CHAPTER 9

COMMON OPERATING ADJUSTMENTS: RADIO TRANSMITTERS AND RECEIVERS

The ET 3 must know how to make many operating adjustments on a variety of electronic equipments. These equipments include communications transmitters and receivers (and associated TTY and FAX circuits), surface search and height finding radars and their associated repeaters (including IFF equipment), and electronic aids to navigation. Common operating adjustments include starting and stopping the equipment, tuning it, and selecting the operating frequency. Meter readings of current, voltage, and power must be taken; gain-control or intensity-control adjustments must also be made. The knowledge of how to perform these functions is basic to his knowledge of maintenance and repair because without it the ET 3 can do little to maintain or repair an equipment.

The common operating adjustments are made by means of external controls. Other chapters in this training course describe various electronic circuits associated with external controls and analyze their functions. The purpose of this and the following two chapters is to describe the common operating adjustments for radio, loran, teletype, facsimile, and radar equipments.

RADIO TRANSMITTING SET AN/SRT—15

First, consider the Radio Communications Transmitting Set AN/SRT-15 (fig. 9-1). A general description of the major components is followed by a discussion of some of the common adjustments.

The set may transmit an r-f carrier at either a 100-watt or a 500-watt nominal level. The r-f carrier may be amplitude modulated for radiophone (type A3 emission), or it may be ON-OFF c-w telegraphy (type A1 emission), either hand or machine keyed. Other modes of operation include telegraphy by frequency-shift keying (type F1 emission), using an FS machine key (teletype operation), and facsimile (type F4 emission), using frequency modulation.

Frequency selection is manually accomplished. A set of nine frequency selection control knobs located on the radio frequency oscillator provides a range of frequencies from 0.3 mc to 26 mc in 10-cycle steps.

Start-stop control, keying, and radiophone may be obtained from a remote location. Standard Navy six-wire radio transmitter control circuits are used for all remote-control operations.

The AN/SRT-15 with all accessories includes a 100-watt transmitter group and booster, antenna tuning equipment, antenna, and remote radiophone unit. The booster includes modulator-power units to accomplish 500-watt operation. The transmitter bay consists of the 100-watt transmitter group, a transmitter coupler, two mountings, and the radio modulator-power supply (booster).

The antenna tuning equipment includes an antenna coupler and r-f tuner.

The 100-watt transmitter group contains all circuits for generating the desired radio frequency and amplifying it to the 100-watt carrier level, and provides it either in amplitude or frequency-modulation communication, as previously described. The modulated r-f carrier output is fed through a 50-ohm coaxial cable to an adjustable autotransformer (transmitter coupler) for matching the output of the radio frequency amplifier to the input of the antenna coupler.

The transmitter group includes a cabinet holding five pull-out drawer-type chassis. From top to bottom these units are (1) the radio frequency amplifier (RFA), (2) the low-level radio modulator (LLRM), (3) the radio frequency oscillator (RFO), (4) the low-voltage power supply (LVPS), and (5) the medium-voltage power supply (MVPS).

The functional block diagram of Radio Transmitting Set AN/SRT-15 is shown in figure 9-2.

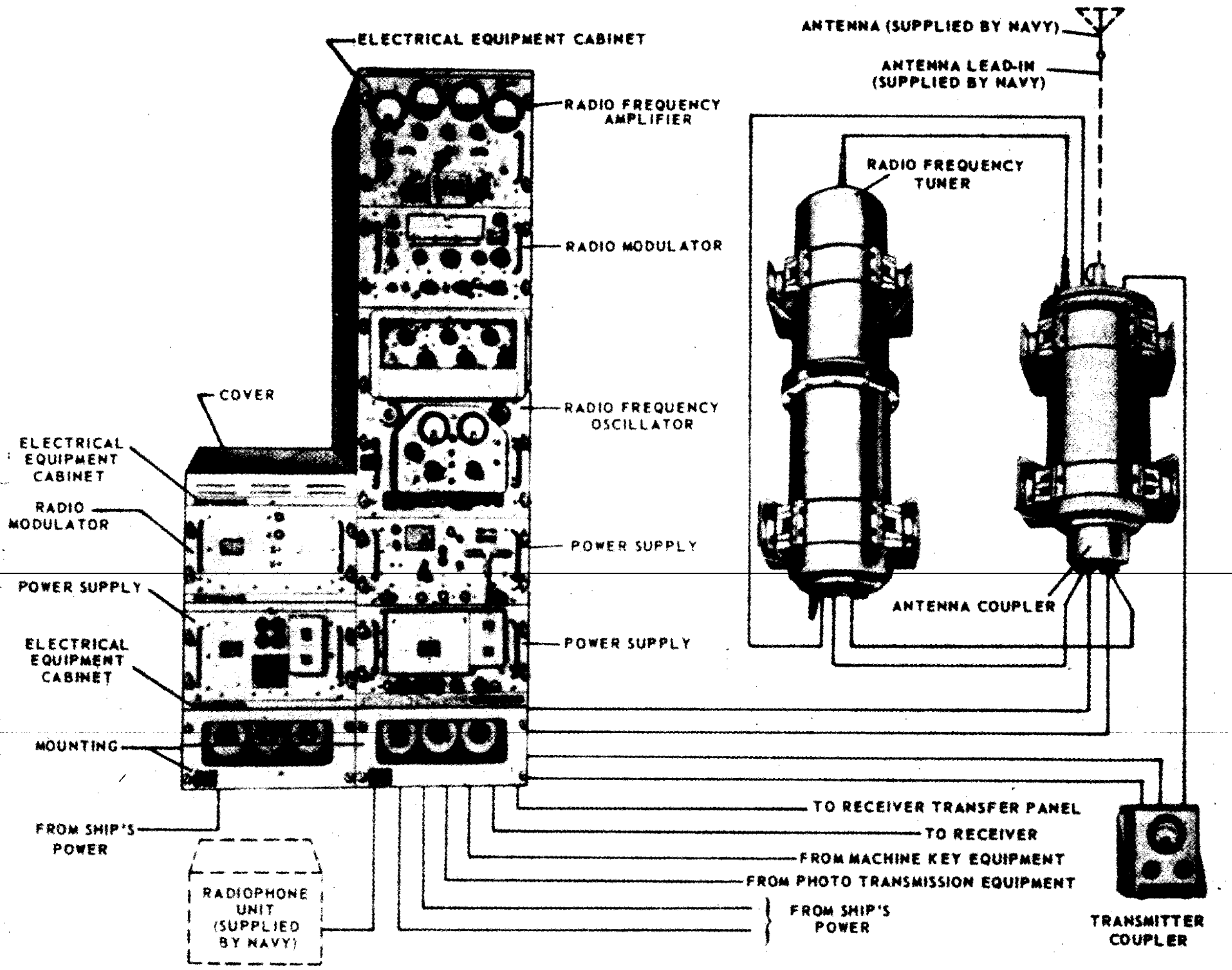

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Figure 9-1.—Radio transmitting set AN/SRT-15.

The r-f Carrier originates in the radio frequency oscillator and is amplified in the radio frequency amplifier. The output of the radio frequency amplifier is fed to the antenna via the load adjusting unit and the antenna coupler. For 100-watt operation the output of the low-level radio modulator is fed directly to the radio frequency amplifier. For 500-watt operation the output of the low-level radio modulator is fed to the high-level radio modulator and the output of the high-level radio modulator is fed to the radio frequency amplifier. The radio modulator power supply (in the booster) provides the necessary additional power to increase the r-f carrier output from 100 to 500 watts.

It should be noted that where references are made to the low-level radio modulator or the high-level radio modulator, they should not be interpreted as meaning the technique of modulation known as grid modulation as opposed to plate modulation, but rather as referring to the operating power level of 100 or 500 watts.

RADIO FREQUENCY AMPLIFIER

The radio frequency amplifier (fig. 9-3) amplifies the r-f signal received from the radio

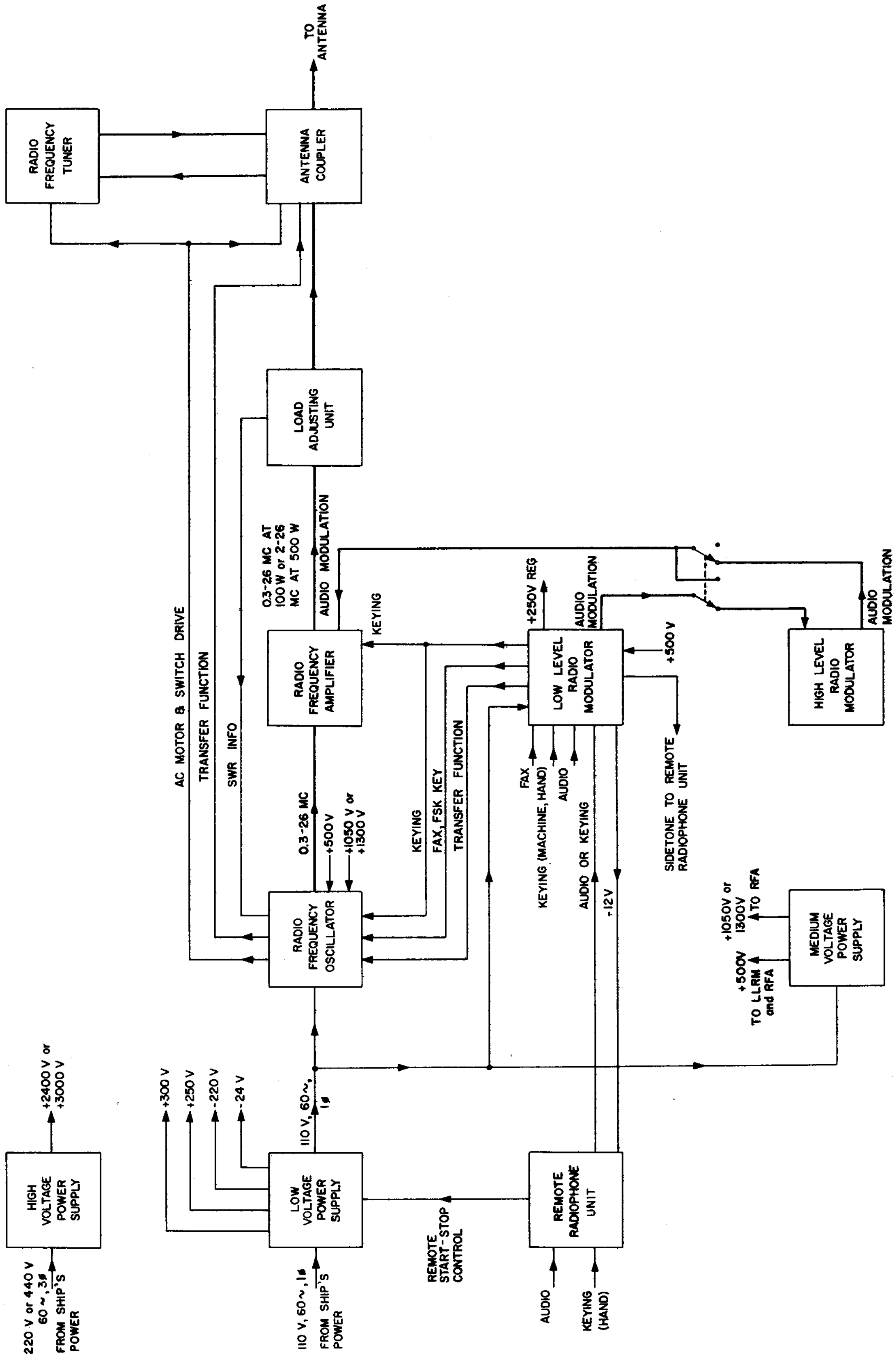

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Figure 9-2. —Block diagram of radio transmitting set AN/SRT-15.

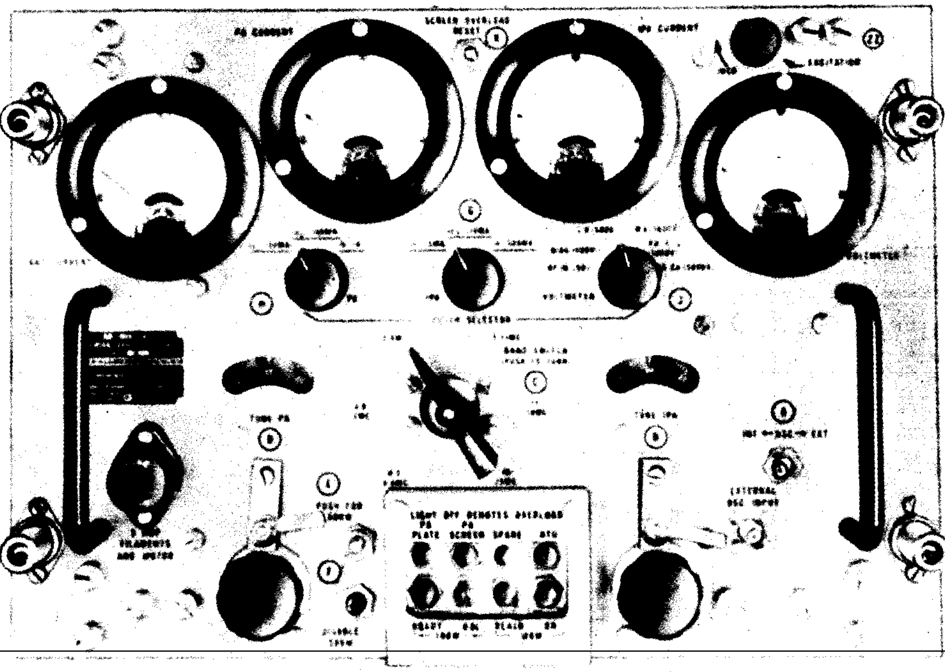

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Figure 9-3.—Radio frequency amplifier AM-1008/SRT.

frequency oscillator to either the 100- or 500-watt nominal level. It consists of three stages of amplification, which include (1) the buffer, (2) the intermediate power amplifier (IPA), and (3) the power amplifier (PA).

The output of the radio frequency oscillator drives the tuned buffer stage. This stage also receives keying signals from the low-level radio modulator to key the output of the RFA ON and OFF during hand-key, machine-key, and phone operation. The tuned IPA stage, which follows, uses a beam power tetrode.

The final stage is the power amplifier, employing a tetrode with forced-air cooling. In phone operation, an audio modulating signal is received from either the low-level radio modulator (100-watt operation) or the high-level radio modulator (500-watt operation) to amplitude modulate the output of the RFA.

The RFA is manually tuned by the adjusting of three front-panel controls (the band switch, the tune IPA control, and the tune PA control). In both the IPA and the PA stages of amplification there is a tuned plate tank circuit that is affected by these controls. The first of the tuning controls is a six-position band switch that connects a tank circuit to each of the three stages in accordance with the band of frequencies in which the selected transmission frequencies lie. The second control tunes the buffer and IPA stage tank circuits and the third control tunes the PA stage. The second and third controls vary the capacity of the tank circuits to bring them into resonance at the desired frequency.

In addition to the tuning controls, there is a control (excitation control) for regulating the input level of the signal from the radio frequency oscillator. The RFA front panel contains four meters used for tuning indicators and as test meters for various operating voltages and currents. A set of indicator lamps is provided to indicate overload conditions and operating conditions of the carrier.

A pushbutton switch, which is used to place the set in nominal 500-watt operation, is mounted on the RFA front panel. A second pushbutton is used to restore the set to the 100-watt level.

LOW-LEVEL RADIO MODULATOR

The low-level Radio Modulator MD-229/SRT is illustrated in figure 9-4. This unit accepts

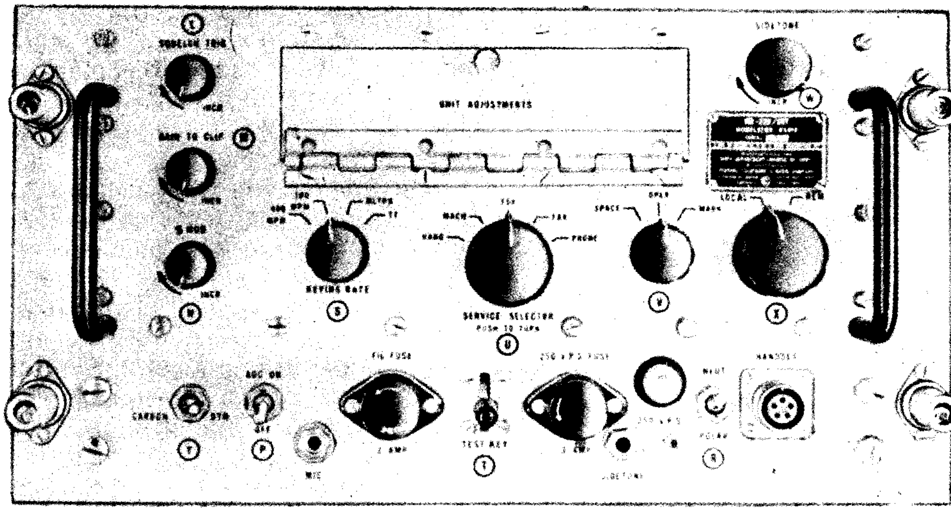

Figure 9-4.—Radio modulator MD-229/SRT (low level modulator LLRM). 1.147

voice, telegraphy (hand or machine key), frequency shift (teletype), or facsimile signals. It contains audio-amplifying and modulating circuits for amplitude modulation of the r-f carrier at the 100-watt level. For 500-watt operation the low-level radio modulator feeds the high-level radio modulator (HLRM) that boosts the signal to the required level. Peak limiting and noise suppression (squelch) circuits are provided in the audio circuits. Either carbon or dynamic microphones may be used.

An electronic keyer circuit provides the keying voltage to control the radio frequency amplifier during c-w telegraph (hand-key and machine-key operation) and to control the radio frequency oscillator in frequency—shift telegraphy. The keying circuits are suitable for speeds from hand keying to 600 words per minute. Facsimile signals are connected through the low-level radio modulator to the frequency-shift circuits in the radio-frequency oscillator drawer. An audio oscillator (200-cycle output) is included in the LLRM to phase-modulate the transmitter signal to overcome selective fading in frequency-shift transmission; in c-w telegraphy the oscillator has a 100-cycle output used for aural monitoring of the keying signals.

The front panel of the LLRM has controls for selecting the mode of transmission, receptacles for a local carbon or dynamic microphone, gain controls, and a squelch circuit control. A test key is provided for carrier control.

RADIO FREQUENCY OSCILLATOR

The radio frequency oscillator (Fig. 9-5) is the source of the r-f carrier signal. It consists of 15 sections: 14 removable units (holding the electron tube circuits) and a mounting to which these units are attached. The 15 sections have official standard item name and symbol designations but are usually referred to by their common name or unit number.

The output stage of the RFO is divided into three separate units (11a, 11b, and 11c) each of which covers a portion of the total frequency range of the radio transmitter.

Units 1 through 12 are equipped with multiple pin-type connectors that mate with receptacles on unit 14. Radio-frequency connections are made through connectors and jumper cables. On each subchassis, test points are provided at r-f input or output points. By using a test cable, any subunit can be examined in detail with each part readily accessible.

There are three individual oscillators in the RFO. Unit 1 is the crystal oscillator, which generates the basic frequency of 100 kc with an accuracy of 1.5 parts per million over the temperature range of -4°F to +122°F. Unit 3 is the interpolation oscillator used to obtain the 10-cycle steps. Unit 12 is the frequency-shift oscillator. The 100-kc carrier frequency of this oscillator is capable of being shifted from

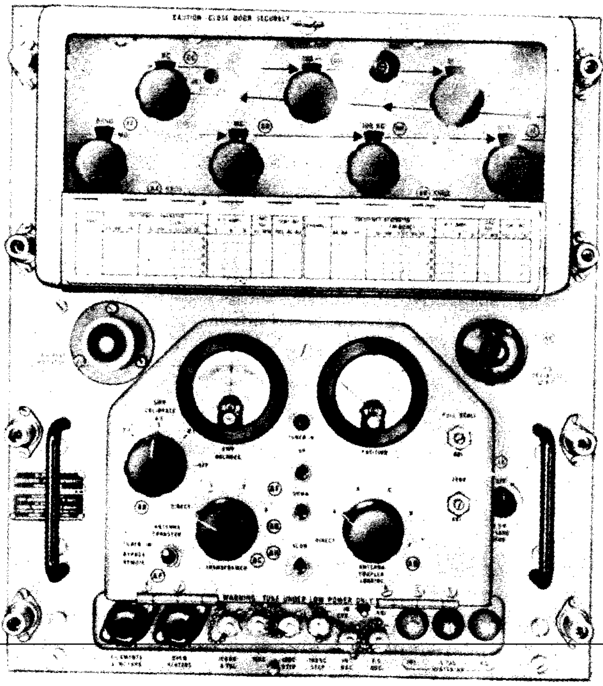

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Figure 9-5.—Radio frequency oscillator O-275/SRT(RFO).

+2000 to -500 cycles about the 100-kc value. The frequency-shift oscillator is used in the mixing sequence only when service selector control, U, on the LLRM (fig. 9-4) is set in one of the frequency-shift positions, FSK or FAX.

The 100-kc signal from the crystal oscillator controls several frequency multipliers that generate a high order of frequencies for the mixing stages. Locked to the crystal oscillator are 10-kc, 100-kc, and 1-mc step generators, each of which provides 10 frequency increments used in the mixing sequence. The independent interpolation oscillator is used to obtain 10-, 100-, and 1000-cycle steps. This interpolation can be checked readily against the crystal oscillator and may be adjusted to maintain its accuracy. Several frequency converters mix the signals from the crystal oscillator, interpolation oscillator, and step generators to provide an r-f signal in steps of 10 cycles over the frequency range of 0.3 to 26 mc.

The front panel of the RFO (fig. 9-5) has all the controls for setting up any frequency within the frequency range. Nine knobs are provided for manually setting a frequency. An electron-ray tube is provided for checking the frequency-shift oscillator or the interpolation oscillator against the standard crystal oscillator. A set of test receptacles is provided on the front panel; these bring out important signals in the RFO for monitoring with a standard test oscilloscope.

The Antenna Control Indicator C-1352/SRT is mounted on the face of the FRO front panel and is considered as a component of the RFO. The control indicator has all the controls and indicators required to accomplish the manual tuning of the antenna coupler and r-f tuner.

A set of three pushbutton switches controls the UP and DOWN movement of the shorting ring on the main tuning coil in the r-f tuner. One toggle switch is used to control the action of the bypass switch in the antenna coupler, enabling the antenna tuning equipment to be placed in the antenna line or to be completely bypassed. One rotary switch controls the loading switches in the antenna coupler, selecting various values of capacitive or inductive reactance loading in conjunction with the main tuning coil. Another rotary switch controls the action of a switch in the r-f tuner, which switches an impedance-matching transformer in or out of the transmission line. An indicator is provided to show the standing-wave ratio on the transmission line. The indicator has an associated switch that is used to set the range of the indicator. A second indicator shows the position of the shorting ring on the main tuning coil in the r-f tuner.

LOW-VOLTAGE POWER SUPPLY

Power Supply Unit PP-1094/SRT (fig. 9-6) is commonly called the low-voltage power supply (LVPS) to distinguish it from other power supplies in the transmitting set. It includes three conventional full-wave rectifiers employing electron tubes and the associated filter circuits. A metallic full-wave rectifier provides a separate -24-volt supply for control circuit functions. One plate-filament transformer supplies all voltages for the rectifier circuits. The primary a-c input is 110 volts, 60 cycle, single phase.

The two controls for turning power on and off in the 100-watt transmitter group are located on the front panel of this unit. A cabinet heater switch controls heaters provided to raise the equipment temperature under some conditions. The standby operate switch may be used to

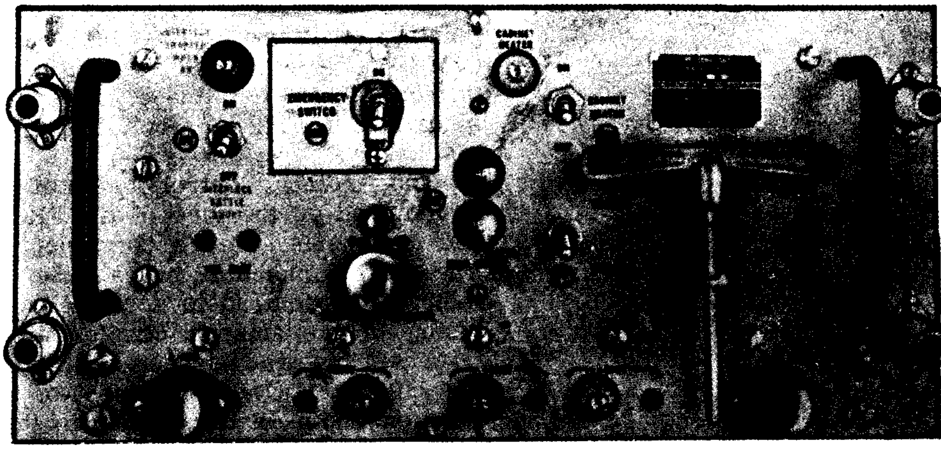

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Figure 9-6.—Low voltage power supply (LVPS) PP-1094/SRT.

put the equipment in a "ready" or "standby" condition. The front panel indicator lights show the proper operation of controls and circuits of this unit.

MEDIUM-VOLTAGE POWER SUPPLY

Power Supply Unit PP-1095/SRT (fig. 9-7) is commonly called the medium-voltage power supply (MVPS). It contains the necessary power transformers, rectifier tubes, filter components, and miscellaneous parts to provide outputs of +500 volts and +1050/1300 volts for the IPA and PA tubes of the RFA and portions of the low-level radio modulator. This unit is energized by operating the appropriate controls on the front panel of the low-voltage power supply. The +500-volt supply is used when the equipment is operating at the 100- and 500-watt levels, but the +1050/1300-volt supply is used only at the 100-watt level. The +1050-volt output is used with phone service only; whereas, the +1300-volt output is used with all other modes of transmission. The elapsed time meters on the front panel are provided for logging transmitter-group tube hours (filament and plate).

TRANSMITTER COUPLER

The load adjusting unit (fig. 9-8) is Transmitter Coupler CU-402/SRT. This unit has a mounting bracket to permit independent mounting. The unit includes an autotransformer with four taps and a standing-wave ratio monitor circuit. An input switch and an output switch, each with four positions that connect to the four taps of the autotransformer, are also components of this unit.

The r-f output of the radio frequency amplifier is connected by interconnecting cabling to the standing-wave ratio monitor and then to the input switch and one of the taps of the autotransformer, which acts as an impedance-matching device. The output from the autotransformer (from the tap selected by the output switch) is fed to the antenna coupler.

RADIO MODULATOR POWER SUPPLY

The Radio Modulator Power Supply OA-685/SRT (booster) (fig. 9-9) provides additional audio and plate power to increase the r-f carrier output of the 100-watt transmitter group to 500 watts. Limitations within the transmitter and antenna tuning equipment make it impracticable to obtain 50-watt carrier operation on the lower frequencies from 0.3 mc to 2 mc. With this exception, all features of the 100-watt transmitter are retained when 500-watt operation is used. Transmitter and antenna tuning is performed at the 100-watt level; high power is applied only when tuning has been completed.

The booster includes (1) Radio Modulator MD-230/SRT (high-level radio modulator) (fig. 9-9 A) and (2) Power Supply PP-1096/SRT (high-voltage power supply) (fig. 9-9, B). The

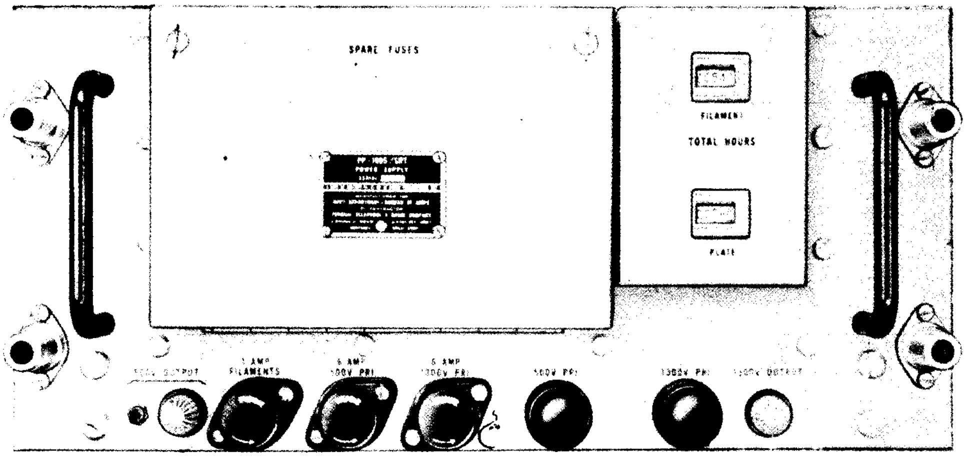

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Figure 9-7.—Medium voltage power supply (MVPS) PP-1095/SRT.

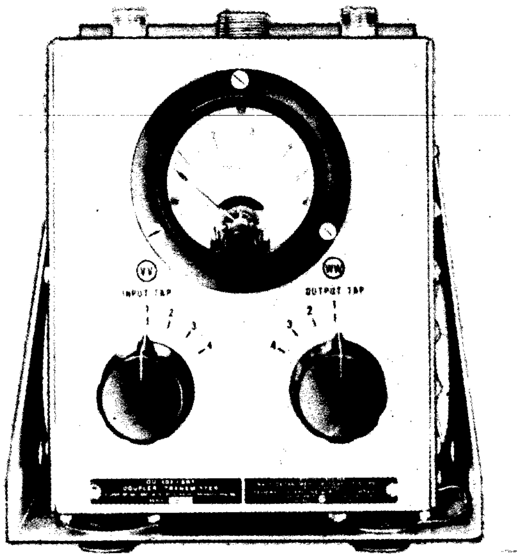

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Figure 9-8.—Transmitter coupler CU-402/SRT (load adjusting unit).

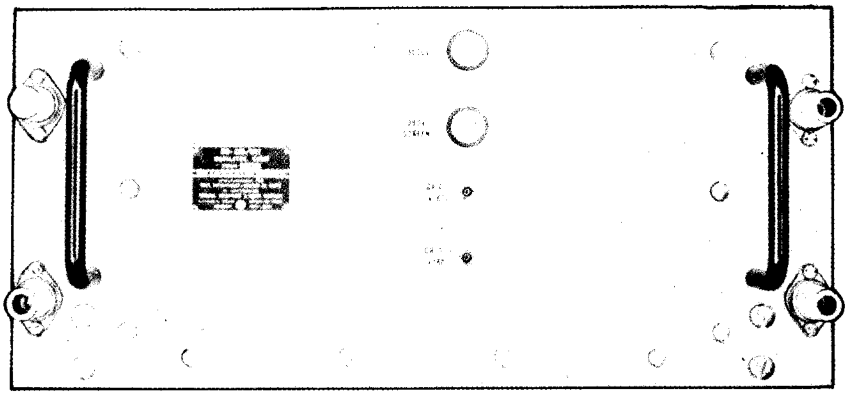
mechanical construction of the booster components is similar to that used in the 100-watt transmitter group. The high-level radio modulator and the high-voltage power supply are of the pull-out drawer design and are housed in individual cabinets equipped with slide and rail arrangement.

The high-level radio modulator (HLRM) modulates the r-f amplifier during phone service at the 500-watt power level. A push-pull, high-level audio power amplifier consisting of two tetrodes operating in class AB2 provides plate modulation for the final r-f amplifier stage. The low-level radio modulator (LLRM) supplies 6 watts of power to drive the HLRM.

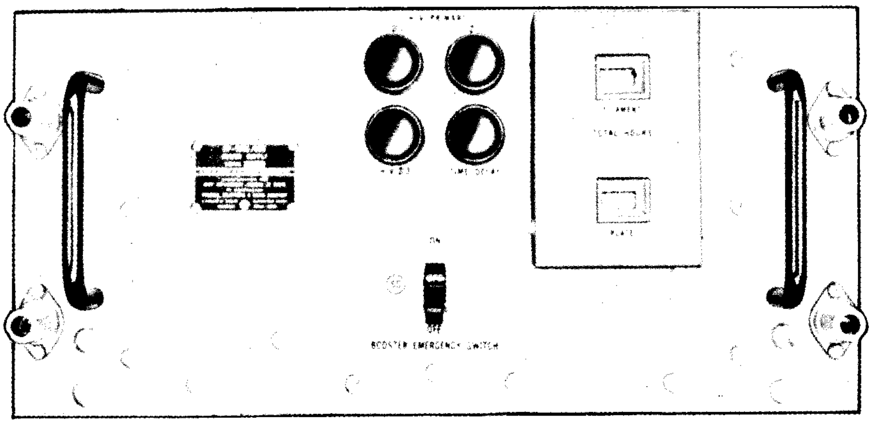
The control that energizes the HLRM is located on the RFA front panel.

The high-voltage power supply (HVPS) consists of six hot cathode gas rectifier tubes in a three-phase, full-wave rectifier circuit with choke input filter. It provides an output of either +2400-volt or +300-volt d-c power, as required for the plate of the power amplifier tetrode in the RFA. The +2400-volt output is used for phone service only; whereas, the +3000-volt output is used with all other modes of transmission. By means of links the input connections of the HVPS may be changed to use either 220- or 440-volt, 3-phase, 60-cycle primary power.

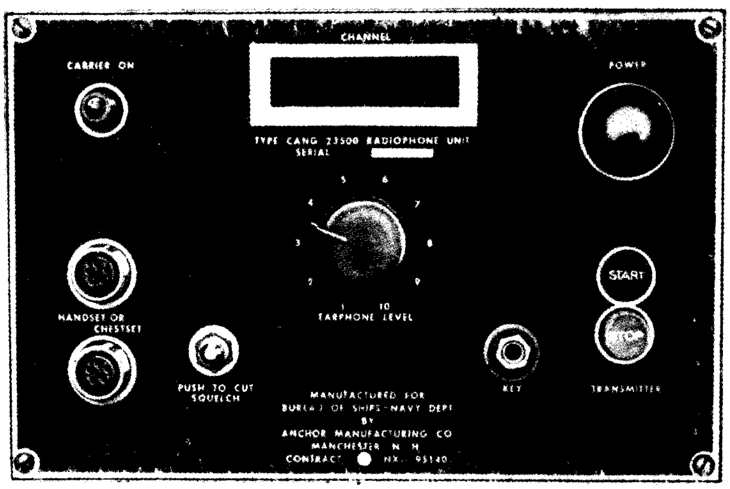
An emergency switch on the front panel of the HVPS controls the 3-phase input power. Filament power is applied to the HVPS (and the HLRM) when the booster emergency switch is on. Application of plate power is controlled by a time delay element and a pushbutton



A HIGH LEVEL RADIO MODULATOR



B HIGH VOLTAGE POWER SUPPLY



C REMOTE CONTROL UNIT

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Figure 9-9.—Radio modulator power supply OA-685/SRT (booster) and radio phone unit type 23500.

switch on the front panel of the RFA. Indicator lights are also provided on the front panel of the HVPS to show power-on and time-delay status.

REMOTE CONTROL UNIT

To operate the transmitting set from a remote location requires a remote-control unit. A typical remote-control unit is Navy type 23500 (fig. 9-9C). This unit contains a start-stop switch for turning the transmitter on or off, jacks for connecting a handset, chest set, or hand key, a volume control for the earphones, and indicator lamps for transmitter-on and carrier-on indications.

R-F TUNER

The function of the antenna tuning equipment (fig. 9-10) is to match the impedance of the r-f transmission line (50 ohms) to the antenna input impedance over the entire frequency range. The principal tuning component to accomplish this match is the main tuning coil found in the r-f tuner. This coil is a helically wound length of transmission line whose length can be varied by the position of a concentric sliding short circuit. A single coupling coil concentric with the main coil is mounted on the sliding short. The sliding short is positioned by a drive motor and associated gear train; the drive motor is controlled from the control indicator mounted on the face of the RFO panel. An impedance matching transformer is also located in the r-f tuner. The transformer can be inserted or removed from the transmission line by a motor-driven switch that, in turn, is controlled at the control indicator. The transformer is required at the low frequencies to match the very low antenna impedance to the 50-ohm transmission line.

A blower is provided for heat dissipation in the r-f tuner. A thermostatic switch that is normally closed and a blower centrifugal switch that is closed only when the blower is rotating are provided as safety devices when the equipment is operated at the 500-watt level. If either or both of these switches are open, the transmitter can function only at the 100-watt level.

The r-f tuner is a sealed moisture-proof unit equipped with valves and a pressure gauge to permit pressurizing the unit to a pressure of 20 pounds per square inch with dry nitrogen gas.

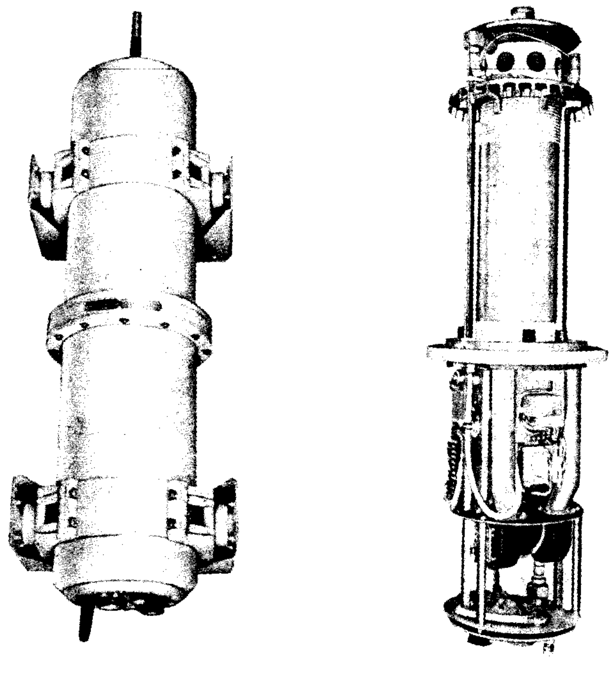

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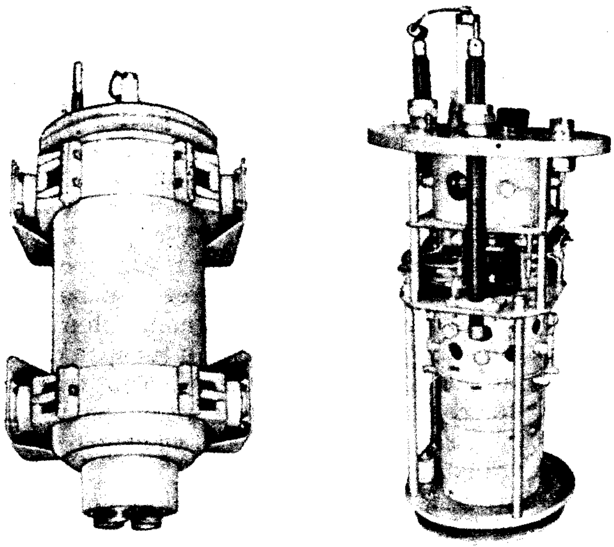
Figure 9-10.—Radio frequency tuner TN-229/SRT (r-f tuner)

ANTENNA COUPLER

The Antenna Coupler CU-372/SRT (fig. 9-11) has two basic functions: (1) to switch various inductive or capacitive reactance components into the transmission line to extend the range of tuning of the main tuning coil, and (2) to provide a switch that permits the antenna to be connected through the tuning components to the transmitter r-f output or to connect the antenna directly to the transmitter r-f output.

To extend the tuning range of the main coil in the r-f tuner, three capacitors and two coils are in the antenna coupler that can be inserted in various combinations in series, or in shunt with the main tuning coil. A motor-driven switch selects the component desired; the switch is controlled from the control-indicator on the front panel of the RFO in the transmitter bay (fig. 9-5). This switch also has a position in which no loading components are added, leaving the main tuning coil in the r-f tuner as the only tuning component in use.



SIDE VIEW, COVER ON

SIDE VIEW, COVER OFF

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Figure 9-11.—Antenna coupler CU-372/SRT.

The switch to either bypass the tuning components or insert them on the transmission line is motor driven. It has two positions and is manually controlled at the control indicator (fig. 9-5).

The antenna coupler, like the r-f tuner, is a sealed unit with similar provisions for charging with dry nitrogen gas.

The transmitting set is designed to work into a 35-foot whip antenna, Navy type C66047, or into a 60 to 130-foot single wire with a 40-foot downlead.

COMMON ADJUSTMENTS

Common adjustments for Radio Transmitting Set AN/SRT-15 include starting and stopping the equipment for 100- and 500-watt operation, selecting the types of service (mode of transmission), selecting a frequency, tuning, and remote operation.

As an example of common operating adjustments, the sequence of operations is given for starting and stopping the equipment for 100- and 500-watt operation.

All the controls for starting and stopping the equipment for 100-watt operation are located on the LVPS (Fig. 9-6).

To start the transmitter for 100-watt operation:

1. Turn the emergency switch, MM, on.
2. Depress the start pushbutton of the main power switch, RR. When the main power is on, the following events take place:
   a. The main power indicator light on the LVPS is energized.
   b. The blower motor in the RFA fig. 9-3 starts to operate.
   c. The -12- and the +250-volt regulated power supplies in the LLRM (fig. 9-4) are energized, and the 250-volt power supply indicator light in the LLRM comes on.
   d. The filament supplies in all units are energized.

Approximately 25 to 30 seconds after the main power is on the following actions occur:

1. The LVPS time delay expires and the time delay indicator light on the LVPS energizes.
2. The +250-v and -220-volt indicator lights on the LVPS are energized, thereby denoting the presence of the corresponding supply voltages.
3. The carrier 100-watt ready indicator on the RFA (Fig. 9-3) energizes.
4. The blower motors in the mounting start operating.

If the standby operate switch, PP, in the LVPS is in the STANDBY position, there will be no plate power and nothing further will happen. Set the standby-operate switch, PP, to OPERATE. If the service selector, U, in the LLRM (fig. 9-4) is set to HAND, the following actions will occur:

1. The +500-volt and the +1050/1300-volt supplies together with the 500-volt primary, 500-volt output, 1300-volt primary, and 1300-volt output indicator lights in the MVPS (fig. 9-7) will energize.
2. The +300-volt indicator light in the LVPS will energize, denoting the presence of this supply voltage.
3. The 100-watt carrier ON indicator light in the RFA (fig. 9-3) will energize.

The actions indicated in items 1 through 2 will occur when the service selector, U (fig. 9-4) is in the MACH, FSK, and FAX positions only if the keying line is closed. If the service selector is in the PHONE position, these actions will occur only when the press-to-talk button on the phone is depressed.

Power in the 100-watt transmitter group may be turned off by depressing the stop pushbutton on the main power switch, RR, on the LVPS (fig. 9-6) or by throwing the emergency switch, MM, to the OFF position. The latter control removes all power; whereas, the former removes all power except that to the mounting heaters.

The radio modulator power supply (booster) is energized only when it is desired to have the AN/SRT-15 transmitting set operate at the 500-watt level. To energize the booster, the transmitter group must be energized, and the standby operate switch, PP, on the LVPS (fig. 9-6) must be in the STANDBY position. The booster now may be energized as follows:

1. Set the booster emergency switch, SS, on the high-voltage power supply (HVPS) (fig. 9-9B) to ON. After a 30-second time delay, the time delay indicator light is energized.

2. Depress pushbutton E, on the RFA (fig. 9-3) to initiate the following action:

a. The carrier 500-watt ready indicator light on the RFA will energize. At this time filament power has been applied to the booster but there will be no plate power. The equipment is now in the OPERATE condition. Assume that the service selector, U, in the LLRM (fig. 9-4) is set to the HAND position.

b. The +1050/+1300-volt supply in the MVPS (fig. 9-7) is deenergized and the 1300-volt primary and 1300-volt output indicator lights in the MVPS will be extinguished.

c. The O1, O2, and O3 high-voltage primary indicator lights on the HVPS (fig. 9-9B) are energized.

d. The 3000-volt and 350-volt screen indicator lights on the HLRM (fig. 9-9A) are energized, thereby denoting the presence of these supply voltages.

e. The carrier 500-volt on indicator in the RFA (fig. 9-3) is energized.

To turn off the booster, depress the disable 500-watt pushbutton, F, on the RFA. This action disables plate power only in the booster. Turning the booster emergency switch, SS, on the HVPS (fig. 9-9B) to OFF removes both filament and plate power in the booster. If the 100-watt transmitter group power is turned off while booster power is still on, plate power will be removed from the booster also.

Figure 9-12 illustrates, by functional block diagrams, the sequence of operation of the control circuits. Figure 9-12A shows the operation through "-24 volt after time delay," which is the same for either 100- or 500-watt operation. Figure 9-12B continues the sequence for 100-watt operation; figure (fig. 9-12C) shows the sequence for 500-watt operation.

The main power input (top block of figure 9-12A is 117-volt, 60-cycle, single-phase power received from the ship's supply. Emergency switch MM controls the power input to the transmitter bay. When switch MM is closed, power is delivered to the cabinet heater switch, NN, and to the main power switch, RR.

When the start button of switch RR is depressed, the master control relay is energized, which distributes a-c power for the following purposes: to distribute a-c power throughout the transmitted bay, to energize all filament supplies in the transmitter bay, to energize the blower in the RFA, to energize the main power indicator, to turn on the +250-volt regulated and -12-volt power supplies in the LLRM, and, through the interlocks, to energize the LVPS time delay. After the time delay, the "-24-volt after time delay" supply is energized, which is a control voltage. With "-24 volt after time delay" the -220-volt and the +250-volt unregulated supplies in the LVPS are energized.

The following sequence applies with the service selector, U, on the LLRM set at the HAND position.

At this point for 100-watt operation (fig. 9-12B) with the standby operate switch, PP, in STANDBY, the carrier 100-watt ready indicator will be energized. If a different frequency is desired from the last previous transmission, the manual settings of the new frequency by adjustment of the control knobs on the RFO are made at this point in sequence followed by the corresponding manual band switching in the RFA, the readjustment of the initial setting of the two switches on the load adjusting unit (transmitter coupler), and then readjustment of the initial antenna tuning by the manual controls on the control indicator.

Placing the standby operate switch, PP in OPERATE energizes the +500-volt and +1050/+1300-volt supplies in the MVPS and energizes the 100-watt carrier on indicator. Energizing the +500-volt supply allows the +300-volt supply in the LVPS to energize. Placing the transmitter in a 'key down' condition will now energize the carrier, and manual tuning of the IPA and PA stages of the RFA is performed. The final fine antenna tuning adjustments are now made at the control indicator. Further adjustment of the switches on the load adjusting unit will be required only if satisfactory tuning is not accomplished with the switches in their initial setting.

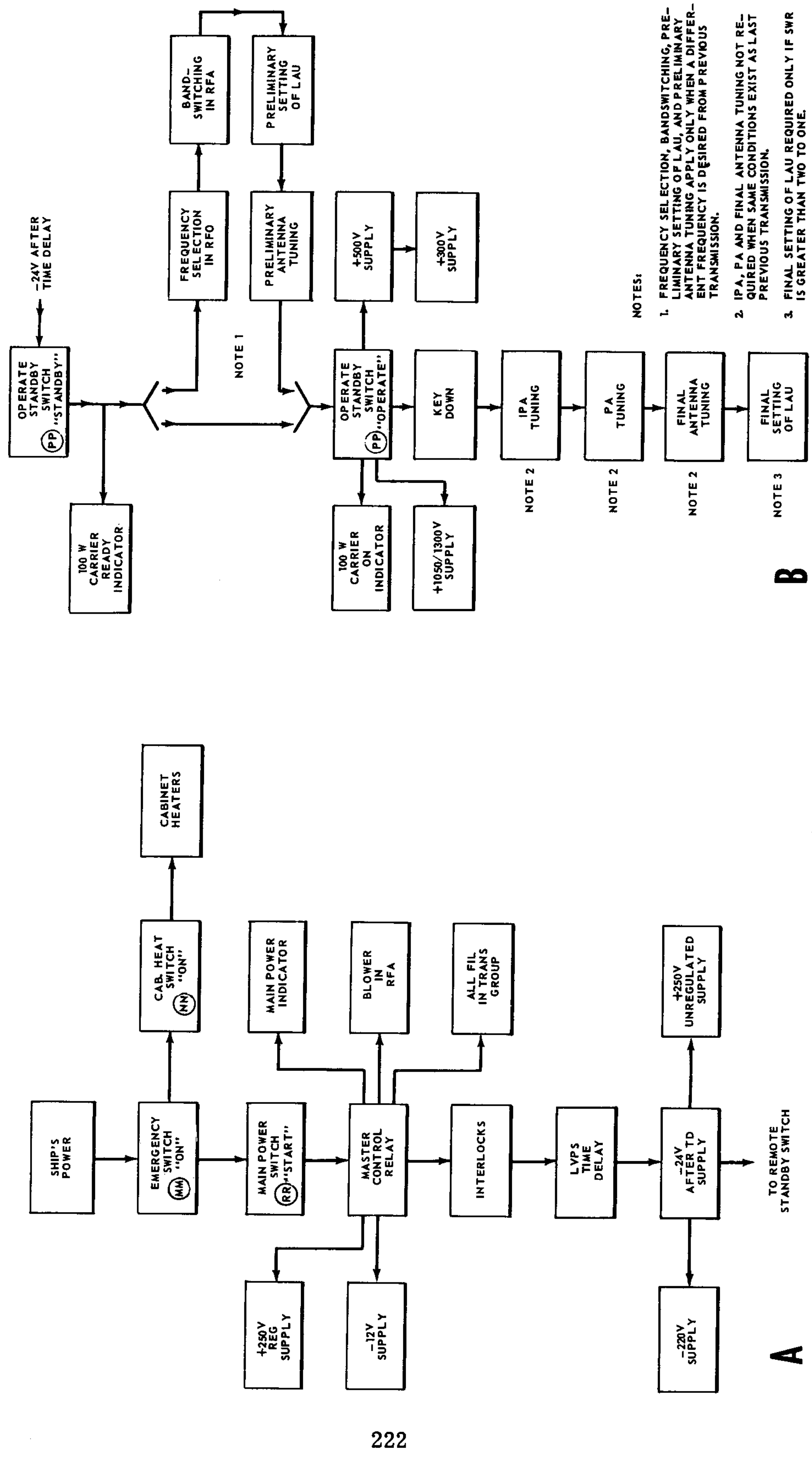

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Figure 9-12.—Functional block diagram of sequence of control circuit operation for AN/SRT-15 transmitter.

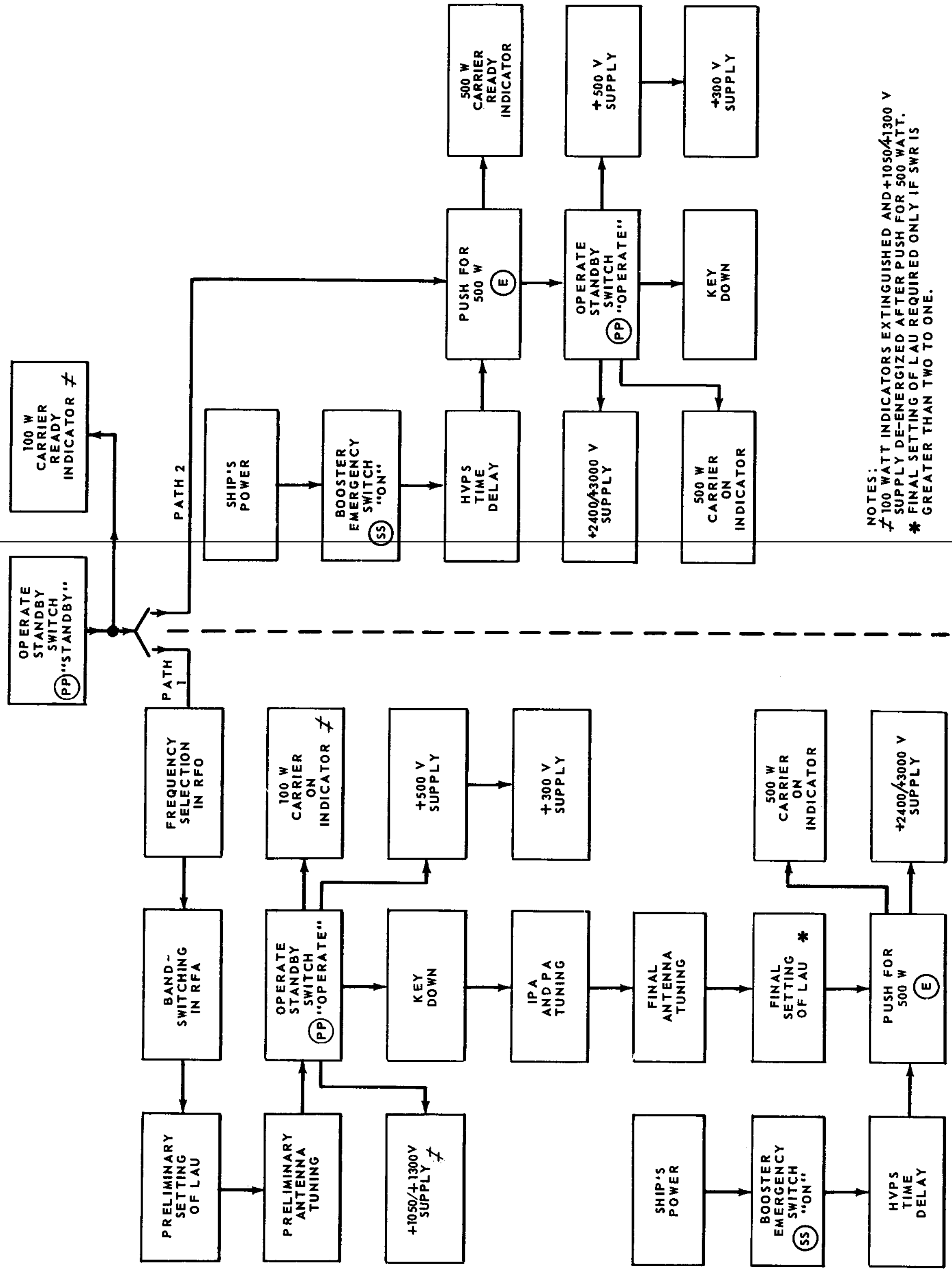

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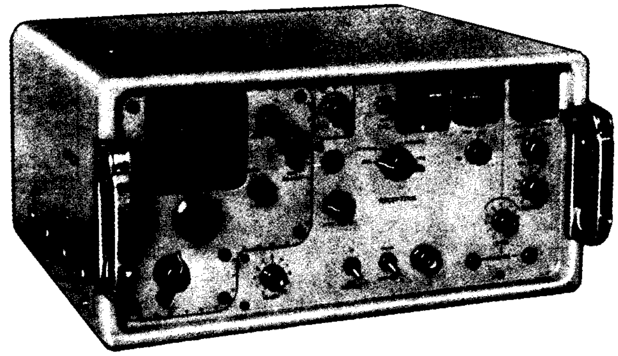
Figure 9-12.—Functional block diagram of sequence of control circuit operation for AN/SRT-15 transmitter—Continued

For 500-watt operation (fig. 9-12C) after LVPS time delay, and with the standby operate switch, PP, in STANDBY, frequency selection, if required, takes place as previously described. The sequence now takes one of two paths, depending on whether or not tuning is required.

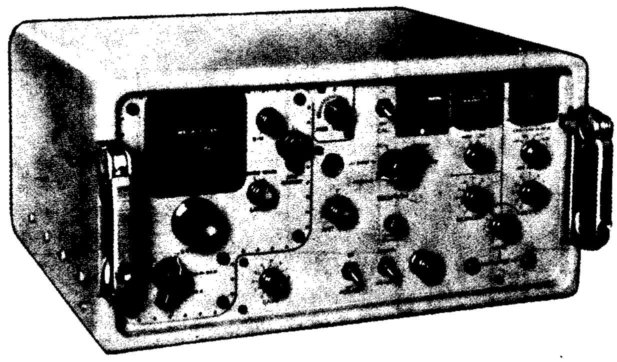
If tuning is required, it should be done with the transmitter energized at the 100-watt level (path 1), which gives the same sequence of operation as for 100 watts, as previously described. After tuning is complete, the booster emergency switch, SS, which controls power input to the booster, is turned on.

This action supplies either 220- or 440-volt, 60-cycle, three-phase power to the booster, energizing the HVPS time delay. After the time delay is over, the push for 500-watt button, E, is depressed, energizing the +2400/+3000-volt supply and the carrier 500 watt on indicator. Concurrently the 100-watt indicator and the +1050/+1300-volt supply are deenergized.

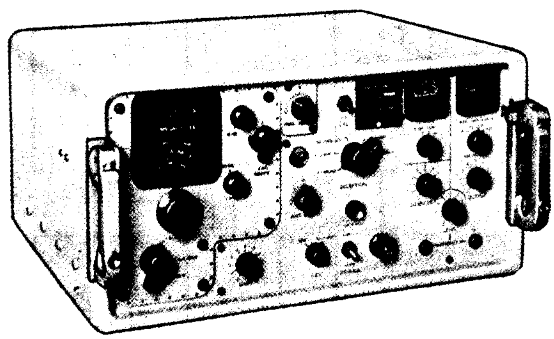
If no tuning is required (path 2), the booster emergency switch, SS, is placed in the ON position. When switch SS is closed, the booster receives either 220- or 440-volt, 60-cycle three-phase power from the ship's supply, energizing the HVPS time delay. After the time delay is over, the push for 500-watt button, E, is depressed, energizing the carrier 500-watt ready indicator. Placing the standby operate switch, PP, in OPERATE energizes the +2400/+3000-volt supply in the HVPS, the +500-volt supply in the MVPS, the carrier 500 watt on indicator (when the +500-volt supply is energized), and it allows the +300-volt supply also to energize. Placing the transmitter in a "key down" condition will now energize the carrier.



(A) AN/SRR-11



(B) AN/SRR-12 AND 13



(C) AN/SRR-13A

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Figure 9-13.—Radio receiving sets AN/SRR-11, 12, 13, and 13A.

RADIO RECEIVING SETS AN/SRR-11, 12, 13

Radio Receiving Sets AN/SRR-11, 12, and 13 (fig. 9-13) are representative communications receivers designed for general application in all types of vessels of the U. S. Navy. The AN/SRR-13A receivers are illustrated in figure 9-13C. They are companion receivers to the previously described transmitting sets, AN/SRT 14, 15, and 16, and cover frequencies between 14 kc and 32 mc. A general description of these sets is given to acquaint the ET 3 with the nature of the circuits and components with which the external operating controls are associated. An explanation of the common operating adjustments on the AN/SRR-11 receiver is then given, and this is concluded with a summary of operating procedures.

GENERAL DESCRIPTION

The AN/SRR-11, 12, and 13 receivers are designed for table-top mountings. Each is self-contained in a metal case with operating controls, switches, meters (tuning and output), phone jack connectors, and main tuning dial assembly mounted on the front panel. The receiver chassis is mounted on rails in the receiver cabinet and can be withdrawn and positioned 45 or 90 degrees (up or down) for ease in servicing.

The frequency range of each receiver is divided into five bands. Continuous tuning is available throughout each band. The frequency range of the AN/SRR-11 receiver is from 14 to 600 kc (low frequency), that of the AN/SRR-12 receiver is from 0.25 to 8 mc (medium frequency), and the range of the AN/SRR-13 receiver is from 2 to 32 mc (high frequency).

The AN/SRR-11 receiver is provided with circuits and switching to receive A1 (c-w telegraphy) signals, A2 (m-c-w telegraphy) signals, and F1 (telegraphy by frequency-shift keying) signals. In addition, the AN/SRR-12 and 13 receivers are capable of receiving A3 (radiophone) emissions.

A functional block diagram of the AN/SRR-11 receiver is illustrated in figure 9-14.

The basic receiver represented by the AN/SRR-11, 12 and 13 sets is a double superheterodyne having two stages of r-f amplification ahead of the first mixer and oscillator.

A first intermediate frequency amplifier (which is essentially the second converter) follows, and its output is fed to the second i-f assembly. Signals of A2 (m-c-w) and A3 (phone) emissions are rectified in a diode detector. The diode detector is bypassed when the receiver is switched to c-w or frequency-shift reception. Such signals are heterodyned in a beat frequency oscillator mixer stage with those from a BFO to produce a difference frequency in the audio range. A manual gain control or delayed automatic gain control circuit (depending upon the setting of the reception control) is provided to reduce the gain of the r-f and second i-f amplifiers when strong signals are received.

Audio frequencies are amplified through a four-stage amplifier, which feeds a balanced audio line and an unbalanced line for phone jack connections.

Circuits from the antenna stage through the first i-f amplifier are designed so that they will have different characteristics in order to provide for optimum reception on the several bands of frequencies covered by the low-, medium-, and high-frequency receivers.

In the AN/SRR-11 receiver the signal is fed from the antenna through the first and second r-f amplifiers, V101 and V126, to a mixer, V151, in which it is combined with the output of a local oscillator, V201. The output of the mixer has a frequency of 60 kc (bands 1 and 4) and passes through a band-pass filter, Z702, to a first i-f stage, V701, where it is converted to a frequency of 200 kc. This action is accomplished in a dual purpose tube, V701, which operates both as a crystal-controlled heterodyning oscillator (140 kc) and as a mixer. The 200-kc output is transformer coupled to the second i-f input assembly. This assembly includes filters Z1001 and Z1002; three stages of i-f amplification (V1001, V1002, and V1003) at 200 kc; a BFO mixer, V1004; diode detector, V1005; and a cathode follower, V1007 used to supply i-f signals to a frequency-shift converter or other accessory equipment.

The 200-kc input to the second i-f assembly is filtered before it is applied to the first amplifier, V1001. The filter selected depends on the position of wafer switches S1001 and S1002, which are actuated by the reception control. When this control is set at FSK, A1 broad, or A1 sharp, signals are fed through the "sharp" filter, Z1001, which provides a pass band of approximately 3.2 kc centered about 200 kc. When the reception control is set at A2 broad, the "medium" filter, Z1002, is used, which provides a pass band of approximately 8 kc centered about 200 kc.

On bands 2, 3, and 5 the first i-f input from the output of the mixer, V151, is 200 kc. On these bands the signal is bypassed around the first i-f filter, Z702, and the first i-f converter (oscillator mixer), V701. Plate and screen voltages are removed from X701, thereby rendering this stage inoperative.

The second i-f, power supply, beat frequency oscillator, and audio amplifier are similar for the AN/SRR-11, 12, and 13 equipments.

A crystal-controlled calibrator circuit is incorporated in each receiver to provide crystal check points. These check points are spread uniformly over the tuning range of the receivers and occur at 10-kc intervals for the AN/SRR-11, at 50-kc intervals for the AN/SRR-12, and at 200-kc intervals for the AN/SRR-13. The frequency check points are used in conjunction with the CAL adjust knob on the receiver front panel to calibrate the tuning dial.

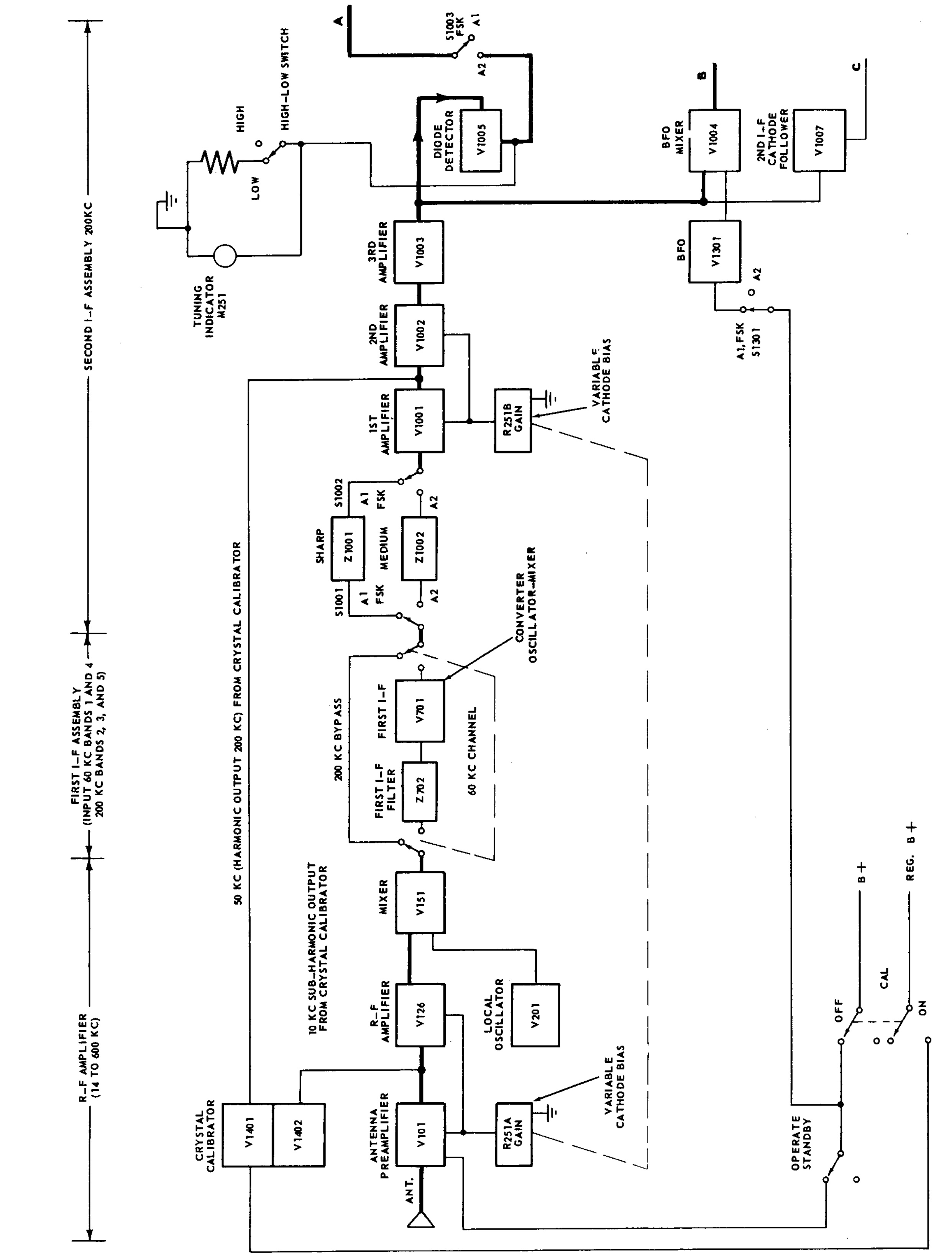

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Figure 9-14.—Block diagram of AN/SRR-11 receiver.

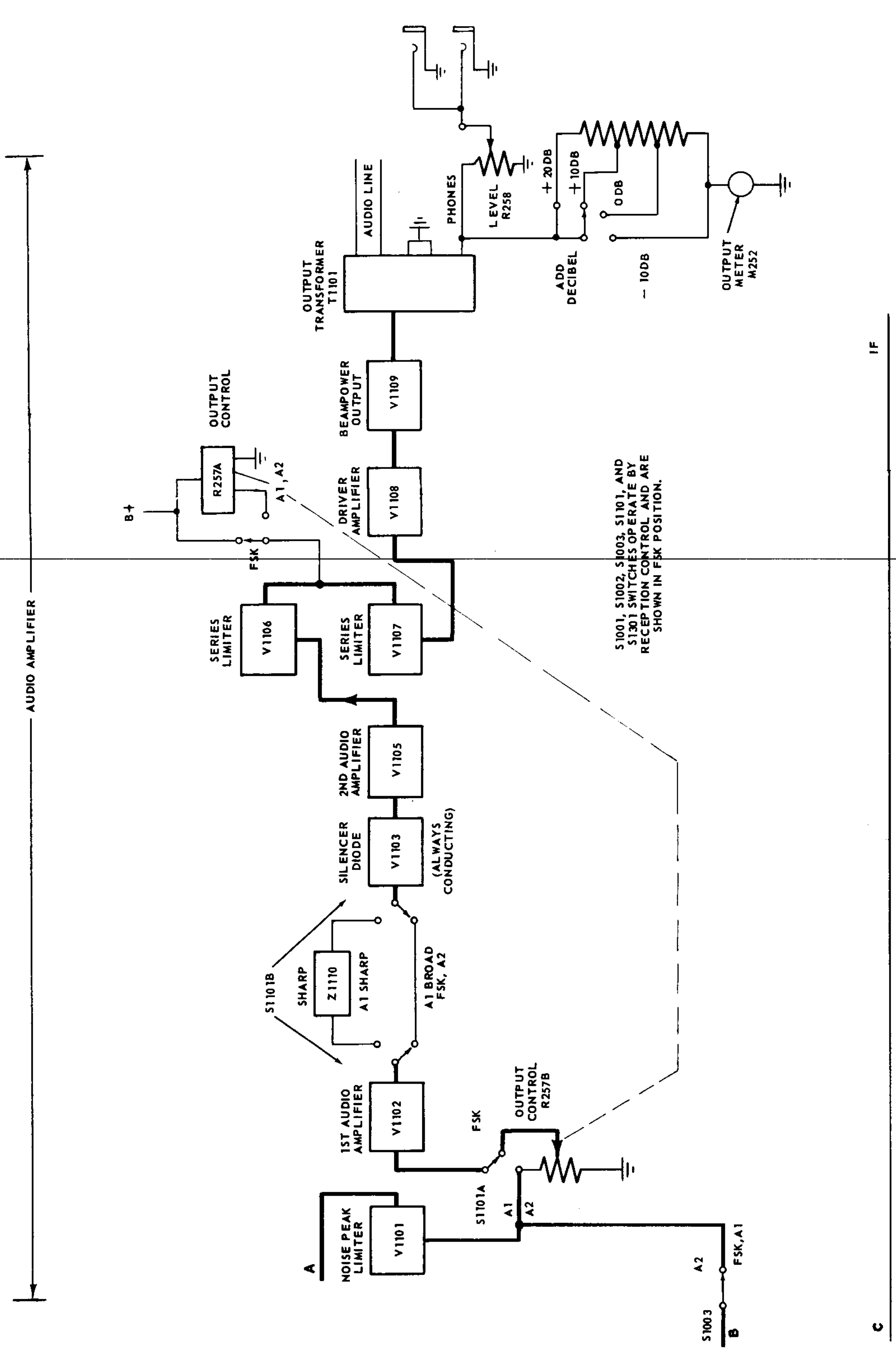

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Figure 9-14.—Block diagram of AN/SRR-11 receiver—Continued.

External connections are furnished from the AN/SRR-12 and 13 receivers to provide an AGC voltage and circuit connection to a common external diode load, so that these receivers may be operated with a companion receiver in a dual diversity reception system.

External connections are also furnished for feeding a frequency-shift converter of either the i-f or audio type. An additional external connection on the AN/SRR-12 and 13 is provided to supply i-f signals to a panoramic adapter.

The frequency to which the receiver is tuned appears projected on a translucent screen (tuning dial) located at the upper left of the front panel. The dial is calibrated in kilocycles on the AN/SRR-11 and in megacycles on the AN/SRR-12 and 13. The projection system consists of a glass disk on which the tuning range of the receiver is calibrated in five scales. A light source is mounted in a housing behind the tuning dial. A portion of one of the optical scales on the glass disk is projected through a system of lenses and onto a mirror that reflects the image of the scale back upon the translucent screen. The glass disk is rotated by gears as the tuning knob is turned. When the setting of the band switch is changed, the dial light and lens housing are moved up or down by a cam driven from the band switch gears to align the lens system with the corresponding frequency scale on the glass disk.

The CAL adjust knob and locking screw located to the right of the tuning dial provide a means of shifting the frequency scale on the translucent screen when recalibrating the receiver in conjunction with the crystal controlled calibrator. This action is accomplished by a slight horizontal movement of the lens system.

COMMON EXTERNAL ADJUSTMENTS

All operating controls and switches necessary for the operation of the three receiver types (AN/SRR-11, 12, and 13) are mounted on the front panel of the receivers together with two meters to be used when tuning and reading the output level. The functional name of each control and meter is marked on the panel near the particular control, as illustrated in figure 9-15. Figure 9-15A illustrates the front panel controls for the AN/SRR-11 receiver, and figure 9-15B illustrates the front panel controls for the AN/SRR-12, and 13 receivers.

Before operating the receivers, make sure that the chassis is firmly placed in the receiver cabinet. If the chassis is not firmly placed in the cabinet, no power will be applied to the receiver.

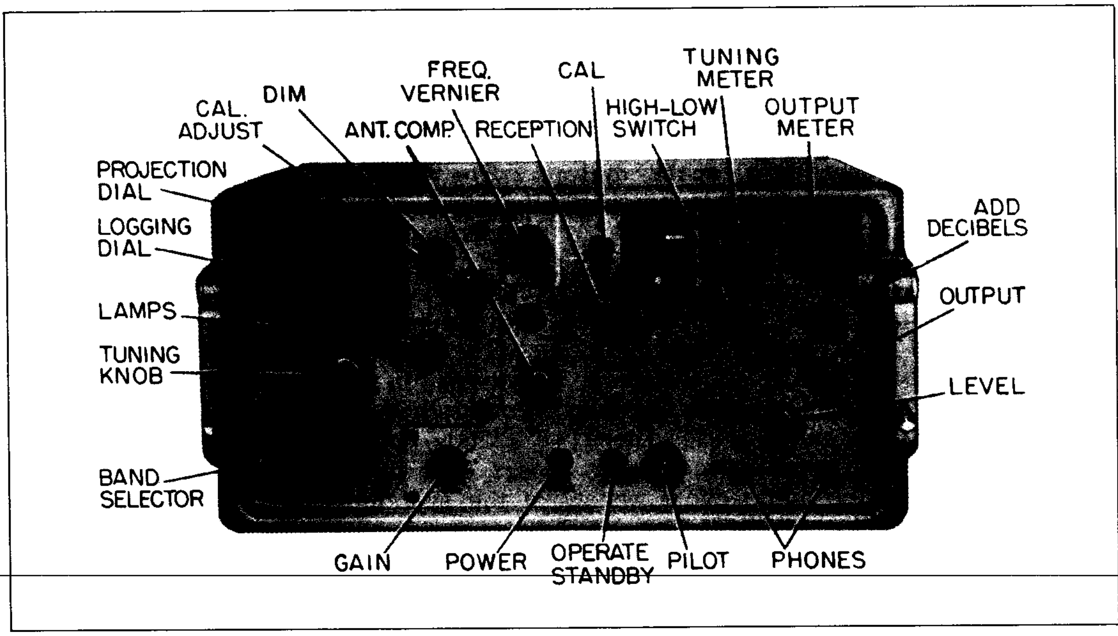
The on-off power switch applies primary power when in the ON position. When the operate standby switch (not included on the AN/SRR13A) is at STANDBY, plate voltage is removed from the antenna preamplifier. The pilot light is energized when high voltage is applied on the set.

The gain control, R251 A, and B (fig. 9-14) operates in the r-f and i-f stages. Maximum gain in these stages occurs when the control knob is turned fully clockwise. In this position the cathode bias, for example that of V101, V126, V1001, and V1002 in the AN/SRR-11 receiver is a minimum, and the mμ of these tubes is a maximum. The gain control is inactive when the reception control on the AN/SRR-12 and 13 is positioned at A3 sharp, A3 broad, or FSK.

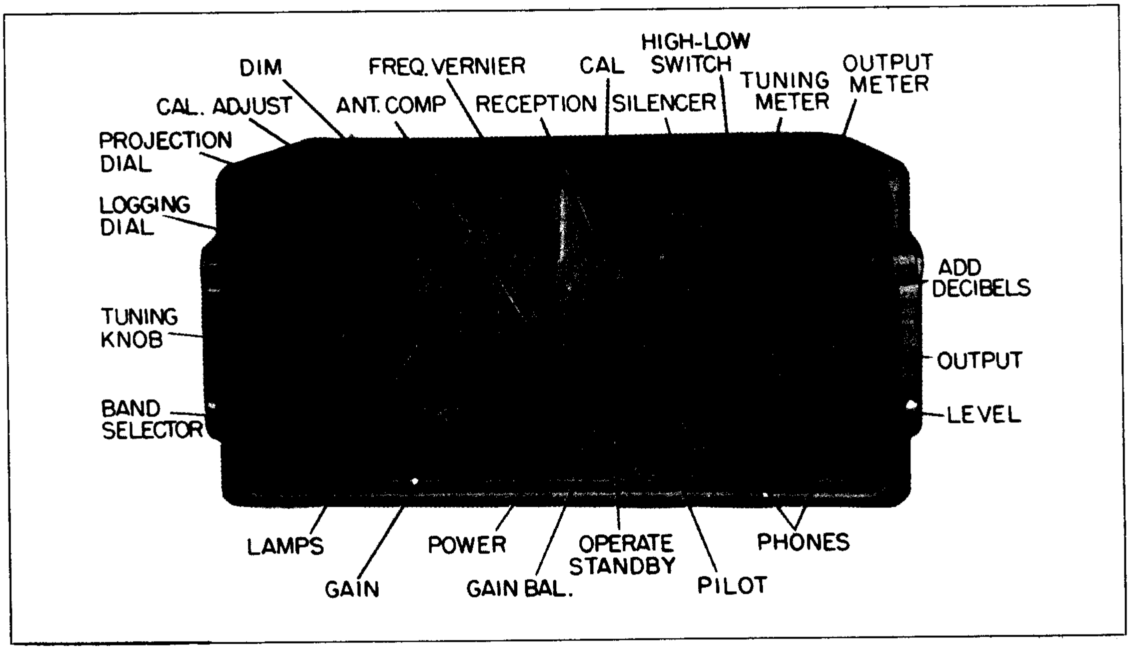
The Ant Comp (antenna compensating) control (not shown in the block diagram) provides a tuning adjustment for the antenna preamplifier to compensate for variations in the antenna impedance. This control actuates an air-dielectric trimmer capacitor (C103 figure 8-12 in Chapter 8) in shunt with the tuned circuit of the first r-f amplifier. A fixed mica capacitor (C102 figure 8-12) is also connected in series with the antenna input lead. This capacitor is shorted by a microswitch (S102 figure 8-12) operated by a cam on the shaft of the antenna compensating control for 180 degrees of rotation of the control, designated low. In this case, the primary circuit capacitance is that of the antenna. The switch is open for the second 180 degree rotation of the control, designated high, and the fixed capacitor is inserted in series with the antenna. In this case, the total capacitance of the antenna and fixed capacitor is reduced to match that of the primary input circuit.

The band selector provides selection of the tuning range of the receiver in any one of the five bands as discussed in chapter 8.

The tuning knob is used to tune the receiver to the desired frequency. The indication of this frequency appears on the translucent screen above the tuning knob, as previously described. A four-section, air-dielectric, ganged tuning capacitor is mechanically linked to the tuning knob. The four sections are connected across appropriate transformer coil groups in the grid circuits of the first and



A AN/SRR 11



B AN/SRR 12-13

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Figure 9-15.—Radio receiving sets AN/SRR-11, 12, 13—front panel controls.

second r-f amplifiers, the mixer, and the local oscillator. The linear scale below the translucent screen is a logging dial used to log stations. It is mechanically linked to the tuning knob control and is used as a convenient method of quickly locating a station.

The dim control knob is turned to vary the intensity of the dial light.

The lamp switch connects a spare dial light in the event of failure of the operating light.

The output control, potentiometer R257B (fig. 9-14) for the AN/SRR-11 receiver adjusts the signal level, for FSK signals, before the signal is applied to the grid of the first audio amplifier, V1102. For A1 and A2 signals, potentiometer R257A varies the voltage applied to limiter diodes V1106 and V1107. These diodes are combined to clip equally on positive and negative portions of the audio cycle when S1101A on the reception is set for A1 or A2.

The reception control on the AN/SRR-11 receiver is a four-position switch used to select the appropriate circuits for the type of signal being received. The FSK position provides circuits for receiving F1 (frequency-shift) signals when a suitable converter is connected to the receiver; a beat note is provided. The A1-broad setting is used for receiving c-w (unmodulated) signals; a beat note is also provided. The A1 sharp setting is used to separate c-w signals by narrowing the frequency response; a beat note is also provided. The A2 position provides for the reception of m-c-w signals; no beat note is provided. In addition to the four signal positions on the AN/SRR-11 reception control, the corresponding switches on the AN/SRR-12 and 13 receivers have two additional settings. These are designated A3 sharp and A3 broad. Both settings provide circuits for the reception of voice-modulated signals.

The silencer (AN/SRR-12 and 13 only) provides for the reduction of background noise when the reception control is set at A3 sharp or A3 broad, and the desired station is not transmitting. The silencer diode is in series with the signal circuit between the first and second audio amplifiers. When a strong carrier is present, this tube conducts and the signal is amplified. In the absence of a carrier the diode plate is negative with respect to the cathode, and the tube is cut off, thereby preventing noise from being further amplified by the succeeding a-f stages.

The frequency vernier varies the pitch of the beat note when the reception control is in the A1 broad, A1 sharp, and the FSK positions.

When CAL switch is in the ON position, frequency check points are provided.

The CAL adjust control is used to reset the projection dial after the desired check point frequency has been zeroed.

The tuning meter reads up scale (toward the right) when the desired signal is tuned to a maximum. The meter reads down scale (toward the left) when the desired station is detuned. The tuning meter is used in conjunction with the high-low switch.

The high-low switch normally is in the LOW position. In this position the tuning meter is protected by a resistor.

When the tuning meter reads on the lower part (left side) of the scale in the LOW position of the switch, use the HIGH position and tune the receiver slightly for an up-scale reading on the meter. The HIGH position of the switch is spring loaded; when released the switch will return to the LOW position.

The output meter reads the output power level between -20 db and +25 db when used in conjunction with the add decibel switch. Zero db is equivalent to 6 mw in a 600-ohm load.

The add decibel switch provides attenuation for the output meter circuit. The +10 decibel position should be used for checking strong output levels. The zero-decibel position is used to measure weak levels, and the -10 decibel position is used for a momentary reading of weak levels. The add decibel switch should be in the +20 decibel position when not using the output meter.

SUMMARY OF OPERATION

When starting the equipment, (1) make sure the receiver chassis is firmly in the cabinet, (2) turn the power switch to ON, (3) adjust the dial illumination by turning the dim control (turn the dim control fully counterclockwise to extinguish the dial light; should the dial light fail, switch the lamp knob to the SPARE position and replace the burned out light), (4) turn add decibel switch to the +20 position, (5) turn the standby switch to OPERATE (note that the pilot light glows except when the knurled ring around the light is turned clockwise), (6) make sure that the CAL switch is in the OFF position, and (7) plug one or two pairs of headsets into the jacks marked phones.

Two pairs of headsets can be operated from the receiver at the same time. Low-impedance phones (600 ohms nominal) similar to Navy type 49507 should be used. The level control regulates the gain through the headphones.

In order to tune a signal:

1. Turn the gain and output controls up (clockwise) until background noise is heard. Turn the silencer control fully counterclockwise. This control is effective only when the reception control is set at A3 sharp or A3 broad. (The silencer control is not included on the AN/SRR-11.)
2. Select the appropriate frequency band using the band selector control.
3. Calibrate the receiver at the nearest frequency check point.

To calibrate the receiver, turn the CAL switch on. Set the tuning dial at the nearest calibration marker (designated by an inverted V on the frequency scale). Rock the tuning knob slightly on both sides of the chosen frequency until a beat note is heard. Zero beat should occur at the calibration marker chosen. If zero beat does not occur at this marker, adjust the tuning knob until zero beat is indicated.

Then loosen the thumb screw holding the CAL adjust knob (turn counterclockwise) and turn CAL adjust knob until the nearest calibration marker is under the hairline on the projection screen. Tighten the thumb screw over the CAL adjust knob. Turn the CAL switch to OFF.

Tune in the desired station by setting the desired station's frequency under the hairline index on the projection screen by means of the tuning knob. Turn the antenna compensating control until the signal is the loudest. This control will have the most effect at the high end of each frequency band. Adjust the signal to maximum, as indicated on the tuning meter.

As the station is tuned in, the tuning meter reads up scale. When below 1/4 scale on the low setting of the high-low switch, hold the switch in the HIGH position and readjust the tuning knob for an up-scale indication of the tuning meter. (Never hold the high-low switch in the HIGH position when the tuning meter is at full scale with the high-low switch in the LOW position as this action would remove the protection afforded by the resistor.) Use of the tuning meter is optional for c-w signals (A1 broad or A1 sharp positions of the reception control).

To use the logging dial, the receiver should be calibrated, as previously described, and tuned to the desired station. The logging dial includes a fixed index and two movable scales immediately below the tuning projection dial. The logging dial is not affected by the CAL adjust knob. When the receiver is tuned to the desired station, record the settings of the two movable scales, using the index mark on the middle segment, as in the following example. The top scale reads between 200 and 300. The bottom scale reads 63. The setting of the logging dial is 263. By resetting this figure (263) on the logging dial for the same band-selector position, the previously received station can be returned quickly. The logging dial should always be set approaching from the same direction (clockwise rotation of the tuning knob).

Other tuning procedures will vary, depending on the position of the reception control and the class of emission of the desired signal.

When the receiver is supplying signals to a frequency-shift converter of the i-f type (similar to Navy Model CR-57/URR), tune the receiver to the desired station by means of the tuning knob and adjust the antenna compensating control for maximum signal, as indicated on the tuning meter.

When the receiver is supplying audio signals to a frequency-shift converter similar to Navy Model CV-60/URR, tune the receiver to the desired station by means of the tuning knob and then adjust the output and frequency vernier controls, as required for the operation of the frequency-shift converter.

RADIO TRANSMITTER-RECEIVER SET AN/GRC-27A

The Radio Transmitter-Receiver Set, AN/GRC-27A (fig. 9-16), is intended for shipboard installation, and is used for u-h-f communications from ship-to-ship, ship-to-shore, or with aircraft. The AN/GRC-27A comprises Radio Transmitter, T-217A/GR; Radio Receiver, R-278B/GR; Modulator-power Supply, MD-129A/GR; Distribution Panel, J-390/GR; and Control Radio Set, C-1897/GRC-27A.

The transmitter and modulator-power suppy together form a transmitting installation. The receiver is used separately for reception of either u-h-f voice modulated or mcw signals.

GENERAL DESCRIPTION

The transmitter normally generates a radio frequency carrier in a range from 225.0 to 399.9

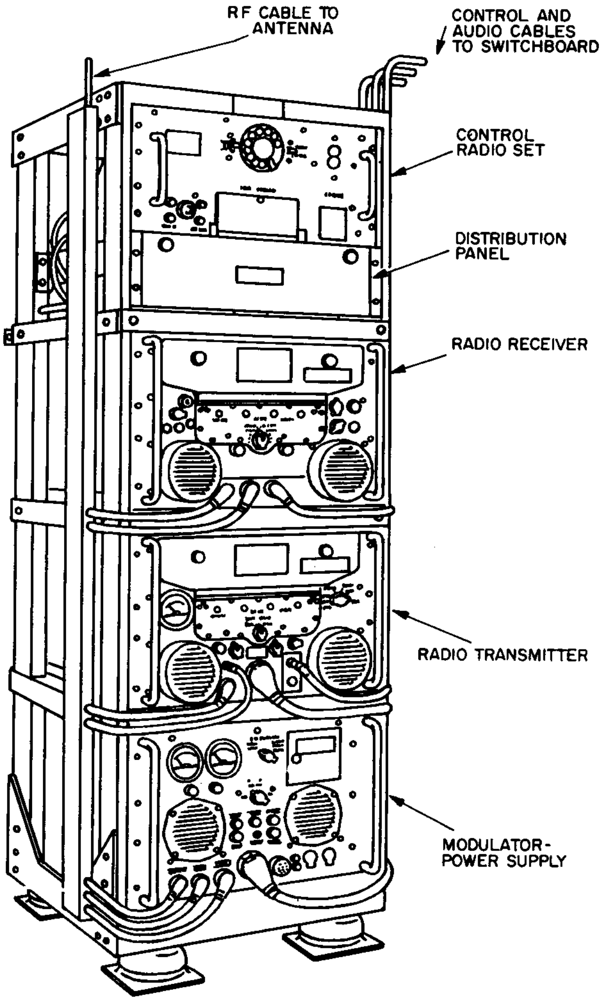

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Figure 9-16.—Radio transmitter-receiver set AN/GRC-27A.

mc with a nominal power output of 100 watts over this range. The transmitter employs 3 crystal-controlled oscillators (frequency generators) which employ a total of 38 crystals. The combination and multiplication (synthesizing) of these 38 crystal frequencies make it possible to produce 1750 frequencies spaced at 100-kc intervals from 225.0 to 399.9 mc. Any 10 of these 1750 frequencies can be manually preset by a series of selector switch dials (calibrated in megacycles) in 100-kc increments. Any one of these 10 frequencies (channels) can be selected automatically, either locally or from a remote station. Automatic selection of a preset channel is accomplished in 2 to 7 seconds by a combined autopositioner drive system and a servosystem.

The modulator-power supply provides the transmitter with all necessary operating and control voltages, and supplies amplitude modulation power (either voice or mcw tone) for the transmitter. The transmitter output includes both upper and lower sidebands generated when the carrier is amplitude modulated.

The receiver normally operates on any one of 1750 frequencies spaced at 100-kc intervals from 225.0 to 399.9 mc. The receiver employs a triple conversion superheterodyne system using crystal-controlled oscillators, and employing a total of 38 crystals in a synthesizer system. Any 10 channels of the 1750 frequencies can be manually preset, and then, any one of the 10 can be automatically selected either locally or from a remote station.

Automatic channel selection in the receiver is accomplished by a frequency selector and autopositioner system similar to that in the transmitter. A motor-driven system of gear trains operates the various crystal switches and tuning mechanisms to permit rapid change of operating frequency. Here again, automatic shifting of channels can be accomplished in 2 to 7 seconds.

The receiver is designed for use with directional or omnidirectional antennas having a characteristic impedance of 52 ohms. Audio output circuits for operation of loudspeakers and for operation into telephone lines are built into the receiver. A special output circuit for direction-finding applications is also provided. The receiver is equipped with automatic volume control, automatic noise limiter, and carrier-operated squelch circuits.

The preset channels for the transmitter or the receiver are selected by operating a channel selector switch on the front panel of the respective units or by telephone-type dials on associated radio set control facilities.

The radio set control C-1897/GRC-27A, adapts the control circuits of the Radio Set AN/GRC-27A to the standard 12-wire shipboard remote system. The control provides for the control of power for Radio Set AN/GRC-27A, starting and stopping the modulator-power supply, automatic channel selection in the transmitter and receiver, local or remote control of the transmitter, and squelch adjustment for the receiver.

RADIO RECEIVER R-278B/GR

The receiver R278B/GR, figure 9-17 consists of four major sections: (1) a multi-channel receiver section, (2) a frequency selector system, (3) an audio amplifier section, and (4) a power supply.

Multi-channel Receiver Section

The multi-channel receiver section normally operates on any one of 1750 frequencies ranging from 225.0 to 399.9 mc as stated previously. The system includes RF, IF, mixer, detector, and noise limiter stages, to be discussed later.

Frequency Selector System

The frequency selector system mechanically tunes the receiver to any one of 1750 available frequencies. Essentially, the system consists of two main parts; the preset panel and the autopositioners (fig. 9-18). The preset panel provides switches for presetting 10 automatically tunable channels, and for setting up one manual channel. The autopositioner is an electromechanical device actuated by operating a channel selector switch located on the front panel of the receiver, or by remote control facilities. The autopositioner tunes the receiver to a desired channel selected from the 10 preset channels. The manual channel can be selected only from a panel-mounted channel selector switch, not shown.

PRESET PANEL.—The preset panel (fig. 9-18) employs 33 rotary switches. For purposes of setting up channels, these switches are arranged in 11 horizontal banks of 3 switches each. The "tens" mc frequencies are set up on the first bank, the "units" are set up on the second bank, and the "tenths" on the third bank.

For example, if a frequency of 245.6 mc is to be selected, the "tens" mc switch should be set to 24, the "units" switch to 5, and the "tenths" switch to 0.6. By combining the setting of the 3 switches (horizontal rows), the frequency of each of the 11 channels can be read directly on the front panel of the receiver.

The manual channel is set up the same as the other 10 channels, except that it is not possible to select the manual channel from a remote position. This channel is reserved for the local operator.

AUTOPOSITIONERS.—Associated with each autopositioner is an electrical control system consisting of a control switch and a corresponding symmetrical "seeking" switch which is driven by the autopositioner shaft (fig. 9-19). This control system is designed so that when the control switch and seeking switch are not set to the same electrical position, the autopositioner is energized and operates to drive its shaft (and the driven elements to which it is coupled) to the proper position to restore the symmetry of the control system.

When the control and seeking switches are in corresponding positions, the ground is removed from the motor control relay, the pawl is engaged in a notch on the stop wheel, and the motor is not energized. In this position, the autopositioner is at rest.

If the operator changes the position of the remote control switch, the symmetry between the remote control and seeking switches will be upset. In this condition, a ground connection is established through the seeking switch to the motor control relay, causing this relay to become energized. The current through the solenoid of the motor control relay exerts a magnetic attraction on the pawl which lifts the pawl out of the notch on the stop wheel. The grounded motor control relay contact arm is mechanically operated by the pawl, so that as the pawl is removed from the notch a ground is simultaneously applied to the solenoid of the motor start relay. The operation of the motor start relay closes another set of contacts which apply power to the motor.

As the motor turns, it drives the autopositioner shaft and the rotor of the seeking

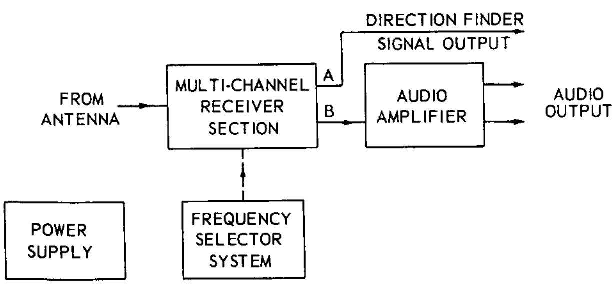

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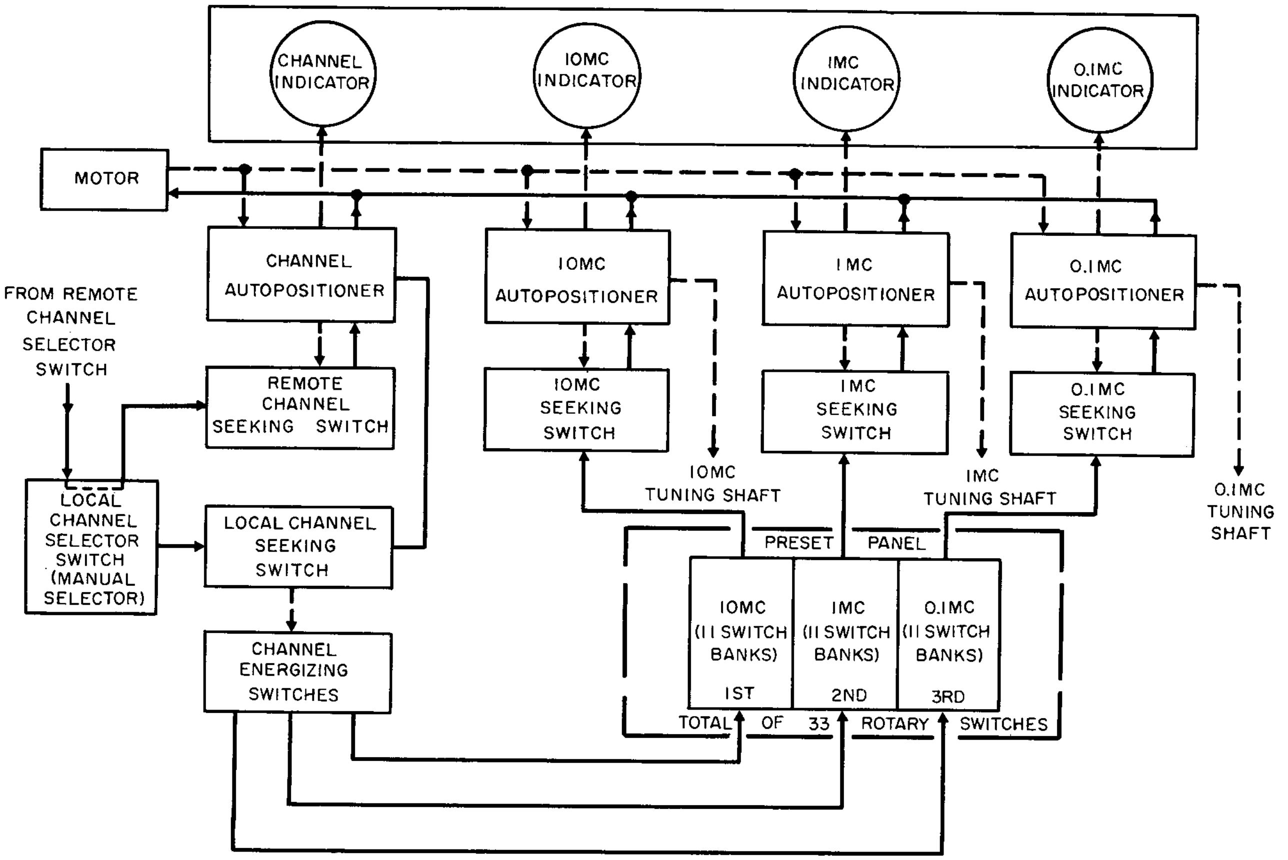
Figure 9-17.—Radio receiver R-278B/GR-major sections.



32.112

Figure 9-18.—Frequency selector system, block diagram.

switch. When the seeking switch reaches the point corresponding to the new position of the remote switch, the ground is again removed from the motor control relay. The pawl drops back into a notch on the stop wheel to stop the shaft rotation. Simultaneously, the ground is removed from the motor start relay. The contacts which were applying the 115-volt a-c power to the motor are now released, and the motor stops.

Audio Amplifier Section

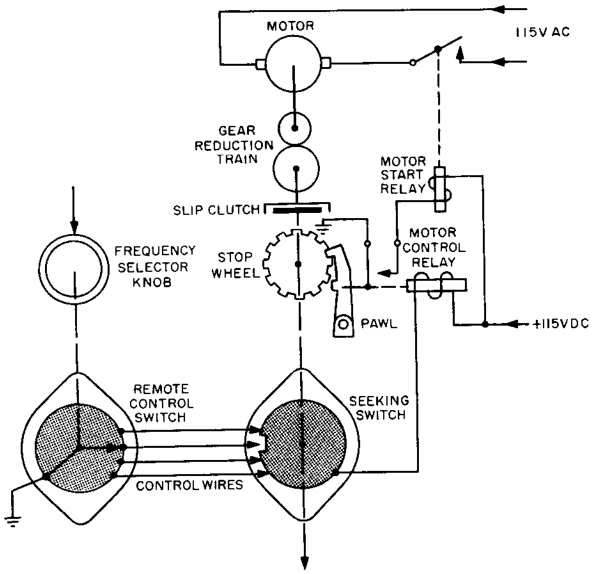
The audio amplifier section increases the amplitude of the audio before it is applied to the loudspeaker or telephone line output circuits. Two output circuits are provided; the main audio output, and the low level audio output.

Power Supply

The power supply consists of filament, bias, relay, and plate supply transformers, power supply rectifiers, and a filter system. Three gas rectifiers in conjunction with the transformers and filter provide the voltages necessary for operation of the receiver.

Operation

The frequency selector unit (fig. 9-20) has three output shafts which, by mechanical drive, select the proper crystals and tune various circuits to establish a particular operating frequency. These output shafts are called the 10-mc, the 1-mc, and the 0.1-mc shafts, respectively. The 10-mc shaft rotates in 18 incremental steps, each increment representing



32.113

Figure 9-19.—Autopositioner, basic elements.

10 mc. The 1-mc shaft rotates in 10 incremental steps, each step representing 1 mc. The 0.1-mc shaft rotates in 10 incremental steps, each step representing 0.1 mc.

The r-f amplifiers, V101 and V102, may be tuned in 18 incremental steps by the 10-mc shaft and in 10 incremental steps by the 1-mc shaft. For each position of the 10-mc switching shaft, the 1-mc shaft can be rotated through 10 positions, thereby tuning the r-f amplifiers to 10 different frequencies for each position of the 10-mc shaft. In this manner, the r-f amplifiers can be tuned to 180 frequencies in steps of 1 mc.

The antenna input signal is amplified in the first and second r-f amplifiers, V101 and V102, and fed to the first mixer, V401. The r-f signal input to the first mixer is heterodyned with the input signal from the first injection system to produce the first intermediate frequency between 40.0 and 49.9 mc.

The first injection system (comprising the main oscillator and frequency multiplier-amplifier stages) is tuned in eighteen 10-mc steps by the 10-mc output shaft. This shaft also operates the main oscillator crystal selector switch to select one of 18 crystal units (not shown). The first injection system output is fed from amplifier V305 to the first mixer stage, V401. The signal from the first mixer (between 40.0 and 49.9 mc) is amplified in the first i-f amplifier, V402.

The first i-f amplifier, V402, employs two permeability tuned transformers, one at the input to the stage and the other at the output. The powdered iron cores of these transformers are driven by the 1-mc and 0.1-mc shaft. The rotation of these shafts is combined in a differential tuning mechanism to produce one hundred 0.1-mc steps. The first i-f amplifier output is applied to the second mixer, V403.

The crystal selector switch and tuned circuits of the second injection oscillator, V404, are controlled by the 1-mc shaft. The 31- to 40-mc signal from the second injection oscillator, V404, is heterodyned in the second mixer, V403, with the 40.0- to 49.9-mc injection signal from V402. The difference frequency (9.0 to 9.9 mc) is fed to the second amplifier, V501.

The second i-f amplifier, V501, is tuned in ten 0.1-mc steps by the 0.1-mc shaft. The 9.0- to 9.9-mc output from the second i-f amplifier is fed to the third mixer, V502A.

The third injection oscillator, V502B, is also tuned in 0.1-mc steps by the 0.1-mc shaft. The heterodyning frequency from the third injection oscillator, V502B, is between 6.95 and 7.85 mc. The final heterodyning process in the third mixer produces a 2.05-mc intermediate frequency. The third mixer output is amplified in three stages of i-f amplification, comprising V601, V602, and V603.

Two detector stages are employed in the receiver. The audio detector, V604A, is used to rectify and filter the audio component of the received signal. The AVC detector, V604B, is used to produce a d-c (AVC) control voltage for various amplifying tubes. The audio signal from V604A is routed through the noise limiter stages, V605A, V605B, and V608B. These stages reduce any spurious noise appearing in the received signal.

The AVC detector, V604B, and the AVC gate, V607A, produce the AVC control signal which is applied to the r-f and i-f stages of the receiver to maintain the audio output level nearly constant for wide variations in the amplitude of the r-f input signal.

The squelch circuit, V608A and V609, produces a d-c voltage to operate the carrier operated relay, K801. The relay functions to increase the audio signal amplitude to the filter

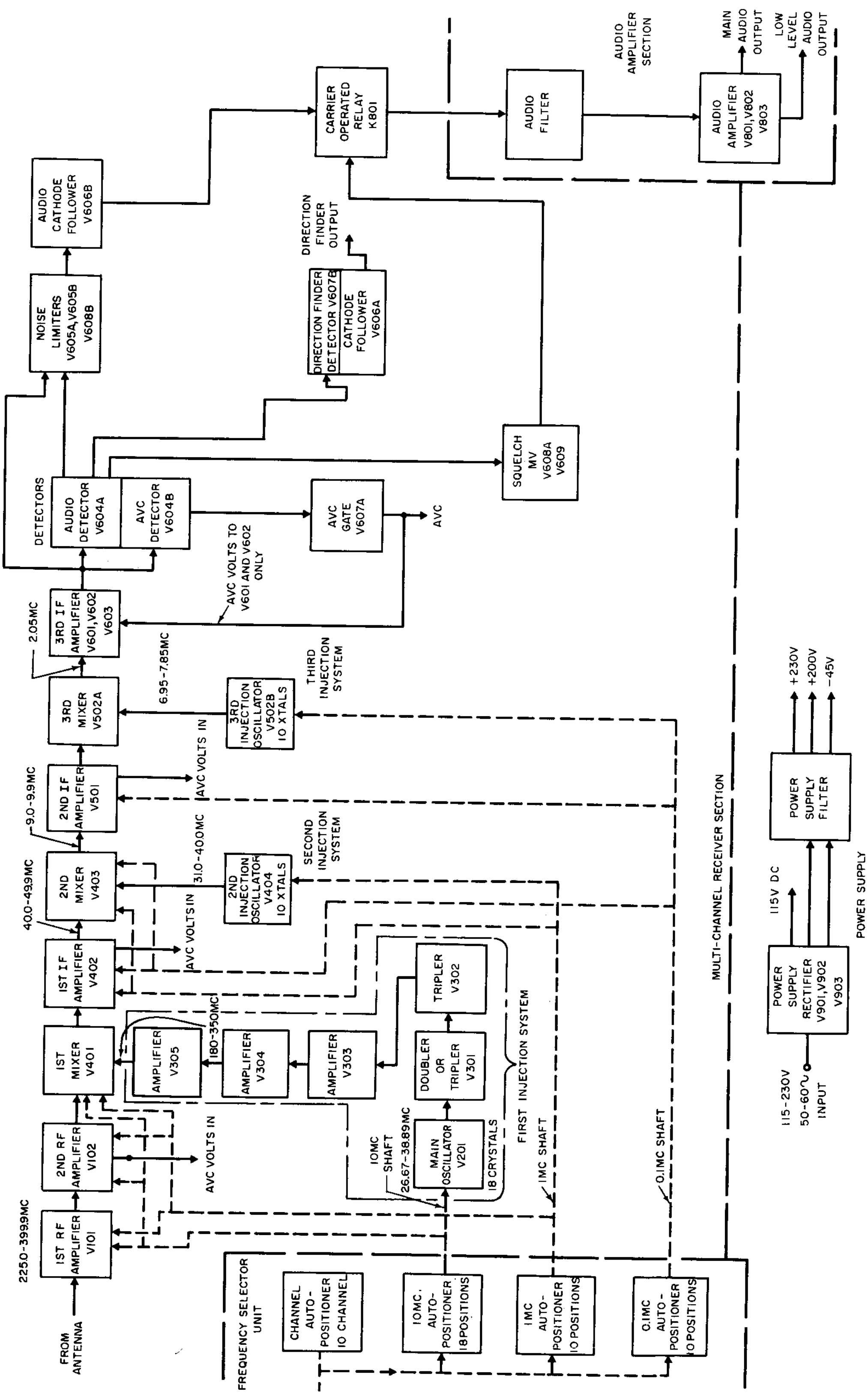


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Figure 9-20.—Block diagram of radio receiver R-278B/GR.

(attenuator quieting control) in the audio path whenever a signal is received.

The direction-finder stages of the receiver, V607B and V606A, make possible the use of the receiver with a direction-finder system such as the Radio Direction Finder AN/CRD-6. This feature of the receiver is not required in the normal communications applications of the Radio Set AN/GRC-27A, aboard ship.

When the carried operated relay is energized, the audio signal from the audio filter is amplified in three stages, V801 and V802, and V803. Twin triode, V801, comprises two cascade connected single-ended audio amplifiers, and V802 and V803 are connected in a push-pull amplifier arrangement.

Two output circuits are provided, which are referred to as the main audio and the low-level audio outputs, respectively. The main audio output at the phone jack delivers approximately 3 watts into a 600-ohm balanced load. The low-level audio output is approximately 10 milliwatts, for operation of external equipment.

RADIO TRANSMITTER T-217A/GR

Radio Transmitter T-217A/GR, and its associated Modulator-Power Supply MD-129A/GR, constitute the radio transmitting installation of Radio Set AN/GRC-27A. The transmitter normally delivers a nominal output power of 100 watts, either tone or voice modulated, in the frequency range of 225.0 to 399.9 mc. Like the receiver, the transmitter has a maximum frequency range of 20 to 399.9 mc.

A block diagram of the major sections of the transmitter is shown in figure 9-21. It can be seen that the transmitter is essentially a frequency generating system, an exciter and driver, and a power amplifier. The modulator-power supply provides the transmitter with power, and voice or tone which modulates the output stage of the transmitter.

The transmitter employs a frequency selector system that automatically tunes the multichannel transmitter to any one of 1750 crystal-controlled frequencies in the range from 225.0 to 399.9 mc. This system is identical to the system used in the radio receiver.

Modulator-Power Supply

The modulator-power supply has two main functions. It provides all necessary power to Transmitter T-217A/GR, and the modulator audio output modulates the transmitter r-f carrier.

The power supplies of the modulator-power supply (fig. 9-22) are conventional a-c rectifier circuits supplied by three transformers. The filament transformer, T1405, is energized as soon as the main switch is closed. The low voltage transformer, T1407, is energized through time delay relay, K1403, and case interlock switch, S1410. The high voltage transformer, T1406, is energized through the bush to talk relay, K1404, and bias interlock relay, K1405.

Operation

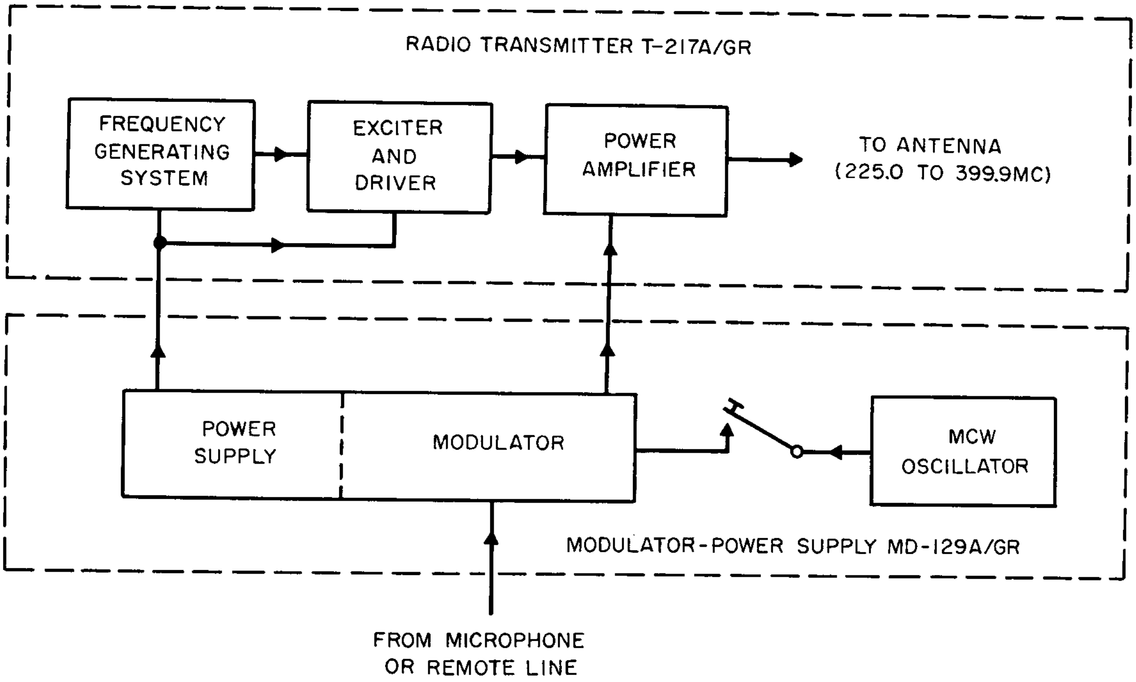
The main oscillator, V201 (fig. 9-23), generates the basic frequency for the transmitter. The oscillator employs 18 crystals which are selected by the 10-mc autopositioner to tune the oscillator from 31.111 to 45 mc. This cirucit is also referred to as the 10-mc frequency generator since the output frequency of V201 is changed one time for each 10-mc change in the transmitter output frequency.

The 31.111- to 45.0-mc output of the main oscillator is doubled or tripled in frequency multiplier, V301. Pentode, V301, operates as a doubler circuit when the output frequency of the transmitter is 299.9 mc or below. For frequencies above 299.9 mc, V301 operates as a tripler circuit. The chosen output of V301 is tripled in a second frequency multipler, V303. Amplifiers V302, V304, and V305 are also a part of the frequency multiplier-amplifier.

The frequency multipler-amplifier produces one of 18 frequencies spaced at 10-mc intervals. The frequencies are 200 to 370 mc and are delivered to the mixer, V406. The heterodyning frequency for the mixing section in V406 is obtained in the following manner:

The 1-mc frequency generator, V404, contains 10 crystals which are selected by the 1-mc autopositioner. This stage generates any one of 10 frequencies at 1-mc intervals in the 18- to 27-mc frequency range. The frequency generated is determined by the crystal selected and also by the tuning of the V404 output circuit by the 1-mc autopositioner.

A second frequency generator referred to as the 0.1-mc frequency generator, V402, contains 10 crystals which are selected at 0.1-mc intervals. The frequency range is from 2.0 to 2.9 mc, as determined by the selected crystal.



32.123

Figure 9-21.—Radio transmitter T-217A/GR-major sections.

The output frequencies of the two frequency generators (V404 and V402) are heterodyned in mixer, V401, to produce the sum frequency (20.0 to 29.9 mc). This sum frequency output is amplified in V403 and V405, and fed to mixer, V406.

The incoming frequency from the frequency multiplier-amplifier (200 to 370 mc) and the output from V405 (20.0 to 29.9 mc) are heterodyned in V406 to yield the sum frequency (220.0 to 399.9 mc). Because of the tuning differential between the 1-mc and 0.1-mc frequency generators, the output from the mixer, V401, can be any of 100 frequencies.

The signal from the mixer, V406, is amplified in the exciter, which comprises V101 and V102. The exciter output signal from V102 is amplified in three stages, V501, V502, and V503. The exciter and driver stages are tuned by the 10-mc and 1-mc autopositioners in 1-mc steps from 220.0 to 399.9. The amplifier stages in the exciter and driver are tuned to the center frequency of each 1-mc band. The bandpass of these stages is broad enough to amplify the 0.1-mc variations.

V601 and V602 amplify the driver (V503) output signal to produce a nominal output power of 150 watts. A servosystem, employing servomotor, B601, is used to tune the power amplifier throughout the frequency range of the transmitter. The servoamplifier circuit receives its error signal input from a servo bridge.

A basic representation of the tuning bridge includes potentiometers R and R'. Both resistors are connected across the 115-volt a-c line input. Actually, this load across the bridge consists of the input circuit to the grid of the first amplifier, V701 (not shown). Since the input circuit to V701 is grounded, the load across the bridge is connected between the arms of R and R'. Note that the arm of R is positioned by the 10-mc and 1-mc autopositioner shafts, and that the arm of R' is positioned by a mechanical connection to the servomotor.

If the power amplifier is on frequency, the potential at the arm of R will be the same as on the arm of R' and the voltage difference across the load (V701 input) will be zero. The bridge is therefore balanced, the motor

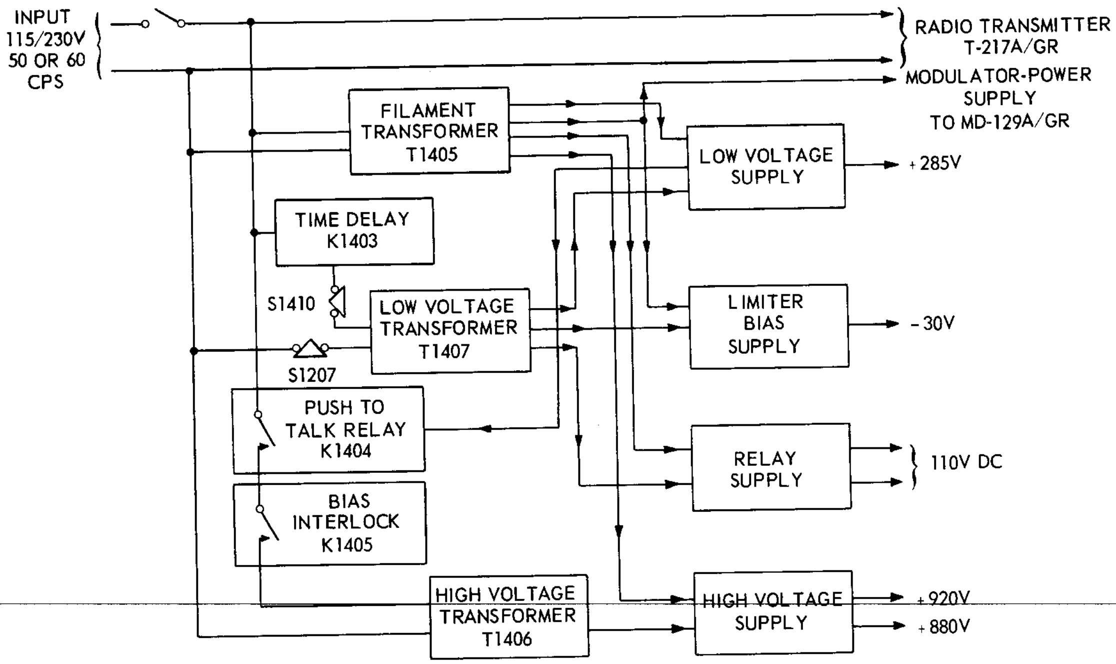


Figure 9-22.—Modulator-power supply MD-129A/GR power supply block diagram.

is not turning, and the error signal is zero. However, if the balance of the bridge is upset, as will be the case when a new channel is selected, the 10-mc and 1-mc autopositioners move the arm of R in an attempt to select the new frequency. Thus, the bridge becomes unbalanced when the potential at the arm of R differs from that at R'. This potential difference represents the error signal which is applied to the input of V701.

The output of V701 is amplified in V702, V703, and V704. The amplified output drives the servomotor, B601, which mechanically tunes the power amplifier. Simultaneously, the servomotor drives the arm of R' until its position corresponds with the new position of R.

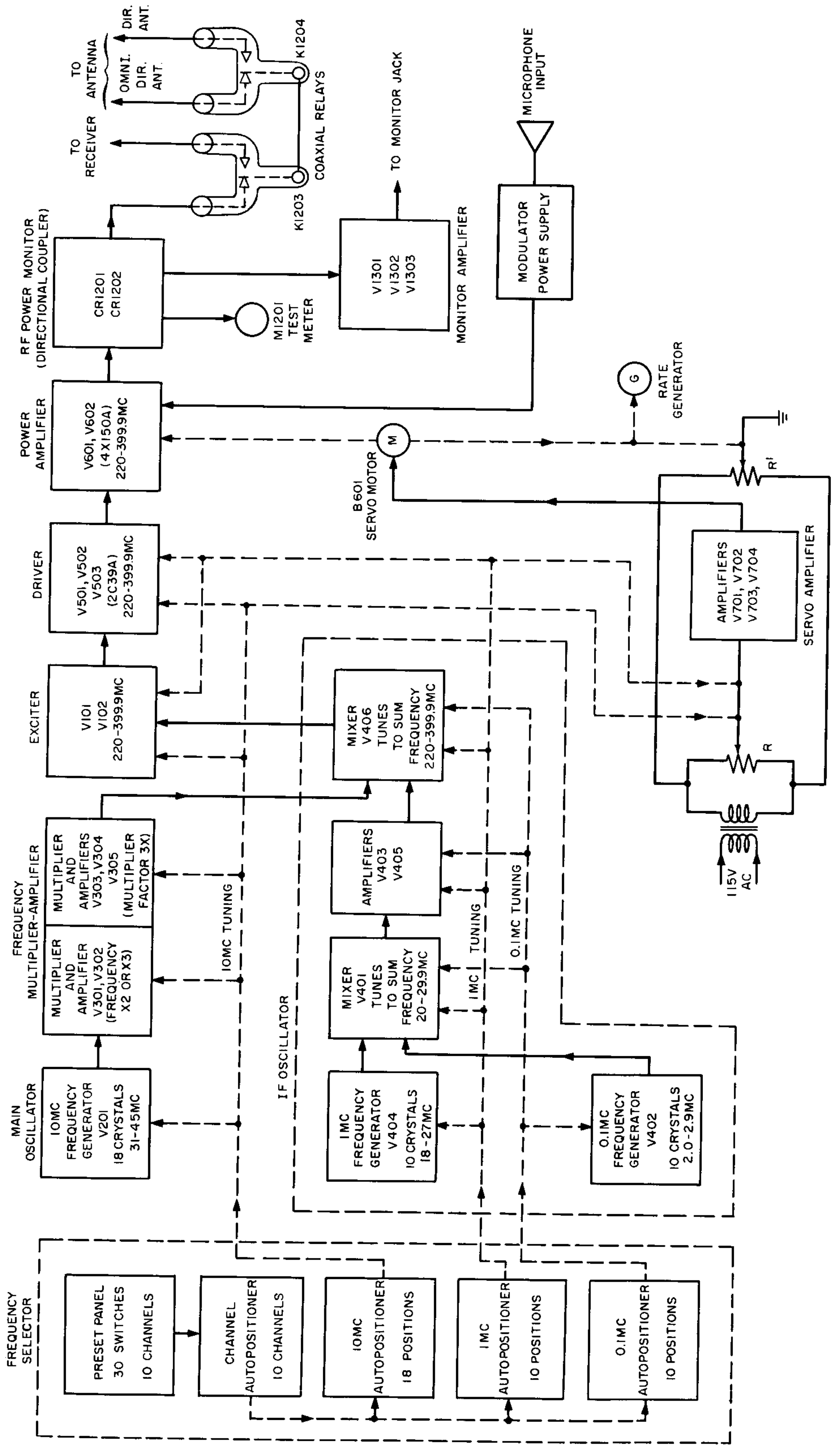
The direction of the error signal is determined by the direction of movement of R from its zero error position. The direction of rotation of the servomotor also is determined by the direction of the error signal.

The output of the power amplifier is fed through coaxial filters (not shown in the block diagram) which employ five tuned stubs to discriminate against frequencies above 450 mc. The output of this filter is connected to the r-f power monitor.

Two directional couplers are used in the r-f power monitor to provide two sampling voltages. The output from one directional coupler is used to indicate power output, to supply an input to the monitor amplifier, and to calibrate a standing wave ratio indicator. The output from the other directional coupler provides standing wave ratio indication in conjunction with test meter, M1201, by measuring reflected power.

The signal from the r-f power monitor is passed to the antenna transfer relay, K1203. This relay works in conjunction with the push-to-talk circuit, transferring the antenna from the receiver to the transmitter when the push-to-talk circuit is energized. The circuitry is arranged so that the antenna is transferred before the high voltage is applied to the transmitter.

A directional or omnidirectional antenna may be selected by the antenna selector switch (S1209) and used with the transmitter. The transmitter output is fed



32.124

Figure 9-23.—Radio transmitter T-217A/GR, functional block diagram.

from K1203 through K1204 to the selected antenna.

OPERATING PROCEDURE

All controls required for normal operation of Radio Transmitter-Receiver Set AN/GRC-27A are mounted on the front panels (fig. 9-24). A brief summary of the procedure in setting up the set for operation follows:

1. Turn the EMERGENCY switch on the radio set control panel (fig. 9-24A) and the POWER switch on the modulator-power supply (fig. 9-24B) to ON.

2. Press the START switch on the radio set control panel. The POWER ON indicator on the modulator-power supply panel, and the FIL (filament) indicator on the transmitter panel (fig. 9-24C) should now be lighted. After about 30 seconds the STANDBY indicator on the modulator-power supply panel should light indicating that the transmitter is in standby condition.

3. Turn the POWER switch on the receiver panel (fig. 9-24D) to on. The POWER INDICATOR should light indicating the receiver is in standby condition.

4. Set each of the 11 channels to the desired frequency with the knurled disc switches provided on the transmitter preset panel (inside door fig. 9-24C). Any one of the channels may now be selected by the transmitter CHANNEL SELECTOR switch, or channel selection for channels 1 through 10 may be transferred to a remote position by turning the CHANNEL SELECTOR switch to the remote position.

5. Set the receiver channels to the desired frequencies as described for the transmitter.

6. Turn the transmitter TEST METER SELECTOR switch to the power output-watts position, and the ANTENNA SELECTOR switch to OMI. ANT

7. On the modulator-power supply panel, turn the METER SELECTOR switch to % mod., the NORMAL-EMERG. switch to EMERG. the MCW-CARRIER ON-VOICE switch to voice, and the AUDIO BANDWIDTH switch to normal. For normal operation the LIMITER CONTROL is set between positions 2 and 3. Adjust the AUDIO GAIN CONTROL until the test meter indicates 50 to 60 percent on normal voice inputs.

8. On the receiver panel, turn the RF GAIN switch to local, the FREQ. RESPONSE switch to narrow, the SQUELCH switch to ON, and the AVC TIME CONSTANT switch to COMM. Adjust the QUIETING and RF GAIN controls.

To Transmit

The desired preset channel may be selected by setting the CHANNEL SELECTOR switch on the transmitter panel to the desired channel, or by placing the CHANNEL SELECTOR switch in the remote position and dialing the channel number on the radio set control (fig. 9-24A). In addition, with the LOCAL-REMOTE switch on the radio set control in the remote position the channel may be selected by any one of the connected remote control units.

For voice operation, plug a microphone into the MICROPHONE JACK on the modulator-power supply panel; press the push-to-talk button to transmit; release the button to receive.

For MCW operation, plug a key into the KEY JACK on the modulator-power supply panel; set the MCW-CARRIER ON-VOICE switch to MCW to transmit; set the switch to voice when receiving.

To Receive

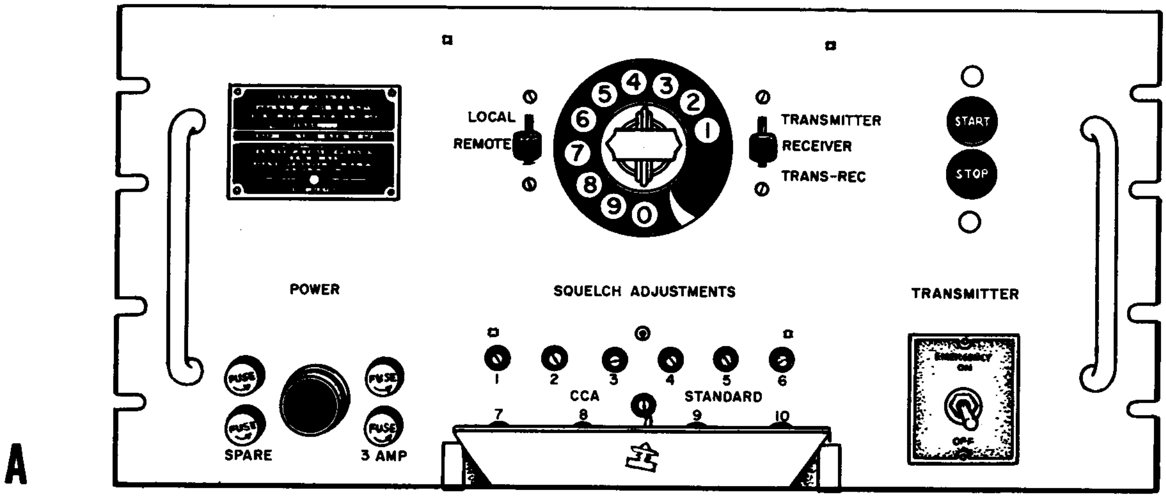
The desired channel may be selected as described for the transmitter. Plug a headset or speaker into the PHONES JACK (fig. 9-24D) and adjust the AF GAIN CONTROL. The CARRIER INDICATOR lights when a signal is present on the selected channel.

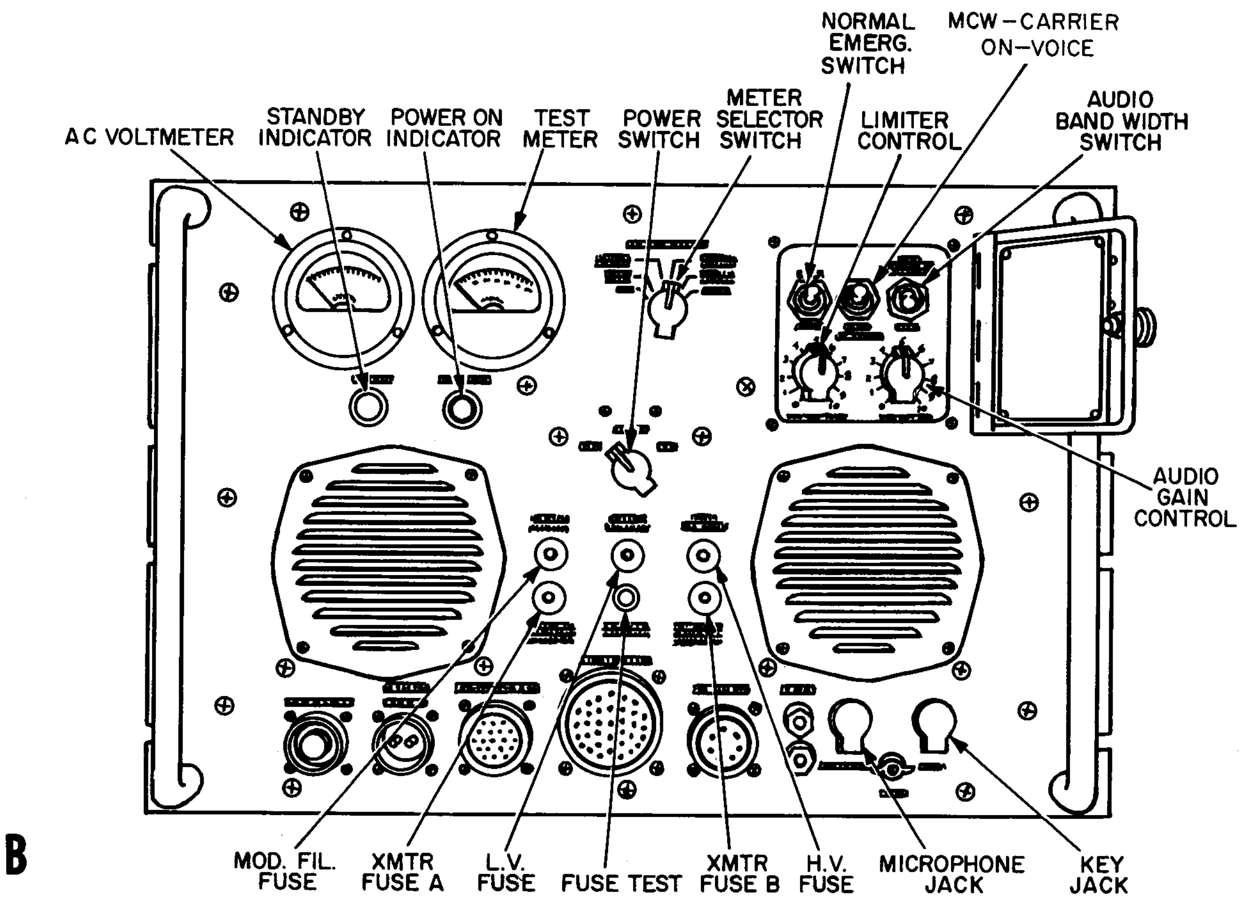
Stopping the Equipment

Turning the EMERG. switch on the radio set control (fig. 9-24A) to OFF removes all power from the set. To control the individual units, turn the POWER switches on the modulator-power supply and receiver panels to OFF. Pressing the STOP switch on the radio set control will remove power from the modulator-power supply and the transmitter.

RADIO SET AN/URC-32

Radio Set AN/URC-32 (fig. 9-25) is a manually operated radio communications transceiver for operation in the 2 to 30 mc (high-frequency) range with a transmit peak-envelope-power (pep) output of 500 watts. This transmitter is designed for single-sideband transmission, and





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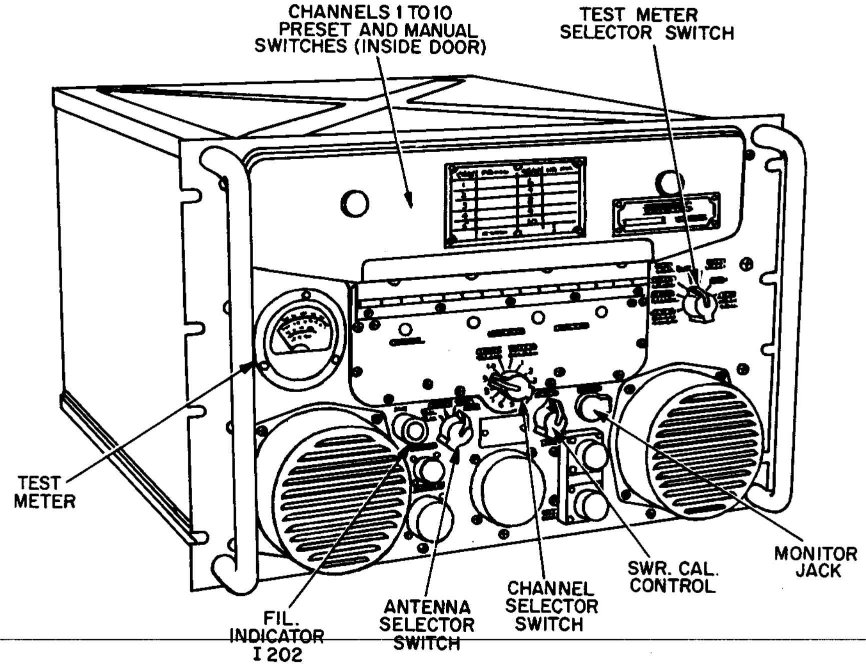
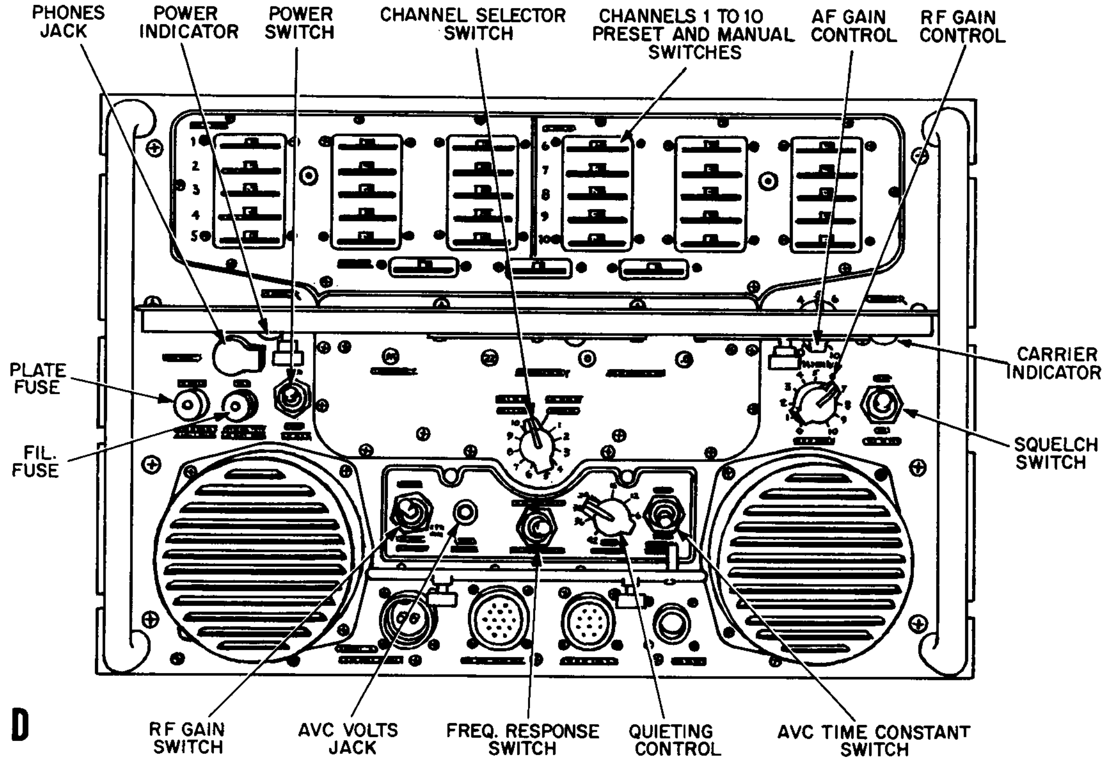
A. Radio set control C-1897/GRC-27A B. Modulator-power supply MD-129A/GR
Figure 9-24.—Radio transmitter-receiver set AN/GRC-27A, front panel controls.





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C. Radio transmitter T-217A/GR D. Radio receiver R-278B/GR

Figure 9-24.—Radio transmitter-receiver set AN/GRC-27A, front panel controls—Continued.

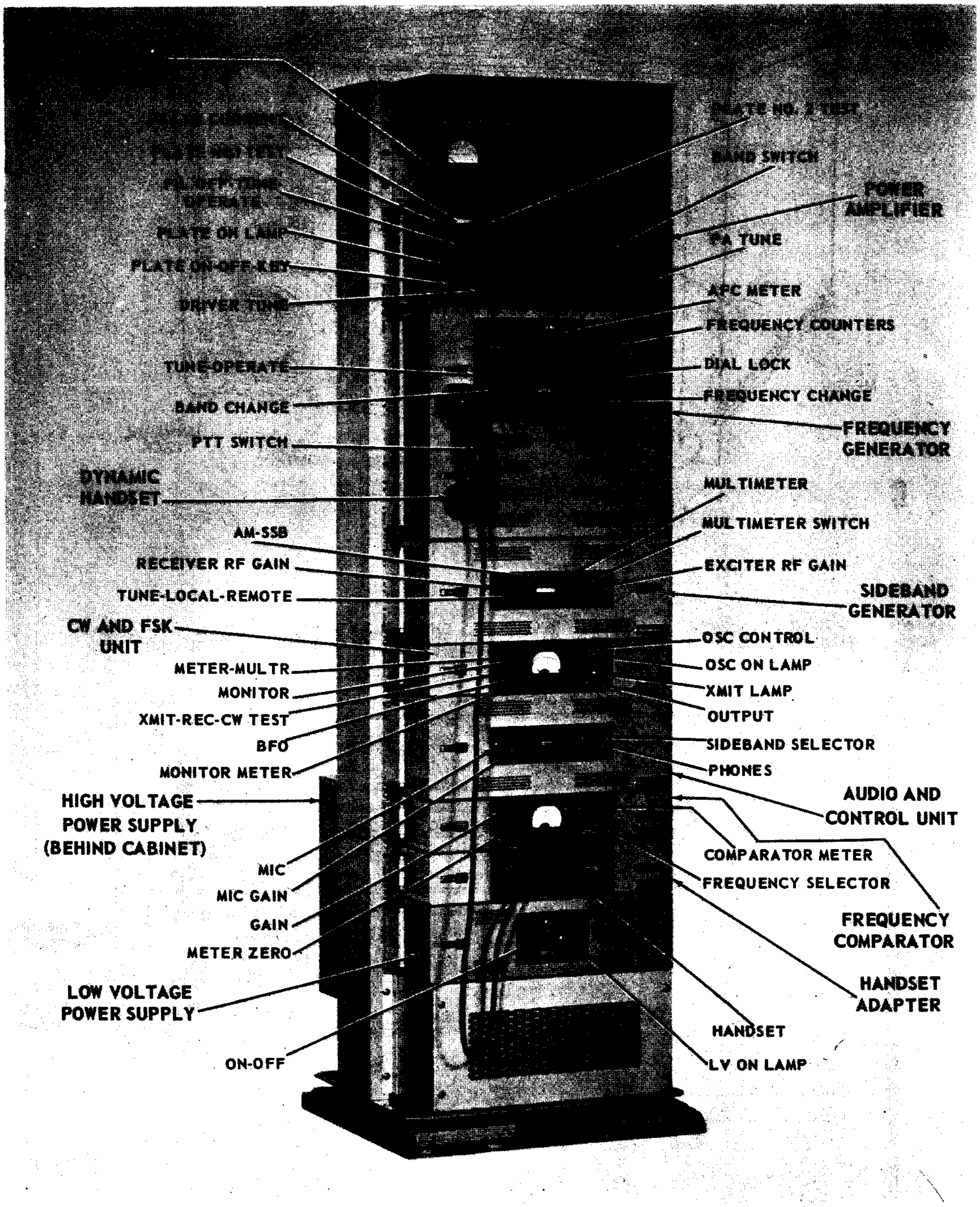

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Figure 9-25.—Radio Set, AN/URC-32, relationship of units and operating controls.

for reception on upper sideband, lower sideband, or two independent sidebands with separate audio and i-f channels for each sideband. In addition to single-sideband operation, provisions are included for a compatible a-m (carrier plus upper sideband), c-w or fsk operation.

GENERAL DESCRIPTION

The frequency range of 2 to 30 mc is covered in four bands. The desired operating frequency is selected in 1 kc increments on a direct-reading frequency counter. Frequency accuracy and stability are controlled by a self-contained frequency standard. Provisions are made for using an external frequency standard such as an AN/URQ-9.

During transmission (fig. 9-26) voice input signals from the dynamic handset are fed to the handset adapter. Input signals (c-w or remote audio) from a remote control unit (when used) are also applied to the handset adapter input terminals. A local-remote switch permits the operator to select either the local audio input from the handset adapter or the remote audio input. Teletypewriter signals are applied directly to the c-w and fsk unit which provides separate audio tones for the mark and space conditions. These frequencies are later converted to the required frequency-shift signals for fsk transmission.

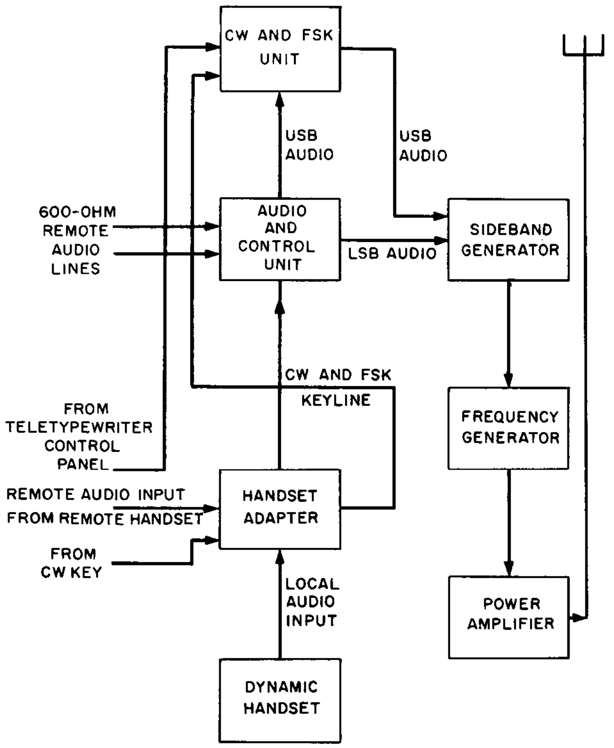

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Figure 9-26.—Radio Set AN/URC-32, transmit function block diagram.

The output from the handset adapter is amplified in the audio and control unit. Two separate audio input paths to the audio and control unit are provided through the 600-ohm remote audio lines.

The audio and control unit amplifies the audio signals and feeds it to the sideband generator. During single-sideband voice operation (using the upper sideband) the audio and control unit output is fed through a selector switch in the c-w and fsk unit. Lower sideband transmit signals are fed directly to the sideband generator. During c-w or fsk operation, the c-w and fsk unit supplies audio tones to the sideband generator.

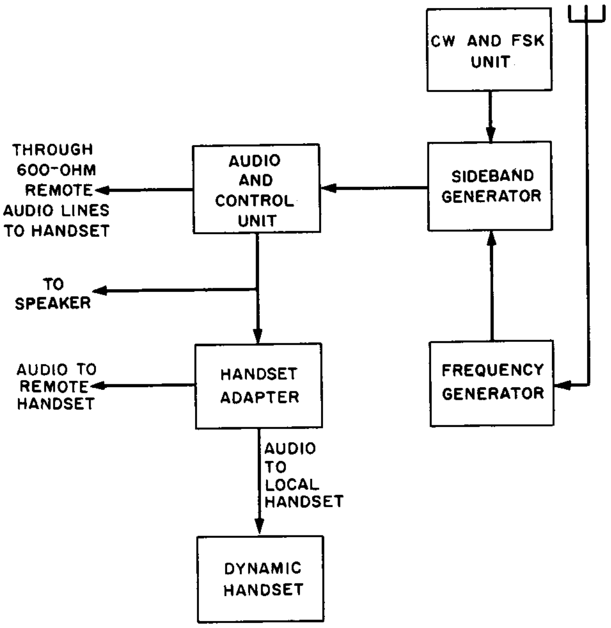
The sideband generator converts the audio input to a 300 kc intermediate frequency on the selected sideband. The modulated 300 kc output is fed to the frequency generator. This unit provides the necessary number of heterodyning processes (while preserving the signal intelligence) to produce the selected carrier frequency in the 2 to 30 mc range. The output signal is amplified in the power amplifier to the required peak-envelope-power output of 500 watts and fed to the antenna.

During the reception of modulated signals (receive operation) the antenna input signal (fig. 9-27) in the range from 2 to 30 mc is heterodyned in the frequency generator so that the output will be a modulated 300 kc signal. This signal is detected and amplified in the sideband generator, further amplified in the audio and control unit, and fed to the speaker.

During c-w reception, the c-w and fsk unit supplies a 300.550 kc signal to the sideband generator as a beat frequency for the received signal. The beat frequency can be changed over a range of ± 1 kilocycle.

AUDIO AND CONTROL UNIT BLOCK DIAGRAM

The audio and control unit (fig. 9-28) is a dual-channel amplifier which can accept audio



32.137
Figure 9-27.—Radio Set AN/URC-32, receive function block diagram.

inputs from two 600-ohm balanced lines, a 600-ohm unbalanced line, or a high impedance microphone. In the normal AN/URC-32 installation, the 600-ohm balanced lines and the dynamic microphone input are not used.

When transmitting and using the 600-ohm unbalanced input, the audio signal from the handset adapter is fed to the audio and control unit via audio transformer, T6. This input, after amplification, can be applied to the upper sideband (USB) line amplifier or to the lower sideband (LSB) line amplifier in the audio and control unit.

The sideband selector switch (fig. 9-25) controls the signal transmission and reception. With the switch in the OFF position, (fig. 9-28) the microphone amplifier circuits and the remote audio input are disconnected from the line amplifiers. This switch position also connects the upper and lower sideband audio line inputs to the line amplifiers.

With the sideband selector switch in the UPPER position, the microphone audio or remote audio is fed into the upper sideband line amplifier. The bottom sections of the switch complete the upper sideband receive circuit from the detector in the sideband generator and supplies an audio output to the speaker via the speaker amplifier circuits.

The reverse of this action happens when the sideband selector is placed in the LOWER position. When earphones (not shown) are plugged into the phone jack on the front panel the audio output normally fed to the speaker is removed.

When the sideband selector switch is in the UPPER position, the upper sideband audio is removed from the audio amplifier, A1Q101, (as discussed) and is properly terminated by R14. Resistor R15 performs the same function for the lower sideband circuits when the lower sideband is selected.

The microphone (MIC) jack, MIC GAIN control, SIDEBAND SELECTOR, and PHONES jack are located on the front panel of the audio and control unit (fig. 9-25). The microphone jack input circuits are designed for use with a high impedance dynamic microphone.

Only standard 600-ohm headphones should be connected into the PHONES output jack. The speaker output circuits (not shown) are disabled when the phones plug is inserted.

SIDEBAND GENERATOR

The sideband generator (fig. 9-25) translates audio frequencies to intermediate frequencies during transmit condition, and intermediate frequencies to audio frequencies during receive conditions.

Transmit Function

The block diagram of the sideband generator is shown in figure 9-29. The balanced modulators, carrier generator, and transmit gain control (t-g-c) circuits operate during transmit condition. The audio input to the sideband generator is taken from the secondaries of T1 and T4 on the audio and control unit (fig. 9-28) and applied to the sideband generator via T3 and T4. These transformers couple upper sideband and lower sideband audio inputs to the vox circuit and to the balanced modulators. The balanced modulators modulate a 300-kc carrier to produce separate and distinct upper and lower sideband signals with the carrier suppressed. The operation of the balanced modulator is explained in chapter 5 of this training course. The 300-kc carrier is produced in the carrier

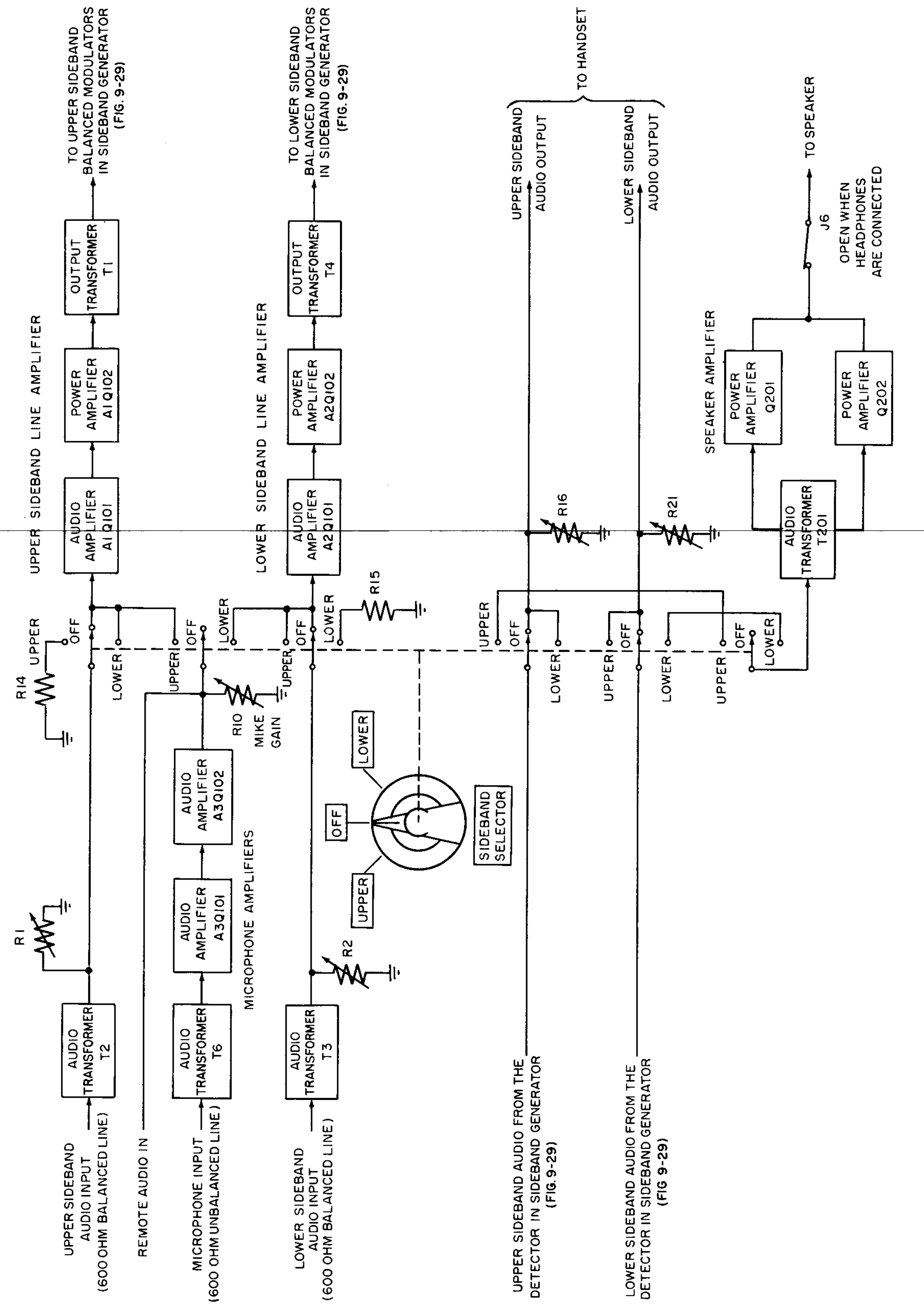


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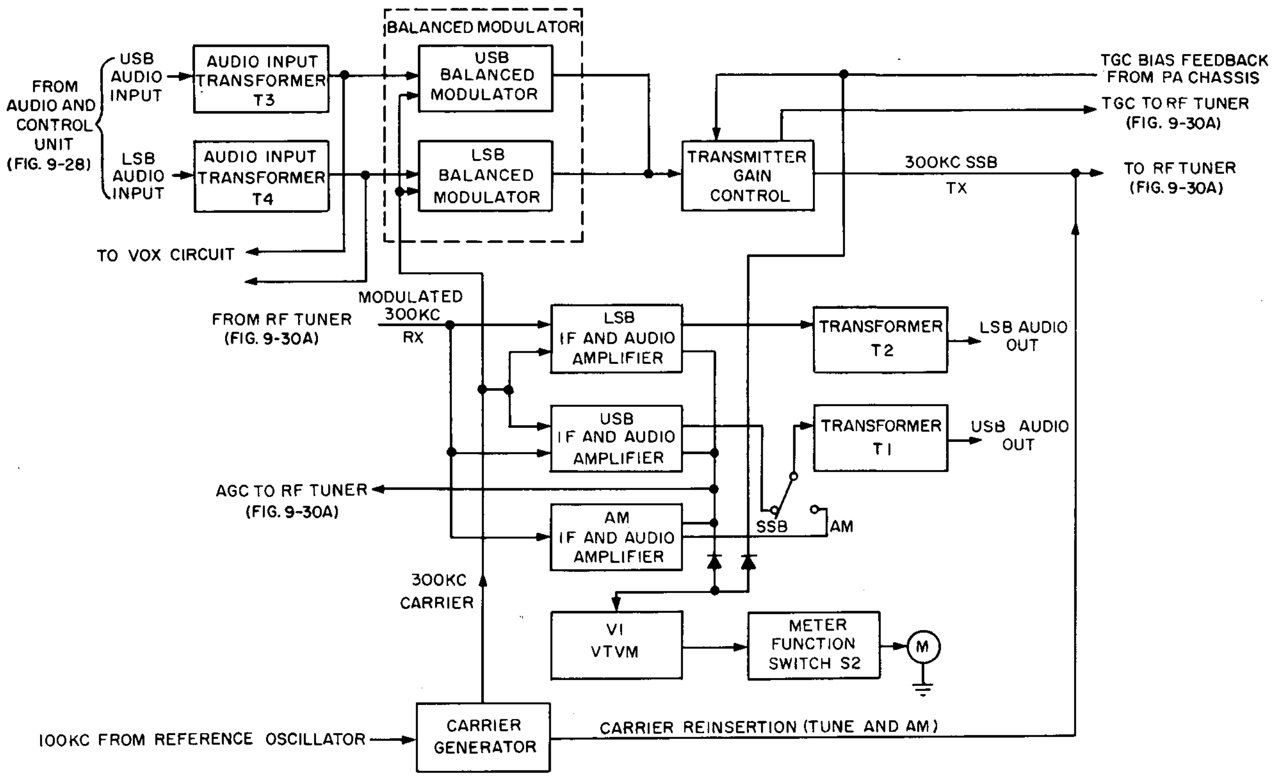
Figure 9-28.—Audio and control unit block diagram.



32.146

Figure 9-29.—Sideband generator, block diagram.

generator by tripling a 100-kc reference oscillator signal from the frequency generator (discussed later).

The balanced modulator section contains two 300-kc balanced modulators. Because of a frequency inversion in the r-f tuner of the frequency generator, the lower sideband balanced modulator is followed with an upper sideband filter and the upper sideband balanced modulator is followed with a lower sideband filter. (The filters are not shown.)

The outputs of the balanced modulators are fed to the transmit gain control. The t-g-c circuit is controlled by a t-g-c voltage which is received from the power amplifier unit (not shown). This circuit maintains the 300-kc i-f output voltage at a sufficiently low level to prevent over-driving any of the subsequent stages.

The 300-kc SSB signals are fed via line TX to the r-f tuner where they are amplified and fed through the power amplifier to the antenna. During tune and a-m transmit conditions only, the unmodulated 300-kc carrier generator output is reinserted in the upper sideband signal at the output of the sideband generator. Reinsertion of the carrier at the transmitter eliminates the necessity for reinsertion at the receiver, and thus permits the use of conventional a-m receivers to receive the transmitted signal. The absence of the lower sideband does not affect the quality of the received signal. However, only one sideband plus carrier is transmitted, and the received signal is considerably weaker than it would be for double-sideband or conventional a-m operation.

Receive Condition

The i-f and audio amplifiers (LSB, USB, and AM) operate only during the receive condition to amplify the modulated 300-kc signal from the r-f tuner (via line RX). These units also demodulate the signal and amplify the detected audio. A 300-kc carrier is reinserted into the LSB and USB I-F/A-F amplifiers from the carrier generator. A carrier reinsert adjust control permits the operator to reinsert a carrier signal which is equal in power to the sideband power at the output of the sideband generator.

When the front panel SSB/AM switch is in the AM position, the LSB, and USB I-F/A-F amplifiers are disabled. The SSB/AM switch also disables the carrier generator during a-m receive condition by deenergizing a SSB/AM relay (circuit connections not shown). The audio output from the AM I-F/A-F amplifier is fed through the SSB/AM switch in the AM position to the USB audio out line via T1. The USB I-F/A-F amplifier output is fed to T1 when the switch is in the SSB position.

The RECEIVER R-F GAIN control (fig. 9-25) controls the gain of the r-f and i-f circuits in the r-f tuner and I-F/A-F amplifiers. The EXCITER GAIN CONTROL is used to adjust the gain of the r-f amplifier circuits in the frequency generator for proper operating level. The t-g-c circuit operates in conjunction with this control to prevent a gain in the r-f stages in excess of that dictated by the gain control setting.

The TUNE-LOCAL-REMOTE switch is normally set in the LOCAL position. In the TUNE position the audio signal input circuits are disconnected, and a carrier is reinserted for tuning the power amplifier. The REMOTE position is used when a remote receiver r-f gain control and tgc-agc meter are used.

The multimeter gives an indication of the -90v, +130v, +250v, tgc-agc, or r-f output circuits as selected by the METER SELECTOR SWITCH.

CW AND FSK UNIT

The c-w and fsk unit (fig. 9-25) enables the AN/URC-32 transceiver to be operated in the c-w and fsk modes of operation. On fsk transmit operation (tone modulation), the c-w and fsk unit converts the keying input from a teletypewriter current loop to audio tones of 1,575 cps for space (no loop current) and 2,425 cps for mark (loop current). On c-w transmit operation (actually mcw) the unit provides a keyed audio tone of 1,000 cps or 1,500 cps as selected by the OSC control switch.

During fsk receive operation, the c-w and fsk unit provides a bfo (beat-frequency oscillator) signal which is required for c-w reception. This signal is centered on 300.550 kc and is variable approximately 1 kc above or below this frequency.

The monitoring circuit contains a meter, M1, which is used for monitoring the receive and transmit audio outputs of the audio and control unit, and for monitoring the output of the c-w and fsk unit.

The function of the c-w and fsk unit is determined by the position of the oscillator control switch, which is located on the front panel. In the OFF position, a section of the switch disables the c-w and the fsk unit by removing the B+ voltage (+130v) from the circuits. Another section connects the USB transmit audio input line from the audio and control unit to the USB transmit audio output line. This line is connected to the USB balanced modulators of the sideband generator, which, in turn, feeds the transmit circuits. Thus, in the OFF position, the c-w and fsk unit circuits are deenergized, and the voice input signals from the handset are transmitted.

When the OSC control switch is in the FSK position, teletypewriter signals will be fed through the transmitter. In the final two positions of the switch, c-w signals are transmitted.

FREQUENCY GENERATOR

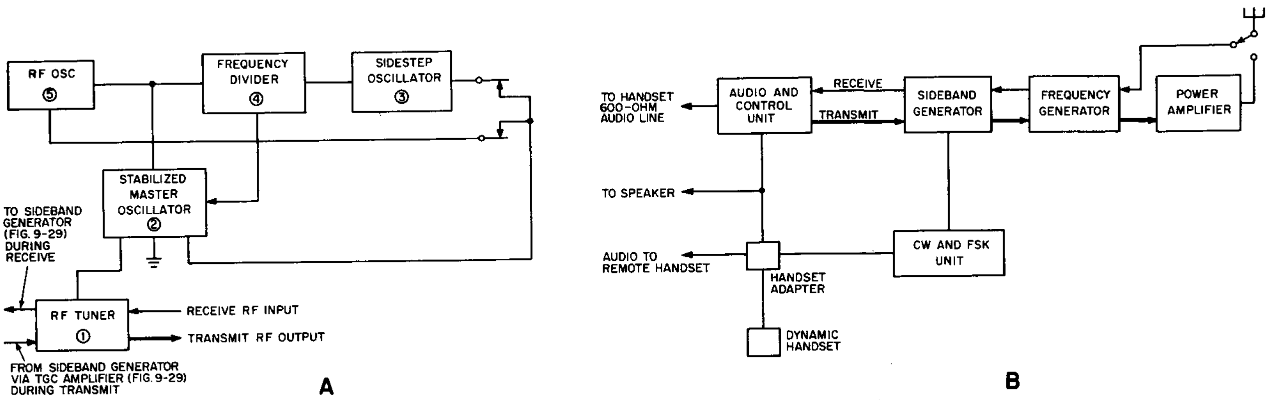
The frequency generator (fig. 9-25) produces the desired radio frequency as determined by the settings of the BAND CHANGE and FREQUENCY CHANGE controls. This unit also provides frequency control and r-f amplification for either transmit or received signals.

The frequency generator block diagram (fig. 9-30A) shows that this unit consists of a main chassis and five plug-in units. These units include the:

1. R-f tuner
2. Stabilized master oscillator (SMO)
3. Sidestep oscillator (optional)
4. Frequency divider
5. Reference oscillator or isolation amplifier

The path of the signal through the various transmitter units during TRANSMIT condition is indicated by the heavy lines in figure 9-30B. The RECEIVE signal path is indicated by the light lines.

The r-f tuner of the frequency generator (fig. 9-30A) is an i-f to r-f translator during transmit condition, and an r-f to i-f translator during receive condition. During the transmit



(A) Frequency generator
(B) AN/URC-32 Transceiver

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Figure 9-30.—Block diagram.

condition, the r-f tuner accepts the 300-kc single sideband signal from the balanced modulators of the sideband generator via the t-g-c circuit, and translates it to the desired frequency (in 1 kc steps) ranging from 2.0 to 30.0 mc.

During receive condition, the r-f tuner accepts and amplifies the selected signal from the antenna (as indicated on the band dial) and translates it to a 300-kc i-f signal. This signal is fed to the I-F/A-F amplifier of the sideband generator (or AM I-F/A-F amplifier depending on the type of reception) for demodulation and amplification.

The names of the controls on the frequency generator front panel are indicative of their function.

POWER AMPLIFIER

The power amplifier (fig. 9-25) is a two-stage r-f power amplifier which amplifies the 0.15 watt PEP signal from the frequency generator to a nominal output power of 500 watts PEP. It contains a driver stage, a power amplifier stage, a t-g-c rectifier, a bias and filament supply, and the necessary control and interlock circuits.

The driver and power amplifier plate circuits are manually tuned (by the DRIVER TUNE and PA TUNE controls, respectively) through the frequency range from 1.7 to 31.7 mc in 4 bands. The power amplifier plate circuit uses a tuned pi network to obtain an unbalanced 50-ohm output impedance over the complete range of frequencies.

The controls, switches, and meters on the power amplifier and their function are as follows:

1. PL NO.1 TEST—Test switch to disconnect one of the power amplifier tubes while checking power amplifier tube balance. PL NO. 2 Test is used to disconnect the other PA tube while performing this check.
2. PLATE CURRENT METER—Test meter to indicate plate current drawn by the power amplifier tubes.
3. FIL OFF-TUNE-OPERATE SWITCH—The different positions and their function are:
   a. FIL OFF—Disables power amplifier and the high voltage power supply.
   b. TUNE—Reduces the power amplifier voltages for tuning.
   c. OPERATE—Normal operating position.
4. PLATE ON-OFF KEY—The different positions and their function are:
   a. ON-OFF—Controls application of plate and screen voltage to the power amplifier tubes.
   b. KEY—Performs same function as the ON position plus keying the transmitter.

5. DRIVER TUNE—Tunes the driver amplifier plate circuit.
6. PA TUNE—Tunes the power amplifier plate circuit.

OPERATING PROCEDURE

The following preliminary settings must be performed before turning on the equipment:

Low-Voltage Power Supply	ON-OFF switch to OFF.
Power Amplifier	FIL OFF-TUNE-OPERATE switch to FIL OFF.
	PLATE switch to OFF.
Sideband Generator	RECEIVER RF GAIN control counterclockwise.
	EXCITER RF GAIN control counterclockwise.
	TUNE-LOCAL-REMOTE switch to LOCAL.
Frequency Comparator	FREQUENCY SELECTOR switch to OFF.
CW and FSK Unit	XMIT-REC-XMIT TEST switch to REC. OSC CONTROL switch to OFF.
Audio and Control Unit	MIC GAIN control counterclockwise. SIDEBAND SELECTOR switch to OFF.

TURNING ON EQUIPMENT

The following procedure is used to apply power to the equipment. If the equipment is to be used only as a receiver, perform only steps a and b.

a. Set OFF-ON switch on Low-Voltage Power Supply to the ON position. The indicator lamp on Low-Voltage Power Supply will light when air pressure is present in the cooling system.

b. Set the meter selector switch on Sideband Generator to the -90, +130, and +250 positions and check that the meter reads between 35 and 50 db in each position.

c. Turn the FIL OFF-TUNE-OPERATE switch on Power Amplifier to the OPERATE. Wait 30 seconds before performing step d.

d. Depress the PLATE switch on the Power Amplifier to KEY and check that PLATE CURRENT meter on Power Amplifier reads 150 ma of static plate current. PLATE lamp on Power Amplifier HV ON lamp on High-Voltage Power Supply, and XMIT lamp on CW and FSK Unit should light.

e. Depress PLATE switch to KEY and alternately depress PLATE NO. 1 TEST switch and PL NO. 2 TEST switch on the Power Amplifier, checking that the PLATE CURRENT meter reads between 60 and 90 ma of static plate current for each tube.

f. Operate PLATE switch on Power Amplifier to ON. PLATE LAMP on Power Amplifier and the HV ON lamp on High-Voltage Power Supply should light.

TUNING PROCEDURE

The following tuning procedure is used whenever the AN/URC-32 is set to a new operating frequency:

a. Set PLATE switch on Power Amplifier to OFF.

b. Set BAND CHANGE switch on the Frequency Generator to the desired frequency band. The band indicator lamp will light over the selected frequency counter. The AN/URC-32 frequency bands are as follows:

Band 1	2.0 to 3.7 mc
Band 2	3.7 to 7.7 mc
Band 3	7.7 to 15.7 mc
Band 4	15.7 to 30.0 mc

c. Release DIAL LOCK on the Frequency Generator. Set the desired operating frequency on the lighted frequency counter using the FREQUENCY CHANGE control. When selecting a frequency which is not on the band 7.7-15.6 mc, or 15.7-to 30.0 mc frequency counters, set the frequency counter to the next lower frequency on the counter and set the BAND CHANGE switch to ADD 1, ADD 2, or ADD 3. When the desired operating frequency is on the frequency counter, set the BAND CHANGE switch to ADD 0. EXAMPLE: To select an operating frequency of 23.699 mc, set the BAND CHANGE switch to BAND 4, set the 15.7- to 30.0-mc frequency counter to 23.696 mc using the FREQUENCY CHANGE control, and reset the BAND CHANGE switch to BAND 4 ADD 3.

When setting up a frequency on any band, make certain the white index line on the last dial of the 15.7- to 30.0-mc frequency counter is centered in the window.

d. Reset DIAL LOCK and momentarily depress the TUNE-OPERATE switch on Frequency Generator to TUNE. This prevents the stabilized master oscillator from locking on spurious signals. The AFC meter shows the amount of correction being supplied to the master oscillator from the stabilization circuits and should not be expected to read 0 unless the master oscillator is exactly on frequency and no correction is required.

e. Adjust RECEIVER RF GAIN control so that the AGC does not increase the gain excessively between characters in CW and FSK or between words in single-sideband voice reception. The RECEIVER RF GAIN control is normally set so that the sideband generator meter (AGC) "kicks up" about 15 db with the meter switch in the TGC-AGC position. If speaker, handset, or remote audio output level is not adequate, set SPEAKER GAIN control (under dust cover of Audio and Control Unit) for desired output level. On FSK operation, adjust BFO control for proper operation of FSK converter. This completes tuning of the receiver portion of the AN/URC-32.

Before performing the following steps, the AN/URC-32 must be connected to an antenna system containing an antenna tuner control such as the AN/SRA-22 or 180U-2 and a dummy load such as the 172J-1. These antenna tuners contain a directional wattmeter and switch for selecting the antenna or the dummy load. On installations which use the 180U-2 and an antenna tuner such as the AN/BRA-3, AN/BRA-5, AN/SRA-18, or a 50-ohm multicoupler, set the couple control power switch to ON and the tuner bypass switch to OFF. The ready light must also be on. Unless this is done, the interlock circuits of the antenna tuner will prevent operation of the AN/URC-32 power amplifier.

f. Set the ANT-LOAD switch on the antenna tuner control to LOAD. Set the FIL OFF-TUNE-OPERATE switch on Power Amplifier to TUNE. Set the meter selector switch on the Sideband Generator to RF OUT. Set TUNE-LOCAL-REMOTE switch on the Sideband Generator to TUNE.

In the following steps, key to transmit by depressing the PLATE switch on the Power Amplifier 367A-3 to KEY.

g. With the EXCITER RF GAIN control in the maximum counterclockwise position, key to transmit and turn EXCITER RF GAIN control clockwise until meter on the Sideband Generator 786F-1 reads approximately 40 db.

h. Key to transmit and adjust DRIVER TUNE control on the Power Amplifier within the desired band limits to peak the PLATE CURRENT meter reading, adjust the EXCITER RF GAIN control as necessary to maintain a PLATE CURRENT meter reading of approximately 200 milliamperes. The red index on the DRIVE TUNE control must fall within the proper band limits marked on the panel. If a power output reading is observed on the power output meter of the antenna tuner, detune the P. A. TUNE control until no power output is indicated. This effectively disables the r-f feedback so that optimum adjustment of the driver plate circuit can be obtained. Reducing EXCITER RF GAIN control for a decrease in PLATE CURRENT meter reading, as necessary, will result in a sharper indication of driver tuning.

After completing step h, make no further adjustments on the DRIVER TUNE control for the remainder of the tuning procedure.

i. Set the P. A. TUNE control on the Power Amplifier within the desired frequency band limits. Key to transmit and adjust P. A. TUNE control for a dip in the PLATE CURRENT meter reading.

j. Set EXCITER RF GAIN control maximum counterclockwise. Set FIL OFF-TUNE-OPERATE switch on the Power Amplifier to OPERATE.

k. Key to transmit, turn EXCITER RF GAIN control clockwise until 500 watts of forward power is indicated and redip PLATE CURRENT meter reading using the P. A. TUNE control. The PLATE CURRENT meter reading should not exceed 500 milliamperes.

DO NOT OPERATE ANT-LOAD SWITCH WHILE AN/URC-32 IS KEYED TO TRANSMIT.

l. Set ANT-LOAD switch on antenna tuner control to ANT and adjust antenna tuner controls for minimum reflected power. For this procedure see the operating procedures in the antenna tuner control technical manual.

m. Key to transmit and adjust EXCITER RF GAIN control for a forward power output meter reading of 500 watts. The reflected power meter reading should be less than 10 watts. The PLATE CURRENT meter reading should be between 450 and 550 milliamperes.

n. Key to transmit and adjust the EXCITER RF GAIN control for a forward power output of 125 watts.

o. Key to transmit and check the following meter readings:

PLATE CURRENT. . . . meter	Approximately 300 ma
Forward power. . . . . . output	125 watts.
Reflected power	Less than 3 watts
Sideband Generator . . . meter RF OUT	10 to 20 db
Sideband Generator . . . meter TGC	0 db

p. Set TUNE-LOCAL-REMOTE switch on the Sideband Generator to LOCAL. On AM transmit operation, readjust EXCITER RF GAIN control for 125-watts forward power. Set PLATE switch on the Power Amplifier to ON. This completes the tuning procedures.