350 watts and uses one UX-860 tube as master oscillator and two similar tubes in parallel as power amplifiers. Plate voltage supply is obtained from a rotary converter which connects to a built-in rectifier using six UV-872 tubes. The rectifier has sufficient capacity to supply a suitable modulator unit also, this combination having found extensive application throughout the country as an airport transmitter.

For shipboard applications where a fairly high power transmitter is required for communication over long distances, the 1 kw ET-3656-

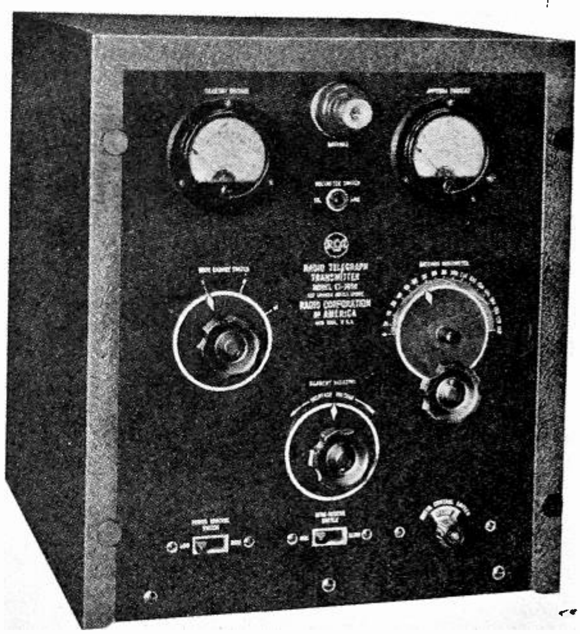

Fig. 11—ET-3650 emergency transmitter.

A transmitter may be used. A view of this transmitter is shown in Fig. 10. This is a crystal controlled unit covering a frequency range of 5500 to 17,150 kilocycles and has provision for using six crystals in a temperature controlled compartment. Some of the amplifier stages which follow the crystal oscillator are arranged to function as fundamental frequency amplifiers or as doublers, with the result that the six crystals provide 12 transmitting frequencies.

A standard arrangement on many steamships is to provide a small emergency transmitter which might be utilized in case of difficulty with the main transmitter, or for short-distance transmission when nearing port. The type ET-3650 transmitter shown in Fig. 11 has been developed for this purpose. Four UX-210 tubes are used which obtain their plate power from a 350-cycle motor generator set. This arrangement provides modulated transmission giving a 700-cycle note. The motor generator has the motor end designed so that a 12-volt storage battery may be used as a primary source of power supply. This machine is also built in 32- and 110-volt motor ratings. The transmitter is provided with a wave-change switch which is usually adjusted to four frequencies in the 375- to 500-kilocycle band.

Present-day practice on many large vessels provides a number of motor-driven lifeboats in addition to the regular lifeboats. These motor-driven lifeboats may be provided with complete radio installations

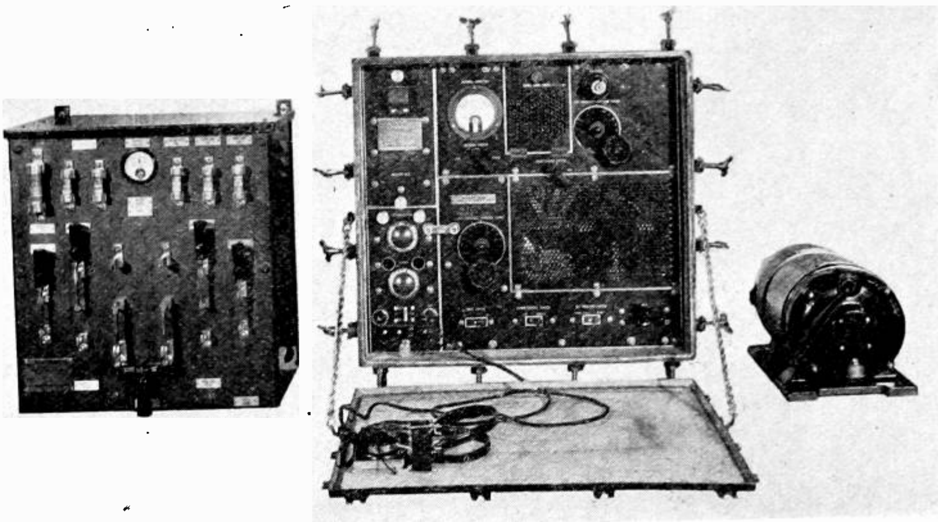

Fig. 12—ET-3677 lifeboat equipment.

designed especially for such service. The type ET-3677 lifeboat equipment is shown in Fig. 12. The unit at the left is a combined battery charging and switching panel and provides not only power control for the transmitter-receiver unit, but also control for a searchlight, a signal light, and various other lights throughout the lifeboat. The center unit is a combined transmitter and receiver mounted in a completely water-tight case. The transmitter provides two frequencies, one the standard distress frequency of 500 kilocycles and the other a frequency in the 5500-kilocycle band. Instant change from one frequency to another is obtained by a band switch on the panel. A regenerative receiver covering the intermediate-frequency band is provided in the left section of the panel.

One of the design problems in equipment of this type is to provide

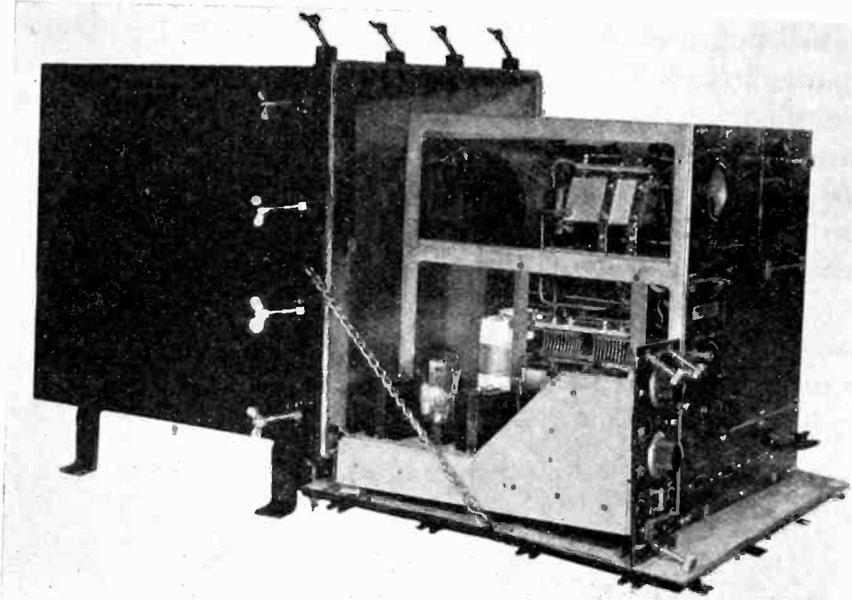

Fig. 13—ET-3677 lifeboat transmitter.

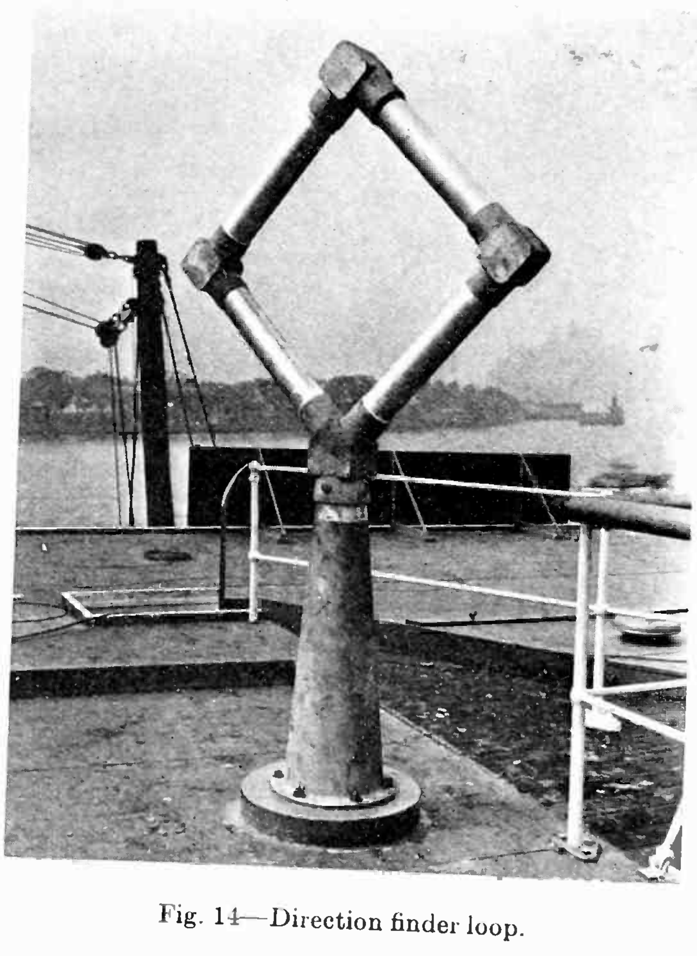

Fig. 14—Direction finder loop.

satisfactory operation with the very small antenna which may be erected on the lifeboat. This antenna usually consists of a single wire about 25 feet high and 20 feet long. By having transmission facilities in the 5500-kilocycle band comparatively long ranges may be obtained despite the small antenna. Power supply for the transmitter is obtained from a motor alternator which furnishes a 350-cycle output voltage to the plates of the tubes. Experience has shown that a properly maintained storage battery provides the most reliable source of emergency

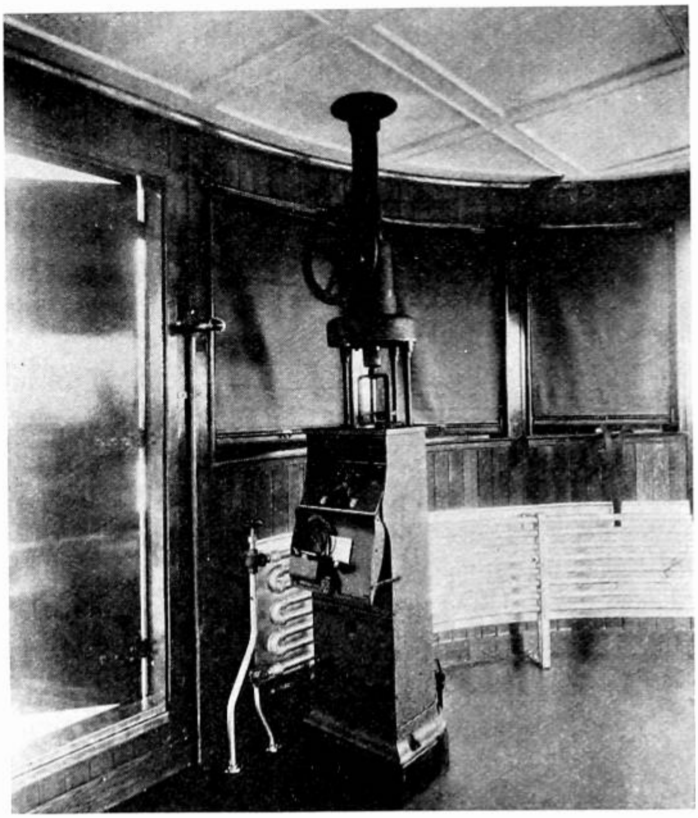

Fig. 15—ER-1455-B direction finder.

supply and it is for this reason that storage batteries are used. The lifeboat is provided with a suitable charging fitting and it is possible to trickle charge the battery continuously when the lifeboat is on the deck of the ship. The battery has sufficient capacity to operate the radio equipment, the lifeboat searchlight, and all other lights continuously for six hours. The charging panel is also arranged so that by throwing suitable switches the operator may use his telegraph key to signal with the searchlight or the "Morse light." Fig. 13 is a view of the transmitter-receiver unit withdrawn from the water-tight case.

Radio direction finders have become practically a standard aid to navigation on large numbers of ships. The type ER-1445-B direction finder has been designed for installation in the wheelhouse so that it may be used by the navigating officer at any time. A view of the rotatable loop used with this direction finder is shown in Fig. 14. Special precautions have been taken to make the loop weather-tight. The view in Fig. 15 shows a typical installation in the wheelhouse. The loop is rotated by the large handwheel. An automatic compensator is employed to correct the calibration of the loop, when deviations are caused by rigging and other objects aboard ship. At the top of the pedestal a dumb compass card may be mounted although provision is also made for connecting to a live gyroscope repeater. In order to provide sharp nulls and high selectivity a unicontrol superheterodyne circuit and a loop balancing arrangement are used. When it is necessary to determine the sense of the incoming signal an auxiliary antenna, coupled to the input circuit of the receiver, is utilized. This arrangement provides the well-known heart-shaped diagram when determining the sense of the incoming signal.

In order that the direction finder may not require undue attention by the navigating officer an automatic trickle charge circuit for the filament batteries is provided. When the observer is through using the instrument he closes the cover. This places the filament battery on charge and grounds the sense antenna.

Contributing companies in the design and manufacture of the equipment described in this paper, are: the RCA Victor Company, the General Electric Company, and the Westinghouse Electric and Manufacturing Company.