Proceedings

of the

Radio Club of America

Incorporated

Founded 1909

April, 1940

Volume 17, No. 3

RADIO CLUB OF AMERICA, Inc.

11 West 42nd Street ❖ ❖ New York City

The Radio Club of America, Inc.

11 West 42nd Street - New York City

TELEPHONE—LONGACRE 5-6622

OFFICERS FOR 1940

President

Keith Henney

Vice-President

J. L. Callahan

Treasurer

J. J. Stantley

Corresponding Secretary

C. E. Dean

Recording Secretary

Carl Goudy

DIRECTORS

J. G. Aceves

E. V. Amy

E. H. Armstrong

H. H. Beverage

Paul Godley

L. C. F. Horle

H. W. Houck

Wallace James

F. A. Klingenschmitt

J. H. Miller

L. C. Nichols

Paul Ware

COMMITTEES

Membership—P. B. Collison

Affiliation—E. V. Amy

Papers—Lincoln Walsh

Entertainment—H. W. Houck

Publicity—Lee Galvin

Year Book—George Burghard

Publication—Donald G. Fink

PROCEEDINGS
OF THE
RADIO CLUB OF AMERICA

Volume 17 — April, 1940 — No. 3

MOTORBOAT SHIP-SHORE RADIOCOMMUNICATION SYSTEM

By H. B. Martin

Engineering Department, Radiomarine Corporation of America

Radiotelephone service for small craft of all descriptions is one of the most recent developments in the communication field. It will be recalled that the first commercial use of radio or "wireless," as it was then called, was to communicate with ships.

Radiotelephone service for trans-oceanic ships was inaugurated in 1929 when large passenger ships or "luxury-liners" began to carry radiotelephone equipment as an added service for passenger convenience. Ships in this classification carry multi-channel transmitters capable of communicating with high-power coastal stations over distances of several thousand miles. Equipment of this type is relatively complicated, and requires the services of a trained radio operator. The *SS Leviathan* was the first, and for a number of years the only American ship offering radiotelephone service. The charges were originally $21.00 for three minutes. Telephone costs were subsequently reduced so that now the cost to the user for three minutes is $18.00 for distances greater than 1500 miles, $9.00 for distances between 500 and 1500 miles, and $4.50 for distances less than 500 miles. As a matter of interest, the long distance ship rate corresponds closely with the point-to-point trans-oceanic rates of $21.00 for week days and $15.00 for nights and Sundays.

Trans-oceanic ships giving this service communicate with the A. T. & T. station at Ocean Gate, New Jersey, from which point the calls are placed on regular land telephone circuits, the user paying the additional land line rates. "High-seas" ships also communicate by radiophone with England, Germany, and France, as well as Hawaii, Australia, New Zealand, and other countries.

General Plan for "Harbor-Telephone" Service

In 1933 the radio representatives of the United States and the Canadian Government agreed to a tentative plan for radio-telephone stations to provide service to boats operating in or near the main ports on the Atlantic, Gulf and Pacific coasts as well as the Great Lakes. The plan called for U.S. stations at Boston, New York, Norfolk, Charleston, Miami, St. Petersburg, New Orleans, Galveston, Los Angeles, San Francisco, Astoria (Oregon), and Seattle. All but Charleston,* Galveston, St. Petersburg and Astoria, Oregon are now in operation. It is believed that these will be added soon. Five U.S. and seven Canadian stations are now operating in the Great Lakes area.

The Atlantic, Gulf and Pacific coast stations are operated by the local Bell System Company in whose territory they are located.

* Started operation April 1, 1940.

Service to harbor and coastwise vessels differs from that needed for trans-oceanic vessels in several respects. First, the service is primarily "local," rarely exceeding 300 miles. For this reason, a narrow band of frequencies suffices. Frequencies used are in the 2 to 3 megacycle band, and are duplicated in some cases. For example, Boston and San Francisco use the same frequencies for transmission since the propagation characteristics of frequencies in the 2 to 3 megacycle band prevent interference between points which are widely separated geographically.

The second difference between "harbor" and "transoceanic" services is because the greater portion of the potential traffic is with small vessels having limited space, limited primary power for the operation of the equipment and a small personnel usually having only a layman's knowledge of radio equipment. The service, to be attractive to all classes of small boats, as well as coastwise freighters and passenger boats desiring to use radiotelephone as a supplemental service, must be reasonably inexpensive. The Bell System radio tolls for distances less than 150 miles is $1.50 for three minutes. For distances greater than 150 miles, the charges are $3.00 for three minutes. The regular land line tolls are added to the radio link charges. Thirty-three and one-third (33⅓) per cent of the radio link tolls are refunded to the boat owner. A dispatching service for harbor tugboats is available at slightly lower rates. The dispatching service allows a fleet of boats to talk to only one shore telephone subscriber and limits the length of conversations. A number of New York towing and tugboat companies use this type of service.

Facilities of New York Harbor Station—WOX

The New York Harbor Station, call letters WOX, is located at St. George, Staten Island. The transmitter operates on 2590 kc. with a power of 400 watts. To better serve the small boat with limited transmission facilities, WOX has five receiving stations located at Rosebank, S.I., Tottenville, S.I., Bay Shore, L.I., Whitestone, L.I., and Port Jefferson, L.I. The use of remote receiving stations located at strategic points permits the boat transmitter to be of relatively low power, compared to the shore station, since a boat on Long Island Sound or along the south shore of Long Island or along the Jersey coast would rarely be out of the normal range of at least one of the remote receivers. The 400-watt transmitter on Staten Island normally delivers a working signal to the extremities of Long Island and to Philadelphia or the Delaware Breakwater.

Propagation Characteristics

Frequencies between 2 and 3 megacycles follow the inverse-distance law up to about 50 miles.[1,2,3] Beyond this distance the sky-wave influence reduces field strength by approximately 0.06 db per mile. Attenuation over land ordinarily decreases field strength by 6 to 12 db per mile.[1] Thus the ground-wave range of frequencies within the 2 to 3 megacycle band is considerably better when the path is essentially over sea water. Signals transmitted over fresh water are attenuated almost as much as over land.

The actual communication range of marine telephone equipment depends upon a number of factors, the principal ones being the local noise level on the ship (caused by electrical machinery or ignition); the static level (which depends on the time of day, the season of the year and the latitude); the terrain; the power (and frequency) of the transmitter; the transmitting and receiving antennas employed and the receiver inherent noise. All of these factors may be controlled to a certain extent except those concerning static and the transmission path.

Guy wires, stays, etc., which do not make a solid connection between themselves or to the ship's hull (if metal) may be either bonded by a jumper wire connected around the poor electrical connection or insulated by the use of "compression type" egg insulators. The latter is preferable since the guy wires, if more than 10 or 20 feet long, should be broken up with insulators to reduce losses in the actual antenna system during transmission.

Electrical equipment such as fans, ventilator motors and battery charging generators, may be treated with spark-suppression filters and low-pass filters in the power line supplying the motors or coming from the generators.

The ignition system, if the boat is gasoline-driven, may require exhaustive treatment consisting of complete shielding of spark plugs, magnetos, distributors, high and low-tension wiring and possibly a low-pass filter in the battery line; the latter being necessary to avoid interference traveling from the shielded ignition system to the battery and thence to the lighting circuits which would radiate the noise exceptionally well, since the lighting wires run to the roof of cabins, to mast-head lights, running lights, etc.

Authorities differ on the ratio of signal-to-noise necessary for various types of communication. For broadcast reception of voice only, e.g., news events and announcements where the listener has some special reason for wanting to listen and will tolerate some annoyance from noise, it is conceded that the signal should be 10 or more times the noise level. Marine communication can be carried on with somewhat less than 10 to 1, providing occasional repeats are allowable and the conversation is in plain language using generally familiar terms.

Estimates of minimum field strengths for barely acceptable communication indicate that for the vicinity of New York, and barring local thunderstorms, the signal field should be 8 to 10 μv/meter in daytime and 80 to 100 μv/meter at night.

While it is difficult to reliably predict the range of radiotelephone equipment due to the many factors, it is possible to estimate field strengths developed from available data on wave propagation.

A 75-watt transmitter operating into a boat antenna having a radiation efficiency of 20 per cent will produce approximately 10 μv/meter at 300 miles over sea water and slightly more than 100 μv/meter at 75 miles. Thus the daytime (low static level) range is up to 300 miles and the night-time range may be up to 75 miles. From practical experience it has often been difficult to communicate 50 miles during heavy summer night static. Also, for example, boats at Miami have talked to Boston, etc.

A 15-watt transmitter operating into an antenna radiating one watt will develop 10 μv/meter at approximately 200 miles and 100 μv/meter at about 50 miles.

A 5-watt transmitter radiating 0.25 watt produces 10 μv/meter at slightly more than 100 miles and 100 μv/meter at 25 miles.

Thus, speaking generally, the ranges of 5, 15, and 75-watt equipment may be as follows:

Watts Output	*Night-time*	*Daytime*
5	25 miles	100 miles
15	50 miles	200 miles
75	75 miles	300 miles

A 400-watt shore station radiating 200 watts will produce fields of 10 μv/meter at 400 miles and 100 μv/meter at 200 miles provided the station is close to the shore and the path of the ship is not over intervening land. The balance of power is in the right direction, since the shore station can use remote receivers and thereby increase the overall range. The corresponding 10 and 100 μv/meter points for shore transmission overland are only 10 miles and 30 miles. This is the chief reason for using remote receiving stations, since many points from which the boat wishes to communicate are separated from the shore station by intervening land.

Design of Boat Equipment

The limitations imposed on radio equipment for motor boats narrow down to fundamental points, as follows:

1. On a small boat the equipment must be designed so that the holder of a "Restricted Radiotelephone" operator's permit may operate it according to the Rules of the Federal Communications Commission.[4] To quote the Rules,

(1) Such operator is prohibited from making adjustments that may result in improper transmitter operation.

(2) The equipment is so designed that none of the operations necessary to be performed during the course of normal rendition of service may cause off-frequency operation or result in unauthorized radiation.

(3) A third paragraph states that all adjustments that may affect proper operation be made by a 1st or 2nd class license holder.

To comply with the law as above, marine radiophone equipment invariably employs quartz crystal-control of transmitting frequencies. The tolerance on transmission frequencies is only 0.04 per cent. While this is possible with careful design using a "master oscillator," it is much more easily and reliably attained through the use of quartz crystals. Changing from one shore channel to another or to intership is ordinarily accomplished with a switch. It is permissible to allow the user to resonate the antenna for each frequency used since the frequency is selected by a switch and cannot be varied by improper antenna tuning.

A real limitation is the amount of power the boat's electrical system can provide for radio purposes. Engine starting, ignition and lighting batteries may be 6, 12, 32 or 110 volts, d.c. of course. Usually the smaller boats use 6 or 12 volts of storage battery. The prospective purchaser of radio equipment is advised to consider the extra drain on his battery system before he decides on any particular model. Even the smallest boats have batteries of sufficient size that an additional load of 5 to 10 amps. can ordinarily be accommodated providing the generator charging rate is increased or special dock charging facilities are available.

Additional limitations are the antenna system and the equipment cost. See Fig. 1a, b, and c for typical antenna arrangements.

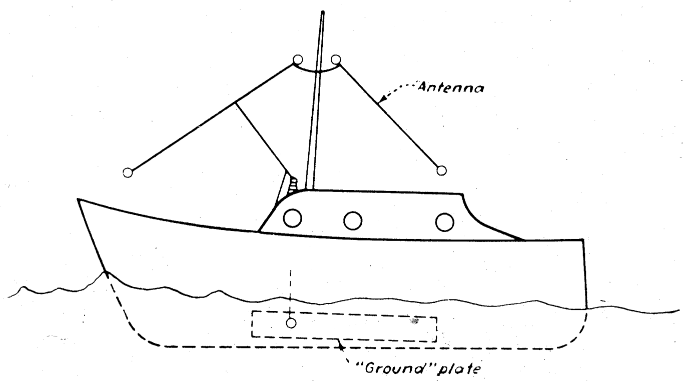

Fig. 1a—Small boat antenna system.

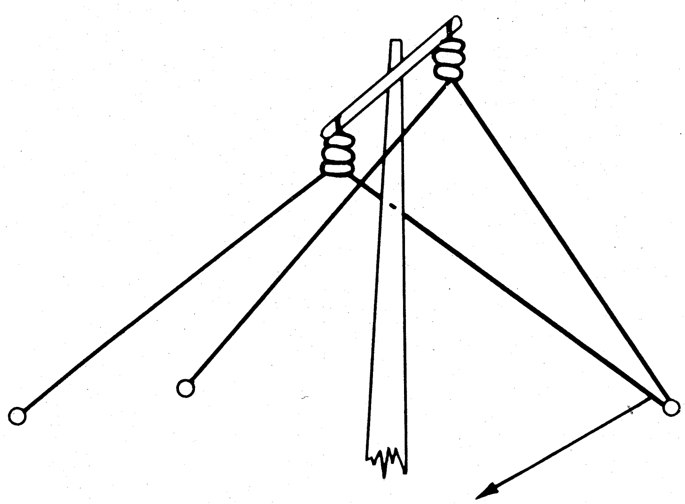

Fig. 1b—Two-wire antenna for small boats.

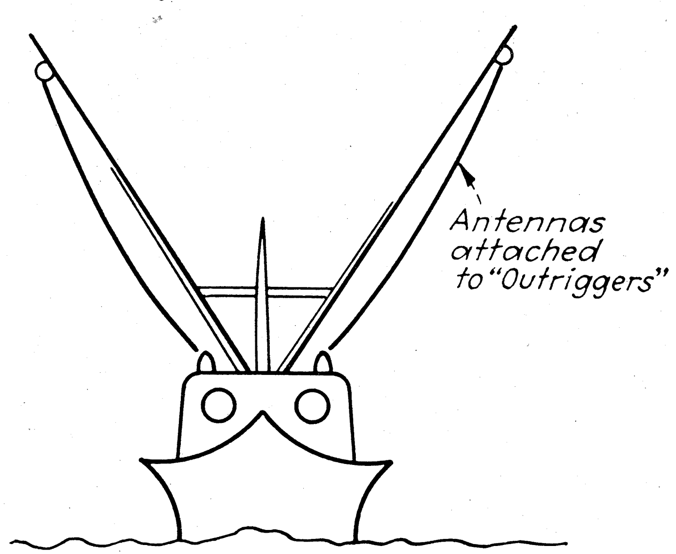

Fig. 1c.

ET-8013 Type of Equipment

The ET-8013[5] "5-watt" equipment requires a battery drain of 6 to 7 amps. during stand-by periods and 11 amps. while transmitting, which is a negligible part of the total time so far as additional ampere-hours are concerned. A brief description of this equipment is now in order. Figure 2 shows the panel arrangement.

The ET-8013 is designed for use by small boats requiring only limited range such as pleasure cruisers, launches belonging to larger boats, small fishing boats that do not venture far from shore, etc. Since boats answering these descriptions are essentially "local" in character, the equipment is provided with 3 channels—one for ship-to-shore communication with the local harbor station (if New York, the boat transmits on 2198 kc and receives on 2590 kc), one for intership communication (2738 kc) and one for emergency conversation with the Coast Guard stations or boats (2670 kc). This frequency is not licensed by the Federal Communications Commission for use by boats, but may be used in cases of absolute emergency involving danger to life and property.

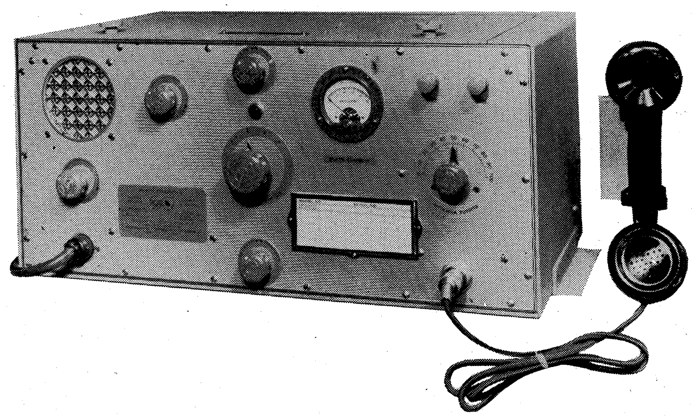

Fig. 2—Five-watt transmitter-receiver.

Both receiver and transmitter frequencies are selected by a master switch (also having an "off" position). The circuits are pre-tuned by adjustments accessible only from the inside of the cabinet. The transmitter antenna circuit must be resonated for each frequency by turning the "ANT" tuning dial. The proper setting is indicated by a milliammeter which shows vacuum tube plate currents. Send-receive operation is obtained by a small panel switch which is thrown to "send" while talking and back to "receive" while listening. This switch transfers the antenna and applies either transmitter or receiver plate voltages. The user may receive on the loud speaker or the telephone receiver in the handset.

The receiver uses the superheterodyne circuit and employs 4 tubes as follows: 6K8 converter-oscillator, 6K7 i-f amplifier, 6J7 detector and 6F6 a-f amplifier. R-f and i-f sensitivity is controlled by varying control grid bias of the mixer and i-f amplifier stages. A synchronous vibrator supplies transmitter and receiver high voltage.

The transmitter employs 3 tubes: 6C5 crystal oscillator, 807 plate and screen modulated power amplifier and 807 modulator. The microphone handset is the standard land-line, single-button carbon type.

Since the antenna is series resonated for transmitting, a wide range of antenna constants may be tuned with the inductance and variable capacity provided. Antennas on small boats may be anything from a vertical rod 12 or more feet high to a 2 or more wire flat-top L or T antenna, (Fig. 1). The L, C and R antenna constants will vary widely with various installations. The antenna loading inductor is tapped so that by selecting the proper inductance tap at the time of installation, the antenna-tuning capacitor (front panel controlled) will swing 2110 to

2738 kc. The antenna coupling utilizes a special circuit composed of capacity and variable inductive coupling (Fig. 3).

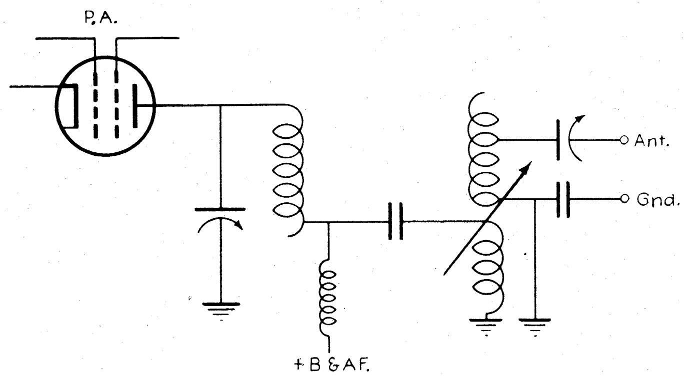

Fig. 3—Antenna coupling system (ET-8013).

The battery power is supplied through a polarized plug.

A special "ground" plate is recommended for wooden hulls rather than using the motor, propellor shaft, etc., since the latter does not always make a good electrical and radio ground (Fig. 1a). This ground plate should be located on the outside of the hull, below the waterline and directly under the radio apparatus to give the shortest ground lead possible. The area should be twelve or more square feet. It is desirable to keep the ground lead and plate electrically free of the motor as an aid to interference reduction. A separate battery has also been found to be of assistance in reducing electrical noise. When a separate battery is used, the polarity should be arranged so that either of the positive or the negative terminals of both battery systems go to ground. Either polarity may be used for the ET-8013 since the vibrator plug may be "plugged in" according to the polarity chosen. Opposite polarities to "grounds" (if two battery systems are used) will cause electrolysis. In most cases the propellor will be "eaten away" or

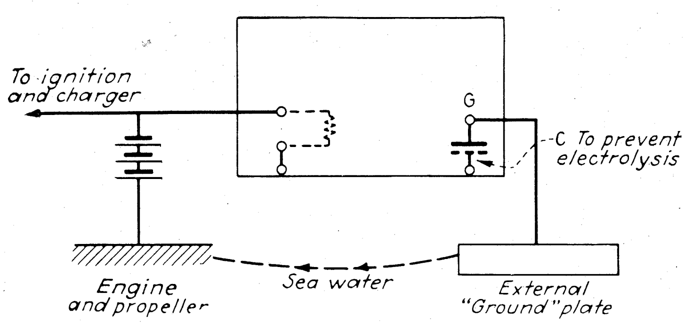

Fig. 4—Path of the electrolysis current.

pitted. This is prevented in the ET-8013 by isolating the ground post of the cabinet by means of a fixed internal capacitor (Fig. 4). Even when only one battery is used, there may be local action due to the dissimilarity of metals in the external ground plate and the propellor, etc.

ET-8011 Type of Equipment

A number of small boat owners use broadcast receivers aboard their boats so that entertainment, news events, weather broadcasts, and so forth may be utilized for obvious reasons.

The ET-8011[6] provides the 3 standard bands normally found on modern broadcast receivers so that the equipment may be used for entertainment as well as communication purposes. Also, since this equipment is slightly larger in power and is used on boats travelling up and down the coasts, provision is made for 6 transmission frequencies instead of 3 as in the 5-watt equipment. With 6 frequencies available, the boat may communicate with any one of the Bell-System Harbor Stations located along the coasts, and may communicate with other boats on the intership frequency as well as Coast Guard Stations in the event of an emergency. Figure 5 illustrates a front panel view.

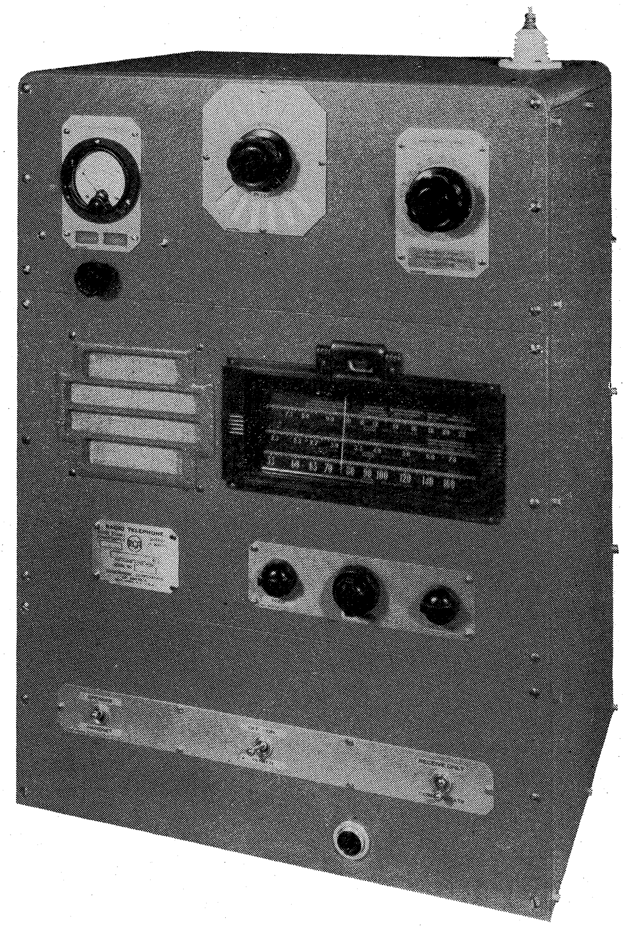
Fig. 5—Fifteen-watt equipment for small boats.

The ET-8011 will deliver 15 watts of carrier to the antenna. Both the transmitter and the receiver are a-c operated, each having its own rectifier-filter system. The power supply on the boat may be either 12, 32, or 110 volts dc, the proper rotary converter being supplied depending upon the voltage. The power drain for the various voltages as above is approximately 35, 15, and 5 amps. for ship-supply voltages of 12, 32, and 110 volts respectively. The same rotary converter is used to supply both the transmitter and receiver. When power supplies of 12 or 32 volts are used, a small relay box is supplied so that the converter may be located at a distance from the radio equipment and be controlled by the front panel tumbler switch. This obviates the necessity for bringing heavy current wires up into the radio equipment and back again to the rotary converter with the consequent loss of voltage due to *IR* drop. The transmitter circuits utilize quartz crystals for the control of frequencies.

The radio frequency tube complement in the transmitter is as follows: 807 crystal oscillator, 807 plate and screen modulated power amplifier.

The 6-position gang switch used for the selection of frequency changes crystals, crystal-oscillator plate trimming capacitors, power amplifier tuning capacitors and power amplifier plate-coil taps. Coupling to the antenna is accomplished by means of a common capacity which is an aid to flat antenna loading over a band of frequencies and materially reduces harmonic radiation. The antenna is resonated by means of a variable condenser adjusted from the front panel, and together with a tapped antenna load coil, will resonate any small boat antenna to the frequencies required. A small switch on the front panel must be thrown to either "Talk" or "Listen" during communication. The speech amplification equipment consists of a 6F5 microphone amplifier, a 6F6 driver, and two 6L6 beam tubes in Class B for modulators. The output of the modulators is transformer coupled to the plate and screen circuits of the power amplifier. Two type 83 mercury vapor rectifier tubes are used for producing the transmitter d.c. from 110 volts, 60 cycles a.c. The receiver provides frequency ranges of 540–1700, 2300–7500 and 7000–22000 kc. The middle band as indicated above is used for ship-to-shore and ship-to-ship communication. A tuning eye is provided to facilitate adjustment.

The receiver tube complement consists of the following tubes: 6A8 mixer-oscillator, 6K7 i-f amplifier, 6H6 detector and a.v.c. tube, 6F5 first a-f amplifier and 6F6 second a-f amplifier. A 5W4 rectifier tube converts the 110-volt, 60-cycle a.c. to receiver direct current. Calls may be made using the speaker or the telephone receiver in the handset as desired.

The two types of radiotelephone equipment just described exemplify the simplest types available for the power output. Both have advantages and limitations not possessed by the other. That is, the ET-8013 is more automatic in that the receiver is pre-tuned and the ET-8011 has 6 frequencies available instead of 3 and has the provision for BC reception in addition to the ship-to-shore frequencies. It may also be operated from a variety of DC ships' voltages or from 110 V, 60 cycles a.c.

However, in both cases incoming calls from the shore must be received on the loud speaker. Unless the boat is close enough to the shore station transmitter to receive a signal much stronger than static or local boat electrical noise, the continued "blaring" of the loud speaker is a necessary evil. Some boats arrange schedules with the harbor station and other boats so that they may turn on their equipment just prior to expected calls or according to schedule. This method is satisfactory in most respects, but had distinct limitations. For example, during the night when the receiver was either shut off or the loud-speaker volume reduced to allow sleep, the boat could not be contacted for important messages.

Selective Signaling

The harbor stations are equipped to call boats with a selective ringing system.[7] To utilize this system, the boat receiver must be provided with a special device called a "selective ringer." With this equipment, the shore station may ring the telephone bell on any ship desired merely by dialing that particular ship's telephone number. Since each number is different, except in cases where duplicate assignments may be made such as for local craft never venturing away from a certain harbor etc., the bell rings only on the boat called.

The special ringing equipment at the shore station consists fundamentally of a telephone dial and an a-f oscillator capable of modulating the shore transmitter with alternate 600 and 1500-cycle tones. The dial is especially constructed so that successive tones are always alternate. For example, if the numbers 2 and 3 were dialed, the tones transmitted would be 600–1500 and 600–1500–600. If the number 4 were dialed following the 2 and 3, the transmitter would radiate A-2 transmission of 1500–600–1500–600 cycles. The receiving device is arranged so that alternate tones must be received to actuate the stepping (or storing) mechanism in order to avoid the possibility of an occasional false alarm due to static or voice components when the channel is in use by another ship.

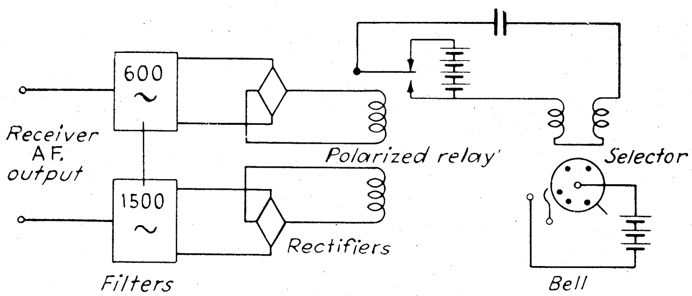

Fig. 6—Simplified selective ringer schematic.

The selective receiving system has four fundamental parts (Fig. 6). The receiver a-f output is fed to two filters, one tuned for 600 cycles and the other for 1500 cycles. The filters attenuate all other frequencies and feed the 600 and 1500 cycles to two copper-oxide rectifiers. Each rectifier output is connected to separate coils on a polarized relay. The contacts of the polarized relay charge and discharge a capacitor whose charging current flows through a special stepping relay. The capacitor is charged from alternate d-c voltages each time the polarized relay is energized by one tone or the other. The stepping relay coils thus have their current reversed for every movement of the polarized relay. Several things must happen in order to successfully operate the relay which finally rings the bell, that is, the successive tones must be alternate and must be between 8 and 11 impulses per second since the stepping mechanism allows the code wheel to fall back to "zero" unless the impulses are received at the correct rate. Also when the final tone is reached for each number dialed, there must be a retaining pin in the code wheel to hold it there so that the next number may properly move it up to the following pin.

A total of 23 impulses are used for one telephone number. For example, $4 + 4 + 5 + 4 + 6 = 23$. Pins would be set on the code wheel to correspond to these numbers. All code wheels on all ships advance for all calls but return to "zero" at the end of each number unless a retaining pin occurs at that number. For example, a ship having the number 44654 would follow the call made to a ship using 44564 up to the 3rd number at which time the 44654 wheel would drop back since there was no pin at 5. Since ordinary noise is partially balanced in the two polarized relay coils, it is possible to put through ringer calls when the signal is only 2 db above the noise; for this condition, speech would be almost impossible to understand.

The advantages of the selective calling system are obvious since the receiver may be receptive to calls for the ship but totally "dead" to other calls and conversations.

Vodas Method of Control

More elaborate marine telephone equipment uses what is known as "voice-operated carrier control" so that no send-receive switch need be thrown during communication. This is also called VODAS, the letters being the first ones of the words "voice-operated device anti-sing." The anti-sing term comes from telephone practice and means anti-feedback. The relay or relays which turn on the transmitter due to speech in the microphone must also disable the receiver to keep the circuit from "howling." This system complicates the equipment, but is desirable particularly when passengers or people unfamiliar with the system wish to make calls, since it is difficult to throw a send-receive switch just at the right time without practice. Using VODAS, the system more nearly approaches the land-line telephone except for one more point; it is only possible to transmit *or* receive at one time. Therefore, if both ends of the circuit talk at once the transfer of intelligence is quite nil. The shore station circuits are arranged, however, so that the ship has control and may interrupt the shore conversationalist. This is made possible by shore station land-line VODAS, which must be used to connect a 4-wire circuit (transmitter and receiver) to a 2-wire land line. The complete system, is then, quite complicated but operates like a land telephone except as noted above.

ET-8012-B Type of Equipment

The advantages from a performance standpoint of the ET-8012-B[8] ship radiotelephone equipment over the other two models described are as follows:

Fig. 7—Radio equipment, 75 watts in power.

1. Ten frequency channels—transmitter and receiver both crystal-controlled.
2. Completely self-contained—all in one cabinet. At installation, it is only necessary to connect power wires, the antenna, ground and the handset circuits.
3. Power rating: Transmitter 75 watts, capable of 100 per cent modulation; receiver 1 microvolt sensitivity.
4. Separate transmitter and receiver power units to reduce stand-by drain on the boat's power system. (Available for 32, 110 and 230 volts, d.c.)
5. Selective ringer for receiving shore calls.
6. Loud speaker for receiving shore calls and ship calls, and for communication when using the "press-to-talk" method of carrier control.
7. VODAS or "press-to-talk" operation as desired.
8. Sensitivity control for regulating volume instead of depending entirely on a.v.c. The sensitivity control adjusts the signal strength at which AVC starts.
9. Standby-communicate, speaker on-off and control of volume from a remote control box.

The transmitter employs 10 tubes as follows: 807 crystal oscillator, 4 807 (paralled) plate and screen-modulated power amplifiers, 2 809 modulators, 6A6 driver, 6A6 microphone amplifier, 6A6 Vodas tube. A 3-gang 10-position switch selects the desired transmitting crystal, the correct tap on the plate tank coil, and closes a special interlock circuit designed to prevent the transmitter from passing plate currents unless the switch is set on a position for which a crystal is supplied. The oscillator circuit is a modified Colpitts, and uses band-pass coupling to the power amplifier grids. The power amplifier is coupled to the antenna by means of capacity common to the inductive branch of the tank and the antenna. A switch allows adjustment of the coupling to match the antenna. This is done when the installation is made. A rotating (variable-inductance) coil tunes the antenna to the desired frequency. A milliammeter and a meter switch provide for adjustment and occasional checking. An r-f ammeter indicates antenna tuning and "modulation" also. A switch on the transmitter panel allows the selection of either VODAS or "press-to-talk" control of carrier.

The receiver is a superheterodyne employing 9 tubes as follows: 6L7 r-f amplifier; 6L7 mixer, 6C5 r-f crystal oscillator, 6L7 1st i-f amplifier, 6L7 2nd i-f amplifier, 6R7 detector, a.v.c. and 1st a-f amplifier, 6C5 ringer a-f amplifier, 6F6 2nd a-f amplifier (speaker and handset output). The separate ringer a-f amplifier is used to prevent the reaction of the 600 and 1500-cycle filters in the ringer on the speaker and phone fidelity.

A 3-gang 10-position switch selects the proper receiver crystal, and the corresponding r-f amplifier and mixer-grid trimmer capacitors. Volume is controlled by adjusting the a.v.c. delay bias.

The delayed a.v.c. sensitivity control operates to overcome disadvantages of full a.v.c. having control of volume in the a-f circuits as follows.

Assuming noise is high, in order to reduce the racket from the speaker, the a-f volume control would be set to a low value. Then, any signal coming in will also be at a low value and may not be heard unless it is quite strong. In other words, having reduced level in the a-f stages it is impossible to get more than a certain comparatively low level from incoming signals. In the ET-8012-B the a-f stages operate at full gain and the r-f and i-f sensitivities are reduced so that incoming noise is not objectionable during speaker stand-by periods. Then any incoming signal stronger than the noise level will produce strong speaker signals. In other words, the receiver is taking full advantage of strong incoming signals so that reception will be noise free. After communication is established, the sensitivity is set by the user so that his particular preference for volume is satisfied.

When the remote unit is used, either the local or remote speaker or both may be used to stand-by. The receiver and remote unit both have volume (sensitivity) controls having a speaker disconnecting switch (marked "ringer only"). Sensitivity may be controlled from either location by a special circuit.

Statistics

There are over 20[9] manufacturers of ship radiotelephone equipment. It is believed that less than 20 per cent of the total marine telephones in use were made by any one manufacturer. Following is an approximation of the number of the three types of equipments described which are actually in use on all types of ships:

ET-8013 (5 watt)	80
ET-8011 (15 watt)	150
ET-8012-B (75 watt)	70
totaling	300 units.

References

(1) Attenuation of Overland Radio Transmission in the Frequency Range 1.5 to 3.5 MC." C. N. Anderson, Proceedings I.R.E., Vol. 21, No. 10.

(2) Report of Committee on Radio Wave Propagation." Proceedings I.R.E., Vol. 26, No. 10.

(3) Report of Committee on Radio Wave Propagation." Proceedings I.R.E., Vol. 21, No. 10.

(4) "Rules Governing Commercial Radio Operators." Effective July 1, 1939.

(5) Radiotelephone for Small Yachts." I. F. Byrnes, *RCA Review*, January, 1939.

(6) "Ship-to-Shore Harbor Telephone Equipment." H. B. Martin, *RCA Review*, July, 1938.

(7) "Radiotelephone System for Harbor and Coastal Services." C. N. Anderson and H. M. Pruden, Proceedings I.R.E., Vol. 27, No. 4.

(8) "Medium-Power Marine Radiotelephone Equipment." J. F. McDonald, I.R.E. Convention, New York, September, 1939.

(9) "Radiophone Service for Small Ships." Beverly Dudley, *Electronics*, March, 1939.