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RADIO AND SOUND BULLETIN

No. 8

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Restricted

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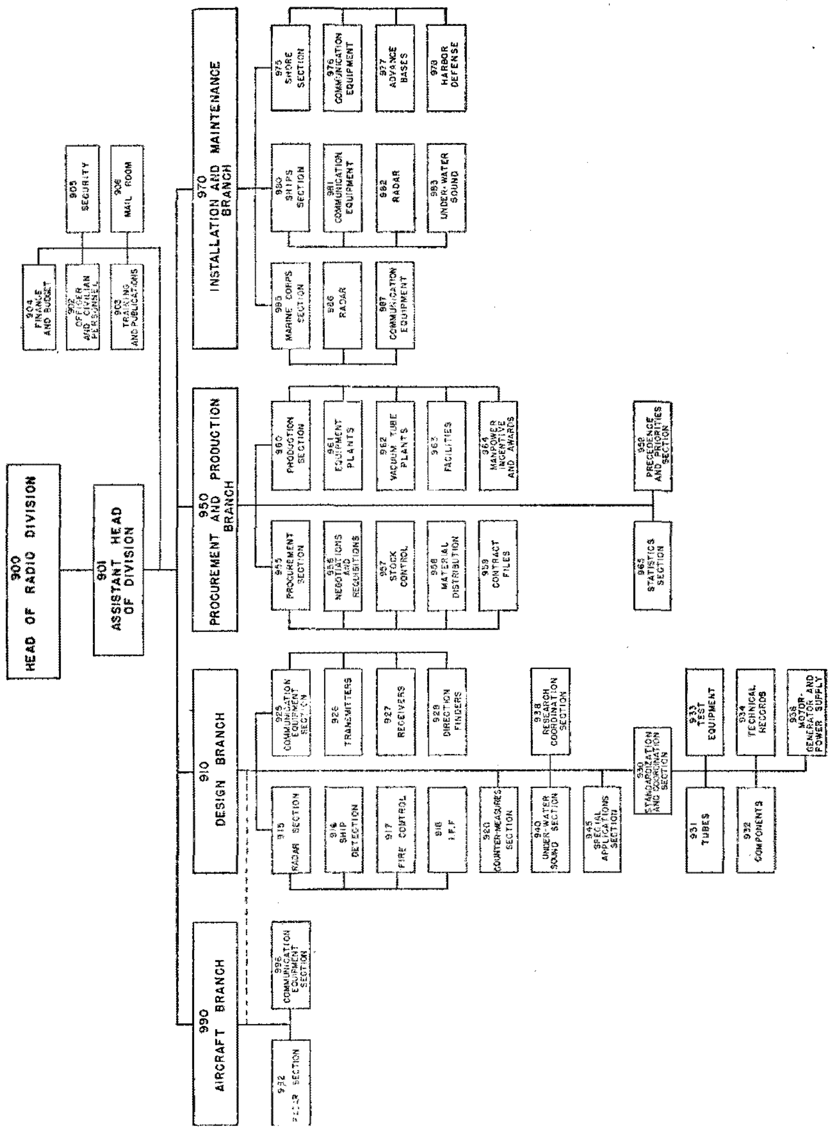
RADIO AND SOUND BULLETIN

NAVY DEPARTMENT,
BUREAU OF SHIPS,
October 1, 1942.

ORGANIZATION OF THE RADIO DIVISION

Under the recent reorganization of the Bureau of Ships a separate Division has been created to handle radio material matters. The organization of the Radio Division is shown in the following chart, and code numbers of the various branches, sections, and subsections are indicated.



MATCHING HIGH FREQUENCY TRANSMISSION LINES

I. INTRODUCTION

In Radio and Sound Bulletin No. 5 an article was presented describing a method for matching high-frequency transmission lines to antennas of various impedances by installing a tuning loop or stub near the antenna end of the line. Figure 1 represents the standing current waves on an unmatched line. Over a convenient span of the line

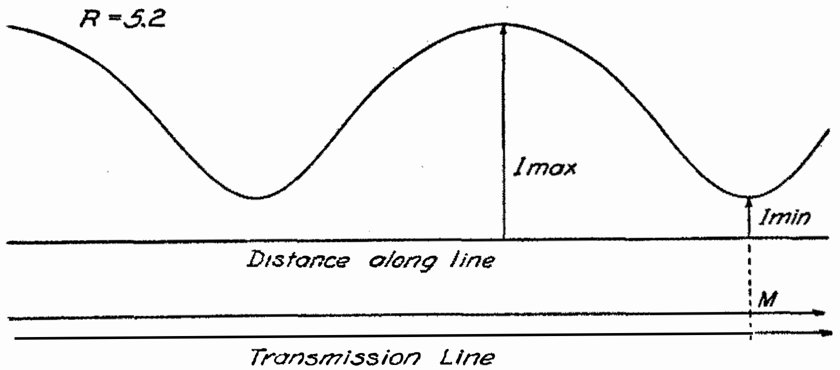


FIGURE 1.—Standing current waves on a transmission line improperly matched to antenna.

a point M of minimum current is established and the ratio R of current maximum to current minimum is determined by direct measurement. By means of a chart appearing with the article, a loop of length l is indicated for the measured ratio R, and from the same chart the location of this loop is given in terms of a distance d measured from the point of current minimum M. Figure 2 indicates the line with the loop installed.

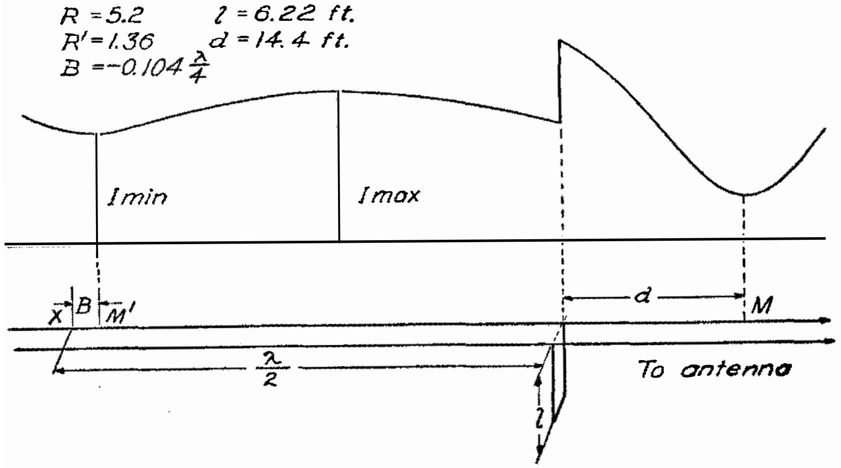


FIGURE 2.—Transmission line with matching loop located by first approximation, showing reduction in magnitude of reflected waves.

While the installation of such a loop will considerably reduce the reflection, further adjustment in the size and position of the loop may be necessary to produce the desired match. In the article of Bulletin No. 5 this precise adjustment was left to cut-and-try methods. Such a process may at times increase the length of time the transmitter must be on the air for adjustment purposes.

Therefore, Ensign C. A. Martin, U. S. N. R., U. S. Naval Radio Station, Annapolis, has devised a further refinement of the method whereby one or two repetitions of the original measurements will indicate precise adjustments which will reduce the standing waves to the final value desired (a ratio not exceeding 1.05 to 1.00 is used at Annapolis).

II. PRELIMINARY MEASUREMENTS

1. By the method described in Bulletin No. 5 determine a convenient point of current minimum M as near the antenna as possible and measure the ratio R of current maximum to current minimum.
2. From the curve given in that article find the length and position of the matching loop, and install it on the line.
3. With the loop so installed a new condition of reflection will exist and the standing waves will be as shown in Figure 2.
4. Place a stake-marker, X, in the ground at a distance of one-half wavelength from the loop.
5. Measure the new ratio R' of maximum current to minimum current.
6. Determine the new point of minimum current nearest X and by means of a plumb line place ground marker M'.
7. Measure the distance B from the marker X to the point of current minimum M'. The sign of B is taken to be positive if measured toward the transmitter and negative if toward the antenna.
8. Convert B to a decimal part of a quarter wavelength.
9. With the values of R' and B determined it is now possible to find the precise correction in the size and position of the loop from the charts of figures 4, 5, 6, 7, and 8. Figure 3 indicates the effect of the corrected loop on the magnitude of the standing waves.

III. DESCRIPTION OF CHARTS

A separate chart is provided for each value of the ratio R from $R=5$ to $R=10$, where R is the ratio of maximum to minimum current in the line before the loop is installed.

The ordinates of these charts indicate the correction in length of the loop (Δl); the abscissas show the correction in position (Δd). The corrections are read as decimal parts of a wavelength. Positive values of Δd denote the distance the loop shall be moved toward the transmitter, while negative values will be toward the antenna. Positive values of Δl indicate lengthening the loop; negative values shortening the loop.

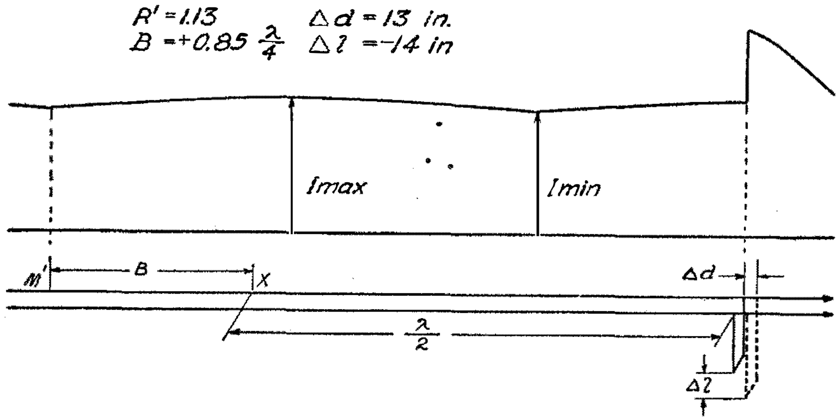


FIGURE 3.—Standing waves on transmission line with matching loop relocated by use of Martin charts.

IV. USE OF THE CHARTS

1. Select the chart for the value of R nearest that determined for the unmatched line.
2. Locate the radial curve corresponding to the dimension B.[1]
3. Follow this curve to its intersection with the ellipse corresponding to the previously measured ratio R'.[1]
4. At the point of intersection read the values of Δl and Δd.
5. Make the indicated correction in the size and position of the loop.
6. Further improvement in the match can be achieved by repeating the process using the same chart but newly measured values of R' and B.

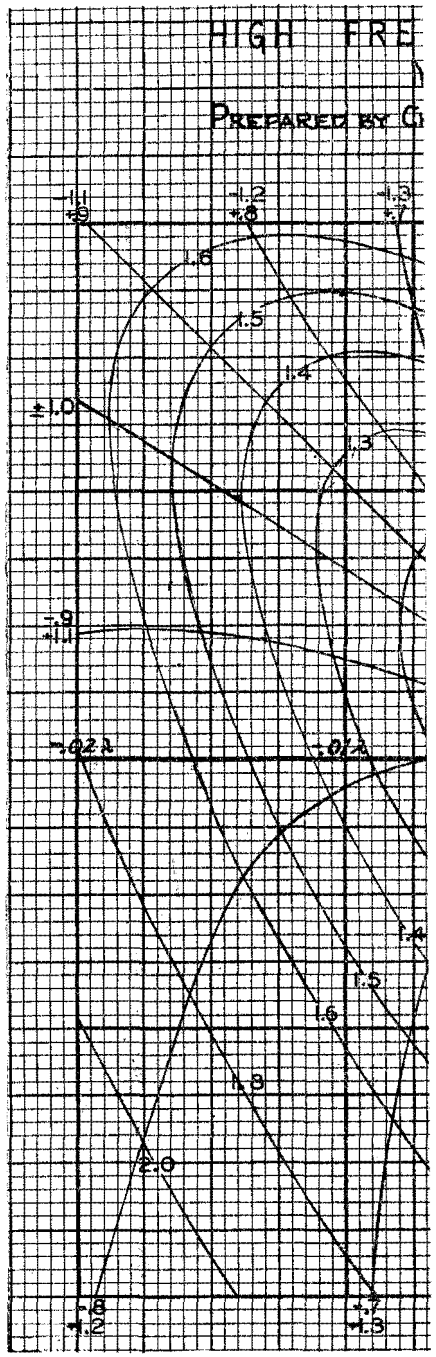
V. EXAMPLE

In order to further clarify the method an example is given of the application of the charts to a typical problem:

A transmission line is to be matched to its antenna for operation on a frequency of 12630 kc. Preliminary measurements as described in Bulletin No. 5 indicate a ratio of maximum to minimum current of $R=5.2$ and from figure 3 of that article it is found that the approximate matching loop has length and position of

$$l = 6.22 \text{ ft.}$$
$$d = 14.4 \text{ ft.}$$

[1] Interpolation may be necessary.



n. Positive values
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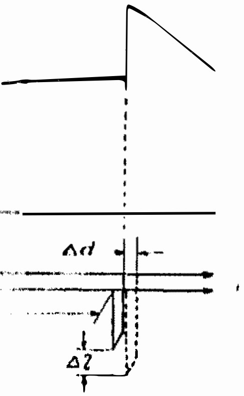

loop relocated by use of

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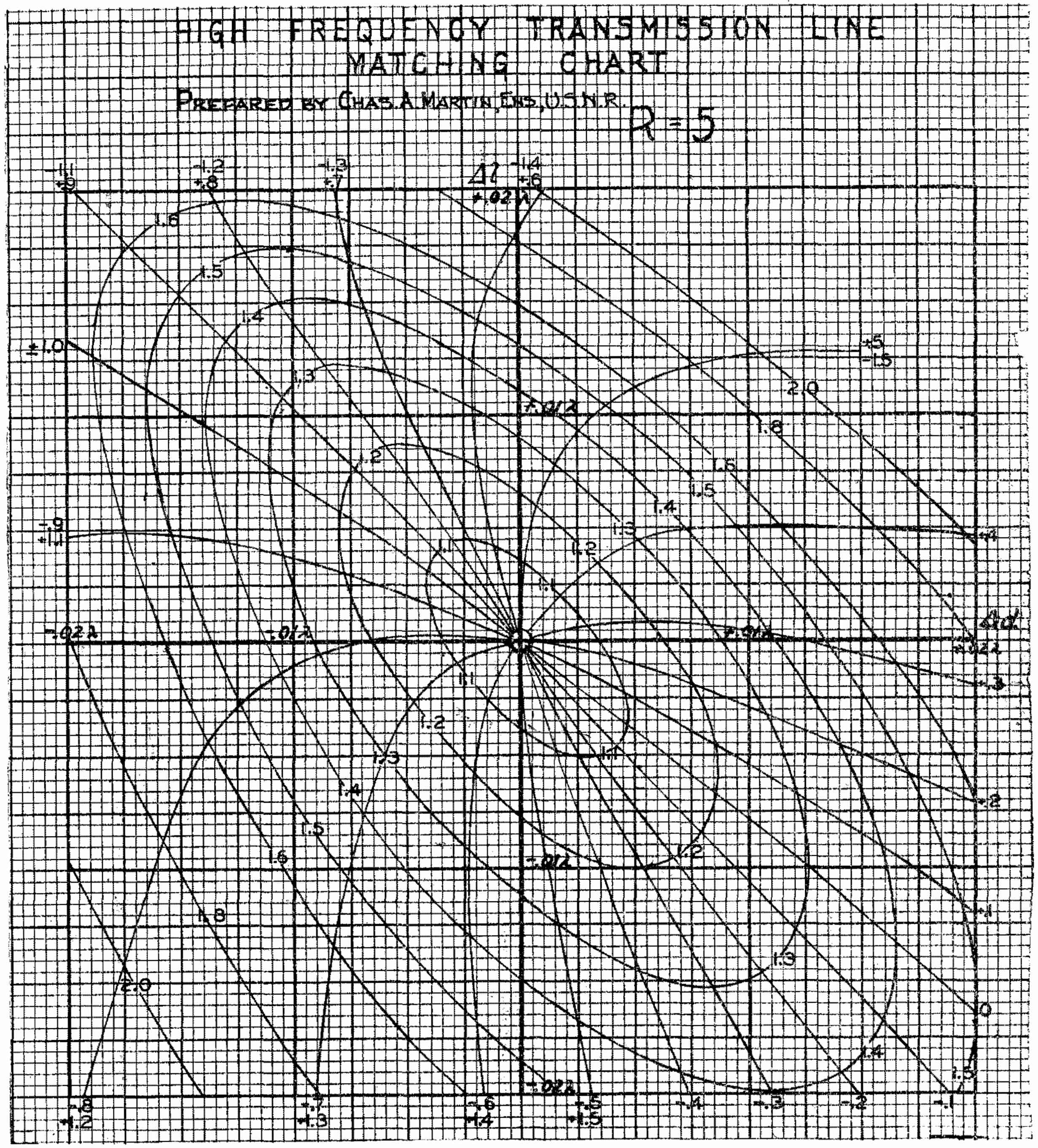

FIGURE 4.

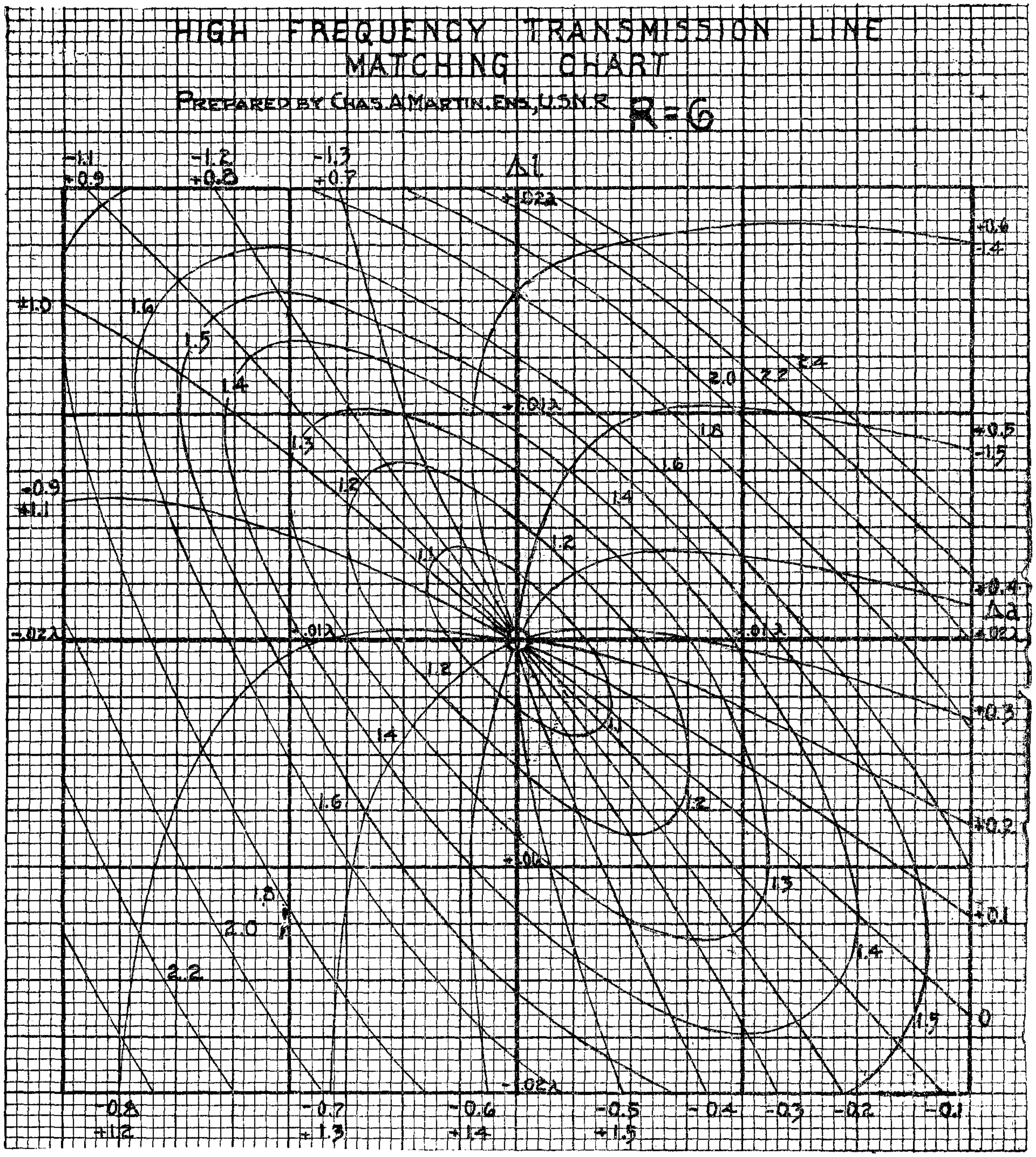
HIGH FREQUENCY TRANSMISSION LINE
MATCHING CHART
PREPARED BY CHAS. A MARTIN. ENS, U.S.N.R.
R=6
Δl
Δa

FIGURE 5.

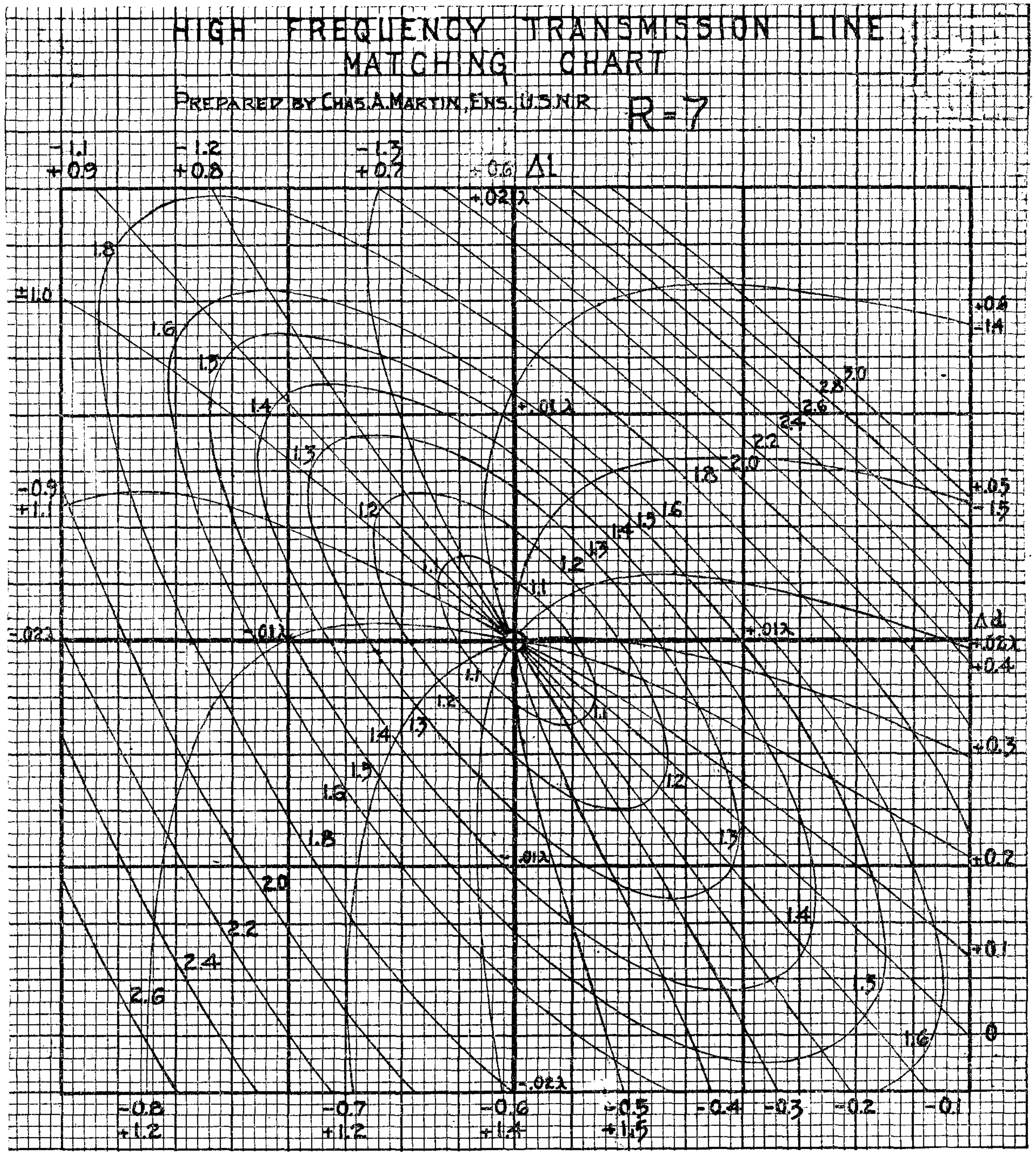
HIGH FREQUENCY TRANSMISSION LINE
MATCHING CHART
PREPARED BY CHAS. A. MARTIN, ENS. U.S.N.R.
R=7
Δl
Δd
−1.1
+0.9
−1.2
+0.8
−1.3
+0.7
+0.6
+.02λ
+.01λ
−.01λ
+.01λ
−.02λ
+.02λ
±1.0
−0.9
+1.1
+0.6
−1.4
+0.5
−1.5
+0.4
+0.3
+0.2
+0.1
0
−0.8
+1.2
−0.7
+1.2
−0.6
+1.4
−0.5
+1.5
−0.4
−0.3
−0.2
−0.1

FIGURE 6.

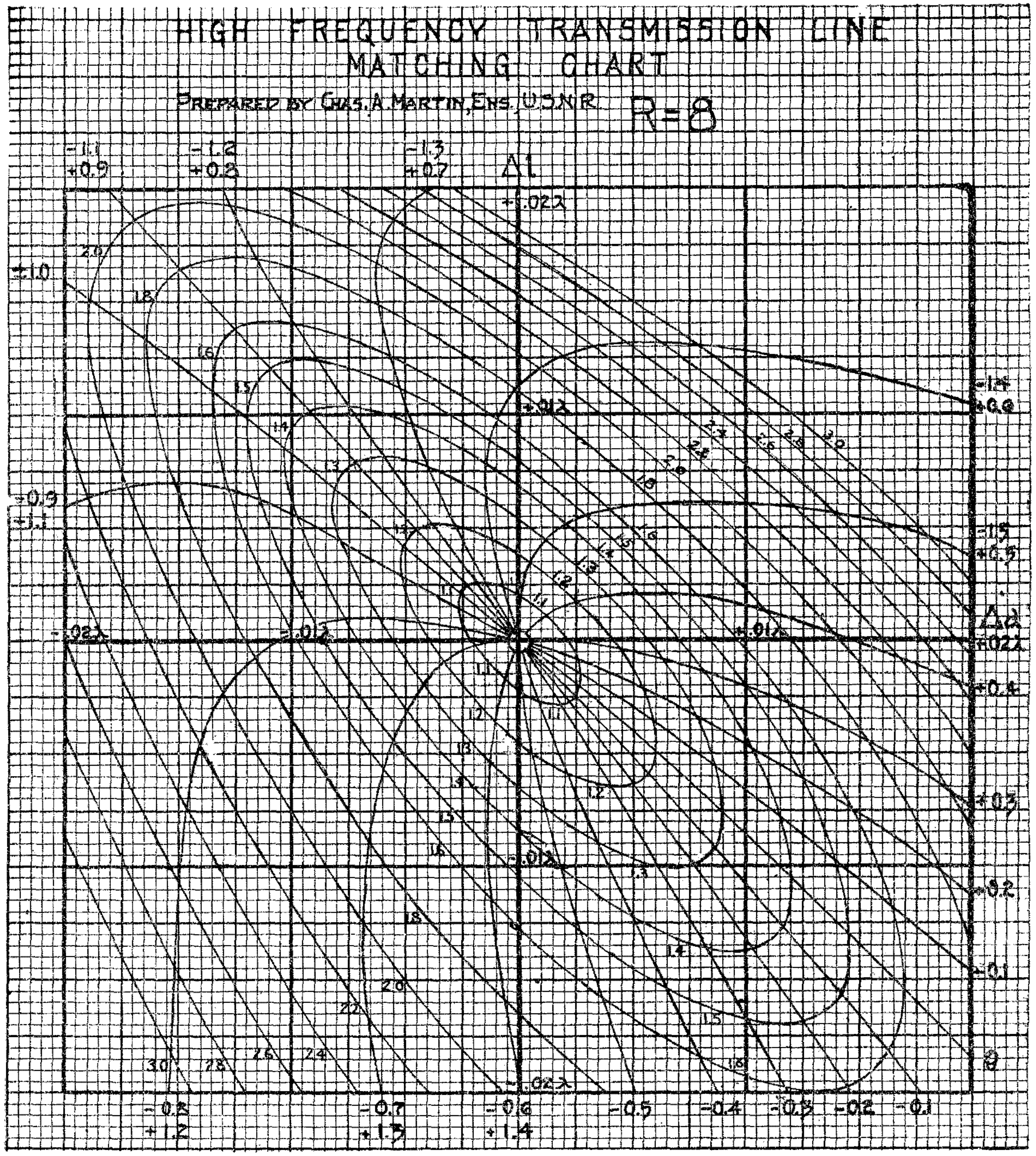
HIGH FREQUENCY TRANSMISSION LINE
MATCHING CHART
PREPARED BY CHAS. A. MARTIN, ENS. U.S.N.R.
R=8
Δl
+.02λ
+.01λ
-.02λ
-.01λ
+.01λ
+.02λ
-.01λ
-.02λ
Δl
-1.1
+0.9
-1.2
+0.8
-1.3
+0.7
±1.0
-0.9
+1.1
-1.4
+0.6
-1.5
+0.5
+0.4
+0.3
+0.2
+0.1
0
-0.8
+1.2
-0.7
+1.3
-0.6
+1.4
-0.5
-0.4
-0.3
-0.2
-0.1

FIGURE 7.

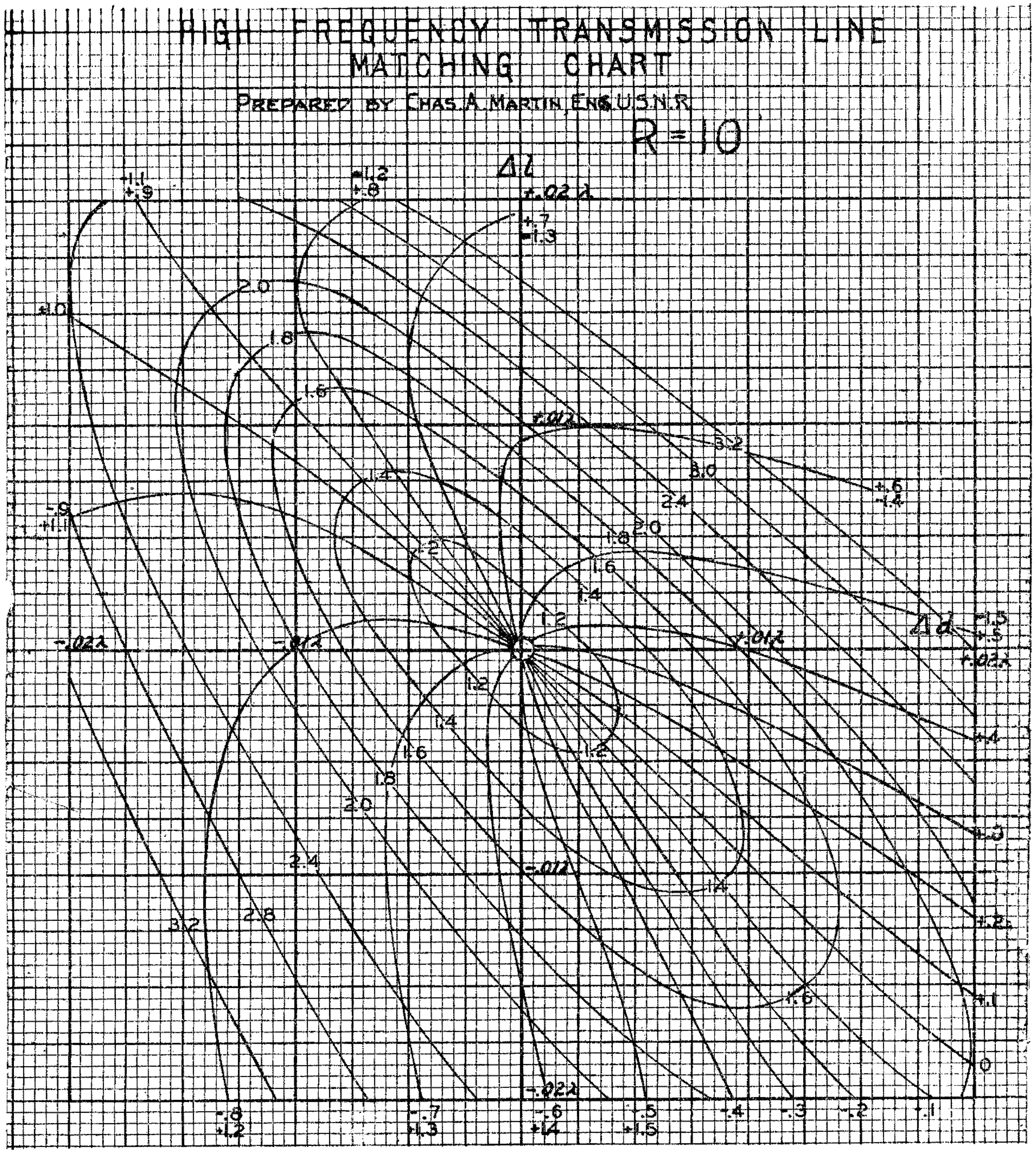
HIGH FREQUENCY TRANSMISSION LINE
MATCHING CHART
PREPARED BY CHAS. A. MARTIN, ENS. U.S.N.R.
R=10
Δl
+.02λ
+.01λ
-.01λ
-.02λ
Δd
+.02λ
+.01λ
-.01λ
-.02λ
3.2
3.0
2.8
2.4
2.0
1.8
1.6
1.4
1.2

FIGURE 8.

Accordingly, a loop is placed on the line, and a marker X is located at a distance one-half wavelength from it. This distance is

$$\frac{\lambda}{2}=\frac{77.91}{2}=38.96 \text{ ft.}$$

With the loop installed new measurements of the standing wave ratio and minimum current point are taken. It is found that $R'=1.36$ and that M' is positioned 2.03 ft. from X toward the antenna. Converting this distance into units of quarter wavelengths, and remembering the sign convention (plus toward transmitter, minus toward antenna), it is found that

$$B=\frac{-2.03}{19.48}=-.104 \text{ quarter wavelengths.}$$

The Chart for $R=5$ (fig. 4) is now selected since this is the value nearest the measured value of 5.2. The radial curve for $B=-.1$ is found in the fourth quadrant and is followed up to a point about midway between the ellipses for $R'=1.3$ and $R'=1.4$. At this point the rectangular coordinates are read.

The horizontal axis shows $\Delta d=+.014\ \lambda$ and the vertical axis gives $\Delta l=-.015\ \lambda$. Converting these values to inches,

$$\Delta d=.014\times 77.91\times 12=13.0 \text{ inches}$$
$$\Delta l=-.015\times 77.91\times 12=-14.0 \text{ inches.}$$

therefore the loop is made 14 inches shorter (Δl being negative) and is moved 13 inches toward the transmitter (Δd being positive).

Since more perfect matching is desired, new measurement of the standing wave ratio and current minimum are taken with the corrected loop in position. These give

$$R''=1.13$$
$$B=+.85 \text{ quarter wavelengths}$$

From the same chart ($R=5$) it is found that

$$\Delta d=-.0044\ \lambda=-4.1 \text{ inches.}$$
$$\Delta l=+.0055\ \lambda=+5.1 \text{ inches}$$

This correction is, therefore, made by lengthening the loop 5.1 inches (Δl positive) and moving it 4.1 inches toward the antenna (Δd negative).

VI. GENERAL REMARKS

The charts were devised for matching by a closed loop because that is the method ordinarily used at high-power shore stations. They may be used to a somewhat lesser advantage, however, when matching by a coil. In this case use of the charts in the same manner as described above will yield the correction to d, but the l will indicate only whether the coil inductance is too large or too small (if Δl is found to be positive, the inductance is too small; if negative, the inductance is too large).

It should be pointed out that the position of the marker X need not necessarily be a one-half wavelength from the loop. It may be placed any integral number of half wavelengths from the loops in order to bring it under a convenient span of the line.

In almost all cases the use of a plumb line and ground markers will greatly facilitate the measurement of B of which either the positive or negative distance may be used, the shorter usually being the most convenient.

A ground on the loop is used at Annapolis to drain off energy picked up from other transmitters.

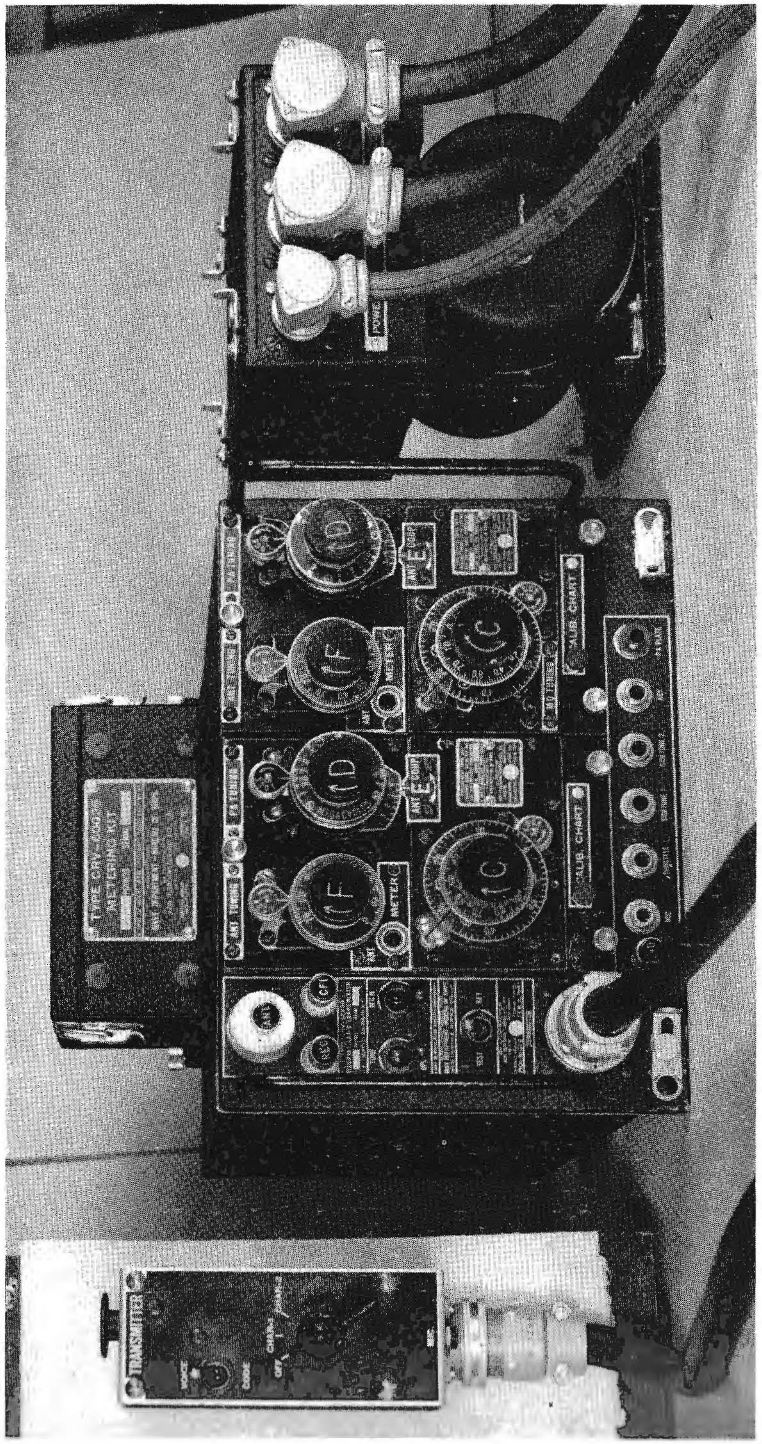

FIGURE 1.—The ATB Transmitter showing the Pilot's Control Box for a one-place installation and the separate metering kit on top of the transmitter. The combination junction box and dynamotor appears on the right.

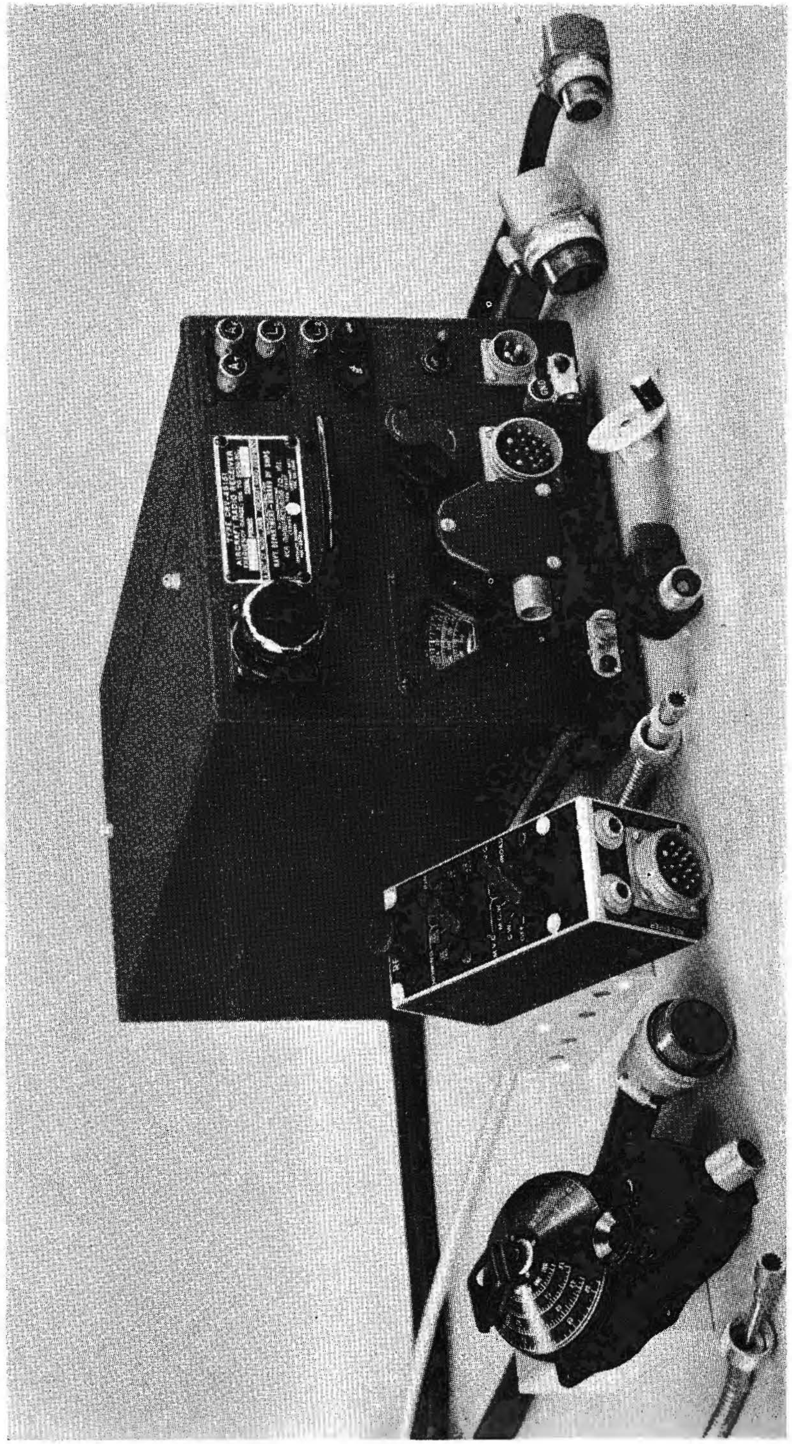

FIGURE 2.—The ARB Receiver, showing components for a complete one-place installation.

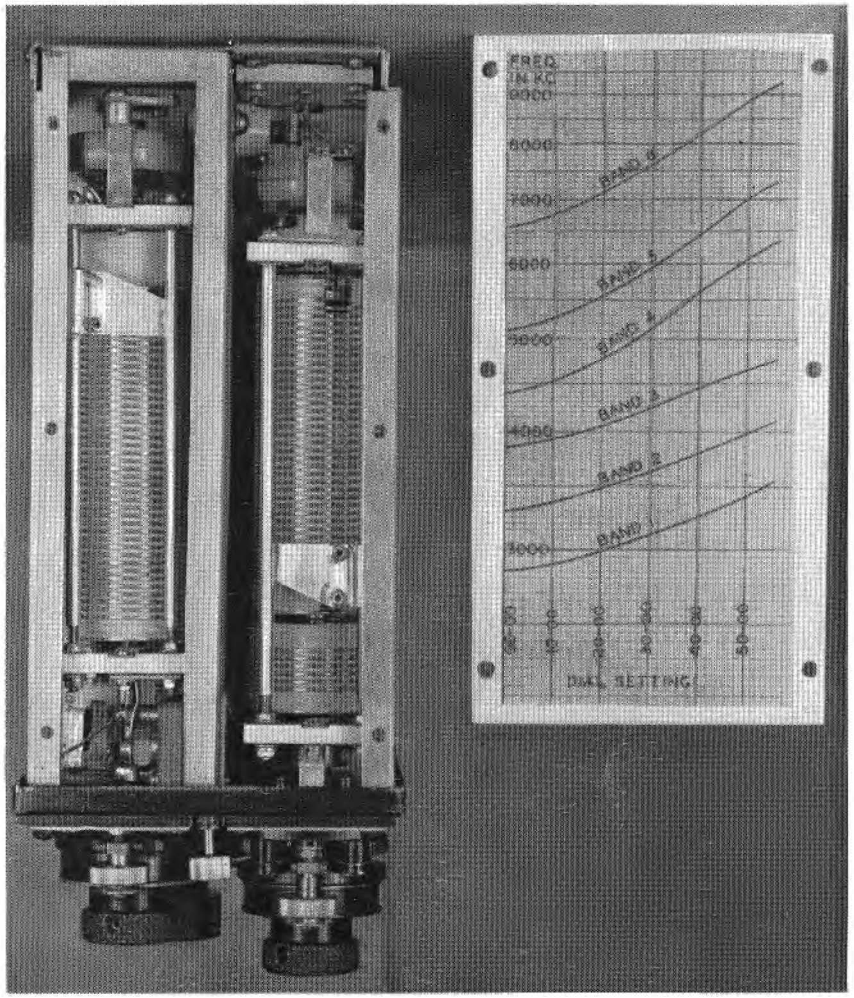

FIGURE 3.—Plug-in tuning unit with calibration chart removed, showing variable tuning inductors. The coil on the right has two sections operated by a double concentric control. The larger section tunes the power amplifier tank circuit, the smaller controls the antenna coupling.

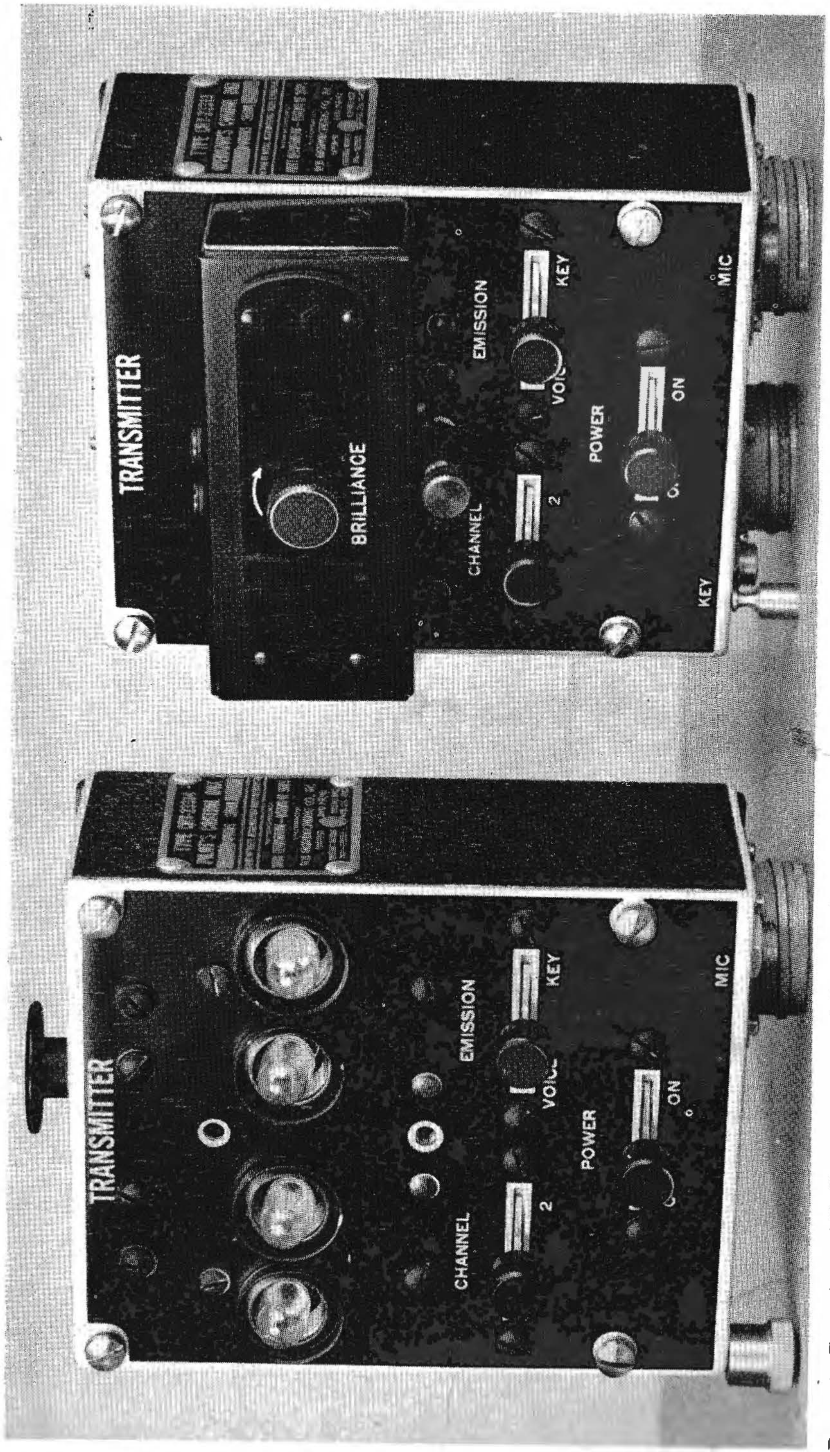

FIGURE 4.—Transmitter Pilot's Control Box (left) and Operator's Control Box (right) for two-place installations. The channel and type of emission is indicated on both control boxes by appropriate signal lights.

ATB/ARB AIRCRAFT TRANSMITTING AND RECEIVING EQUIPMENT

I. INTRODUCTION

A new transmitter, Model ATB, (fig. 1) and a new receiver, Model ARB (fig. 2), have been designed by the Bureau of Ships as replacements for the GF/RU equipment and the RU receiver. The equipment is used both in aircraft and in tanks. Some of the new features employed in this equipment are listed in the following paragraphs.

II. THE ATB TRANSMITTER

1. The ATB transmitter is capable of operating on either of two preselected frequencies by means of two *plug-in tuning assemblies* (fig. 3). Each unit has a range of 3000 to 9050 kilocycles. Either unit may be replaced by an alternate unit having a range of 2300 to 4200 kilocycles. One frequency may be preselected on each plug-in assembly. The pretuning may be accomplished by means of a bench transmitter, leaving only the coarse antenna loading adjustment to be made after the unit is plugged into the plane's transmitter. The shift of the tuning units from the bench to the plane's transmitter is accomplished with only a slight change in frequency due to the difference in the oscillator tubes' characteristics.

2. By means of suitable switches the operator may select either of the two preset frequencies. He may also select the *type of operation:* C. W., modulated C. W., or voice. The choice between C. W. and M. C. W. must be made by a switch on the face of the transmitter. Voice or code may be selected remotely.

3. *Dual control* (fig. 4) has been developed for two-place airplanes, whereby frequency or method of transmission may be remotely selected from two positions instead of one.

4. The *frequency stability* of the ATB transmitter is equal to that of any master oscillator type aircraft transmitter and is superior to that of the Model GF or ATA series. It is maintained over a wide variation in humidity, barometric pressure, altitude, temperature, vibration, roll and pitch, and change of tubes. Some of the factors contributing to this frequency stability are the use of inductive tuning (no air tuning capacitors are used); electronic coupling between the frequency-determining circuit and the work circuit of the master oscillator tube; frequency doubling in the output circuit of the oscillator to

minimize reaction; careful gauging and alignment of the single-control oscillator tuning arrangement; and good mechanical construction and electrical design. The master oscillator reset accuracy is within 3 kc. The calibration charts supplied with each tuning unit are accurate for settings within an audible frequency range of the correct frequency.

5. Because of the limited space available on the face of the transmitter unit and the tuning units, *the controls are reduced to a minimum, and no meters are installed.* An external meter box (see fig. 1) is supplied to be used in adjusting and alining the equipment. The selector switch is designed to choose the proper antenna loading tap when the channel is changed. Since the plate tank circuit of the power amplifier will tune directly to any frequency within the range of the tuning unit, there are no band switches or links in this stage. As a further means for reducing the number of controls, this stage employs a double concentric control (see fig. 3); one portion tunes the tank circuit and the dial is calibrated directly in megacycles; the other controls the antenna coupling. The dial is fitted with stops to prevent the roller from coming off the coil.

6. The modulated *power output* of the ATB is higher than that of the Model GF or ATA. Comparative tests under identical operating conditions indicate that the ATB will deliver intelligible signals of good strength at distances where the GF or ATA can no longer be heard.

7. The *maximum altitude* at which the equipment will operate without flash-over is not known. However, operation up to 40,000 feet was obtained without breakdown.

8. The output stage of the ATB uses an *815 beam power tube.* This tube is approximately equivalent to a pair of 6L6's. An 815 is also used as a plate modulator; the transmitter is modulated 100%.

9. The type ATB transmitter will accommodate either *carbon or dynamic microphones.* When the latter is used an installation adjustment must be made to achieve the necessary additional gain required by the dynamic microphone.

10. The ATB will *match a greater range of antennas* than is possible with the model GF transmitter. The antenna switching relay is located inside the transmitter.

11. The use of *two sidetones* permits simultaneous operation of two receivers. The key relay contacts and jacks are similar to those of the GO series of transmitters.

12. A *separate interphone* has been developed by the Bureau of Aeronautics which may be operated alone or in conjunction with the radio equipment proper.

13. The size and shape of *the mock-up space* of the ATB is approximately the same as that of the model GF with the 4″ coil pull

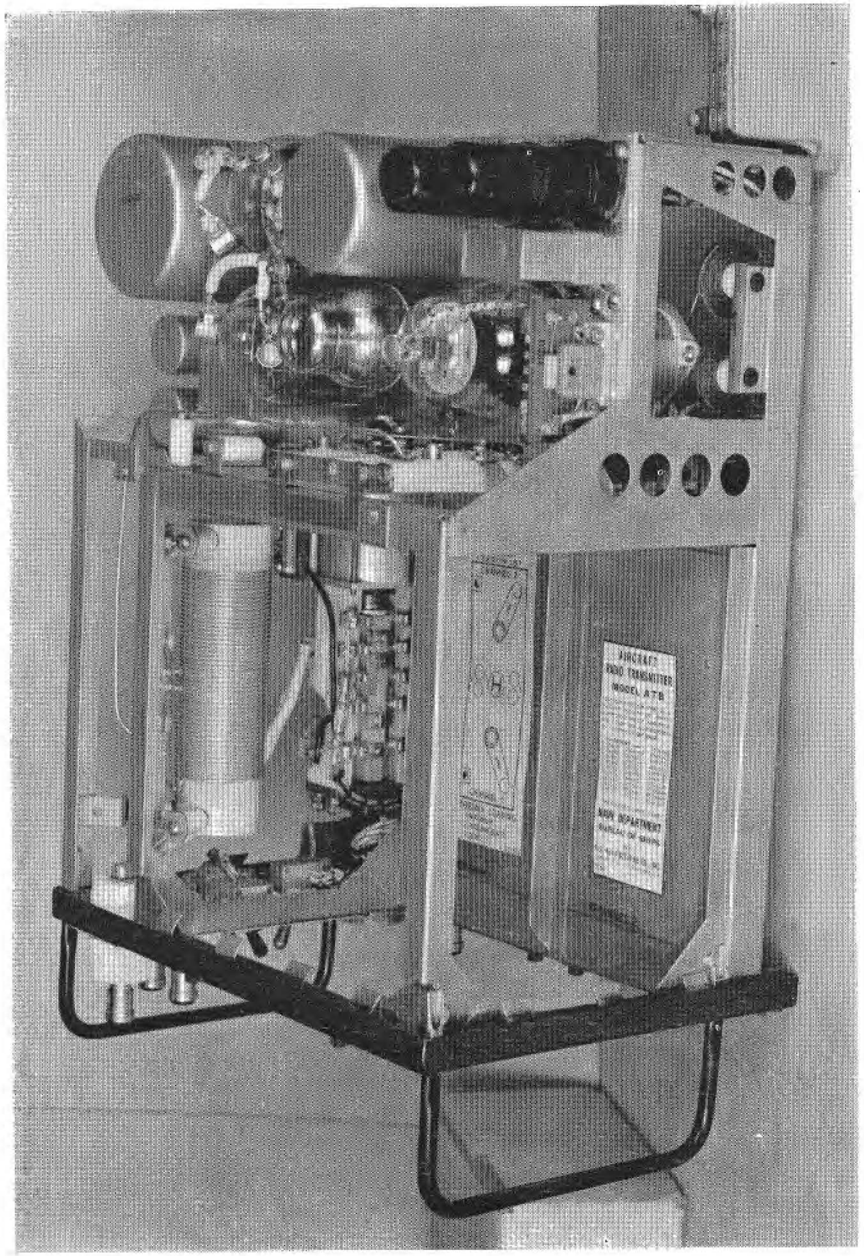

FIGURE 5.—Transmitter with plug-in tuning units withdrawn.

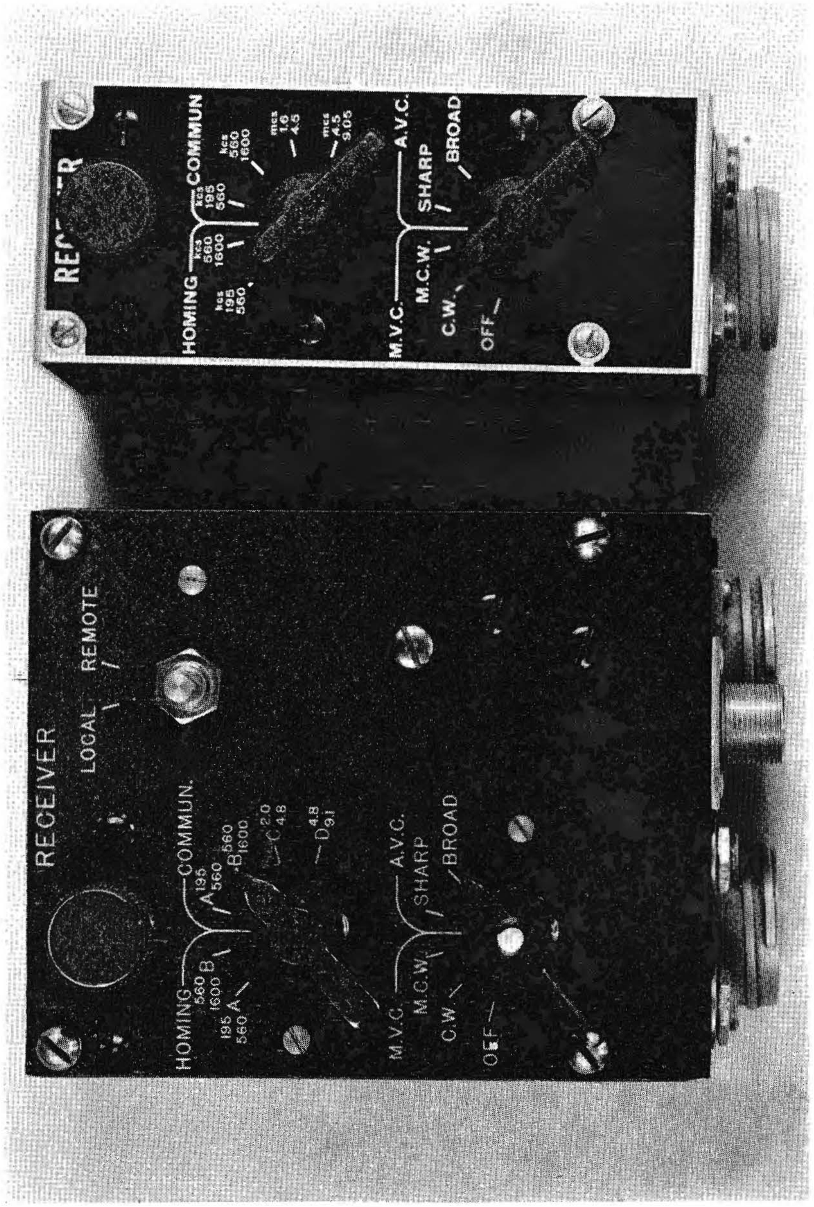

FIGURE 6.—Operator's Control Box (left) and Pilot's Control Box (right) for the two-place installation of the ARB receiver. A separate mechanical control (not shown) enables the pilot to take control of the receiver by throwing the "Local-Remote" switch on the Operator's Box to the "Remote" position.

out space included. In the ATB all access, receptacles, and most of the controls are from the front. The tuning units and the entire chassis can be withdrawn from the front (fig. 5). Coarse tuning controls, such as band changing links, and coarse antenna loading are accessible only from the inside.

14. The *number of separate units is reduced* by combining the dynamotor and junction box into a single unit.

15. An *under-voltage relay* is provided to insure transmission up to almost final exhaustion of the batteries when the plane's motor is dead.

16. The *dynamotor* operates continuously on code transmission, but on voice only when the throttle or microphone switch is closed.

III. THE ARB RECEIVER

1. The ARB receiver covers the *range of 195 to 9050 kilocycles* in four bands. The bands may be selected electrically from remote control points or mechanically from the face of the receiver. The remote band-switching is effected by a motor which supplies the coarse positioning and by a mechanical detent system which makes the precise final position.

2. *Separate antenna terminals* are provided for (*a*) fixed antennas having a capacitance of less than 180 mmf.; (*b*) trailing antennas having a capacitance of more than 180 mmf.; (*c*) loop antennas.

3. The ARB receiver may be *tuned either remotely or from the face of the receiver.* In the latter case the frequency is indicated by a dial seen through a window on the receiver. For remote tuning, a tuning head is provided with four concentric dials each corresponding to one band. Connection to the receiver is made mechanically by a flexible cable.

4. The receiver dynamo has sufficient capacity to supply the *ZB 246 megacycle homing adapter*, which is attached to the top of the receiver by means of snap slides. With the ZB connected between the antenna and the loop post of the receiver, a loop-antenna relay within the receiver connects the input from the antenna to the primary of the antenna coil. This eliminates the necessity for a separate ZB relay or control box.

5. In single place installations a *pilot's control box* (fig. 6) is provided for local or remote control. When the top rotary switch of the control box is in either of the first two positions for homing or loop reception, Manual Volume Control must be used. A mechanical link inside the box assures that this condition is met by preventing the lower switch from being set on automatic volume control when the top switch is in either of the homing positions. When the top switch is in any of the four band positions for communication, the lower switch may select either BROAD or SHARP AVC.

6. The *AVC BROAD and SHARP choice* is novel in naval aircraft receivers. In the BROAD AVC position the intermediate frequency stages are overcoupled. This results in a very wide frequency response curve, which facilitates search or monitoring. In the SHARP AVC position, the receiver attains a high degree of selectivity and improved signal to noise ratio. It is used when receiving signals from transmitters of frequency stability comparable to that of the receiver.

7. For two-place installations an *operator's control box* as well as a pilot's control box is provided. This unit contains the same controls as the pilot's control box. It controls the receiver when the switch on the operator's box is in the local position. The pilot can throw this switch to REMOTE by means of a mechanical linkage between the two units. The position of the LOCAL-REMOTE switch will be indicated to the pilot by the position of the plunger on the mechanical linkage.

8. In order to obtain stability and to eliminate interaction and synchronization on strong signals, the *C. W. oscillator operates at one-half the intermediate frequency.* The second harmonic is then amplified and mixed with the C. W. signal. The resulting beatnote is approximately 1000 cycles.

9. *Two intermediate frequencies are used.* One is for operation between 195 and 1600 kilocycles, and a higher one for operation between 1600 and 9050 kilocycles.

10. *Three tuned circuits* ahead of the mixer stage assure a high rejection of images and undesired signals.

11. *Negative feedback* in the audio circuit results in a more uniform response with change of load and an improvement of the low-frequency response.

12. *The output transformer has 200- and 4,000-ohm outputs*, the latter being used for Army type headsets.

13. The volume control does not short the headset or I. C. S. under conditions of strong signal on AVC as with the earlier RU's.

14. The *number of separate units is reduced* by building the dynamotor into the receiver.

15. The ARB will *mock up* into approximately the same space as the RU. Access to the ARB is entirely from the front.

16. *Unit type of construction* (fig. 7) has been used to facilitate repair and replacement of parts. The r. f. and i. f. components are grouped into metal compartments and the entire compartment or "box" is attached to the chassis.

17. The receiver can be operated without any transmitter components and the transmitter without any part of the receiver.

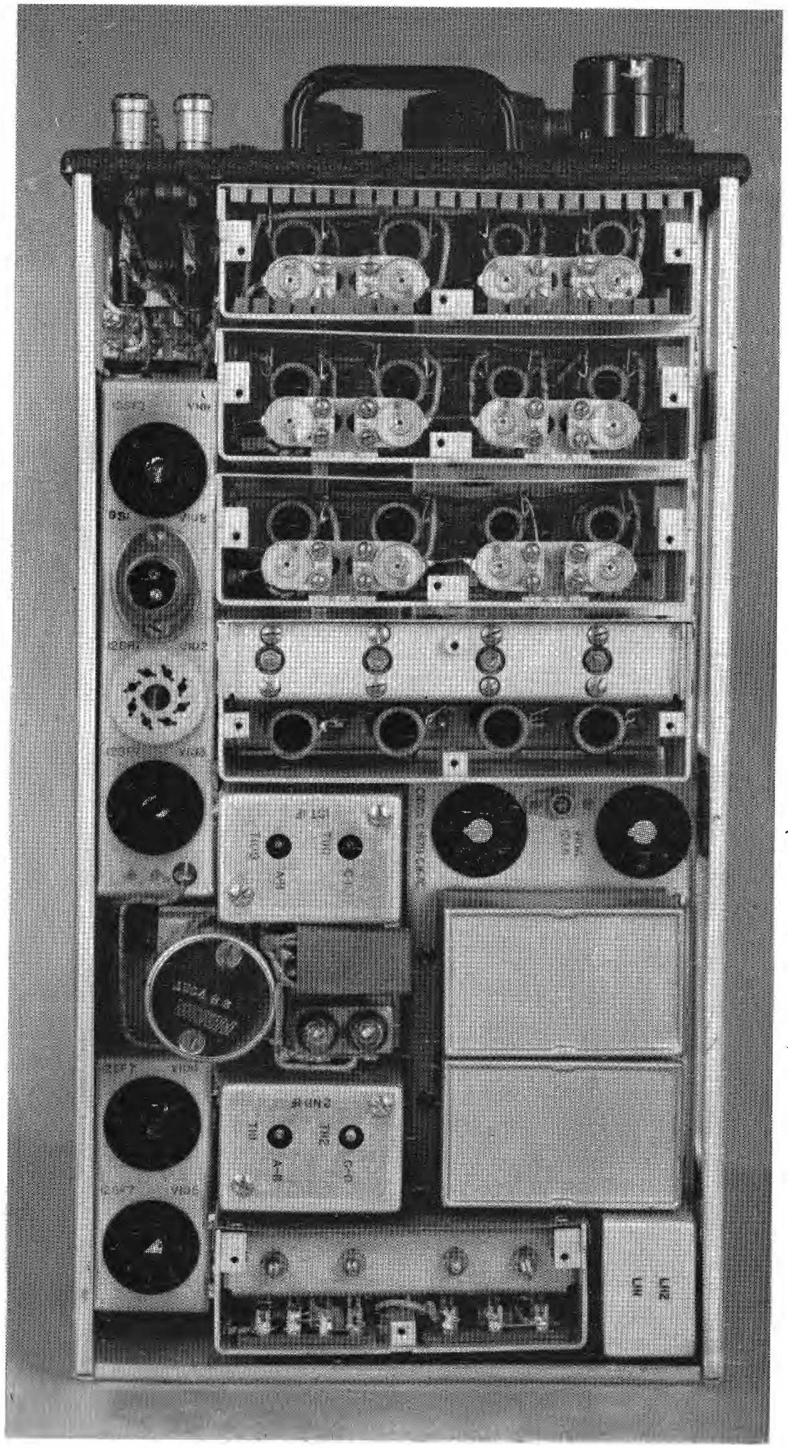

FIGURE 7.—Top view of Receiver, showing unit type of construction. Units may be removed in their entirety to facilitate repair and replacement.

HAZARDS TO SECURITY RESULTING FROM RADIATION OF RADIO RECEIVING EQUIPMENT

I. INTRODUCTION

The necessity of maintaining radio silence in order to prevent location of vessels by radio direction finding has long been recognized. The concept of radio silence in the past always has been directed toward the shutting down of transmitting equipment. The possibility that radiation from receiving equipment may be appreciable has been considered by the Bureau of Ships for some time. Investigation of this subject and quantitative measurements on radiation characteristics of many types of receivers indicate that a real hazard to security exists from this source.

II. CAUSES OF RECEIVER RADIATION

The cause of receiver radiation is identified with the local oscillators in superheterodyne circuits. Most receivers of this type when properly connected to antennas are capable of radiating radio frequency energy considerably in excess of the maximum limits prescribed for maintaining radio silence. This limit has been established by the Chief of Naval Operations as a field strength of 0.1 microvolt per meter at a distance of 1 mile.

The oscillators of most broadcast superheterodyne receivers and those of many communication types in use today are placed electrically close to the antenna circuit, since in most cases there is not more than one tuned circuit ahead of the first detector. With the oscillators operating at a fairly high excitation, and in the absence of adequate preselection stages, considerable energy may be radiated by such receivers when they are properly matched to the antennas.

The presence of preselection stages does not in itself guarantee that a receiver will be free from radiation characteristics. It has been determined that energy may reach the antenna circuit as a result of inadequate shielding between stages even when the oscillator is preceded by several tuned circuits.

For the purpose of discussing the reasons for their radiation characteristics, receivers used aboard ship may be divided into the following groups: (a) commercial broadcast receivers, (b) commercial communications receivers; (c) Navy type receiving equipment.

Commercial Broadcast Receivers.

Commercial broadcast receivers were designed and built for a competitive market. Most of these, furthermore, were designed down to a price rather than up to certain standards.

As a result of this trend in design, commercial broadcast receivers very seldom employ more than a single tuned radio frequency stage ahead of the first detectors. Many models, as a matter of fact, feed the input signal from the antenna directly into a mixer tube which simultaneously functions as the first radio frequency stage, the local oscillator, and first detector. It is reasonable, therefore, that conditions are such that a considerable amount of the energy generated in the local oscillator, or mixer, will reach the antenna through almost a direct connection.

Coupling between the antenna and the local oscillator, of course, also exists due to electrostatic and electromagnetic coupling between leads in the various parts of the circuit, coupling between parts, and circulating currents in the chassis.

Because of the large number of such broadcast receivers, particularly of the cheaper models, that were present aboard ship for entertainment purposes, a serious hazard to security of operation during radio silence periods existed.

Commercial Communication Receivers.

Commercial communication receivers were made available to the Fleet because the demand for communications equipment was sudden and could not be met with standard Navy models. The fact, however, that commercial sets have been made available to the Fleet by the Bureau of Ships does not mean that they are free from the objectionable characteristics found in most broadcast receivers. This is important and must be kept in mind.

The Bureau of Ships has been apprehensive about the radiation characteristics of commercial communication receivers and has endeavored to design and supply preselectors for these receivers in order to minimize the danger of radiation from these units. Such preselection should introduce sufficient attenuation between the local oscillator and the antenna.

Navy Type Receiving Equipment.

Navy type receivers have been designed and built to meet various requirements of the service. One of these requirements is that several such receivers must be operated close together with their antennas in the proximity of each other. Because of these requirements Navy type receiving equipment is well built, well shielded, and employs more than one tuned stage ahead of the first detector.

As a result of the above considerations, Navy Type Receivers are designed to be definitely free of undesired radiation, and, consequently, meet the present requirements for security against oscillator radiation.

III. CONCLUSION

In order to meet the needs of the Forces Afloat for receiving equipments to replace those previously employed aboard ship for the reception of entertainment, news, and educational programs, the Bureau has developed the Model RBO receiver for these purposes. These receivers comply with the directive of the Chief of Naval Operations, with respect to oscillator radiation, and are now being made available to the Fleet. They are especially designed to operate a number of amplifier type loud speakers installed in a manner similar to a centralized radio or hotel system. That is, they will be centrally located and their outputs piped to loud speakers located in various compartments, throughout the vessel, where program reception is desired. The number of receiver and speaker installations provided on any vessel is dependent upon the size of the vessel.

MODIFICATION OF MODEL TBO SERIES AND TBX SERIES EQUIPMENTS

Reports from the field have indicated the desirability of modification of models TBO series and TBX series equipments to permit tuning the transmitter to a received frequency by means of the "zero-beat" method. The purpose of the modification is to facilitate netting the transmitter without reference to a frequency standard.

Tests have indicated that by maintaining the receiver in operation for a short period during transmitter tuning, the transmitter may be accurately tuned to the frequency to which the receiver is set. In order to render this method of calibration practicable in models TBO, TBO–1, TBX, TBX–1, and early TBX–2 equipments, a switch whose contacts parallel the receiver filament switch portion of the "send-receive" switch must be added to the equipments. Then by placing the additional switch in the "ON" position, it will be possible to maintain receiver energized regardless of the position of the "send-receive" switch (S–305).

The following types of switches, which are commonly stocked at Navy Yards, may be satisfactorily employed in the indicated application: Navy Type 24000; Navy Type 24001; Navy Type 24002; Navy Type 24003; Navy Type 24025; Navy Type 24033. The switches enumerated above are of the "toggle" type; the Navy type 24033 switch indicated is now employed in several applications in Model TBO and TBX series equipments and is supplied as an item of stock spare parts.

The installation of the additional switch will involve the following operations:

(*a*) Layout and drill one 15/32″ diameter hole in front panel as shown in figure 1. The panel is .090 thick aluminum alloy. Care must be taken to avoid damaging the panel finish and to prevent metal clips from lodging in the set. The location of this hole is such that it is not too difficult to reach with a support from the rear while drilling.

(*b*) Layout and engrave the nomenclature "NET," "ON," and "OFF," as shown in figure 1, if practicable.

(*c*) Install switch.

(*d*) Wire switch into circuit, as shown in figure 2. This is somewhat difficult due to close clearances in equipment but considerable latitude may be permitted in running the wires as the circuits are not critical. The wire can be of practically any type available, about No. 20 or No. 22 gage stranded, suitably insulated. It should preferably be laced to existing cables to prevent movement.

In order to minimize power drain when TBO series or TBX series receivers are battery operated, care must be exercised to insure that the

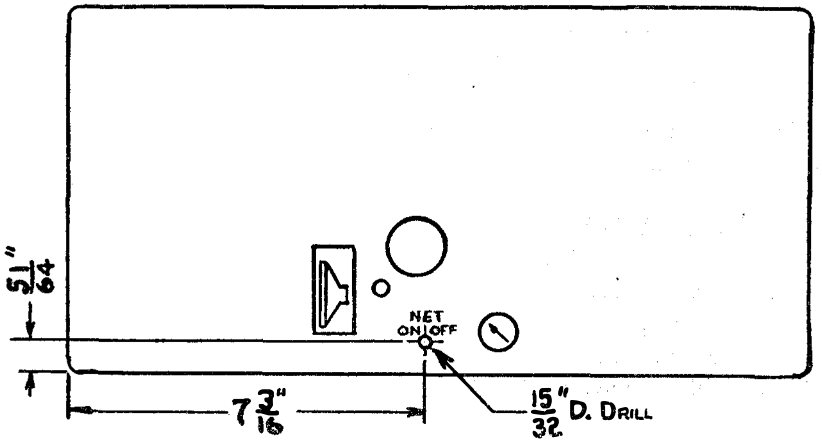

FIGURE 1.—Model TBO and TBX series equipments. Panel layout of "transmitter netting switch" hole.

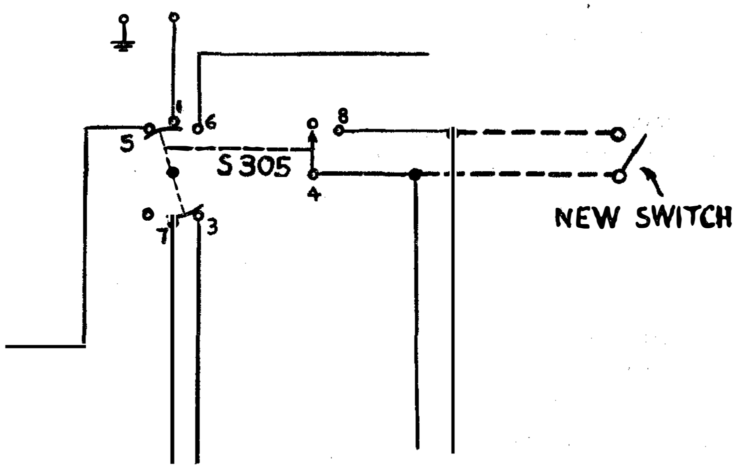

FIGURE 2.—Model TBO and TBX series equipment. Partial wiring diagram showing addition of "transmitter netting switch."

"Transmitter Netting Switch" is off when transmitter tuning is not actually in progress.

Field activities are hereby authorized to make the modification indicated herein in all model TBO series and TBX series equipment. Where the indicated modification is actually made in the equipment, it is desired that instruction books included with the equipment be

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modified to indicate the change; the symbol number and description "S-309—Transmitter Netting Switch" will apply. No change in equipment model or type designation or serial number is required.

Later model TBX-2 and subsequent equipment of the TBX series will incorporate the additional switch as delivered from the factory.

STANDARD FREQUENCY BROADCASTS OF THE NATIONAL BUREAU OF STANDARDS

The service of the National Bureau of Standards in broadcasting standard frequencies now includes two carriers: 5 megacycles and 15 megacycles. These frequencies are broadcast continuously by the Bureau station WWV.

The radio frequencies are modulated by the standard musical pitch of 440 cycles per second. In addition there is a time pulse every second, which may be heard, or viewed on a cathode-ray oscilloscope. This pulse has a duration of .005 seconds.

The usable ranges of these broadcasts are indicated in the following tables.

TABLE I.—*Usable ranges (in miles) of sky-wave.*

Frequency	Winter		Summer	
	Day	Night	Day	Night
5 mc. carrier	0-1,000	700-7,000	0-400	0-2,500
5 mc. carrier—440 C. tone	0-700	700-5,000	0-300	0-1,400
15 mc. carrier	800-5,500	Not usable	900-3,000	1,000-7,000
15 mc. carrier—440 C. tone	800-4,000	do	900-2,500	1,000-5,000

TABLE II.—*Usable ranges (in miles) of ground-wave*

Frequency	All times
5 mc. carrier	0-100
5 mc. carrier—440 C. tone	0- 50
15 mc. carrier	0- 70
15 mc. carrier—440 C. tone	0- 35

For complete instructions and suggestions on the applications of the standard frequency broadcasts, reference should be made to Bureau of Standards Circular Letter LC-645, entitled "Methods of Using Standard Frequency Broadcast by Radio."

THE FORUM

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

The discussions contributed to this section of the Bulletin are of great value to the Bureau. Most of the contributions in the past have been very thorough, indicating considerable time and thought on the part of the author. The Bureau realizes that the requirements of wartime service leave little time for carrying out research projects or for preparing reports. Nevertheless, the observations of personnel on the performance of Radio and Sound equipment under wartime operating conditions are of great importance.

It is hoped, therefore, that suggestions, comments, experiences, difficulties, and other matters of interest will continue to be sent in by the service. They may be prepared as briefly and informally as necessary. They should be addressed to the Bureau of Ships via the commanding officer.

CARE OF TRANSMITTING ANTENNA INSULATORS

The following report has been received from the Commanding Officer, U. S. Naval Station, Key West, Fla.:

"In the past few weeks several ships equipped with Model TCE-1 transmitters have complained of a gradual decrease in range. Investigation showed that the lead-in insulators were salt-encrusted and in some cases had been painted. As a result insulation had dropped to as low as 30,000 ohms to ground. After the yard forces had cleaned the insulators with carbon tetrachloride, the trouble was cleared up."

Bureau comment.—On previous occasions the Bureau has emphasized the necessity of maintaining radio insulators in a clean condition as a means of obtaining maximum efficiency in transmitter output. Results of lack of attention to this requirement are well illustrated in the above letter.

TECHNICAL PAPERS

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(NOTE. Asterisk (*) preceding entry indicates that an abstract only is available in the library.)

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