NAVSHIPS 93294

TECHNICAL MANUAL

FOR

RADIO SET GROUP

AN/WRA-1

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Subj: Technical Manual for Radio Set Groups AN/WRA-1, NAVSHIPS 93294

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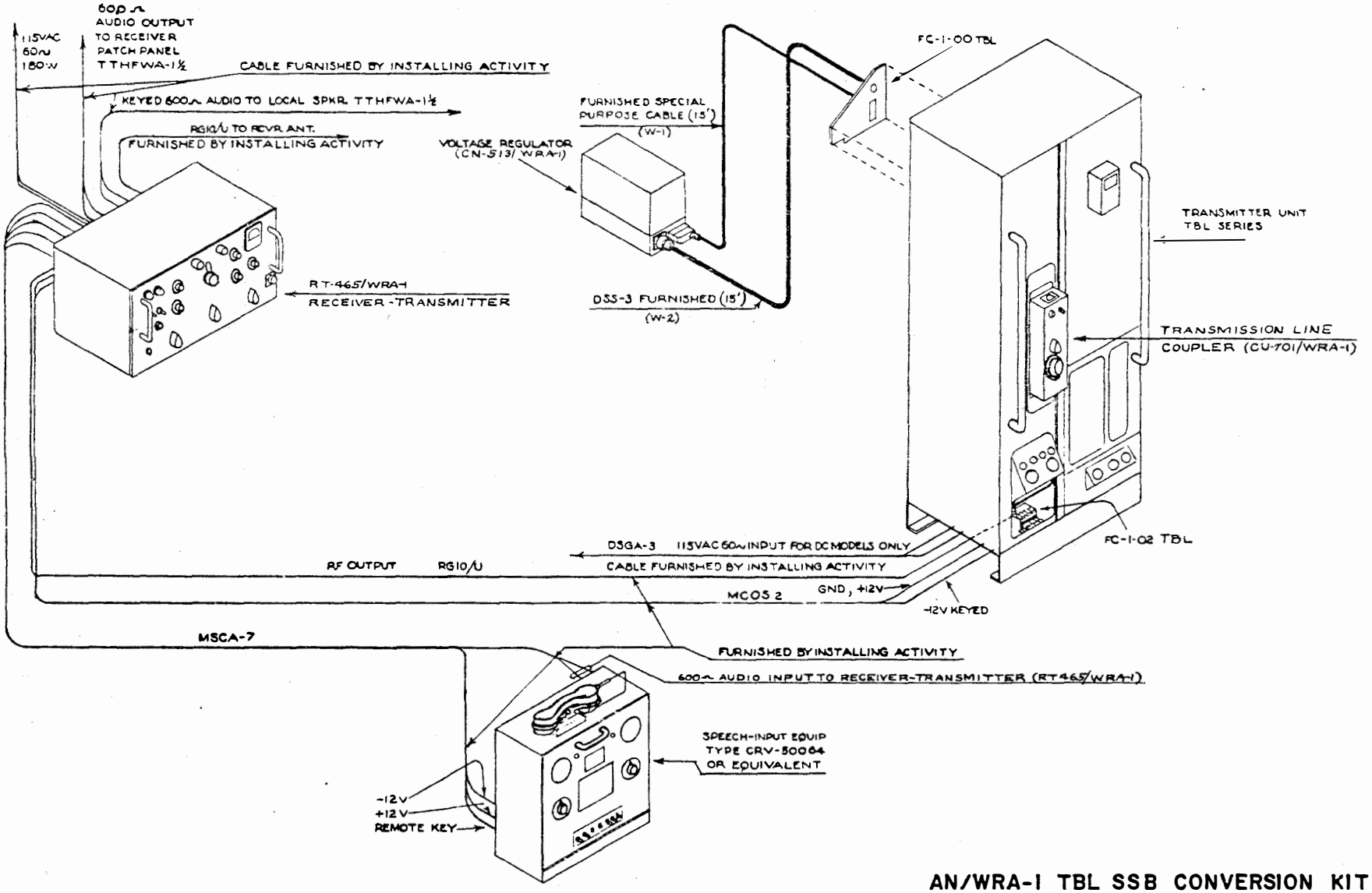


AN/WRA-1 TBL SSB CONVERSION KIT
PICTORIAL WIRING DIAGRAM
FIGURE 1-1

FIGURE 1-1

SECTION 1
GENERAL INFORMATION

1-1. GENERAL.

This technical manual contains information concerning the installation, operation, theory, and maintenance of the single sideband conversion Radio Set Group AN/WRA-1. The AN/WRA-1 is normally for use in conjunction with Field Change 5-TBL-4, 8, 9 or Field Change 6-TBL-5, 6, 7, 10, 11, 12, 13.

1-2. FUNCTIONAL DESCRIPTION. (See Figure 1-1)

a. The equipment is used as a conversion unit to allow use of standard Navy radio transmitters in the single sideband (SSB) mode, and to provide, in the same equipment, an optimized single sideband receiver.

b. The operating frequency range of the equipment is from 2 to 18 MCS and provides eight selectable channels. Frequency control is by temperature controlled crystal oscillators. Circuitry is compatible with standard Navy transmitter models TBL, TBK, TBM and AN/SRT-14, AN/SRT-15 and AN/SRT-16 within the frequency range of the equipment.

c. Instructions for use with any particular transmitter are provided by Field Changes to that equipment. Components peculiar to the parent transmitter modification are also provided as a part of the Field Change.

d. Reference should be made to the applicable Field Change Bulletin for use of the AN/WRA-1 with a particular transmitter. As a typical case, this manual will describe the use of the equipment with the model TBL transmitter. Figure 1-1 shows the various parts of the Radio Set Group AN/WRA-1 in conjunction with the TBL.

e. The Radio Set Group AN/WRA-1 consists of 3 basic units:

(1) Receiver/Transmitter RT-465/WRA-1.

(2) Voltage Regulator CN-513/WRA-1.

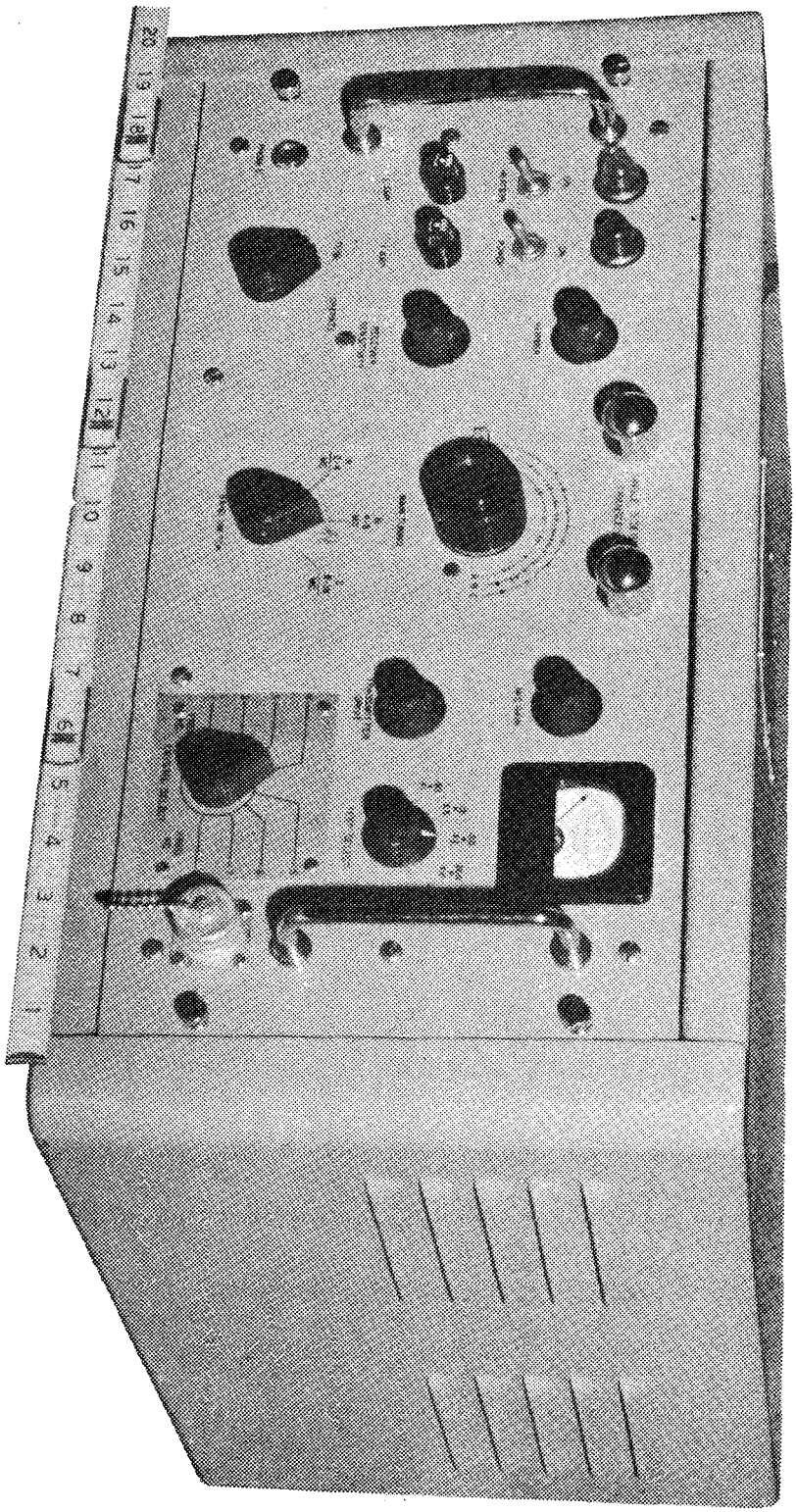
(3) Transmission Line Coupler CU-701/WRA-1.

These units operate with the parent transmitter and its own modulator/remote radiophone circuitry. A separate antenna input and audio output circuit are associated with the RT-465/WRA-1 as will be noted in Figure 2-4.

1-3. GENERAL DESCRIPTION OF UNITS.

The major units of the AN/WRA-1 are housed in three separate cabinets. (See Figures 1-2, 1-3, and 1-4).

a. Receiver/Transmitter RT-465/WRA-1. - This unit contains the circuit elements required to generate and receive single sideband (SSB) signals,



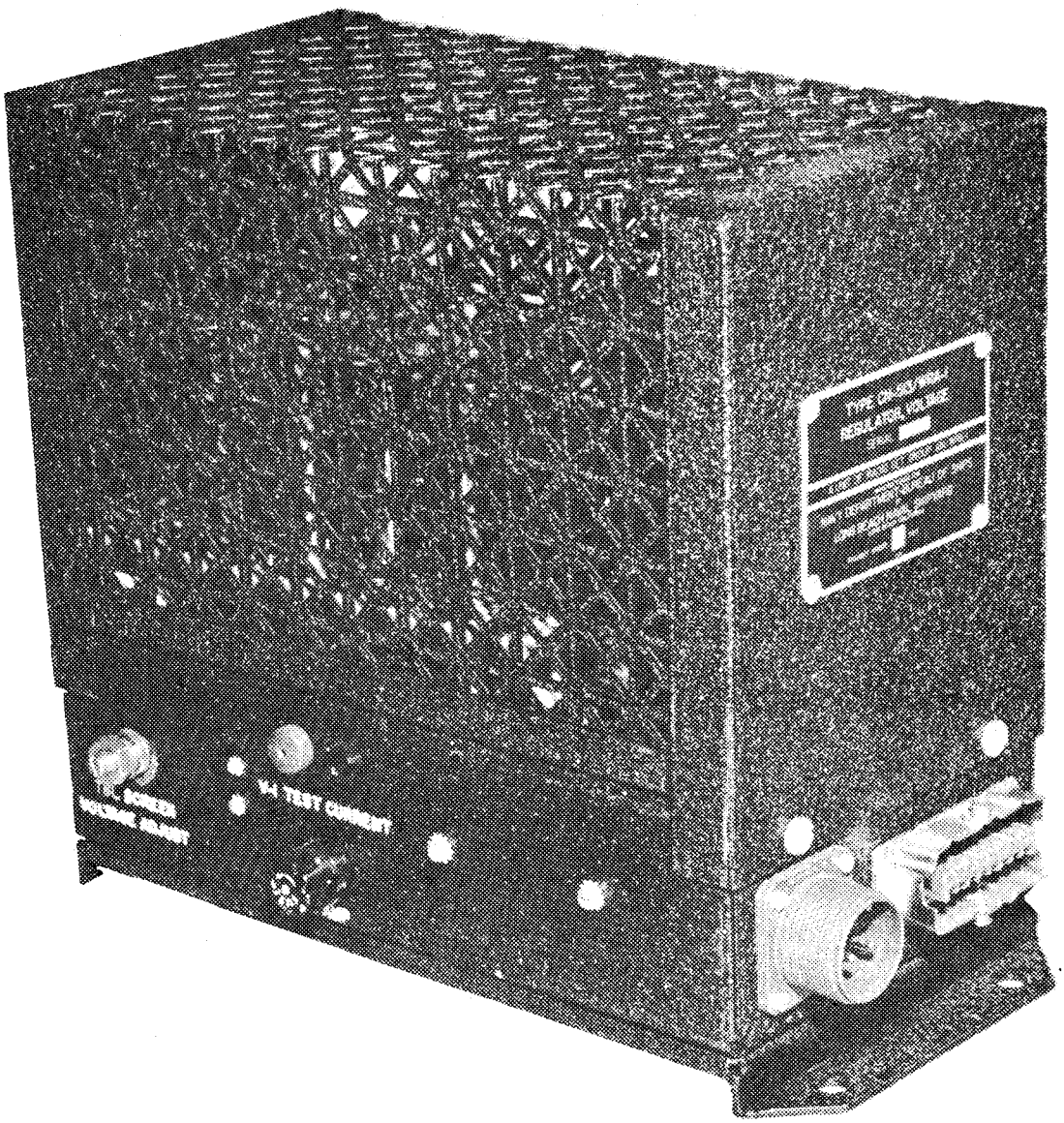
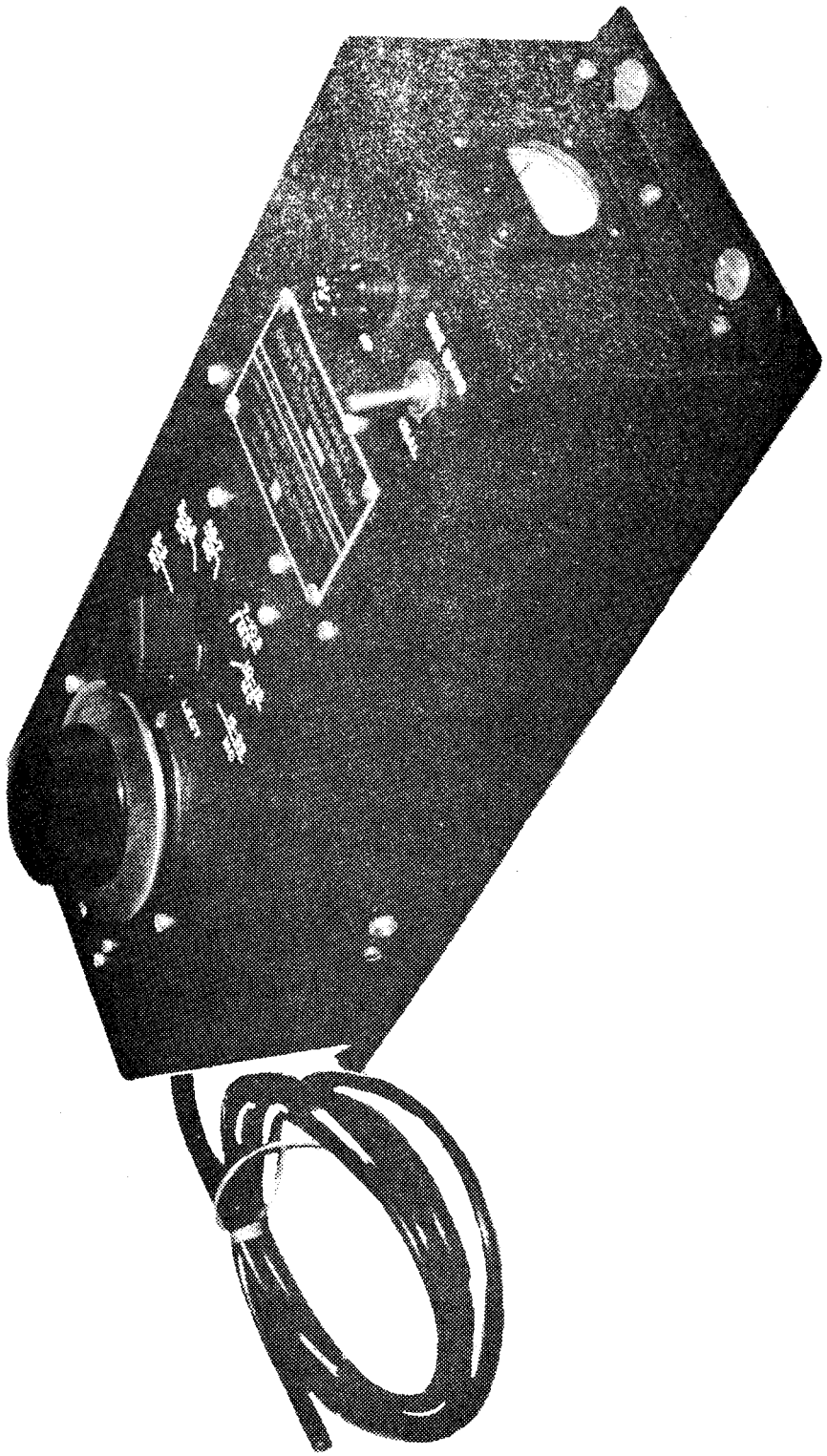


FIGURE 1-3 VOLTAGE REGULATOR CN-513/WRA-1



and to provide D.C. potentials for use with control circuitry in the parent transmitter, and with standard remote control radiophone units. Connections are made to the unit at R.F. coaxial connectors on the rear of the cabinet, and on power/control terminal boards within the cabinet. The chassis may be removed from the cabinet on slides, and a flexible cable is provided for dynamic servicing. All controls for operating the unit, including jacks for microphone and earphones, are located on the front panel. A high quality dynamic microphone handset is provided with the unit. (See Figure 1-2).

b. Voltage Regulator CN-513/WRA-1. - This unit contains circuitry for stabilizing the screen voltages in the transmitter being converted for SSB operation. The unit is required when converting models TBL, TBK, TBM, but is not required when converting the AN/SRT-14, AN/SRT-15 and AN/SRT-16. The CN-513/WRA-1 is mounted near the parent transmitter, and connected to it via a special purpose cable assembly provided with the unit. Current monitoring jacks and a screen voltage adjustment potentiometer are accessible on the front of the unit. (See Figure 1-3).

c. Transmission Line Coupler CU-701/WRA-1. - This unit is an active impedance matching amplifier used to compensate for power loss between the RT-465/WRA-1 and the parent transmitter, and to provide excitation voltage levels compatible with that transmitter. This unit, like the CN-513/WRA-1 is not required for converting the AN/SRT-14, AN/SRT-15 and AN/SRT-16 series transmitters to the single sideband mode. When used with the TBL, TBK and TBM, the unit is mounted on those transmitters as is shown in Figure 1-1. Switching, tuning controls, and a tuning monitor are provided as shown in Figure 1-4.

1-4. REFERENCE DATA.

a. Receiver/Transmitter RT-465/WRA-1.

(1) Frequency Range - 2 to 18 MCS.

(2) Emission/Reception - Lower single sideband.

(3) Frequency Control - Ovenized crystal.

(4) Crystals - 2 CR-47/U and 8 CR-27/U
Note: The CR-27/U crystals are the channel operating crystals. Both types are physically identical.

(5) Frequency Stability - ± 1 ppm/day ± 10 cps.

(6) Impedance - R.F. in/out 50 ohms.
A.F. in/out 600 ohms.

(7) Audio - input 0Db (6 mw/600 ohms).
output 1 w 10% distortion.

(8) Response (Audio) - ± 2 Db 300-3000 cps.

(9) R.F. Output - 5V peak/50 ohms.

(10) Carrier Suppression - -50Db.

(11) Sideband Suppression - -50 Db.

(12) Distortion (SSB) - -40 Db at 1V peak/50 ohms.

(13) Power Requirements - 115V 50-60 cps single phase, power factor 0.8, input power 180 watts with ± 10 percent voltage variation.

(14) Heat Dissipation - 180 watts.

b. Voltage Regulator CN-513/WRA-1.

(1) Input Voltage - 600 to 1000 volts D.C. through normal screen voltage dropping resistor assembly.

(2) Output Voltage - 450-550 volts D.C. (adjustable).

(3) Regulation - ± 6 percent (0 to 80 ma).

(4) Input Power - 115V 50-60 cps single phase, power factor 0.8, 50 watts with ± 10 percent voltage variation. Minus 250/300 volts D.C. at 20 m.a. from parent transmitter bias supply.

c. Transmission Line Coupler CU-701/WRA-1.

(1) Frequency Range - 2 to 18 MCS.

(2) R.F. Input - 3 volts peak (max)/50 ohms.

(3) R.F. Output - 30-40 volts peak/5000 ohms.

(4) Input Power - 115V 50-60 cps single phase, power factor 0.8, 6 watts with ± 10 percent voltage variation. Minus 250/300 volts at 30 m.a. from parent transmitter bias supply.

TABLE 1-1 EQUIPMENT SUPPLIED

QUANT. PER EQUIP.	NAME OF UNIT	NAVY TYPE DESIGNATION	OVERALL DIMENSIONS			VOL. CU. FT.	WGT LBS
			H	W	D		
1	Receiver-Transmitter	RT-465/WRA-1	10-3/4	22½	19	2.64	69
1	Voltage Regulator	CN-513/WRA-1	10-3/8	5-3/4	11-1/8	0.38	11
1	Transmission Line Coupler	CU-701/WRA-1	11½	5	4-1/2	0.184	6
1	Field Change Kit, Associated Cabling and Handset	1-00 TBL, 1-02 TBL, 1-01 TBL					10
2	Technical Manual	NAVSHIPS 93294					

TABLE 1-2 EQUIPMENT REQUIRED BUT NOT SUPPLIED

QUANT. PER EQUIP.	NAME OF UNIT	NAVY TYPE DESIGNATION	REQUIRED USE	REQUIRED CHARACTERISTICS
1	Radio Transmitter	TBL, TBK, TBM AN/SRT-14/15/16	Final Power Amplifier	
1	Local Speaker		Local Monitoring if Desired	
1	Antenna		Antenna for Receiver-Transmitter	
8	Channel Operating Crystals	CR-27/U	Operating Frequency	
As Req'd	Coaxial Cable	RG-10/U	R.F. Output	
As Req'd	Coaxial Cable	RG-10/U	Antenna Cable	
As Req'd	Cable	DSGA-3 or similar	Power Cable	
As Req'd	Cable	TTHFWA-1½	Audio Cable to Rcvr Swbd	
As Req'd	Cable	TTHFWA-1½	Audio Cable to Local Speaker	
As Req'd	Cable	MSCA-7	To Speech-Input Equipment	

TABLE 1-3 SHIPPING DATA

SHIPPING BOX NO.	CONTENTS		OVERALL DIMENSIONS			VOL. CU. FT.	WGT LBS
	NAME	DESIGNATION	H	W	D		
1	Radio Set Group	AN/WRA-1	21	28	24	8.2	164

SECTION 2
INSTALLATION

2-1. UNPACKING AND HANDLING.

No special unpacking and handling procedures are necessary other than the ordinary precautions taken in handling electronics equipment. Be cautious, however, that connectors and other small installation material are not discarded with packing material.

2-2. INSTALLATION LAYOUT.

a. General. - The particular installation will depend upon the location of the transmitter being converted, and the desired operating position. A general consideration is that the Receiver/Transmitter RT-465/WRA-1 should be installed as a receiver insofar as operator convenience is concerned. The Voltage Regulator CN-513/WRA-1 and Transmission Line Coupler CU-701/WRA-1 must be installed at the parent transmitter site. Cabinet size and mounting dimensions are provided in Figures 2-1, 2-2, 2-3. A review of the interconnection diagram, Figure 2-4, will provide details of interconnecting cables and circuitry.

b. Receiver/Transmitter RT-465/WRA-1. - This unit was designed for use within a 50 ft. cable run from the parent transmitter of the model TBL, TBK and TBM series. A cable run of several hundred feet may be used to the AN/SRT-14, AN/SRT-15 and AN/SRT-16 series. Specific cabling is detailed in Figure 2-4; in general the following installation requirements must be met:

(1) Receiving antenna to J10 (coaxial).

(2) 115V A.C. power to TB21.

(3) SSB output to TBL via J20 (coaxial).

(4) Control circuitry to speech amplifier of parent transmitter via TB22.

(5) Control circuitry to parent transmitter via TB22.

(6) Keyed audio to local loudspeaker via TB22 (optional).

(7) Audio output to radio remote receiver switchboard.

The equipment should be removed from the cabinet so that mounting and cabling may be most effectively accomplished. A flexible Power/Signal cable assembly is integral with the cabinet, and is permanently wired to

the cabinet terminal boards and coaxial connectors. After completing cabinet cabling, the equipment may be returned to the cabinet and the flexible cable assembly may be connected to the main chassis.

WARNING

Once 115V power has been connected to TB21, terminals 8 and 16 of P1, of the flexible cable assembly, are "HOT". Although these terminals are recessed, care should be taken not to drop P1 on any protruding metal parts of the chassis.

Refer to paragraph 2-3 for equipment check-out procedures. DO NOT energize equipment until reference to that paragraph has been made.

c. Voltage Regulator CN-513/WRA-1. - This unit is provided with special purpose interconnection cables W1 and W2. These cables are 15 feet in length, accordingly the CN-513/WRA-1 must be mounted within this cable run distance from the transmitter being modified. The following installation requirements must be met:

(1) Unit may be shelf or bracket mounted.

(2) Access to front and right sides is necessary for adjustment and plug entry.

(3) Cable run to parent transmitter must not exceed 15 feet.

Refer to paragraph 2-3 for check-out procedures.

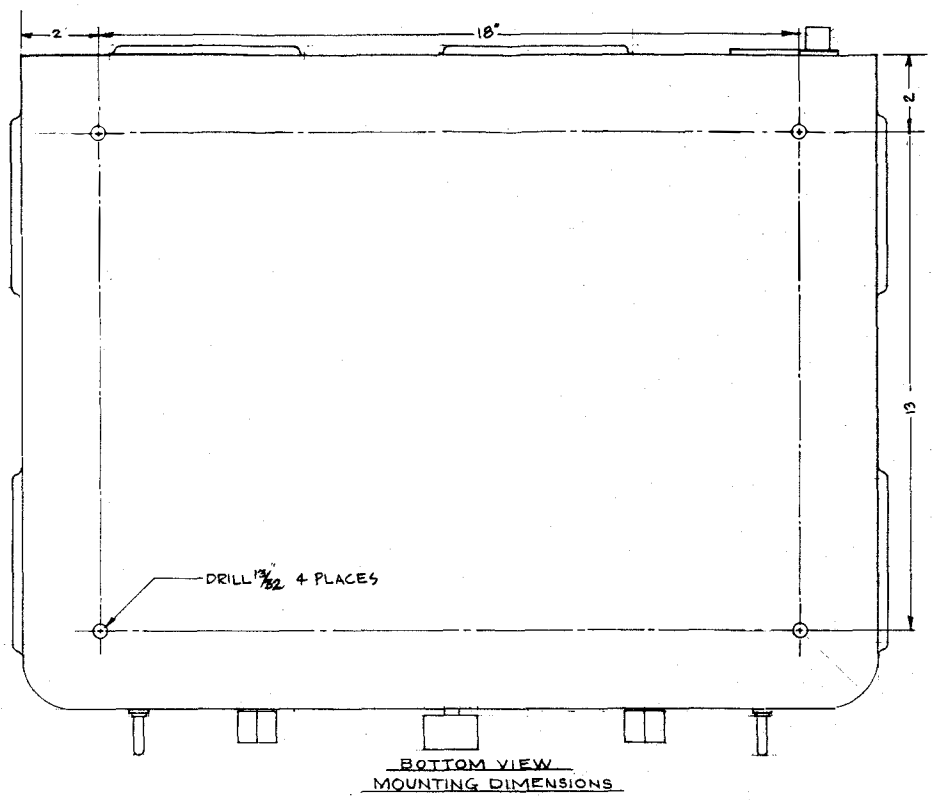
d. Transmission Line Coupler CU-701/WRA-1. - This unit mounts on the access door of the parent transmitter. Stand-off studs are integral with the base mounting plate provided with the unit. Cabling to the parent transmitter is in accordance with the Field Change Bulletin for that transmitter. It is schematically shown in Figure 2-4.

Refer to paragraph 2-3 for check-out procedures.

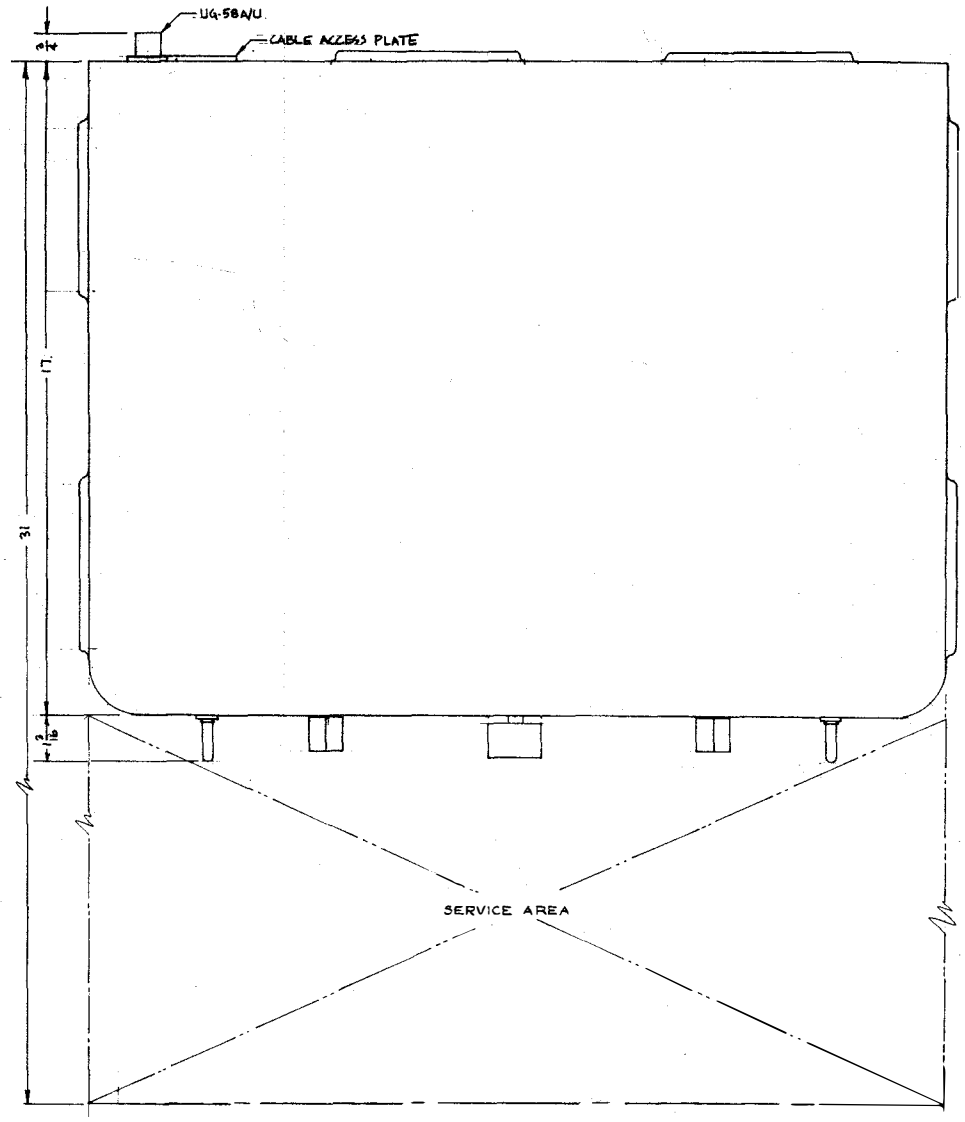
2-3. CHECK-OUT PROCEDURES.

In general, adjustment and operating procedures of the Voltage Regulator CN-513/WRA-1 and Transmission Line Coupler CU-701/WRA-1 are covered in detail in the parent transmitter Field Change Bulletin. All bias and screen voltage adjustments should be first made in accordance with the applicable Bulletin. Keying potentials for relay control of the CU-701/WRA-1 are obtained from the RT-465/WRA-1, however, and that unit will have to be made operative first.

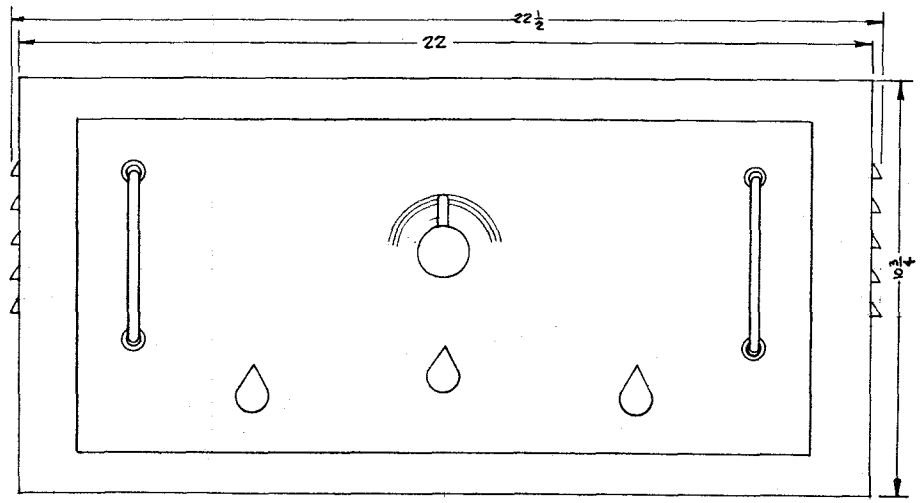
a. Receiver/Transmitter RT-465/WRA-1. - Prior to energizing this unit, at least one channel crystal must be installed. The channel crystals are



BOTTOM VIEW
MOUNTING DIMENSIONS



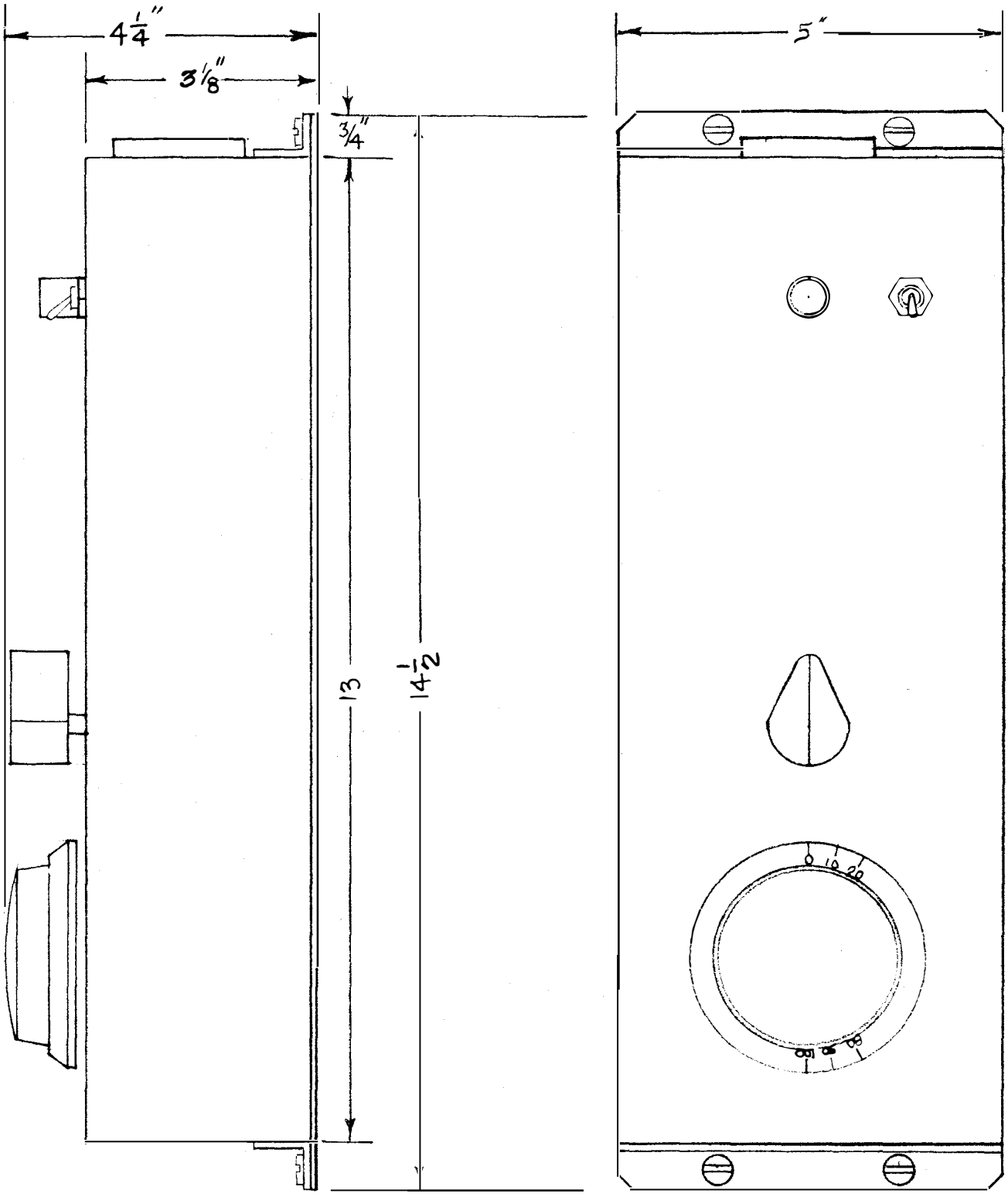
TOP VIEW



FRONT VIEW

RECEIVER-TRANSMITTER
RT-465/WRA-1

FIGURE 2-1



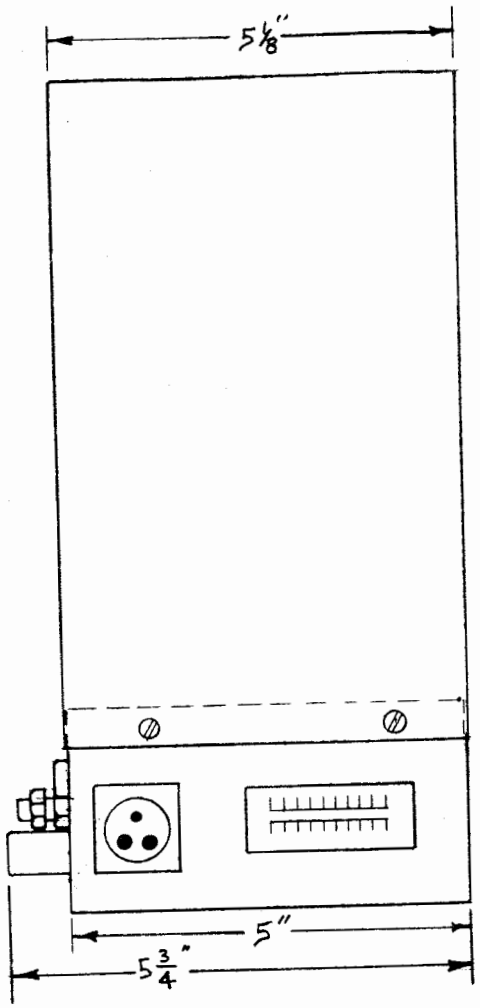
SIDE VIEW

FRONT VIEW

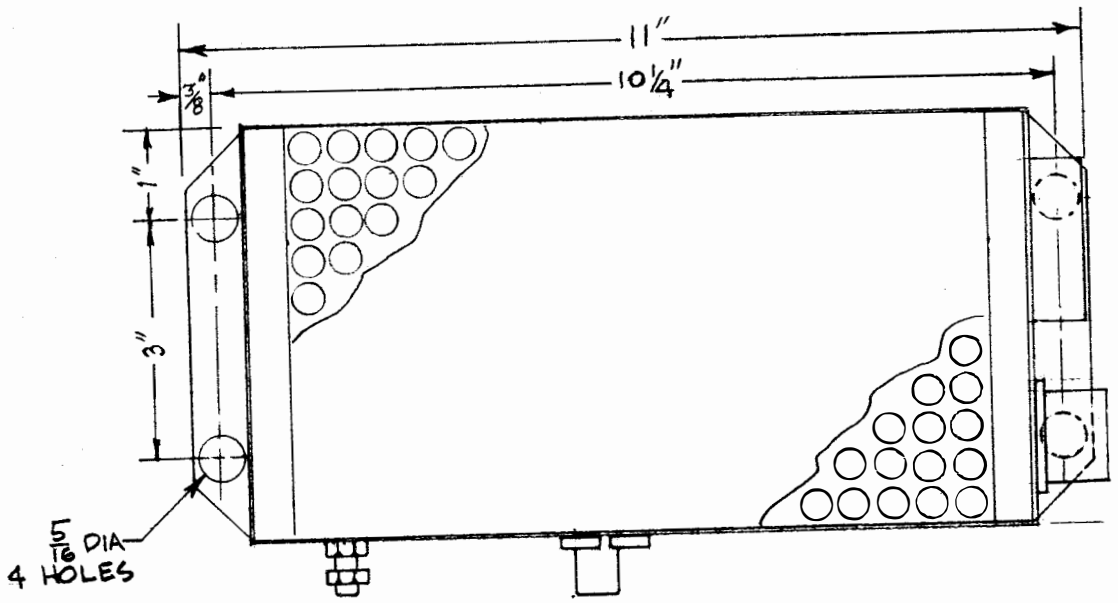
LINE COUPLER

CU-701/WRA-1

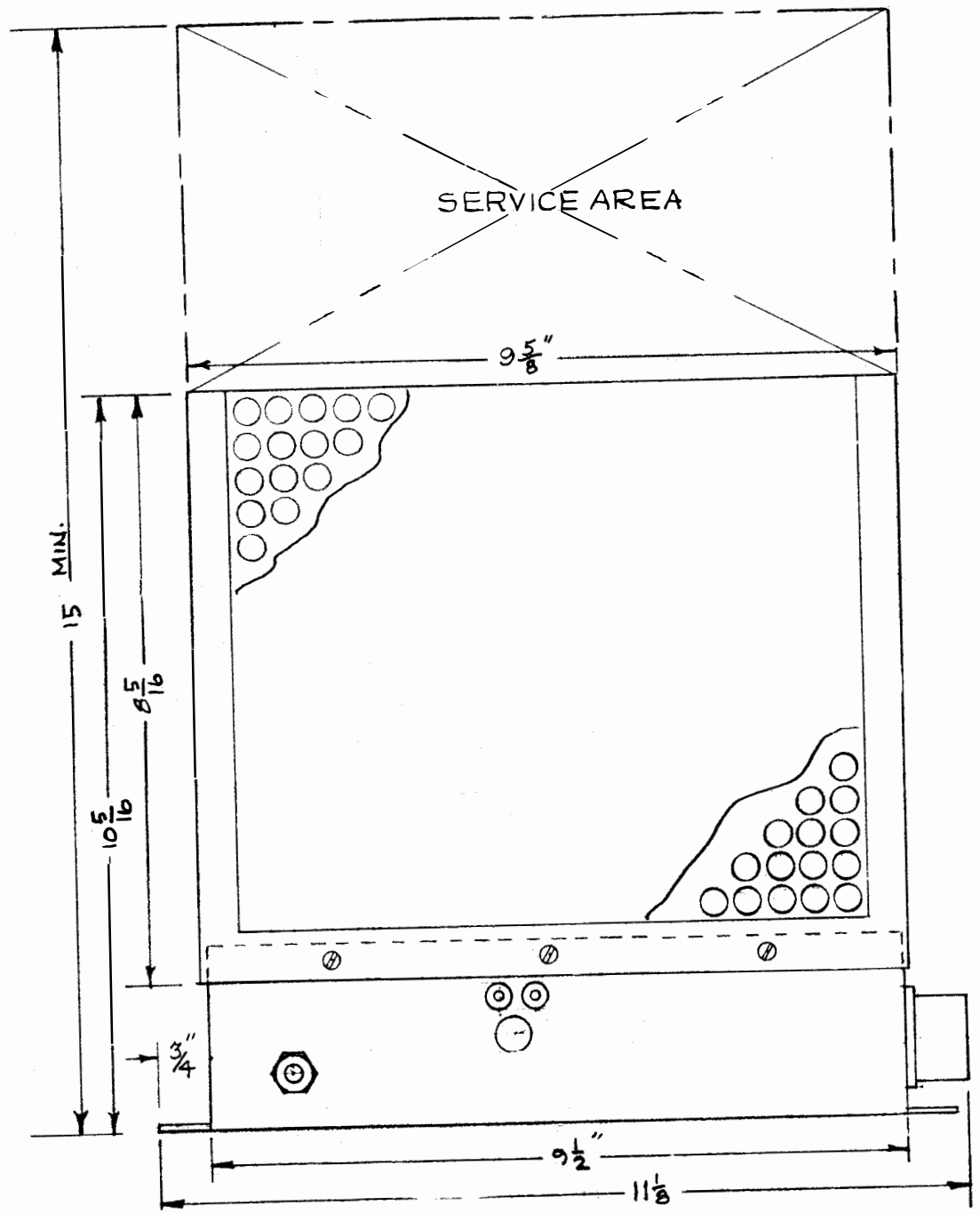
FIGURE 2-2



END VIEW



TOP VIEW

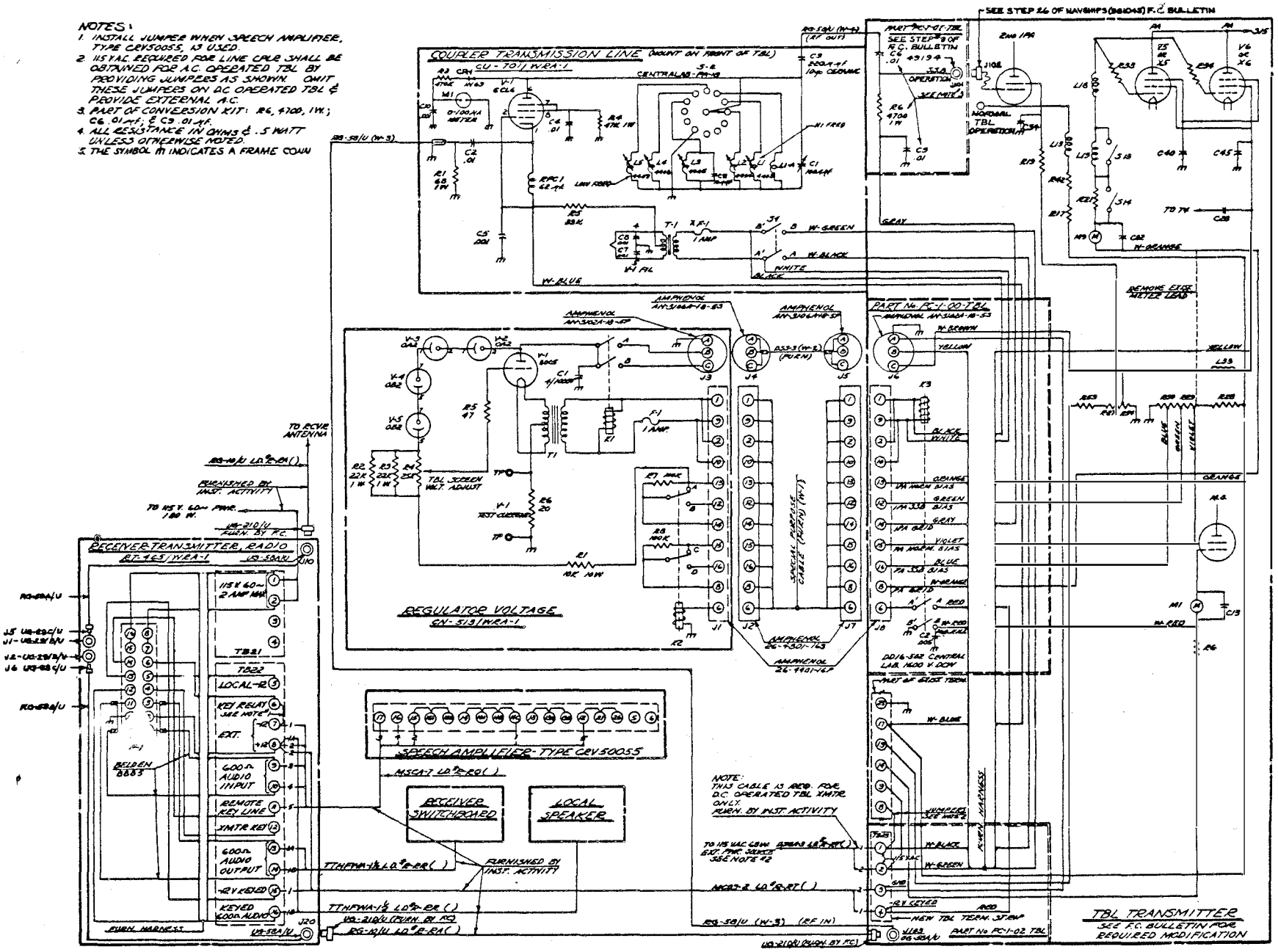


FRONT VIEW

VOLTAGE REGULATOR

CN-513/WRA-1

FIGURE 2-3



AN/WRA-1 RADIO SET GROUP INTERCONNECTION SCHEMATIC WIRING DIAGRAM

FIGURE 2-4

installed in the four ovens adjacent to the front panel on the right side of the chassis. Two crystals may be installed in each oven. Any CR-27/U crystal with a fundamental frequency between 2 and 18 mcs may be used for check-out. With a channel crystal in the equipment, turn the HEATER switch on. The panel light over this switch will indicate power to the equipment, and the HEATER switch. Allow a few minutes for warm up and turn the POWER switch on. The panel light over this switch will indicate application of power to the power supply components. If either of these lights fail to glow, check the fuses directly beneath the switches, and 115V power to TB21 (in that order). With power applied to both heater and power circuitry, follow the procedures listed below.

(1) Set CRYSTAL SELECT switch to channel crystal. Numbers on front panel agree with physical locations of ovens viewed from above chassis.

(2) Set BAND SWITCH to frequency band including channel crystal selected in (1).

(3) Set TUNE/OPERATE switch to OPERATE.

(4) Set all other controls except the TEST SELECT switch to approximately midscale.

(5) With the TEST SELECT switch, sample the -50, -12, 150 and 300 volt potentials. Indicated values should be within approximately 10 percent of these values - apply the meter multiplication factor indicated on the panel TEST SELECT switch. If potentials approximating these values are not measurable, refer to the trouble shooting section of this manual.

(6) Insert the dynamic microphone handset provided with the unit into the jack provided on the front panel. Advance the RECEIVER SENSITIVITY control and listen to the earpiece of the handset. The receiver background noise should be clearly audible.

(7) Set the TEST SELECT switch to LINE. With the receiver background noise present, the meter should deflect upward a small amount.

(8) Set the TUNE/OPERATE switch to tune, and adjust the MAIN TUNING dial to the frequency of the channel crystal. The test meter may deflect beyond full scale as the frequency is approached. Reduce the TRANSMITTER DRIVE control until the maximum response is almost full scale. This meter indication is the "feed-through" of the channel crystal energy. Eight hundred kcs on either side of this response in the 2-8 mcs range, and 1710 kcs either side in the 8-18 mcs range, another lesser indication should be present. For initial check-out, tune up on either of these side responses.

(9) Set the TUNE/OPERATE switch to OPERATE. Advance the MIC GAIN control, depress the handset switch, and speak into the microphone. The TEST METER should deflect upward. Adjustment of the TRANSMITTER DRIVE

control will control the extent of meter swing. Meter swing on voice should be between 0.5 and 0.7 of the LINE indication obtained when the equipment is switched to TUNE. On TUNE, a meter indication of at least 40 should be read.

(10) When either the microphone handset switch or the TUNE switch is activated, the sound of the equipment receive/transmit control relays should be audible.

(11) Keying, and modulation of the equipment should also be possible from the parent transmitter modulator handset, or from any remote radiophone unit when all units are energized.

(12) Proper operation of the equipment throughout the foregoing steps indicates that the RT-465/WRA-1 is in proper order and is feeding SSB energy to the parent transmitter.

b. Voltage Regulator CN-513/WRA-1. - Check-out procedures for this unit cover three phases: 115V power to the unit, keying action of control relays in the unit and the voltage regulating action by the unit.

(1) 115V power to the unit will be evident by the lighted filament of V-1 (8005) in the unit. The 115V power is supplied from the parent transmitter, and is controlled by the SSB/NORMAL switch on the TRANSMISSION LINE COUPLER CU-701/WRA-1. Power is supplied when the switch is in the SSB position.

(2) Keying action of the control relays is actuated by 12 volt power from the RT-465/WRA-1 via terminal 15 of TB22. The control relays apply normal and SSB bias potentials to the IPA and PA stages of the parent transmitter. Proper keying action of these relays will cause these stages to draw Class AB_1 and AB_2 idling current respectively when the transmitter is keyed by either handset or TUNE operation of the RT-465/WRA-1. The applicable Field Change Bulletin for the parent transmitter should be referenced for specific plate currents and bias potentials.

(3) Voltage Regulating action may be checked by inserting a milliameter (AN/PSM-4 or equivalent) into the test jacks provided - a scale of 100 m.a. or more should be used. When properly connected to the parent transmitter adjustment of the screwdriver shafted screen voltage control (R-4) will allow a current indication of 70 to 80 m.a. to be obtained. This reading is the shunt current drawn by the regulator, and should be set as prescribed in the applicable Field Change Bulletin. An additional indication of performance is the glow of the gaseous regulator tubes V-2, 3, 4 and 5. These tubes glow when bias and screen potentials are applied from the parent transmitter but are not in themselves a complete check of the unit.

WARNING

Voltages of 500 to 1000 volts are present in this unit when the parent transmitter is energized. DO NOT remove the connectors OR the cabinet cover without first securing the parent transmitter.

c. Transmission Line Coupler CU-701/WRA-1. - Check-out procedures for this unit involve three phases: 115V and bias potentials to the unit, SSB energy from the RT-465/WRA-1 to the unit, and the amplification and delivery of that energy to the parent transmitter.

(1) The unit receives 115V power from the parent transmitter via the panel switch (S-1). This power is used to heat tube V-1, and is passed via the panel switch (S-1) to the VOLTAGE REGULATOR. The unit uses the parent transmitter bias supply as plate voltage for the amplifier tube (V-1). These potentials may be measured at the terminal board inside the chassis proper.

(2) SSB energy is coupled into the unit via a RG-58/U coaxial cable. Presence of this signal may be measured with a vacuum tube R.F. voltmeter.

(3) The unit is essentially an amplifier, tunable through the 2-18 mcs range. A TUNING METER is provided to indicate the magnitude of the amplified SSB signal delivered to the parent transmitter. With the RT-465/WRA-1 in TUNE, and the unit bandswitch in the proper frequency range, adjust the TUNING dial for maximum response on the TUNING METER. A meter indication of 25 to 30 is usually adequate drive for TBL, TBK and TBM transmitters.

d. The parent transmitter should be tuned as prescribed in the applicable Field Change Bulletin.

SECTION 3
OPERATOR'S SECTION

3-1. INTRODUCTION.

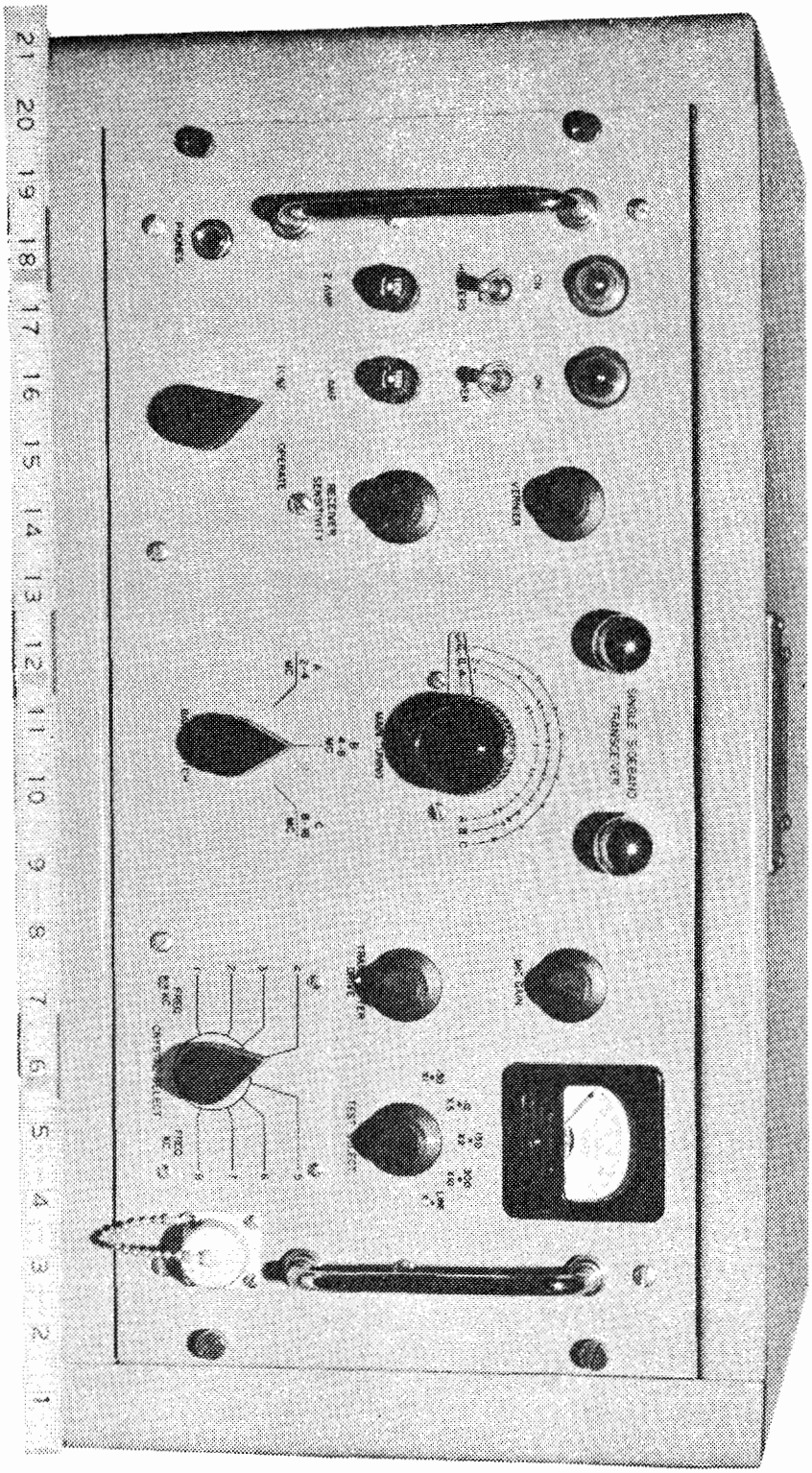
a. Radio Set Group AN/WRA-1 is used for converting standard Navy radio transmitters to the single sideband mode of operation. The equipment may be operated locally at the RT-465/WRA-1 with the local dynamic handset, or remotely with the standard Navy radiophone remote system. Ordinarily the AN/WRA-1 is used in conjunction with the normal remote "patching" circuitry of the parent transmitter with which it is used. Generally, the parent transmitter is tuned and loaded for normal operation on the C.W. mode, and then the single sideband output of the AN/WRA-1 is substituted for the regular oscillator control and excitation of that transmitter. Particular tuning instructions for the parent transmitter are covered in the applicable "single sideband" Field Change Bulletin.

b. This section will cover operation of the three basic units of the Radio Set Group AN/WRA-1. This group will be hereafter referred to as the "conversion kit". The three units are the Receiver/Transmitter RT-465/WRA-1, the Transmission Line Coupler CU-701/WRA-1, and the Voltage Regulator CN-513/WRA-1. These units will be hereafter referred to in the text as the Transceiver, Line Coupler and Voltage Regulator respectively.

3-2. OPERATION OF SPECIFIC UNITS.

a. Receiver/Transmitter RT-465/WRA-1, "Transceiver". - All operating controls, jacks, and metering devices are located externally on the front panel of the unit; no internal adjustments on the part of the operator are necessary. Figure 3-1 shows the front panel of the TRANSCEIVER and its controls. The equipment is provided with a dynamic, noise cancelling, handset. The ear piece of this handset, a pair of standard Navy earphones, or a local loudspeaker may be used as an output device for the receiver portion of the TRANSCEIVER. The dynamic handset plug mates with the 5 prong jack on the lower right side of the front panel. If use of earphones is desired, they may be plugged into the PHONES jack. Access to the equipment for use of a local loudspeaker may be had via terminal board TB-22 in the equipment cabinet. Specific front panel controls for operation of the equipment are as follows:

(1) "HEATERS" - this toggle switch is in fact the main power switch to the equipment. It opens both sides of the 115V power applied to the equipment in the "OFF" position. In the "ON" position it energizes the crystal oven heaters, and vacuum tubes associated with crystal oscillators. It additionally energizes the 12 volt relay power supply, which supplies energy to the RECEIVE/TRANSMIT relays, and remote control circuitry. When power is supplied to these circuits, the indicator light above the switch will glow. A front panel fuse holder is provided for this circuit.



(2) "POWER" - this toggle switch controls power applied to the remainder of the equipment. In ordinary operating conditions, this switch, and the "HEATERS" switch, will be maintained in the "ON" position. An indicator light and circuit fuse are provided on the front panel above, and below, the switch respectively.

(3) "BANDSWITCH" - this control is provided to select the band in which the desired operating frequency appears. Three bands are used in the equipment to cover the 2-18 mc range. Band A covers the 2-4 mc range, Band B covers the 4-8 mc range, and Band C covers the 8-18 mc range.

(4) "MAIN TUNING" - this control tunes the equipment within the frequency range selected. Dial calibrations are read directly in frequency. Scale designations agree with the band selected in (3) above.

(5) "RECEIVER SENSITIVITY" - this control regulates the gain of the equipment as a receiver. It should be set to provide adequate response to weak signals in the communications network; the automatic gain control features of the equipment will ordinarily allow system handling of strong "local" signal response.

(6) "VERNIER" - this control regulates the frequency of the 1255KC crystal oscillator, and is adjusted to provide the clearest response to received signals. Ordinarily one station, the net control station, is assumed to be "on frequency". All other stations adjust their "Vernier" controls to provide optimum reception. With Transceivers such as the RT-465/WRA-1, this will insure that all equipments are "on frequency". Each crystal oscillator (8 channel) is provided with an individual "TRIMMER" frequency control. These "Trimmer" controls, eight in number, allow compensation of individual "CHANNEL" crystals to precise channel frequency. Adjustment of these "Trimmers" should be made with the "VERNIER" control at mid-scale; and should be made to provide for optimum clarity of received signals. This adjustment is NOT a front panel control; it is a screw driver adjustment in the crystal oven group on the horizontal chassis.

(7) "MICROPHONE GAIN" - this control regulates the audio input from the "local" dynamic handset. Its setting should be adjusted to approximate the excitation level produced by the internal two tone oscillator observed when the equipment is set to the "TUNE" position. Particular meter indications pertinent to this control will be provided in future paragraphs.

(8) "TUNE-OPERATE" - this control provides a means for exciting the unit with a two tone oscillator, integral with the equipment, for tuning and adjustment purposes. In the "OPERATE" position, the unit operates as a conventional single sideband receiver. In the "TUNE" position, an artificial audio input (two audio tones) is impressed on the input circuitry to simulate normal speech input. This simulated speech input is

controlled in the production of the TRANSCEIVER to provide a reference level to which all other signal levels in the equipment may be referred.

(9) "TRANSMITTER DRIVE" - this control regulates the level of single sideband output of the equipment in the TRANSMIT mode. This control alone should be used for controlling the level of excitation to the parent transmitter. The particular level chosen for operation is totally dependent upon conditions in the parent transmitter, and should be selected to provide the plate current swing prescribed in the Field Change Bulletin.

(10) "CRYSTAL SELECT" - this control selects one of the eight channel crystals located in the four ovens directly behind this switch on the horizontal chassis. These crystals determine the operating frequency of the equipment. A plate, upon which the operating frequencies may be logged in pencil, is provided on the front panel.

(11) "TEST SELECT" - this control switches the front panel test meter to various power supply and signal sources of the equipment. It is provided as a means for continuously monitoring the performance of the equipment, and as an aid to servicing personnel.

b. Transmission Line Coupler CU-701/WRA-1, "LINE COUPLER" - All operating controls are located on the front panel of the unit; a metering device is located on the top of the unit. Figure 1-2 shows the front panel of the LINE COUPLER and its controls. Specific controls of the unit are as follows:

(1) "SIDEBAND-NORMAL" - this toggle switch applies power to switching circuitry, and to the LINE COUPLER when the switch is thrown to the SIDEBAND mode. A circuit fuse is provided to the left of the switch.

(2) "BAND SELECT" - this control selects the proper inductances to cover the operating frequency range of the equipment. The particular range covered is indicated by the scale calibration provided on the front panel.

(3) "TUNING" - this control tunes the equipment circuitry to the particular operating frequency within the range selected in (2) above.

c. Voltage Regulator CN-513/WRA-1. - This unit has NO operating controls. The only variable element of the unit is the SCREEN VOLTAGE ADJUST potentiometer. This control is set as prescribed in the applicable Field Change Bulletin to the parent transmitter.

3-3. SYSTEM OPERATION.

a. Transceiver. - With suitable channel crystals installed and selected by the CRYSTAL SELECT switch, energize the equipment by throwing the HEATERS switch to the ON position. A warm up period is required for bringing the crystal ovens and other components up to operating temperature for optimum frequency stability. Under ordinary shipboard conditions, the

equipment will stabilize in a period of 30 to 40 minutes. Accordingly, it is best to leave the HEATERS switch in the ON position so that the equipment will be ready for use at short notice. If the equipment is needed on short notice, both HEATERS and POWER switches may be thrown to the ON position at the same time. After the POWER switch is thrown to the ON position, sample the power supply voltages with the TEST SELECT switch and panel meter. If all power supply voltages appear normal proceed as follows:

(1) Set the BANDSWITCH to the range including the operating frequency chosen with the CRYSTAL SELECT switch.

(2) Adjust the MAIN TUNING dial approximately to the operating frequency.

(3) Set the TEST SELECT switch to the LINE position.

(4) Set the TUNE/OPERATE switch to the TUNE position.

(5) Increase the TRANSMITTER DRIVE control and peak the MAIN TUNING control until the TEST SELECT meter indicates 30-40 on the meter scale. This meter, with the LINE and T NE control settings, reads single sideband energy delivered by the TRANSCEIVER.

(6) Return the TUNE/OPERATE switch to the OPERATE position. Leave the TRANSMITTER DRIVE control at step (5) setting.

(7) Depress the handset switch, speak into the microphone, and adjust the MIC GAIN control to provide a peak indication of 10-20 on the TEST meter.

(8) Release the handset switch, and increase the RECEIVER SENSITIVITY control until the receiver background noise is clearly audible in the handset earpiece. Earphones, plugged into the panel jack provided, or a local loudspeaker wired to the equipment terminal board may be used in addition to the handset earpiece if desired.

NOTE

An alternate tuning procedure is feasible with the TUNE/OPERATE switch in the OPERATE position. In this case the MAIN TUNING dial is trimmed to provide maximum receiver background noise. The MAIN TUNING dial should be first set approximately at the operating frequency to avoid setting up on a spurious response point. All transmit functions must be checked however in accordance with the preceding numbered steps.

(9) The final tuning step in either case should be to provide a steady signal to the parent transmitter for the purpose of adjusting the LINE COUPLER (when this unit is used), and the parent transmitter proper. For this purpose the TUNE/OPERATE switch should be set in the TUNE position,

and the TRANSMITTER DRIVE control should be advanced to provide a 30-40 scale indication on the TEST SELECT meter. With these conditions prevailing, the LINE COUPLER and parent transmitter may be properly tuned.

b. Line Coupler. - This unit is provided with a SIDEBAND/NORMAL switch to energize the unit, and in addition, the voltage regulator. Prior to energizing the unit, the grid circuit plug of the parent transmitter 2nd IPA MUST BE switched internally to the field change adaptor jack. The access door of the parent transmitter must be opened for this switching function. The LINE COUPLER (and the VOLTAGE REGULATOR) receive power for their operation from the parent transmitter with which they are used. Accordingly, the following step by step operating procedures apply:

(1) Open the PA/IPA access door of the parent transmitter and plug the IPA grid circuit into the field change adaptor jack.

(2) Check to insure that the TRANSCEIVER is in the TUNE position and delivering SSB energy, as will be indicated by the TEST SELECT switch/meter in the LINE position.

(3) Energize the parent transmitter, and the LINE COUPLER. At this point observe the PA and IPA plate current meters on the parent transmitter. They should be indicating the idling current specified in the Field Change Bulletin for the particular transmitter in use.

(4) Set the LINE COUPLER BAND SELECT switch to the frequency range in use and adjust the TUNING dial for maximum indication on the monitor meter on the top of the LINE COUPLER. The monitor meter indicates the presence of excitation to the parent transmitter.

(5) Tune the parent transmitter as indicated in the applicable Field Change Bulletin. Regardless of the particular transmitter used with the Radio Set Group AN/WRA-1, the transmitter may be first tuned up on CW at the operating frequency, and properly loaded into the antenna system PRIOR to commencing the preceding steps. Until operating personnel become proficient in the overall tuning procedure, it is recommended that the parent transmitter be tuned up for normal CW operation, and then switched to the SSB mode as described above. This will minimize the NEW steps involved and allow the entire system to be set up rapidly.

c. Voltage Regulator. - Except for setting the front panel SCREEN VOLTAGE ADJUST (a technician setting), this equipment does not require attention, except from a maintenance standpoint. Accordingly, this unit may be considered a part of the parent transmitter with NO operating controls.

NOTE

The frequency upon which this equipment operates is controlled completely by the crystal oscillators in the TRANSCEIVER.

Accordingly, neither the MAIN TUNING dial of the TRANSCEIVER, nor the TUNING dial of the LINE COUPLER have any control of the basic output frequency or its stability. These controls merely affect the amplifying functions of the circuits with which they are associated. The only front panel control which affects frequency is the VERNIER dial. This control provides an extremely small change of base frequency (a few hundred cycles per second total) for purposes of synchronizing the equipment in frequency with other single sideband systems.

SECTION 4
PRINCIPLES OF OPERATION

4-1. GENERAL.

a. The Radio Set Group AN/WRA-1 in itself is a complete low power single sideband system. It is a versatile equipment capable of being used with a variety of standard Navy shipboard transmitters. Standard Navy transmitters are used essentially as power amplifiers for the AN/WRA-1. Similarly existing antenna systems and remote radiophone circuitry are used, which reduces installation problems and costs. Use of the AN/WRA-1 with any particular transmitter DOES NOT impair use of the transmitter in any of its regular modes of operation.

b. The heart of the system is the RECEIVER/TRANSMITTER RT-465/WRA-1. This unit is a TRANSCEIVER which is crystal controlled in frequency over its operating range of from 2 to 18 mcs. The unit has been designed to provide the following:

(1) An optimized single sideband receiver.

(2) A low power single sideband transmitter.

(3) Simultaneous tuning of TRANSMIT and RECEIVE circuitry.

(4) Front panel control of eight (8) crystals for channel selection.

(5) Push to talk switching of all units, including the parent transmitter used as a power amplifier.

c. To provide compatibility with various standard Navy transmitters, the TRANSMISSION LINE COUPLER CU-701/WRA-1 and VOLTAGE REGULATOR CN-513/WRA-1 complete the CONVERSION KIT. Various component parts for conversion of the parent transmitter for use with the Radio Set Group AN/WRA-1 are furnished with the applicable Field Change.

4-2. SINGLE SIDEBAND THEORY.

a. It is not the intent of this manual to provide a text on single sideband theory. Sufficient coverage of the subject has been made in the Bureau of Ships Journal, and in specific texts furnished to the fleet.

b. It is assumed that the technician has a basic knowledge of single sideband theory. It is recommended that the material referenced in a. be reviewed as necessary. Additionally, the technician should refresh his general superheterodyne receiver theory.

4-3. RECEIVER/TRANSMITTER RT-465/WRA-1.

a. This unit is a dual conversion superheterodyne receiver, with provisions for reversing the receiving process when it is switched to the

transmit mode. The term double conversion describes a process where a received signal is first heterodyned (converted in frequency by a mixing process) to one intermediate frequency, and then heterodyned again to another intermediate frequency before it is finally detected (demodulated).

b. The dual conversion process is a desirable one because it allows the choice of a reasonably high first intermediate frequency, for effective image rejection, and then a lower second intermediate frequency where construction of a highly selective filter is feasible. Such a process is desirable for the reception of amplitude modulated and continuous wave signals as well as those of the single sideband variety.

c. In a receiver designed for continuous wave, CW, signals, a beat frequency oscillator is provided to heterodyne last intermediate frequency signals down to the audio range. One might reasonably consider this last heterodyning as a third conversion process in which the audio note heard by the operator is the third intermediate frequency. By custom, this final process has become known as detection or demodulation.

d. In paragraph 4-3b, it was stated that the second intermediate frequency was chosen where construction of a selective filter is feasible. All receivers must pass a band of frequencies; the width of the band is determined by the intelligence being transmitted, and the modulation technique employed. Typical bandwidths for various intelligences and techniques follow:

(1) Keyed continuous wave - a few hundred cps.

(2) Speech-amplitude modulation - 6000 cps (6 kcs). (double sideband)

(3) Music-amplitude modulation - 10 to 20 kcs.

(4) Frequency modulation - up to 200 kcs.

(5) Television (video) - up to 5000 kcs (5 mcs).

(6) High resolution radar - up to 10 mcs.

Hence, a range of from a few hundred cps to many mcs is required depending on the nature of the intelligence transmitted and the technique employed. If the human voice is to be transmitted, an audio frequency spectrum extending to 3000 cps has been found adequate. Amplitude modulation of a transmitter with this spectrum of voice intelligence will produce a double sideband signal 6000 cps (6 kcs) wide as described in (2) above. For optimum reception of such a signal the second intermediate frequency stages of a receiver should contain a filter which will pass a band 6 kcs wide.

e. A single sideband signal may be considered as an amplitude modulated signal in which the carrier and one sideband have been filtered out. Hence,

the bandwidth required in the receiver will be half of that required for amplitude modulated signals. In many respects, a single sideband receiver is identical to one designed for reception of CW signals, except that the band pass of the intermediate amplifier stages is tailored to pass a spectrum equal to the speech frequencies. The beat frequency or CW oscillator is used to replace the carrier wave filtered out along with the other sideband when the single sideband signal was originally generated at the transmitter. Single sideband receivers designed for reception of speech normally contain a filter which passes approximately 3000 cps (3 kcs) of bandwidth.

f. Consider now the dual conversion process employed in the RECEIVER/TRANSMITTER RT-465/URA-1. The receiving process will be considered first. The functional block diagram figure 4-1 should be followed along with the text. The relative positions of blocks representing stages approximates the physical location of these stages as viewed from the bottom of the chassis, hence the block diagram and the equipment proper may be followed in learning the principles of operation. Schematic diagrams also approximate the physical and block diagrams. See Figure 4-2, 4-3.

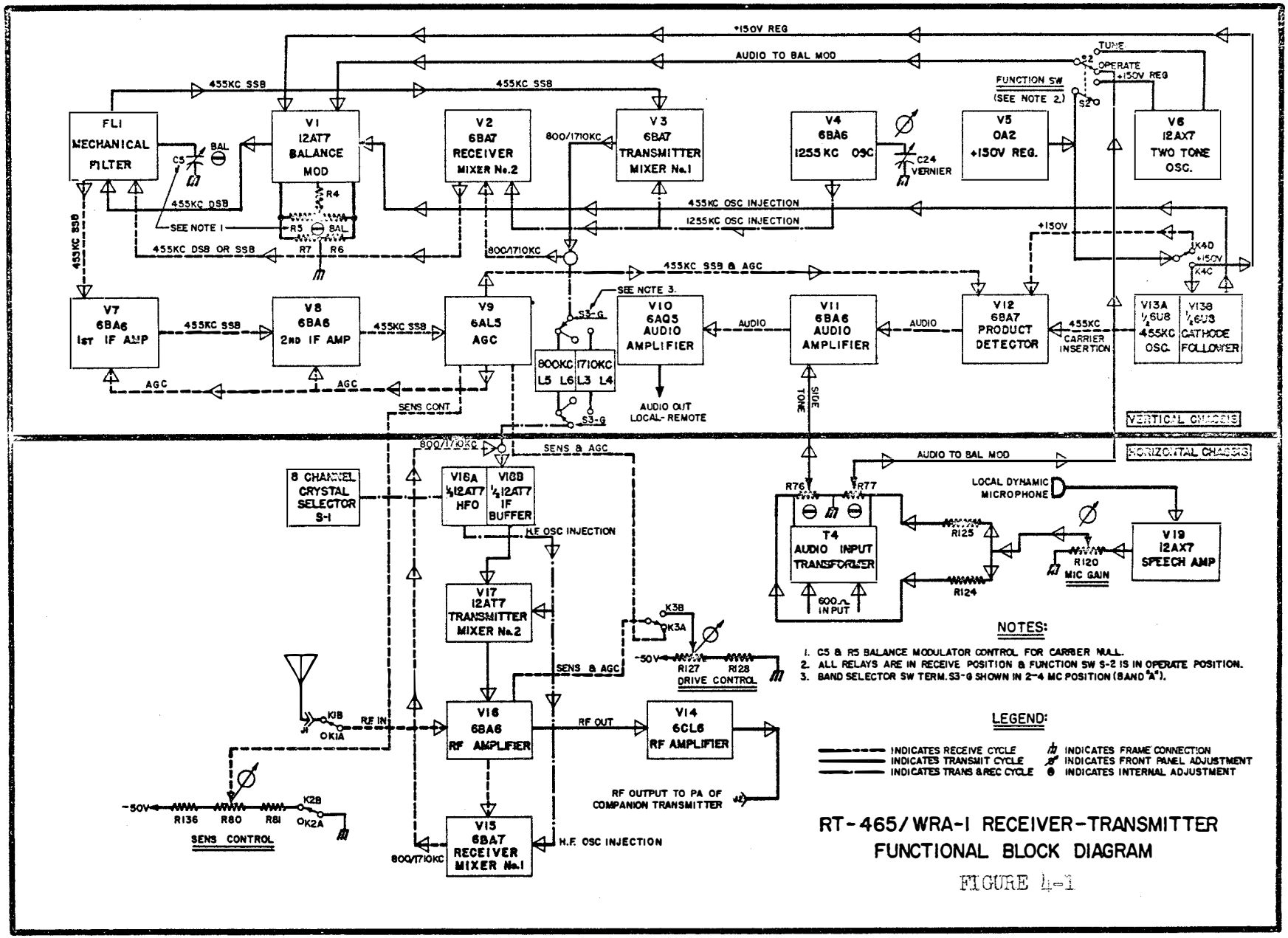
(1) The "front end" or first stages of the unit, as a receiver, is Radio Frequency Amplifier V16, Receiver Mixer #1 V15, and the High Frequency Oscillator V18A. Operation of these stages is identical to that of any superheterodyne receiver. Incoming signals from the receiving antenna arrive via J1 and the antenna relay K1, and are applied to the R.F. Amplifier V16. The frequency of operation is determined by the setting of the BANDSWITCH S3, and the MAIN TUNING control. The signal is then amplified and passed to Receiver Mixer #1 V15. The amount of amplification is controlled by the RECEIVER SENSITIVITY control. The Receiver Mixer #1 also receives energy from the High Frequency Oscillator V18A at a frequency determined by the CRYSTAL SELECT switch and the particular crystal in the oven group.

NOTE

The High Frequency Oscillator V18A is designed to operate 800 kcs HIGHER than the incoming signal in the 2 to 8 mcs range, and 1710 kcs LOWER than the incoming signal in the 8 to 18 mcs range.

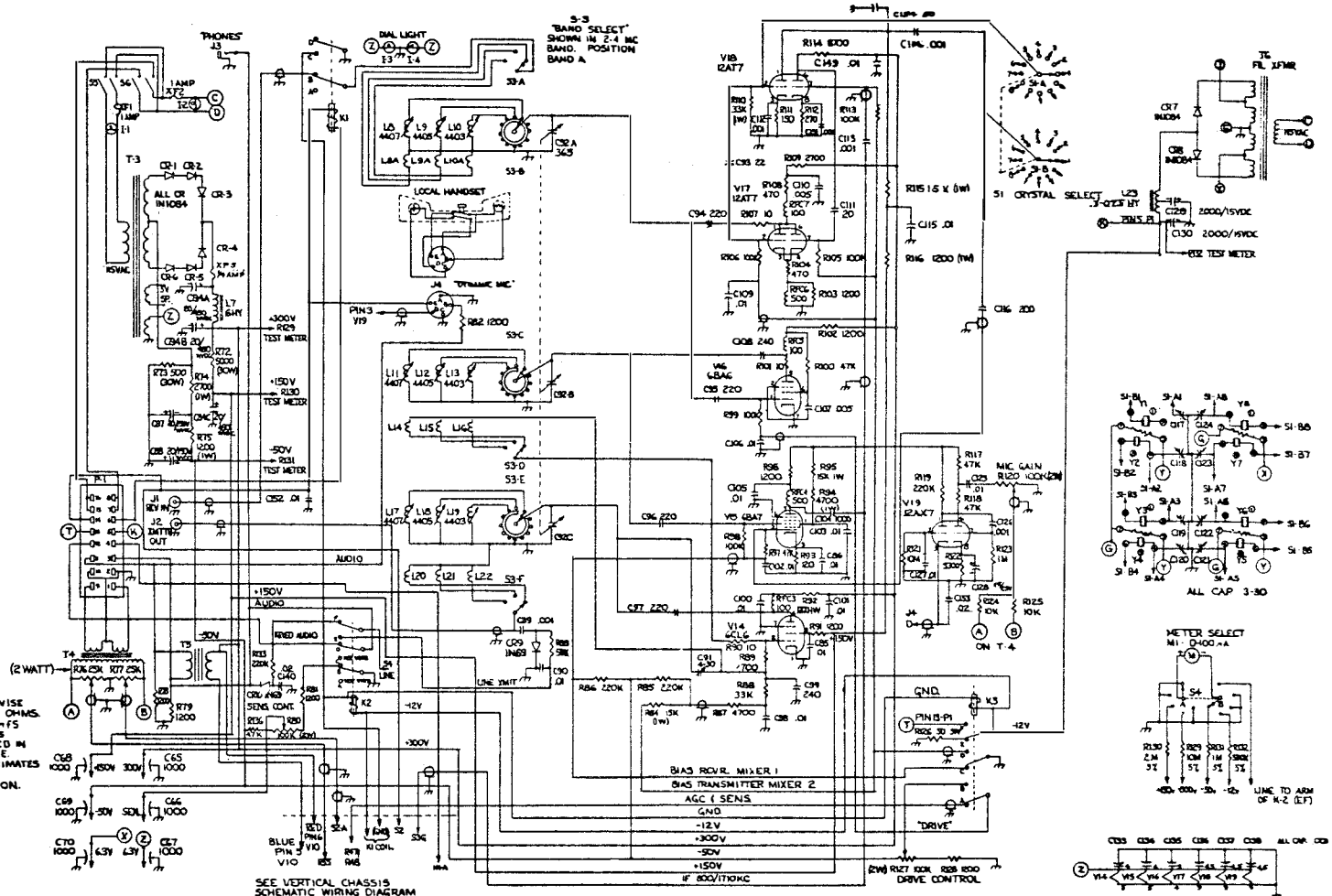
The High Frequency Oscillator energy and the amplified incoming signal are heterodyned by Receiver Mixer #1, and the output at the first intermediate frequency is passed to the IF filter L3/L4, L5/L6 selected by the BANDSWITCH. Actually, two different first intermediate frequencies are used - 800 kcs for 2-8 mcs operation, and 1710 kcs for 8-18 mcs operation. These are chosen to provide adequate image rejection across the range of operation, and to prevent harmonics of the IF stages from imparing performance of the equipment in the transmit mode.

(2) The 800 or 1710 kcs signal is passed from the first IF filter to the Receiver Mixer #2 V2. This mixer also receives energy from the 1255 kcs



RT-465/WRA-1 RECEIVER-TRANSMITTER
FUNCTIONAL BLOCK DIAGRAM

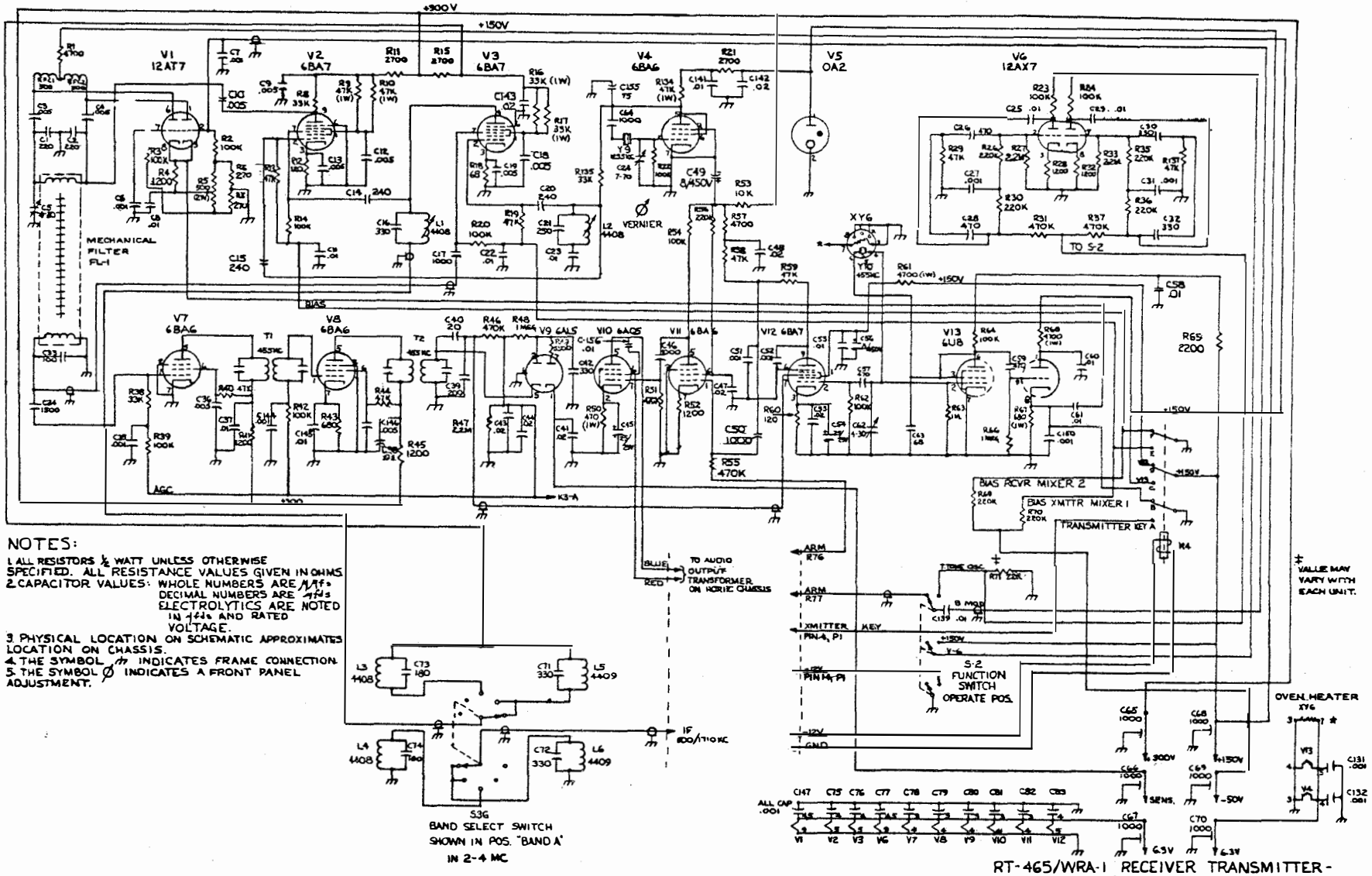
FIGURE 4-1



NOTES:
1. ALL RESISTORS ½ WATT UNLESS OTHERWISE SPECIFIED. ALL RESISTANCE VALUES GIVEN IN OHMS.
2. CAPACITOR VALUES: WHOLE NUMBERS ARE MMFS DECIMAL VALUES ARE MFS ELECTROLYTICS ARE NOTED IN MFS AND RATED VOLTAGE.
3. PHYSICAL LOCATION ON SCHEMATIC APPROXIMATES LOCATION ON CHASSIS.
4. THE SYMBOL ⏚ INDICATES FRAME CONNECTION.

RT-465/WRA-1 RECEIVER TRANSMITTER-
HORIZONTAL CHASSIS - SCHEMATIC WIRING DIAGRAM

FIGURE 4-2



NOTES:

1. ALL RESISTORS ½ WATT UNLESS OTHERWISE SPECIFIED. ALL RESISTANCE VALUES GIVEN IN OHMS
2. CAPACITOR VALUES: WHOLE NUMBERS ARE μμfd. DECIMAL NUMBERS ARE μfds ELECTROLYTICS ARE NOTED IN μfds AND RATED VOLTAGE.
3. PHYSICAL LOCATION ON SCHEMATIC APPROXIMATES LOCATION ON CHASSIS.
4. THE SYMBOL ⏚ INDICATES FRAME CONNECTION.
5. THE SYMBOL Ø INDICATES A FRONT PANEL ADJUSTMENT.

RT-465/WRA-1 RECEIVER TRANSMITTER - VERTICAL CHASSIS - SCHEMATIC WIRING DIAGRAM

Oscillator V4. Regardless of whether the first IF signal is 800 or 1710 kcs, when mixed with 1255 kcs the difference frequency produced will be 455 kcs. The 1255 kcs Oscillator V4 is provided with a VERNIER front panel control. This control allows the operator a limited tuning range of a few hundred cycles in order that the equipment may be precisely set to other single sideband systems, i.e., SSB-1, S-100 equipments.

(3) The 455 kcs output from Receiver Mixer #2 is applied to the mechanical filter FL1. This filter passes a band of 3 kcs (452 to 455 kcs) and is designed to pass the lower sideband of a signal whose suppressed carrier is at the second intermediate frequency of 455 kcs.

(4) The output of filter FL1 is applied to the second intermediate frequency amplifier V7 and V8. These stages are coupled by two conventional 455 kcs IF transformers (T1/T2). The gain of these stages is controlled simultaneously with that of the Radio Frequency Amplifier V16 by the RECEIVER SENSITIVITY control. An additional automatic gain control (AGC) feature is provided and will be discussed in future paragraphs.

(5) The output of the 455 kcs amplifier is applied to the AGC rectifier V9. This stage also receives a control voltage from the RECEIVER SENSITIVITY control (R80). The control voltage determines the basic sensitivity of the receiver, and additionally controls the signal level at which the automatic gain control becomes operative. The bias applied to the RF and IF stages, in the receive mode, is the AGC control voltage plus the rectified component of the incoming signal.

(6) Part of the signal fed to the AGC rectifier V9 is passed via a capacitive voltage divider (C39-C40) to the Product Detector V12. This stage also receives energy from the 455 kcs Oscillator V13A. The Product Detector heterodynes the 455 kcs lower sideband signal down to the audio range. This stage also receives a gain control potential from the RECEIVER SENSITIVITY control and the AGC rectifier V9. Hence, the audio output of the Product Detector is controlled in step with the sensitivity of the receiver, both manually and under automatic gain control conditions. Because of this technique NO audio gain control is provided.

(7) The output of the Product Detector is filtered to remove all but audio frequency components and is passed to the conventional Audio Amplifiers V10 and V11. Audio output is supplied to the dynamic handset, the earphone jack, and to the cabinet terminal board TB-22 via the multiconnection jack/plug P1. From this terminal board audio output is distributed to the regular radiophone remote system, and additionally to a local loudspeaker if desired. Muting contacts are provided for the local loudspeaker to prevent feedback when the equipment is operated locally.

g. The transmitting process will now be considered. Actually, one may think of the process as one in which all stages are reversed, and the signal flow is opposite to that described in f. above. As it is not possible to physically reverse the tubes in their sockets, two tubes are connected so that the plate of one is connected to the grid of the other. Then the plate of the second is connected to the grid of the first. Now

if one tube is biased to cut-off the other may be used in its normal amplifying or mixing direction. Conversely, the process may be reversed by biasing the opposite tube to cut-off and allowing the direction of signal flow to change. The reversing process is simply one of biasing unused stages to cut-off. Four multipole relays are actuated by the push to talk handset; the contacts of these relays perform the required "bias to cut-off" function. The Functional Block Diagram Figure 4-1, as well as the schematic diagrams, Figures 4-2, and 4-3, should be followed with text. Reference to the equipment proper will also be helpful in understanding the transmit process.

(1) From Figure 4-1, note that audio input may be from the local dynamic microphone and/or a standard 600 ohm audio input line. The MIC GAIN front panel control is only for regulating the gain of the dynamic microphone Speech Amplifier V19. Both the Speech Amplifier and the 600 ohm input circuits supply audio energy to screw driver adjustable potentiometers R76 and R77. These potentiometers control side tone levels to the audio amplifier (for radiophone remote monitoring), and audio levels to the Balanced Modulator V1, through the TUNE OPERATE switch S2. In the OPERATE position audio energy is fed to the Balanced Modulator V1. In the TUNE position, the Balanced Modulator receives a signal from the Two Tone Oscillator V6. The Two Tone Oscillator is provided to simulate a steady audio input for tuning purposes. Bear in mind that in single sideband, nothing is produced as a signal until the microphone is spoken into.

(2) The Balanced Modulator therefore receives either true audio, or simulated audio from the Two Tone Oscillator. Additionally, energy from the 455 kcs Oscillator is supplied via a Cathode Follower V13B. By an "outphasing" technique the 455 kcs carrier is balanced out, and a double sideband (less carrier) signal is produced. Carrier Null controls C5 and R5 are provided for balancing the stage and cancelling the carrier.

(3) The output of the Balanced Modulator, a double sideband (less carrier) signal is applied to the mechanical filter FL1. The filter attenuates the upper sideband, and passes the lower sideband signal to the Transmitter Mixer #1 V3. This stage also receives energy from the 1255 kcs Crystal Oscillator V14. By mixing/heterodyning action this stage produces, among other things, the SUM and DIFFERENCE of the two inputs. The SUM product is 1255 plus 455 or 1710 kcs, the DIFFERENCE product is 1255 minus 455 or 800 kcs. Thus the 455 kcs SSB signal is heterodyned simultaneously to two new frequencies, 800 and 1710 kcs. Either may be selected for use with a suitable filter such as the L3-4/L5-6 and S3 combination. To remove the "feedthrough" of 1255 kcs oscillator energy a "trap" circuit, L1/C16 is provided. Additionally, to insure that only 1255 kcs energy is fed to the mixer, a selective filter L2/C21/R33 is employed.

(4) The 800/1710 kcs SSB signal is applied to the IF Buffer V18B. This stage provides isolation and a small amount of gain.

(5) The output from IF Buffer V18B is applied to Transmitter Mixer #2. This stage also receives energy from the High Frequency Oscillator V18A. By mixing/heterodyning action the SSB signal is translated to the operating frequency.

(6) The output of Transmitter Mixer #2 is applied to the Radio Frequency Amplifier V16. During the transmit mode, the gain of this stage is controlled by the TRANSMITTER DRIVE control. Switching of gain control of this stage in the two modes of operation is made via relay K3.

(7) The output of V16 is applied to the Radio Frequency Amplifier V14. This amplifier raises the level of the SSB signal and delivers the useful output of the unit to the coaxial jack J2.

h. Two basic power supplies are integral with the unit. One supply consisting of transformer T3, rectifiers CR-(1-6), and associated filters and voltage dividers provides the plus 300 and minus 50 volt potentials. A gaseous regulator V5 also supplies the plus 150 volt potentials required by the unit. The heaters of V14 through V19 plus V4 are also supplied from T3. The second power supply consisting of transformer T6, rectifiers CR7/8, and associated filters supplies the minus 12 volt potentials for actuating unit relays and the remote radiophone circuitry. Additionally, the oven heaters, panel lights, and heaters of V1 through V12 less V4 are supplied from T6. All potentials may be monitored via the TEST SELECT switch and panel meter S4/M1.

4-4. TRANSMISSION LINE COUPLER CU-701/WRA-1.

a. This device is a single stage, tuned amplifier, used to compensate for transmission line losses between the TRANSCEIVER and the parent transmitter.

b. The equipment receives plate potentials from the bias supply of the parent transmitter. As this supply is negative with respect to ground, it is applied to the cathode of the amplifier tube V1. The heater of V1 receives power from an integral transformer T1; 115V power for this transformer is obtained from the parent transmitter.

c. The incoming signal sideband signal from the TRANSCEIVER is applied to the cathode of V-1 (See Figure 2-4) - The amplifier is a grounded grid pentode. The incoming signal (2-3 volts) is amplified and selected by the tank circuit C1 and L1-5. The output is passed by coupling capacitor C3 to the coupling assembly provided in the field change to the parent transmitter.

d. DC potentials should be measured in servicing with respect to the cathode, pin 1. The plate potential will equal the bias supply of the parent transmitter, 250 to 300V; the screen potential should be 150 to 175V.

4-5. VOLTAGE REGULATOR CN-513/URA-1.

a. This device is a "shunt type" regulator designed to compensate for the variable screen current prevalent under linear operation of the parent transmitter IPA and PA stages.

b. The equipment draws maximum current when the parent transmitter draws the least, and vice versa. As screen potentials are ordinarily obtained from a dropping resistor, the purpose of the unit is to maintain a constant TOTAL current drain on the dropping resistor, and hence a constant voltage drop - and therefore a constant screen potential. Actually, an error signal is required to operate any such control device. The error signal required to operate the equipment is in the order of 40-50 volts. Accordingly, the regulation will be of the same order as the error signal. WITH the regulator, the screen voltage will be maintained at 500V ± 50V over a screen current range of from zero to one hundred milliamperes. WITHOUT the regulator, the screen voltage will vary from 450 to 1200V, under the same screen current variations. Stabilization of the screen voltage of the parent transmitter is necessary in order to maintain linearity in the amplifying function.

c. The plate of the regulator tube V1 is connected to the screen circuit of the parent transmitter when the system is switched to the single sideband mode. This connection is made via the contacts of K1 (See Figure 2-4). The two contacts of this relay also short out the screen modulation choke of the parent transmitter, and add a capacitor C1 to improve the dynamic operation of the regulator. The grid of the regulator tube V1 is supplied with a negative potential from the bias supply of the parent transmitter. A reference voltage feedback circuit consisting of four gaseous glow tubes V-2 - 5 changes the grid potential in accordance with variations in the plate voltage of V1, and the screens of the parent transmitter. Sufficient leak current is maintained through the gaseous glow tubes to maintain a constant voltage drop across them. Accordingly, if the plate potential varies by a given amount, the grid potential will vary by nearly the same amount. As the current drawn by V1 is controlled more by the grid potential than the plate potential, a tendency for the plate voltage (and transmitter screen voltage) to drop due to increased screen current, will cause the grid potential of V1 to go more negative and will cause the V1 current to drop. This opposite action tends to make the total current drawn by the dropping resistor of the parent transmitter approximately constant, and thereby maintains the screen voltage nearly constant.

d. The resting current of V1 is controlled by the SCREEN VOLTAGE ADJUST control, R4, and should be adjusted under conditions as specified for the parent transmitter in the applicable Field Change Bulletin.

SECTION 5
TROUBLE SHOOTING

5-1. GENERAL.

a. Every effort has been made in the design of the unit to provide for trouble free operation. Proper operating and installation techniques will allow the equipment to perform as designed. As with every electro-mechanical device, wear and deteriorization will eventually render the equipment inoperative.

b. Time and experience have proven that it is best to look for simple and obvious faults before clouding the picture with too much theory. Above all, check mechanical devices such as dials, knobs, couplings, plugs and jacks, and other fittings first. Many hours of servicing time have been wasted by overlooking these fundamental concepts.

c. Mechanical devices such as jacks, plugs, and switches should also be suspected of misalignment and sources of poor, open, and shorted connections. When in doubt, examine visually, and check for continuity and shorts with an ohmmeter such as the AN/PSM-4.

d. Use all aural and visual aids provided with the equipment. Earphone jacks and the TEST SELECT switch and meter are devices that should be used to their full extent in localizing faults. Use feel and smell as a means for detecting overheated components. In this equipment, vacuum tubes, ovens, and power transformers will run HOT to touch and feel technique under normal conditions.

5-2. RECEIVER/TRANSMITTER RT-465/WRA-1.

a. A list of operating checks appear in the Trouble Shooting Chart Table 5-1. Use of this reference is recommended for rapid trouble shooting, however, no chart can foresee all difficulties. Do not replace parts without recourse to every means of testing.

TABLE 5-1. TROUBLE SHOOTING CHART.

SYMPTOM	PROBABLE CAUSE	CORRECTION
1. HEATERS and POWER indicator lights do not glow - equipment "dead"	1.a. No primary power b. Fuses blown	1.a. Check power service at TB-21 and P1 b. Replace F1 and F2
2. Indicator lights glow but equipment "dead". TEST METER indicates no 50/150/300 volt potentials	2.a. Defective diodes CR1-6 b. Defective L7 c. Defective R73 and/or R74 d. Defective T3	2. Test and replace as required

SYMPTOM	PROBABLE CAUSE	CORRECTION
3. Low 150/300 volt potentials	3.a. Same as 2. b. Defective C84	3.a. Same as 2 b. Same as 2
4. Low 50 volt potential	4. Defective RC filter	4. Check R74, R75, C87, C88
5. Low 12 volt potential	5. Defective T6, CR7-8, L23, C129, C130	5. Check and replace
6. No audio output	6.a. Audio Amplifier b. Faulty jacks or connections	6.a. Replace V10/V11/V12 b. Check TB22/P1 and jacks
7. Receiver background noise present but no signals	7.a. High Frequency Oscillator b. 1255 kcs Oscillator c. 455 kcs Oscillator d. Receive Mixers #1 and/or #2 e. NO ANTENNA	7.a. Check V18, and S1. Try another channel b. Check V4 stage c. Check V13 stage d. Check V2-V15 stages e. Check J1/K1
8. RECEIVER SENSITIVITY control ineffective	8.a. AGC stage b. Defective relay c. Defective control circuitry	8.a. Check V9 and presence of bias b. Check K3 c. Check R80, R81, R136
9. Signals distorted	9.a. Off frequency b. No carrier insertion c. Defective Product Detector d. RECEIVER SENSITIVITY set too high for strong signals	9.a. Adjust VERNIER; or crystal compensating capacitors C117-C124 b. Check 455 KCS Osc. V13 c. Check V12 stage d. Reduce sensitivity setting
10. Signals present but no LINE meter indication	10.a. Defective S4, CR10, C140, R133	10.a. Replace as necessary

SYMPTOM	PROBABLE CAUSE	CORRECTION
11. LOW Sensitivity, all channels	11.a. Any receiving tube	11.a. Test and replace
	b. LOW oscillator activity	b. Check V4, V13, V18 circuitry
	c. NO ANTENNA	c. Check J1/K1
12. UNIT will not switch to Transmit	12.a. 12 Volt Power supply	12.a. Check Test Meter for presence of 12 volts; trouble shoot power supply
	b. Switch defective	b. Check alternate keying - TUNE/OPERATE switch - handset, etc.
	c. Defective relays	c. Check K1/K2/K3 K4
13. NO transmit LINE indication	13.a. R.F. Amplifier	13.a. Check V14 stage
	b. Defective relays	b. Check K1/K2/K3/K4
	c. Defective sampling circuit	c. Check CR9 and associated circuitry
	d. Defective Transmit Mixers	d. Check V1, V3, V17 circuitry
14. NO transmit LINE indication on TUNE	14.a. Defective Two Tone Oscillator	14.a. Check V6 circuitry
	b. Defective switch	b. Check S2
15. NO transmit LINE indication with speech input, but normal indication on TUNE	15.a. Speech Amplifier	15.a. Check V19 stage
	b. Connectors	b. Check P1, J4, TB22
	c. Faulty switch	c. Check S2
16. LINE indication erratic on TUNE	16.a. R.F. Amplifier oscillating	16.a. Adjust C91
	b. Wrong frequency band	b. Check for proper setting of BANDSWITCH
	c. No load on unit	c. Check J4 circuitry
17. Other stations report presence of carrier	17. Balanced Modulator defective	17. Check setting of C5/R5 using auxiliary receiver to analyze

SYMPTOM	PROBABLE CAUSE	CORRECTION
18. Equipment exhibits unusual frequency drift	18. Faulty ovens or crystals	18. Check other channels

b. The trouble shooting table necessarily does not include all possible symptoms, nor does it include all possible causes for a particular symptom. The "trouble shooter" will of necessity have to depend upon his own initiative to locate faults.

c. Tables 5-2, voltage measurements, and 5-3, resistance measurements are provided as aids to trouble shooting. Measurements differing from these tabulated values in the order of 10 percent may be expected as no two production units are identical.

5-3. TRANSMISSION LINE COUPLER CU-701/WRA-1.

a. This device is a single stage tuned amplifier, and as such, trouble shooting is confined to checking of circuit continuity, power supply potentials, and input and output levels.

b. A test monitor is located on the top of the unit. Under normal conditions the meter will indicate proper performance by a scale indication of 30-40 when the Transceiver is in the TUNE position, and the Line Coupler is tuned to the operating frequency.

c. The level of the SSB input signal level may be checked at the cathode, pin 1, of V1 - or across R-1. Measurement should be made with a vacuum tube voltmeter with an R.F. probe (AN/USM-34 or equivalent). An input level of 2-3 volts rms is adequate for operation of the unit.

d. The equipment receives its plate supply from the bias supply of the parent transmitter. The plate circuit is grounded for DC purposes, and the negative bias (-250 to 300V) is applied to the cathode. This potential may be measured at pin 1 of V1.

5-4. VOLTAGE REGULATOR CN-513/WRA-1

a. Trouble shooting of this unit is best accomplished first by visual means.

(1) Check for lighted filament of V1; tube receives filament power via T1, F-1, J1/J2 and SIDEBAND/NORMAL switch on LINE COUPLER.

(2) Check for gaseous glow in V2/3/4/5; Tubes will glow under normal conditions from presence of high voltage to V1 and bias potentials from parent transmitter.

b. A metering check may be made with a milliameter at the front panel test points. If adjustment of R4 will not provide a test current of 70-80 ma., test tubes, and check components by static means.

c. This unit is connected to the parent transmitter via J1, 2, 3, 4 and cables W101/102 to jacks J5, 6, 7, 8. Check all cables and connectors for continuity and for shorts.

TABLE 5-2 RECEIVER-TRANSMITTER RT-465/WRA-1 VOLTAGE CHART

V-1		12AT7	V-2		6BA7	V-3		6BA7	V-4		6BA6	V-5		CA2
PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS
1	-1.5	150	1	80	300	1	300	96	1	-17	-16	1	150	150
2	-0.3	0.2	2	-4	-60	2	-55	4.5	2	GND	GND	2	GND	GND
3	0	5	3	1	0	3	0	1	3	GND	GND	3	NOT	USED
4	Fil.	Fil.	4	GND	GND	4	GND	GND	4	Fil.	Fil.	4	NOT	USED
5	Fil.	Fil.	5	Fil.	Fil.	5	Fil.	Fil.	5.	60	70	5	NOT	USED
6	-1.5	146	6	GND	GND	6	GND	GND	6	60	70	6	NOT	USED
7	0.3	0.3	7	0.4	-60	7	-55	0	7	GND	GND	7	NOT	USED
8	0.4	5	8	NOT	USED	8	NOT	USED						
9	GND	GND	9	230	300	9	300	260						

1. D.C. Voltage.
2. Values may vary ± 10%.
3. Fil. indicates filament connection.

RECEIVER-TRANSMITTER RT-465/WRA-1 VOLTAGE CHART

V-6	12AX7		V-7	6BA6		V-8	6BA6		V-9	6AL5		V-10	6AQ5	
PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS
1	0	110	1	-0.7	-37	1	-0.7	380	1	-1	-60	1	0.4	0
2	0	-0.6	2	GND	GND	2	GND	GND	2	-1.5	-55	2	17	18
3	0	0.4	3	GND	GND	3	GND	GND	3	GND	GND	3	GND	GND
4	Fil.	Fil.	4	Fil.	Fil.	4	Fil.	Fil.	4	Fil.	Fil.	4	Fil.	Fil.
5	Fil.	Fil.	5	280	300	5	290	300	5	14	0	5	280	280
6	0	110	6	100	270	6	180	270	6	GND	GND	6	300	300
7	0	-0.6	7	GND	GND	7	7	-1.5	7	-1.5	-60	7	0.4	0
8	0	0.4												
9	GND	GND												

1. D.C. Voltage.
2. Values may vary + 10%.
3. Fil. indicates filament connection.

RECEIVER-TRANSMITTER RT-465/WRA-1 VOLTAGE CHART

V-11		6BA6	V-12		6BA7	V-13		6U8	V-14		6CL6	V-15		6BA7
PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS
1	0.4	0	1	90	-0.5	1	-1.5	130	1	GND	GND	1	100	300
2	GND	GND	2	-0.4	-0.2	2	-3	-1	2	-60	-4	2	-2	-62
3	GND	GND	3	2	0.3	3	40	40	3	NOT	USED	3	2	0.2
4	Fil.	Fil.	4	GND	GND	4	GND	GND	4	Fil.	Fil.	4	Fil.	Fil.
5	70	72	5	Fil.	Fil.	5	Fil.	Fil.	5	Fil.	Fil.	5	Fil.	Fil.
6	70	72	6	GND	GND	6	40	40	6	300	290	6	GND	GND
7	3	4	7	-1	-37	7	GND	GND	7	GND	GND	7	0	-60
			8	NOT	USED	8	0.4	4	8	160	150	8	GND	GND
			9	100	270	9	-7.5	-0.5	9	NOT	USED	9	300	310

1. D.C. Voltage.
2. Values may vary ± 10%.
3. Fil. indicates filament connection.

RECEIVER-TRANSMITTER RT-465/WRA-1 VOLTAGE CHART

V-16	6BA6		V-17	12AT7		V-18	12AT7		V-19	12AX7			
PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS	PIN	REC	TRANS		
1	-1.5	-9	1	310	260	1	90	80	1	310	300		
2	GND	GND	2	-60	-0.2	2	-10	-16	2	0.1	0.2		
3	Fil.	Fil.	3	0	6.5	3	0.5	0.5	3	6	0.5		
4	Fil.	Fil.	4	Fil.	Fil.	4	Fil.	Fil.	4	Fil.	Fil.		
5	300	300	5	Fil.	Fil.	5	Fil.	Fil.	5	Fil.	Fil.		
6	100	150	6	310	250	6	310	270	6	250	250		
7	GND	GND	7	-60	0.2	7	-60	0.2	7	0.2	0		
			8	0	6.5	8	0.2	2.5	8	2.2	2		
			9	Fil.	Fil.	9	Fil.	Fil.	9	Fil.	Fil.		

1. D.C. Voltage.
2. Values may vary ± 10%.
3. Fil. indicates filament connection.

TABLE 5-3 RECEIVER-TRANSMITTER RT-465/WRT-1 RESISTANCE CHART

V-11 6BA6		V-12 6BA7		V-13 6U8		V-14 6CL6		V-15 6BA7	
PIN	RES	PIN	RES	PIN	RES	PIN	RES	PIN	RES
1	500K	1	15K*	1	INF	1	0	1	150K*
2	0	2	100K	2	1 MEG	2	300K	2	52K
3	Fil.	3	120	3	130K	3	NOT USED	3	120
4	Fil.	4	Fil.	4	Fil.	4	Fil.	4	Fil.
5	100K	5	Fil.	5	Fil.	5	Fil.	5	Fil.
6	220K	6	0	6	150K	6	30K *	6	0
7	1200	7	3 MEG	7	0	7	0	7	100K
8		8	NOT USED	8	0	8	100K *	8	0
9		9	150K	9	1 MEG	9	NOT USED	9	35K *

V-16 6BA6		V-17 12AT7		V-18 12AT7		V-19 12AX7		
PIN	RES	PIN	RES	PIN	RES	PIN	RES	
1	2 MEG	1	80K*	1	100K*	1	220K*	
2	0	2	380K*	2	35K	2	10 MEG	
3	Fil.	3	500	3	150	3	INF	
4	Fil.	4	0	4	0	4	0	
5	130K*	5	0	5	0	5	0	
6	150K*	6	40K*	6	15K*	6	300K	
7	0	7	380K	7	300K	7	1 MEG	
8		8	500	8	270	8	3300	
9		9	Fil	9	Fil.	9	Fil.	

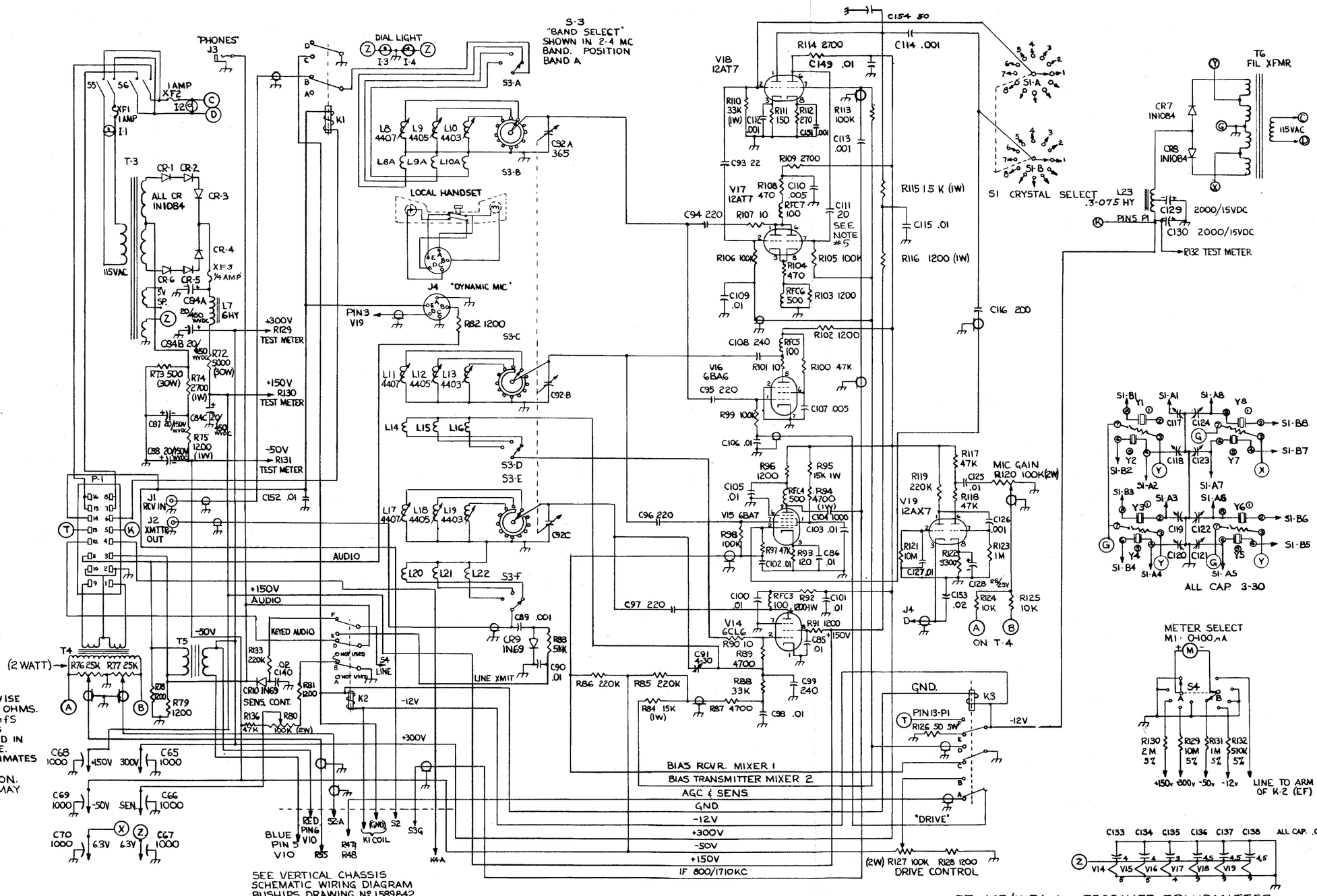
1. All controls at max.
2. *= Instantaneous values.
3. All readings to ground.

TABLE 5-3 RECEIVER-TRANSMITTER RT-465/WRT-1 RESISTANCE CHART

V-1	12AT7	V-2	6BA7	V-3	6BA7	V-4	6BA6	V-5	0A2
PIN	RES	PIN	RES	PIN	RES	PIN	RES	PIN	RES
1	INF	1	40K*	1	40K*	1	100K	1	10K *
2	100K	2	50K	2	300K	2	0	2	0
3	3000	3	110	3	60	3	Fil.	3	NOT USED
4	Fil.	4	Fil.	4	Fil.	4	Fil.	4	NOT USED
5	Fil.	5	Fil.	5	Fil.	5	70K *	5	NOT USED
6	INF	6	0	6	0	6	70K *	6	NOT USED
7	100K	7	100K	7	300K	7	0	7	NOT USED
8	3000	8	NOT USED	8	NOT USED				
9	0	9	70K*	9	30K *				

V-6	12AX7	V-7	6BA6	V-8	6BA6	V-9	6AL5	V-10	6AQ5
PIN	RES	PIN	RES	PIN	RES	PIN	RES	PIN	RES
1	INF	1	2 MEG	1	2 MEG	1	1000	1	500K
2	600K	2	0	2	0	2	3 MEG	2	500
3	1200	3	Fil.	3	Fil.	3	Fil.	3	Fil.
4	Fil.	4	Fil.	4	Fil.	4	Fil.	4	Fil.
5	Fil.	5	12K*	5	12K*	5	10	5	10K*
6	INF.	6	100K	6	100K	6	0	6	10K*
7	600K	7	0	7	680	7	3 MEG	7	500K
8	1200								
9	0								

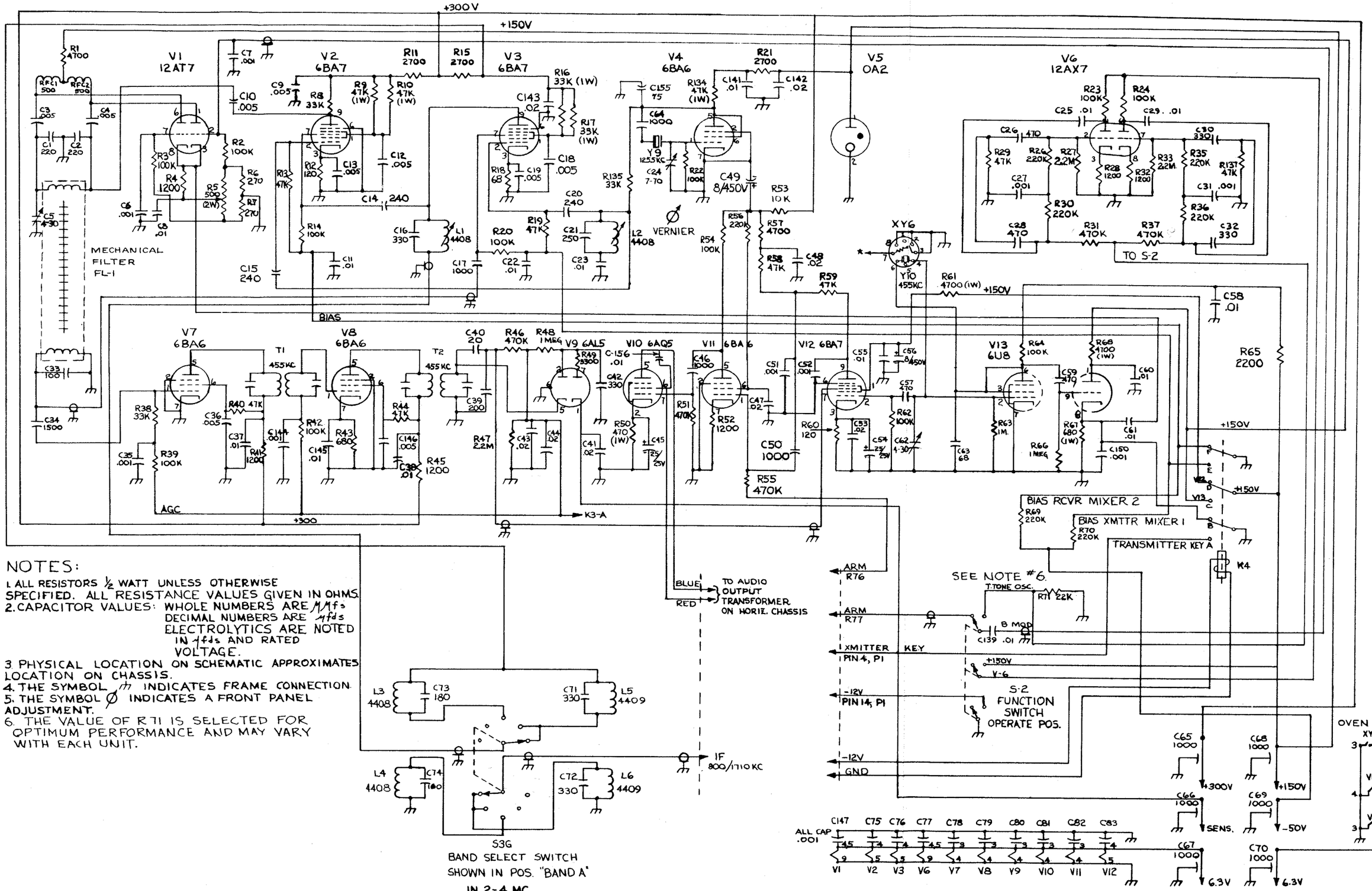
1. All controls at max.
2. *= Instantaneous values.
3. All readings to ground.



NOTES:

1. ALL RESISTORS ½ WATT UNLESS OTHERWISE SPECIFIED. ALL RESISTANCE VALUES GIVEN IN OHMS.
2. CAPACITOR VALUES: WHOLE NUMBERS ARE μμfs DECIMAL VALUES ARE μfds ELECTROLYTICS ARE NOTED IN μfds AND RATED VOLTAGE.
3. PHYSICAL LOCATION ON SCHEMATIC APPROXIMATES LOCATION ON CHASSIS.
4. THE SYMBOL ⏚ INDICATES FRAME CONNECTION.
5. ON SOME UNITS THE VALUE OF C111 MAY BE 220 μμfds.

RT-465/WRA-1 RECEIVER TRANSMITTER-
HORIZONTAL CHASSIS - SCHEMATIC WIRING DIAGRAM Chart #1



NOTES:

1. ALL RESISTORS ½ WATT UNLESS OTHERWISE SPECIFIED. ALL RESISTANCE VALUES GIVEN IN OHMS.
2. CAPACITOR VALUES: WHOLE NUMBERS ARE μμfs
   DECIMAL NUMBERS ARE μfds
   ELECTROLYTICS ARE NOTED IN μfds AND RATED VOLTAGE.
3. PHYSICAL LOCATION ON SCHEMATIC APPROXIMATES LOCATION ON CHASSIS.
4. THE SYMBOL ⏚ INDICATES FRAME CONNECTION.
5. THE SYMBOL Ø INDICATES A FRONT PANEL ADJUSTMENT.
6. THE VALUE OF R71 IS SELECTED FOR OPTIMUM PERFORMANCE AND MAY VARY WITH EACH UNIT.

RT-465/WRA-1 RECEIVER TRANSMITTER - VERTICAL CHASSIS - SCHEMATIC WIRING DIAGRAM Chart #2

SECTION 7
PARTS LIST

7-1. INTRODUCTION.

Reference designations (previously referred to as circuit symbol, reference symbol, etc.) have been assigned to identify all maintenance parts of the equipment. They are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams and the parts list. The letters of a reference designation indicate the kind of part (generic group) such as resistor, capacitor, electron tube, etc. The number differentiates between parts of the same generic group. Sockets associated with a particular plug-in device, such as an electron tube or a fuse, are identified by a reference designation which includes the reference designation of the plugging device. For example, the socket for electron tube V1 is designated XV1.

7-2. NOTES

The following provides additional information about items listed in table 8-1:

(1) For some units the value of C111 may be 220 MMFD.

(2) The value of R-71 may vary between units.

CONTRACT NO. 707 EQUIP. RECEIVER-TRANSMITTER AN/WRA-1

REF. DESIG.	SECTION	NAME AND DESCRIPTION	LOCATING FUNCTION	FEDERAL STOCK NUMBER	NO. PER EQUIP	QUANTITY EQUIP REPAIR PARTS PER SET	QUANTITY STOCK REPAIR PARTS
C-1		Capacitor 220 MMF ARCO CM-15-E-221 J		N5910-270-3196	6		
C-2		Same as C-1					
C-3		Capacitor .005 MFD ERIE ED-.005 Body Style 811		N5910-270-9079	11		
C-4		Same as C-3					
C-5		Capacitor 4-30 MMF ERIE CV11C 300-500 VDC		N5910-636-4271	11		
C-6		Capacitor .001 MFD ERIE ED-.001 Body Style 801		N5910-636-2321	33		
C-7		Same as C-6					
C-8		Capacitor .01 MFD ERIE ED-.01 Body Style 811		N5910-265-5787	32		
C-9		Same as C-3					
C-10		Same as C-3					
C-11		Same as C-8					
C-12		Same as C-3					
C-13		Same as C-3					
C-14		Capacitor 240 MMF ERIE GP-240 GP2-K-241		N5910-248-2240	5		
C-15		Same as C-14					
C-16		Capacitor 330 MMF (silver mica) ARCO CM-15-E-331-J		N5910-256-5569	4		
C-17		Capacitor 1000 MMF ERIE GP-1000 GP2-L-102		N5910-112-8267	5		
C-18		Same as C-3					
C-19		Same as C-3					
C-20		Same as C-14					
C-21		Capacitor 250 MMF (silver mica) ARCO CM-15-E-251-J		N5910-280-8164*	1		
C-22		Same as C-8					
C-23		Same as C-8					
C-24		Capacitor 7-70 MMF Johnson No. 148-5 Type 75S8			1		
C-25		Same as C-8					
C-26		Capacitor 470 MMF ARCO CM-19B-470M 470 MMF MICA		N5910-101-4890*	4		
C-27		Same as C-6					
C-28		Same as C-26					
C-29		Same as C-8					
C-30		Capacitor 330 MMF ARCO CM-19B-331M 330 MMF MICA		N5910-160-1158*	2		
C-31		Same as C-6					
C-32		Same as C-30					
C-33		Capacitor 100 MMF ARCO CM-15-E-101-J		N5910-276-6887	1		
C-34		Capacitor 1500 MMF ERIE GP-1500 GP2-L-152		N5910-112-8262	1		
C-35		Same as C-6					
C-36		Same as C-3					
C-37		Same as C-8					

*Replacement Stock Number

RECEIVER-TRANSMITTER AN/WRA-1

C-38	Same as C-6					
C-39	Capacitor 200 MMF ERIE GP-200 GP2-K-201		N5910-196-0218	2		
C-40	Capacitor 20 MMF ERIE GP-20 GP1-K-200			2		
C-41	Capacitor .02 MF ERIE ED-.02 Body Style 811		N5910-644-6034	10		
C-42	Same as C-13					
C-43	Same as C-41					
C-44	Same as C-41					
C-45	Capacitor 25 MMF Cornell-Dublier BBR-25-25		N5910-195-8467*	3		
C-46	Same as C-17					
C-47	Same as C-41					
C-48	Same as C-41					
C-49	Capacitor 8 MFD 450 WVDC SANGAMO No.PT-4508		N5910-184-3755*	2		
C-50	Same as C-17					
C-51	Same as C-6					
C-52	Same as C-6					
C-53	Same as C-41					
C-54	Same as C-45					
C-55	Same as C-8					
C-56	Same as C-49					
C-57	Same as C-26					
C-58	Same as C-8					
C-59	Same as C-26					
C-60	Same as C-8					
C-61	Same as C-8					
C-62	Same as C-5					
C-63	Capacitor 68 MMF (silver mica) ARCO 15-E-680-J		N5910-553-6909	1		
C-64	Same as C-17					
C-65	Capacitor 1000 MMF ERIE Feed Thru Ceramicon No. 327-102		N5910-518-0819*	6		
C-66	Same as C-65					
C-67	Same as C-65					
C-68	Same as C-65					
C-69	Same as C-65					
C-70	Same as C-65					
C-71	Same as C-16					
C-72	Same as C-16					
C-73	Capacitor 180 MMF ARCO CM-15-E-181-J		N5910-253-9133	1		
C-74	Capacitor 160 MMF ARCO CM-15-E-161-J		N5910-578-5166*	1		
C-75	Same as C-6					
C-76	Same as C-6					
C-77	Same as C-6					
C-78	Same as C-6					
C-79	Same as C-6					
C-80	Same as C-6					
C-81	Same as C-6					
C-82	Same as C-6					
C-83	Same as C-6					
C-84	Capacitor 20-20-20 MF-450WVDC			1		
A-B-C	Sprague PE-3780					
C-85	Same as C-8					
C-86	Same as C-8					

*Replacement Stock Number

C-87	Capacitor 20 MF 150 WVDC Mallory BS-45		N5910-112-7840*	2		
C-88	Same as C-87					
C-89	Same as C-6					
C-90	Same as C-8					
C-91	Same as C-5					
C-92	Capacitor 365 MMF Miller 4 SEC-No. 2114			1		
C-93	Capacitor 22 MFD ARCO (silver mica) CM-15C-220		N5910-666-6197*	1		
C-94	Same as C-1					
C-95	Same as C-1					
C-96	Same as C-1					
C-97	Same as C-1					
C-98	Same as C-8					
C-99	Same as C-14					
C-100	Same as C-8					
C-101	Same as C-8					
C-102	Same as C-8					
C-103	Same as C-8					
C-104	Same as C-17					
C-105	Same as C-8					
C-106	Same as C-8					
C-107	Same as C-3					
C-108	Same as C-14					
C-109	Same as C-8					
C-110	Same as C-3					
C-111	Same as C-40					
C-112	Same as C-6					
C-113	Same as C-6					
C-114	Same as C-6					
C-115	Same as C-8					
C-116	Same as C-39					
C-117	Same as C-5					
C-118	Same as C-5					
C-119	Same as C-5					
C-120	Same as C-5					
C-121	Same as C-5					
C-122	Same as C-5					
C-123	Same as C-5					
C-124	Same as C-5					
C-125	Same as C-8					
C-126	Same as C-6					
C-127	Same as C-8					
C-128	Same as C-45					
C-129	Capacitor 2000 MFD 15V DC Cornell Dublier BR 20001			2		
C-130	Same as C-129					
C-131	Same as C-6					
C-132	Same as C-6					
C-133	Same as C-6					
C-134	Same as C-6					
C-135	Same as C-6					
C-136	Same as C-6					
C-137	Same as C-6					
C-138	Same as C-6					
C-139	Same as C-8					

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C-140	Same as C-41					
C-141	Same as C-8					
C-142	Same as C-41					
C-143	Same as C-41					
C-144	Same as C-7					
C-145	Same as C-8					
C-146	Capacitor .005 ERIE ED .005 Body Style 811		N5910-270-9079	1		
C-147	Same as C-6					
C-149	Same as C-8					
C-150	Same as C-6					
C-151	Same as C-6					
C-152	Same as C-8					
C-153	Same as C-41					
C-154	Capacitor 50 MMF ERIE GP50 Body Style #315		N5910-193-3133*	1		
C-155	Capacitor 75 MMF ERIE GP75 Body Style #315		N5910-270-9216	1		
C-156	Same as C-8					
CR-1	Rectifier, Silicon-Sparks-Tarzian No. 1N1084		N5960-552-8717	8		
CR-2	Same as CR-1					
CR-3	Same as CR-1					
CR-4	Same as CR-1					
CR-5	Same as CR-1					
CR-6	Same as CR-1					
CR-7	Same as CR-1					
CR-8	Same as CR-1					
CR-9	Rectifier, Crystal Diode Type 1N69		N5960-194-9408	2		
CR-10	Same as CR-9					
E-1	Dial, Mfg. By National (Type MCN)		Low Failure Item	1		
E-2	Knob, Raytheon Mfg. Co. Part No. 90-4-2G		N5355-644-2124	3		
E-3	Same as E-2					
E-4	Same as E-2					
E-5	Knob, Raytheon Mfg. Co. Part No. 70-3-2G		N5355-644-2109	5		
E-6	Same as E-5					
E-7	Same as E-5					
E-8	Same as E-5					
E-9	Same as E-5					
E-10	Knob, Raytheon Part No. 125-1-2E		N5355-548-4855	1		
FL-1	Filter, Collins F455Z2			1		
J-1	Panel Jack UG291 B/U Receiver input-mates with UG88 C/U		N5935-201-5983*	2		
J-2	Same as J-1					
J-3	Phone Jack Mfg. Switchcraft Part No. 12A		N5935-615-1720*	1		

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J-4	Receptacle, Dynamic mic. Amphenol AN-3102A-14S-5S		N5935-230-1561	1		
J-5	Plug UG88C/U Mates with J-1 & J-2		N5935-258-4422	2		
J-6	Same as J-5					
J-10	Panel Jack UG58A/U		N5935-149-3483	3		
J-20	Same as J-10					
J-103	Same as J-10					
K-1	Relay-Advance-AM2C12VD			1		
K-2	Relay Potter-Brumfield-KA14D 12VDC			3		
K-3	Same as K-2					
K-4	Same as K-2					
L-1	Coil-Miller 30-69 UH No. 4408			4		
L-2	Same as L-1					
L-3	Same as L-1					
L-4	Same as L-1					
L-5	Coil-Miller 68-130 UH No. 4409			2		
L-6	Same as L-5					
L-7	Reactor-Triad 6HY Triad C12X			1		
L-8	Coil-Miller 14.8-31 UH No. 4407			3		
L-8A	Link 6 turns No. 26 wire Part of L-8					
L-9	Coil-Miller 3.1-6.8 UH No. 4405			3		
L-9A	Link 4 turns No. 26 wire Part of L-9					
L-10	Coil-Miller .9-1.6 UH No. 4403			3		
L-10A	Link 2 turns, No. 26 wire Part of L-10					
L-11	Same as L-8					
L-12	Same as L-9					
L-13	Same as L-10					
L-14	Part of L-11					
L-15	Part of L-12					
L-16	Part of L-13					
L-17	Same as L-8					
L-18	Same as L-9					
L-19	Same as L-10					
L-20	Part of L-17					
L-21	Part of L-18					
L-22	Part of L-19					
L-23	Reactor-Filter, Triad-C47U			1		
M-1	Meter, 0-100 Micro-Ammeter-Simpson Model #127			1		
0-1	Panel Bearing - Part of shaft assy. on tune operate switch S-2 USECO No. 1560		Low Failure Item	10		
0-2	Same as 0-1, Part of Shaft assy. on Vernier Control - C24					
0-3	Flexible coupling - Part of Vernier Shaft assy. C-24 Johnson 104-264.		N3010-606-6631	4		
0-4	Coupling Part No. TR-2-08 Shop Mfg See Dwg. CDP-2-6706 Rev A.		Shop Manufacture			
0-5	Same as 0-3, Part of Band Switch Shaft assy.					
0-6	Same as 0-3, Part of Tune Oper. Shaft assy.					
0-7	Same as 0-3, Part of Band Switch Assy.					

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O-8	Coupling - Part of Band Switch Assy. USECO Part No. 3316		N3010-289-7767	1		
O-9	Shaft - Part of Band Select. Assy. Stainless Steel. O. D. .250.		Shop Manufacture	1		
O-10	Shaft - Part of Vernier Control Assy. Stainless Steel O. D. .250.		Shop Manufacture	1		
O-11	Handles, Nut & Washer USECO No. 1020		Shop Manufacture	1pr		
O-12	Bushing, 3/16 to 1/4 inch adapter - Vernier Shaft Assy. Mfg by H. Smith Part No. 143		Low Failure Item	2		
P-1	Interconnection Socket: Amphenol 26-4401-16P. This mates with Amphenol 26-4301-16S.		N5935-536-2010	1		
	Interconnection Plug Amphenol 26-4301-16S. This mates with Amphenol 26-4401-16P.		N5935-549-3136	1		
R-1	Resistor - 4700 OHM 1/2 W		N5905-279-3504	4		
R-2	Resistor 100 K 1/2 W		N5905-195-6761	17		
R-3	Same as R-2					
R-4	Resistor 1200 OHMS 1/2 W		N5905-190-8880	14		
R-5	Resistor 500 OHMS 2 W-OHMITE CLU 5011±10%		N5905-259-7666	1		
R-6	Resistor 270 OHMS 1/2 W		N5905-171-2006	3		
R-7	Same as R-6					
R-8	Resistor 33 K 1/2W		N5905-171-1998	4		
R-9	Resistor 47K 1 W		N5905-299-2013	3		
R-10	Same as R-9					
R-11	Resistor 2700-1/2W		N5905-279-1880	5		
R-12	Resistor 120 - 1/2W		N5905-252-5434	3		
R-13	Resistor 47 K 1/2W		N5905-254-9201	13		
R-14	Same as R-2					
R-15	Same as R-11					
R-16	Resistor 33K 1 W		N5905-102-2740	3		
R-17	Same as R-16					
R-18	Resistor 68 OHMS 1/2 W		N5905-195-5571	1		
R-19	Same as R-13					
R-20	Same as R-2					
R-21	Same as R-11					
R-22	Same as R-2					
R-23	Same as R-2					
R-24	Same as R-2					
R-26	Resistor 220 K 1/2 W		N5905-192-0667	12		
R-27	Resistor 2.2 MEG 1/2 W		N5905-190-8885	3		
R-28	Same as R-4					
R-29	Same as R-13					
R-30	Same as R-26					
R-31	Resistor - 470 K 1/2W		N5905-279-2515	5		
R-32	Same as R-4					
R-33	Same as R-27					
R-35	Same as R-26					
R-36	Same as R-26					
R-37	Same as R-31					
R-38	Same as R-8					
R-39	Same as R-2					
R-40	Same as R-13					

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R-41	Same as R-4					
R-42	Same as R-2					
R-43	Resistor, 680 OHMS 1/2 W		N5905-195-6791	1		
R-44	Same as R-43					
R-45	Same as R-4					
R-46	Same as R-31					
R-47	Same as R-27					
R-48	Resistor 1M 1/2 W		N5905-192-0390	4		
R-49	Resistor, 3300 OHM 1/2 W		N5905-279-3506	2		
R-50	Resistor 470 OHM 1 W		N5905-279-2628	1		
R-51	Same as R-31					
R-52	Same as R-4					
R-53	Resistor 10 K 1/2 W		N5905-185-8510	3		
R-54	Same as R-2					
R-55	Same as R-31					
R-56	Same as R-26					
R-57	Same as R-1					
R-58	Same as R-13					
R-59	Same as R-13					
R-60	Same as R-12					
R-61	Resistor 4700 OHM 1 W		N5905-299-2040	3		
R-62	Same as R-2					
R-63	Same as R-48					
R-64	Same as R-2					
R-65	Resistor 2200 OHM 1/2 W		N5905-279-1876	1		
R-66	Same as R-48					
R-67	Resistor 680 OHM 1 W		N5905-279-2626	1		
R-68	Same as R-61					
R-69	Same as R-26					
R-70	Same as R-26					
R-71	Same as R-26					
R-72	Resistor 5000 OHM 30 W THU-OHM OR-30-5000		N5905-270-5675	1		
R-73	Resistor 500 OHM 30 W TRU-OHM OR-30-500		N5905-100-6714	1		
R-74	Resistor 2700 OHM 1 W		N5905-279-3837	1		
R-75	Resistor 1200 OHM 1 W		N5905-279-2553	3		
R-76	Resistor 25K 2 W POT-OHMITE CLU2531-25K ± 10% - 1/4" Dia x 3/8" Long Slotted Shaft, with Locking Nut		N5905-501-7314*	2		
R-77	Same as R-76.					
R-78	Same as R-4					
R-79	Same as R-4					
R-80	Resistor 100 K-2W -POT. OHMITE CU-1041- 1/4" Dia x 2" Long Shaft		N5905-539-4576*	3		
R-81	Same as R-4					
R-82	Same as R-4					
R-83	Resistor 51K 1/2W		N5905-279-3496	1		
R-84	Resistor 15 K 1 W		N5905-299-2028	3		
R-85	Same as R-26					
R-86	Same as R-26					
R-87	Same as R-1					
R-88	Same as R-8					
R-89	Same as R-1					
R-90	Resistor 10 OHM 1/2 W		N5905-190-8883	3		
R-91	Same as R-4					
R-92	Same as R-75					
R-93	Same as R-12					
R-94	Same as R-61					

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R-95	Same as R-84					
R-96	Same as R-4					
R-97	Same as R-13					
R-98	Same as R-2					
R-99	Same as R-2					
R-100	Same as R-13					
R-101	Same as R-90					
R-102	Same as R-4					
R-103	Same as R-4					
R-104	Resistor 470 OHM 1/2 W .		N5905-192-3973	2		
R-105	Same as R-2					
R-106	Same as R-2					
R-107	Same as R-90					
R-108	Same as R-104					
R-109	Same as R-11					
R-110	Same as R-16					
R-111	Resistor 150 OHM 1/2 W		N5905-299-1541	1		
R-112	Same as R-6					
R-113	Same as R-2					
R-114	Same as R-11					
R-115	Same as R-84					
R-116	Same as R-75					
R-117	Same as R-13					
R-118	Same as R-13					
R-119	Same as R-26					
R-120	Same as R-80					
R-121	Resistor 10 MEG 1/2 W		N5905-279-1865	1		
R-122	Same as R-49					
R-123	Same as R-48					
R-124	Same as R-53					
R-125	Same as R-53					
R-126	Resistor 50 OHM 5 W OHMITE "Brown Devil"			1		
R-127	Same as R-80					
R-128	Resistor 1200 OHMS 2 W		N5905-256-8352	1		
R-129	Resistor 10 MEG 1/2 W 5%		N5905-279-1865	1		
R-130	Resistor 2 MEG 1/2 W 5%		N5905-279-1875	1		
R-131	Resistor 1 MEG 1/2 W 5%		N5905-192-0390	1		
R-132	Resistor 510K 1/2 W 5%		N5905-279-2516	1		
R-133	Same as R-26					
R-134	Same as R-9					
R-135	Same as R-8					
R-136	Same as R-13					
R-137	Same as R-13					
RFC-1	RF Choke National R-50 (500 UH)		N5950-647-9281	4		
RFC-2	Same as RFC-1					
RFC-3	RF Choke Miller 4632 (100 UH)			3		
RFC-4	Same as RFC-1					
RFC-5	Same as RFC-3					
RFC-6	Same as RFC-1					
RFC-7	Same as RFC-3					
S-1	Crystal Select. 30 Degree Index Assy Centralab Part No. PA300		N5930-607-0298	3		
S-1A	Part of S1.Wafer Centralab Part No. PA-1		N5930-581-1871	2		
S-1B	Same as S-1A					
S-2	Tune-Operate Switch Centralab Part No. PA-5		N5930-581-1874	6		
S-3	Band Select Switch 30 Degree Index Assy. Centralab Part No. P-272		N5930-548-6782	1		
S-3A	Part of S3 Centralab #PA-5		N5930-581-1874	3		
S-3B	Part of S-3 Centralab #PA-18					
S-3C	Part of S-3 Centralab #PA-18					

S-3D	Part of S3 Centralab #PA-5		N5930-581-1874			
S-3E	Part of S3 Centralab #PA-10					
S-3F	Part of S3 Centralab #PA-5		N5930-581-1874			
S-3G	Part of S3 Centralab #PA-5		N5930-581-1874			
S-4	Same as S2 Centralab #PA-5		N5930-581-1874			
S-5	Switch, H. H. Smith Part #547-ST22E		N5930-050-2635	2		
S-6	Same as S-5					
T-1	Transformer 455 KC-Input XFMR MILLER 912-C1		N5950-647-8597	1		
T-2	Transformer 455KC Interstage XFMR MILLER 912-C2		N5950-647-7642	1		
T-3	Transformer PL & FIL. XFMR. TRIAD R16A			1		
T-4	Transformer Audio-Input XFMR TRIAD A-10J			1		
T-5	Transformer Output XFMR TRIAD S29X			1		
T-6	Transformer FIL. XFMR TRIAD F36A			1		
TB-1	Terminal Board USECO Part No 1181			12		
TB-2	Same as TB-1					
TB-3	Same as TB-1					
TB-4	Terminal Board USECO Part No. 1182			8		
TB-5	Same as TB-4					
TB-6	Same as TB-4					
TB-7	Same as TB-4					
TB-8	Same as TB-4					
TB-9	Same as TB-4					
TB-10	Same as TB-1					
TB-11	Same as TB-4					
TB-12	Same as TB-4					
TB-13	Same as TB-1					
TB-14	Same as TB-1					
TB-15	Same as TB-1					
TB-16	Same as TB-1					
TB-17	Same as TB-1					
TB-18	Same as TB-1					
TB-19	Same as TB-1					
TB-20	Same as TB-1					
TB-21	Terminal Strip-Bakelite Barrier Terminal Strip H. H. Smith Part No. 602-4		N5940-204-5439	2		
TB-22	Terminal Strip-Bakelite Barrier Terminal Strip H.H. Smith Part No. 602-12		N5940-171-0580	1		
TB-23	Same as TB-21					
V-1	Tube 12AT7		N5960-615-5528*	3		
V-2	Tube 6BA7		N5960-188-0806	4		
V-3	Same as V-2					
V-4	Tube 6BA6/5749		N5960-193-5139*	5		
V-5	Tube OA 2/6626		N5960-262-0964*	1		
V-6	Tube 12AX7		N5960-166-7664	2		
V-7	Same as V-4					
V-8	Same as V-4					
V-9	Tube 6AL5/5726		N5960-262-0185*	1		
V-10	Tube 6AQ5/6094		N5960-669-6861*	1		

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V-11	Same as V-4					
V-12	Same as V-2					
V-13	Tube 6U8		N5960-543-0966*	1		
V-14	Tube 6CL6		N5960-295-0464	1		
V-15	Same as V-2					
V-16	Same as V-4					
V-17	Same as V-1					
V-18	Same as V-1					
V-19	Same as V-6					
Y-1 THRU Y-8	Type CR-27/U Crystals Determined by Freq. Allocation of BUSHIPS		BUREAU Furnished	8		
Y-9	Crystal 1255KC .005% or better-Monitor Products Type CR-27/U			1		
Y-10	Crystal 455KC .005% or better Monitor Products Type CR-27/U			1		
	Crystal Ovens Mfg. By J. T. Knight Type No. JK09 6.3V 75 DEG C		N5955-642-5282*	5		
XI-1	Holder, Lamp, 5/8" Red Lucite Lens, With 180 K OHM Resistor. E. F. Johnson #147-1143-2, Accomodates I-1			1		
I-1	Lamp, Min. Bayonet Type, T3 1/4 NE-51 Neon Bulb		G6240-223-9100	2		
XI-2	Holder, Lamp, 5/8" Amber Lucite Lens With 180 K OHM Resistor. E. F. Johnson #147-1143-4. Accomodates I-2			1		
I-2	Same as I-1					
XI-3	Holder, Dial Light, E.F. Johnson Part #147-329			2		
I-3	Lamp, Dial Light Min. Bayonet, Type T3 1/4 #47, 6.3V, 0.15 Amp			2		
XI-4	Same as XI-3					
I-4	Same as I-3					
XF-1	Fuse Holder, Little Fuse 342003		N5920-280-4088	2		
XF-2	Same as XF-1					
XF-3	Fuse Holder, Little Fuse 357001			1		
XV-1	Socket -9 Pin Shield Base-Mica Filled TS103P01		N5935-201-8529*	7		
XV-2	Same as XV-1					
XV-3	Same as XV-1					
XV-4	Socket - 7 Pin Shield Base-Mica Filled TS102P01		N5935-232-3758*	7		
XV-5	Same as XV-4					
XV-6	Same as XV-1					
XV-7	Same as XV-4					
XV-8	Same as XV-4					
XV-9	Same as XV-4					
XV-10	Same as XV-4					
XV-11	Same as XV-4					

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XV-12	Same as XV-1					
XV-13	Same as XV-1					
XV-14	Vector 8N9TU-9 Pin Nov.		N5935-501-6314*	4		
XV-15	Same as XV-14					
XV-16	Vector 8N9TU-7 Pin Min.		N5935-259-4643*	1		
XV-17	Same as XV-14					
XV-18	Same as XV-1					
XV-19	Same as XV-14					
XV-20	Amphenol -77MIP-8-T OCTAL (Fil. Cap. Socket)		N5935-224-1036*	6		
XY-1	Same as XV-20					
XY-2	Same as XV-20					
XY-3	Same as XV-20					
XY-4	Same as XV-20					
XY-5	Cinch-Jones No. 2K2C			1		
XY-6	Same as XV-20					
	The following items have not been assigned reference designators:					
	Stand-Off, USECO 1550A		Shop Manufacture	20		
	Stand-Off, USECO 1550D		Shop Manufacture	6		
	Stand-Off, USECO Insulated-1400B		Low Failure Item	50		
	Plug UG21D/U		N5935-201-3216*	3		
	Handset, Local Electro Voice-Microphone Model 625SKK			1		

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VOLTAGE REGULATOR AN/WRA-1

REF DSG	NOTES	NAME AND DESCRIPTION	LOCATION FUNCTION	FEDERAL STOCK NUMBER	NO PER EQUIP	QUANTITY EQUIP REPAIR PARTS PER SET	QUANTITY STOCK REPAIR PARTS
C-1		Capacitor 4MFD, 1000 VDC, Cornell-Dublier. Cat No. TJL 10040J		N5910-243-6383 *	1		
C-2		Capacitor .005 MFD Centralab DD16-502 1600 VDC		N5910-577-9036	1		
E-1		Insulator, Mfg. Johnson Cat. No. 35-501		N5970-280-8838	2		
E-2		Same as E-1					
J-1		Plug, Mfg. Amphenol, No. 26-4401-16P		N5935-536-2010	2		
J-2		Socket, Mfg. Amphenol, No. 26-4301-16S		N5935-549-3136	2		
J-3		Plug, Mfg. Amphenol, No. AN3102A-18-5P		N5935-149-3421	1		
J-4		Socket, Mfg. Amphenol, No. AN3106A-18-5S		N5935-552-2808 *	1		
J-5		Plug, MFG Amphenol No. AN3106A-18-5P			1		
J-6		Socket, MFG Amphenol No. AN3102A-18-5S			1		
J-7		Same as J-2					
J-8		Same as J-1					
K-1		Relay, DPDT, Mfg. Advance No. AH/2C/115VA, 115VAC 450 OHMS 10 AMPS		N5945-237-1145	1		
K-2		Relay 3PDT, Mfg. Potter-Brumfield KA14D 12VDC 5AMPS			1		
K-3		Relay DPDT, Mfg. Advance No. AM/2C/115VA			1		

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R-1	Resistor, 10,000 OHMS, 10 WATT Ohmite Brown Devil			1		
R-2	Resistor, 22,000 OHMS, 1 WATT		N5905-299-2022	2		
R-3	Same as R-2					
R-4	Potent., 25,000 OHMS, Mfg. Ohmite, Type AB, Cat. No. CLU2531		N5905-501-7314 *	1		
R-5	Resistor, 47 OHMS, .5 WATT		N5905-252-4018	1		
R-6	Resistor, 20 OHMS, .5 WATT		N5905-279-3520	1		
R-7	Resistor, 100,000 OHMS, .5 WATT		N5905-195-6761	2		
R-8	Same as R-7					
T-1	Transformer, Filament, Mfg. Merit, Cat. No. 3145 DRI 115V SEC 10V @ 5 AMPS			1		
TB-1	Te inal Board, USECO 1182		Shop Manufactured	1		
V-1	Tube, Electron 8005		N5960-116-9988	1		
V-2	Tube, Electron OA2		N5960-262-0964 *	2		
V-3	Same as V-2					
V-4	Tube, Electron, OB-2		N5960-262-3763 *	2		
V-5	Same as V-4					
XF-1	Holder, Fuse Extractor Post, Little Fuse No. 342003		N5920-280-4088	1		
XV-1	Socket, Tube 4 pin, Mfg. E. F. Johnson, No. 123-210-200		N5935-666-3363 *	1		
XV-2	Socket, Tube 7 pin, Ceramic, Mfg. EBY 8328		N5935-222-9850	4		
XV-3	Same as XV-2					
XV-4	Same as XV-2					
XV-5	Same as XV-2					
	Misc. Items Not Assigned Ref. Desig.					
	Standoff-USECO 1400B			3		
TP	Test Point, H. H. SMITH Cat. No. 223 RED		N5935-237-3957 *	1		
TP	Test Point, H. H. SMITH Cat. No. 223 BLACK		N5935-201-3456 *	1		
	Tube Cap, National SPP9		N5940-151-4045	1		
	Tube Shield, Type TS-103U03		N5960-284-4352	4		

* Replacement Stock Number

LINE COUPLER AN/WRA-1

REF DESIG	NOTES	NAME AND DESCRIPTION	LOCATION FUNCTION	FEDERAL STOCK NUMBER	NO. PER EQUIP	QUANTITY EQUIP REPAIR PARTS PERSET	QUANTITY STOCK REPAIR PARTS
C-1		Capacitor Variable, Mfg. Cardwell, No. 6018-140 MMF MAX.			1		
C-2		Capacitor .01 MFD ERIE EF .01, Body Style 811		N5910-270-9088	4		
C-3		Capacitor 220 MMF 10% Ceramic, Tublar, ERIE type GP-2K-221		N5910-236-4508	1		
C-4		Same as C-2					
C-5		Capacitor, .001 MFD ERIE ED .001 Body Style 801		N5910-636-2321	4		
C-6		Same as C-2 (Mounted on Part #FC-1-01 TBL)					
C-7		Same as C-5.					
C-8		Same as C-5					
C-9		Same as C-2 (Mounted on Part #FC-1-01 TBL)					
C-10		Same as C-5					
C-11		Capacitor 10 MMF ERIE ED 10 Body Style 831			1		
CR-1		Rectifier, Crystal Diode Type 1N69		N 5960-194-9408	1		
E-1		Knob, Main Tune, Mfg. National, Vernier Dial, Type AM (3")			1		
E-2		Knob, Pointer RF Select., Raytheon Cat. No. 90-4-26		N 5355-644-2124	1		
J-101		Receptacle, #49194 (On Part #FC-1-01 TBL)		N 5935-666-1334	1		
J-102		Plug Amphenol Type 71-1L			1		
L-1		Coil, RF, Ceramic, Mfg. Miller, No. 4403 .9-1.6 Microh'y			1		
L-1A		Coil, RF, Shop Mfg. Plan CDP-2/6728-TR		Shop Mfg.	1		
L-2		Coil, RF, Ceramic, Mfg. Miller, No. 4404 1.5-3.2 Microh'y			1		
L-3		Coil, RF, Ceramic, Mfg. Miller, No. 4405 3.1-6.8 Microh'y			1		
L-4		Coil, RF, Ceramic, Mfg. Miller, No. 4406 6.7-15 Microh'y			1		
L-5		Coil, RF, Ceramic, Mfg. Miller, No. 4407 14.8-31 Microh'y			1		
M-1		Meter, 0-100 D.C. Micro Ammeter, International Instr. Inc. Model 153C 100X1			1		
RFC-1		Choke, RF, 62 Microh'y. Mfg Miller No. 4630			1		
R-1		Resistor, 68 OHMS, 1 WATT		N5905-279-1733	1		
R-3		Resistor, 470 K OHMS. .5 Watt		N5905-279-2515	1		
R-4		Resistor, 47K OHMS, 1 Watt		N5905-299-2013	1		

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R-5		Resistor, 33,000 OHMS, .5 Watt		N 5905-171-1998	1		
R-6		Resistor, 4,700 OHMS, 1 Watt (Mounted on Part #FC-1-01 TBL)		N 5905-299-2040	1		
S-1		Switch, Toggle, DPST, 125V, 6 AMPS, H. Smith Cat. 547ST22K		N 5930-050-2635	1		
S-2		Switch Section, Centralab PA18			1		
S-0-2		30° Index Assembly, Part of S2 (PA-300)		N5930-607-0298	1		
T-1		Transformer, Fil. Triad No. F-14X		N 5950-645-0888	1		
TB-1		Terminal Board, USECO 1182			1		
XF-1		Holder, Extractor Post Fuse, Little Fuse 342003		N 5920-280-4088	1		
XV-1		Socket, Tube, 9 Pin Shield Base-Mica Filled TS103P01		N 5935-201-8529 *	1		
V-1		Tube 6CL6		N5960-295-8464	1		
		Misc. Items Not Assigned Ref Desig.					
		Standoff, USECO 1400B			4		

*Replacement Stock Number

LIST OF MANUFACTURERS

Advance Relays	Burbank, Calif.
Amphenol	Chicago, Illinois
Arco Electronics Inc	New York, N. Y.
Cardwell Mfg. Co	Wichita, Kansas
Centralab	Milwaukee, Wisconsin
Collins	Cedar Rapids, Iowa
Cornell Dubilier	South Plainfield, N. J.
Electro-Voice	Buchanan, Michigan
Erie Resistor Corp	Erie, Pa.
International Instruments	New Haven, Conn.
Johnson, E.F.	Waseca, Minnesota
James Knight	Sandwich, Illinois
Little Fuse	Des Plaines, Illinois
Merit	Hollywood, Florida
Miller, J. W.	Los Angeles, Calif.
Monitor Products	South Pasadena, Calif.
National Co	Malden, Mass.
Ohmite	Chicago, Illinois
Potter & Brumfield	Princeton, Indiana
Raytheon	Waltham, Mass.
Sangamo	Marion, Illinois
Simpson	Chicago, Illinois
Smith, H. H.	Brooklyn, N. Y.
Sparks-Tarzian	Bloomington, Indiana
Sprague	North Adams, Mass.
Switchcraft	Chicago, Illinois
Triad	Venice, Calif.
USECO	Litton, Indiana