NAVSHIPS 92121(A)

INSTRUCTION BOOK

for

RADIO TRANSMITTING SETS

AN/SRT-14, AN/SRT-14A, AN/SRT-15, AN/SRT-15A, AN/SRT-16 AND AN/SRT-16A

SECTION 2

THEORY OF OPERATION

FEDERAL TELEPHONE AND RADIO COMPANY

A division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

CLIFTON, NEW JERSEY

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SECTION 2
THEORY OF OPERATION

1. INTRODUCTION.

a. FUNCTION.—Radio Transmitting Sets AN/SRT–14, 15 and 16 are designed to transmit c-w, voice, facsimile or frequency-shift signals, with a nominal 100-watt output over a 0.3- to 26-mc range. In addition, the AN/SRT–15 and the AN/SRT–16 may be operated at a nominal 500-watt output over a 2- to 26-mc range. Radio Transmitting Set AN/SRT–14 operates only at the 100-watt level. The AN/SRT–14 and the AN/SRT–15 are each limited to transmission on one frequency at a time. The AN/SRT–16 may transmit two signals simultaneously from two transmitter bays, either with both signals at the 100-watt level or with a 500-watt output from the one transmitter bay that is so equipped and a 100-watt output from the other transmitter bay. Output power is a function of frequency and may vary from 80 percent to 160 percent of the nominal output levels.

Transmission of c-w signals may emanate from either hand-key or machine-key facilities, while frequency-shift signals are generated by machine-keying signals. Tuning of all three sets is manually accomplished at the site of the transmitter bay. When used with the appropriate Navy furnished equipment, the AN/SRT-14, 15 or 16 may be energized and have key or voice signals supplied to it from a remote position. These same functions can also be accomplished locally at the site of the transmitter bay.

Note

The AN/SRT–14A, 15A and 16A are nonmagnetic versions of the AN/SRT–14, 15 and 16 respectively. As the nonmagnetic versions vary from the standard types only in the material used for cabinet panels, all information on the theory of operation of the AN/SRT–14, 15 and 16, as set forth in the following section, applies equally as well for the AN/SRT–14A, 15A and 16A.

Note

Where, throughout this section, reference is made to either low level radio modulator or high level radio modulator, it should not be interpreted as meaning the technique of modulation known as grid modulation or low level modulation, but rather as referring to the operating *power* level.

b. MAJOR UNITS.—The major units of Radio Transmitting Sets AN/SRT–14, 15 and 16 and the number of units under each set are shown in table 1-1 of Section 1. Table 1–2 of Section 1 lists, for each major unit, the official Navy nomenclature, the common title, the abbreviations, and the numerical group assigned for circuit reference symbols. The relationship between the major units and the paths of signal flow from one to another are shown in the block diagram, figure 2–1.

Each set is comprised of two general groups of equipment: the transmitter bay and antenna tuning equipment. The transmitter bay generates and modulates the signal, and the antenna tuning equipment matches the antenna load to the optimum output impedance level of the transmitter bay for maximum radiated energy. The major units of the transmitter bay are outlined in paragraphs 1*b*(1) through 1*b*(13) of this section and are shown on the functional block diagram, figure 2–129. The antenna tuning equipment is outlined in paragraphs 1*b*(14) and 1*b*(15). For greater clarity, cabinets, mountings, and control circuits are not shown in the introductory block diagrams, figures 2–1 and 2–129.

Immediately following this general discussion, a detailed circuit analysis is given, beginning with paragraph 2. In this analysis, the major components are discussed individually from the radio frequency oscillator through the antenna coupler. The descriptions of most major units are accompanied by complete block diagrams and simplified schematics. Control circuit functions are discussed within the major units, as they apply, but an overall transmitter bay control circuit description (paragraph 16) follows the discussion of the load adjusting unit and an antenna tuning equipment control circuit discussion (paragraph 17*d*) follows the description of the antenna coupler.

(1) RADIO FREQUENCY OSCILLATOR O–275/SRT (RADIO FREQUENCY OSCILLATOR, RFO).—The radio frequency oscillator (RFO) generates an r-f signal variable in steps of 10 cps from 0.3 to 26 mc. A modulated frequency shift corresponding to the keying signals from the low level radio modulator is provided for frequency-shift keying and facsimile services. These signals are produced by a set of 14 subunits that plug into a mounting and that employ oscillators, frequency multipliers, and frequency converters. During c-w and phone operation, the RFO receives a signal from the low level radio modulator to key the output of the RFO. A nominal two-volt r-f output signal from the RFO is fed to the radio frequency amplifier. In addition, mounted on the RFO front panel and considered a component of the RFO is the Control-Indicator C–1352. The control-indicator contains the controls and indicating meters required to manually control the tuning of the antenna tuning equipment.

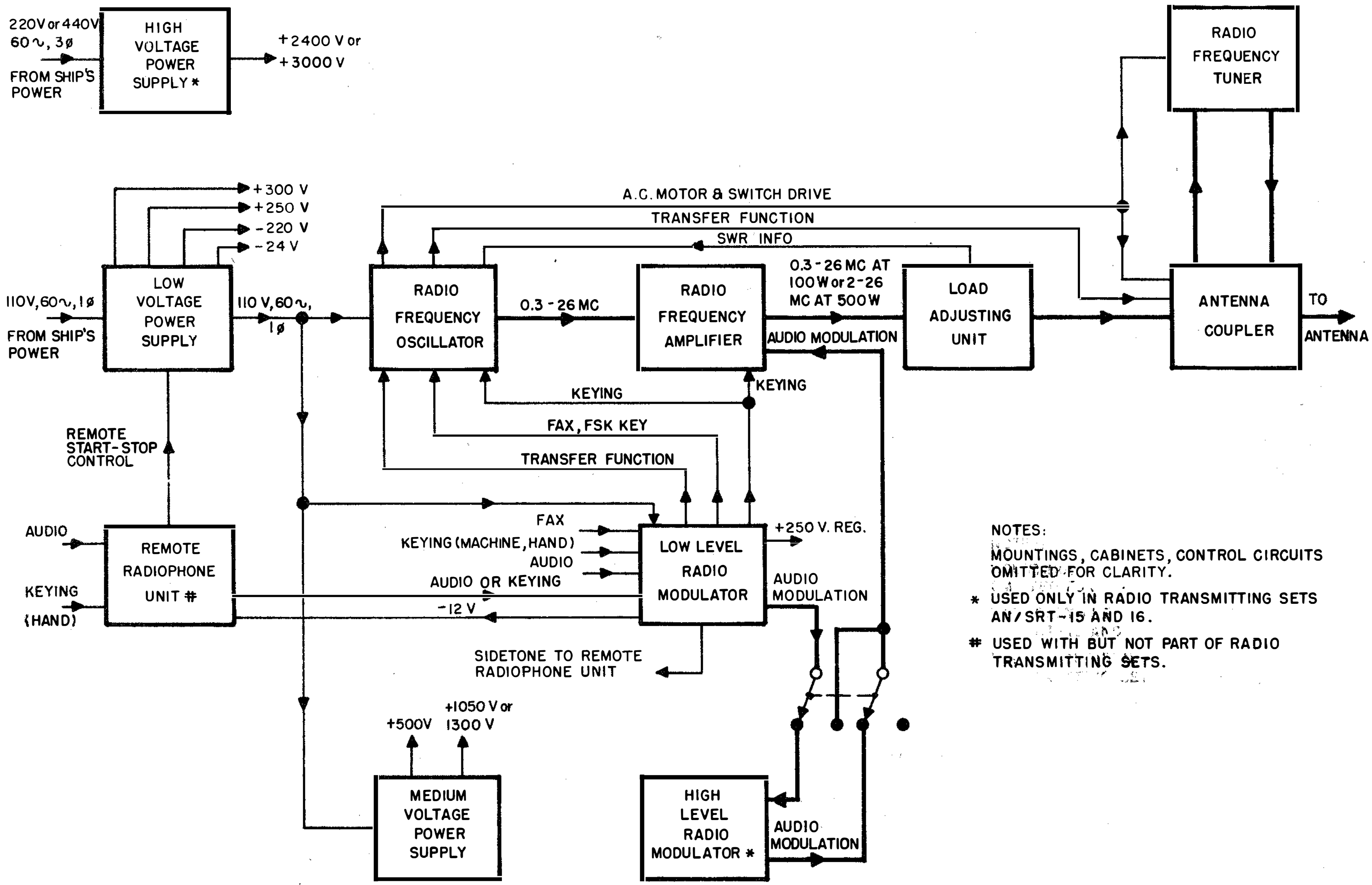


Figure 2—1. Radio Transmitting Sets AN/SRT—14, 15 and 16, Functional Block Diagram

(2) POWER SUPPLY PP–1094/SRT (LOW VOLTAGE POWER SUPPLY, LVPS).—The low voltage power supply (LVPS) is supplied with 110 volts ac from the ship's supply and distributes this power to other units. It contains rectifier circuits that provide B+ voltage of +300 volts, +250 volts, −24 volts for control circuits and motor lines, and −220 volts for bias.

(3) POWER SUPPLY PP–1095/SRT (MEDIUM VOLTAGE POWER SUPPLY, MVPS).—The medium voltage power supply (MVPS) receives 110 volts ac from the LVPS and supplies +500 volts dc to the low level radio modulator and the radio frequency amplifier and +1,300 volts, which is reduced to +1,050 volts during phone operation, to the radio frequency amplifier. In addition to the rectifier circuits, the MVPS contains a switching relay to insure that the +500-volt supply is present before the +300-volt supply in the LVPS comes on.

(4) POWER SUPPLY PP–1096/SRT (HIGH VOLTAGE POWER SUPPLY, HVPS).—The high voltage power supply (HVPS), used only in the AN/SRT–15 or 16 during 500-watt operation, is provided with a separate input of 220-volt or 440-volt, three-phase, 60-cycle ac from the ship's supply. The HVPS has a d-c output of +3,000 volts that replaces the +1,300-volt output of the MVPS during 500-watt operation. During phone operation, the +3,000 volts is reduced to +2,400 volts.

(5) RADIO MODULATOR MD–229/SRT (LOW LEVEL RADIO MODULATOR, LLRM).—The low level radio modulator (LLRM) accepts audio and keying signals from external units. It amplifies and shapes them as required to modulate the carrier in a manner selected by the operator. For 100-watt phone transmission the LLRM feeds a 50-watt modulating audio signal directly to the radio frequency amplifier; in 500-watt phone operation, the LLRM output is reduced to 6 watts and is fed to the high level radio modulator, which, in turn, amplifies it to 250 watts and then feeds it to the RFA. Audio signals are obtained locally from either a carbon or dynamic microphone or by way of a standard Navy remote radiophone unit, which restricts the input to a carbon microphone. Keying signals for frequency-shift and c-w transmission may be accepted from either machine-key or hand-key equipment. For c-w operation, the LLRM feeds keying signals directly to the RFA and RFO at either 100-watt or 500-watt levels and feeds keying signals to the unused audio amplifier chain of the LLRM, which provides a dumping action, keeping the load on the +500-volt supply of the MVPS during c-w keying. This prevents transients in the +500-volt supply. In frequency-shift key service, the LLRM reshapes the input keying signals and feeds them to the RFO. Facsimile signals are switched through the LLRM directly to the RFO. In addition to its modulating function, the LLRM has two power supplies: one is a regulated +250-volt supply used as a B+ supply for critical keying circuits in the LLRM and in the RFO, the other is a −12-volt supply for energizing a carbon microphone or supply to the remote radiophone unit.

(6) RADIOPHONE UNIT.—The remote radiophone unit (not part of Radio Transmitting Sets AN/SRT–14, 15 and 16), usually located at a remote position, consists of a power start-stop circuit and an audio and keying input circuit. The power start-stop circuit is connected to the control circuits of the LVPS and may be used to turn the transmitter on or off. The audio input circuit receives audio signals from a carbon microphone and transmits them to the LLRM. The keying input circuit receives signals from a hand-keying device and transmits them to the LLRM.

(7) RADIO MODULATOR MD–230/SRT (HIGH LEVEL RADIO MODULATOR, HLRM).—The high level radio modulator (HLRM) is used only in the AN/SRT–15 and 16 during 500-watt operation. It amplifies the six-watt audio signal developed in the LLRM and feeds it to the radio frequency amplifier to modulate the carrier.

(8) RADIO FREQUENCY AMPLIFIER AM–1008/SRT (RADIO FREQUENCY AMPLIFIER, RFA).—The radio frequency amplifier (RFA) receives an r-f signal from the RFO at any frequency from 0.3 to 26 mc. During 100-watt operation the RFA amplifies all signals within this frequency range to the required nominal 100-watt level. During 500-watt operation, only signals within the range of 2 to 26 mc are amplified to the nominal 500-watt level; selection of a frequency in the range from 0.3 to 2 mc automatically switches the output to the 100-watt level. The three stages of amplification (buffer, intermediate power amplifier, and power amplifier) that comprise the RFA are manually tuned to the frequency selected. The RFA receives a signal from the LLRM to key the carrier during c-w and phone operation. In addition, during phone operation, an audio signal is received from either the LLRM (100 watts) or HLRM (500 watts) to amplitude-modulate the carrier. The RFA output is fed to the load adjusting unit.

(9) TRANSMITTER COUPLER CU–402/SRT (LOAD ADJUSTING UNIT, LAU).—The load adjusting unit (LAU) improves the impedance match between the characteristic 50-ohm r-f output impedance of the RFA to the impedance presented by the antenna. The r-f output of the RFA is fed to the LAU. The output of LAU is fed to the antenna coupler of the antenna tuning equipment.

(10) ELECTRICAL EQUIPMENT CABINET CY–1571/SRT (TRANSMITTER GROUP CABINET).—The transmitter group cabinet houses the five chassis of the transmitter group consisting of the RFA, LLRM, RFO, LVPS, and MVPS. The cabinet is provided with retractable intercabling, mating connectors for each chassis, and terminal boards for inputs and outputs to other assemblies of the AN/SRT–14, 15 and 16. The transmitter group cabinet may rest on a Mounting MT–1423/SRT or on one of the booster cabinets. There is one transmitter group cabinet in the transmitter bay of the AN/SRT–14, another in that of the AN/SRT–15, and two in the AN/SRT–16.

(11) ELECTRICAL EQUIPMENT CABINET CY-1572/SRT (HLRM CABINET).—The HLRM cabinet houses the high level radio modulator chassis in the AN/SRT-15 and AN/SRT-16. The cabinet is provided with retractable intercabling, with mating connectors for the HLRM chassis and terminal boards for inputs and outputs to other assemblies of the AN/SRT-15 and 16.

(12) ELECTRICAL EQUIPMENT CABINET CY-1573/SRT (HVPS CABINET). — The HVPS cabinet is similar to the HLRM cabinet and houses the HVPS chassis in the AN/SRT-15 and AN/SRT-16. The terminal board for the 220/440-volt, three-phase, 60-cycle input is also contained in this cabinet. The HVPS and HLRM cabinets, together with the units they house, form Radio Modulator-Power Supply OA-685/SRT (the booster).

(13) MOUNTING MT-1423/SRT (MOUNTING). — The mounting provides mechanical support for the units of the transmitter group or booster and houses the blowers and heaters that are used to provide temperature control for the transmitter bay. All input and output cables for the transmitter bay enter through the cable access areas provided in the rear and bottom of this unit.

(14) RADIO FREQUENCY TUNER TN-229/SRT (R-F TUNER).—The r-f tuner serves as an adjustable length transmission line whose function is to sufficiently match the impedance presented by the antenna to the characteristic output impedance of the RFA so that the standing-wave ratio on the transmission line is no greater than 4:1. Tuning is accomplished by the moving of a shorting mechanism along the main coil, which constitutes the adjustable length transmission line. Control of the shorting mechanism is accomplished manually and remotely at the transmitter bay location by controls on the control-indicator, which is located on the RFO front panel.

(15) ANTENNA COUPLER CU-372/SRT (ANTENNA COUPLER).—The antenna coupler has two prime functions. Primarily, the antenna coupler is used to extend the range of tuning that can be accomplished with the main coil in the r-f tuner. This is done by switching inductance or capacitance into the antenna line to lengthen or shorten the apparent electrical length of the antenna. This switching is also manually controlled at the control-indicator. In addition, the antenna coupler contains a switch that makes it possible to bypass the tuning components completely, connecting the antenna directly to the load adjusting unit of the transmitter bay. The control-indicator unit also contains the manual control for the setting of the bypass switch.

Note

In all simplified schematics in Section 2, resistance values are expressed in ohms, capacitance values in micromicrofarads and inductance values in microhenries, unless otherwise indicated. For example, a 10-ohm resistor will have its value shown on a simplified schematic as "10", whereas a 10-kilohm or 10-megohm resistor will be marked "10K" or "10M".

2. RADIO FREQUENCY OSCILLATOR O-275/SRT (RFO).

The radio frequency oscillator consists of 14 removable subunits containing the vacuum tube circuits, a mounting to which these units are secured, and a unit that is mounted on the front panel of the mounting. The RFO is the master frequency source for the transmitting set. The 14 subunits include: the crystal oscillator (unit 1); the interpolation oscillator (unit 3); the frequency-shift oscillator (unit 12); step generators for 10 kc (unit 6), 100 kc (unit 8), and 1 mc (unit 10); three frequency multipliers (units 2, 4, and 7); five frequency converters (units 5, 9, 11a, 11b, and 11c). The unit that mounts on the front panel of the RFO mounting, Control-Indicator C-1352/SRT, contains all controls and indicators required to manually tune the antenna tuning equipment components.

Note

In the schematics accompanying the RFO discussion, the outputs and inputs of the subunits are identified by numbers and lower-case letters. The number refers to the unit which produces the output signal, and the letter identifies which output is being referred to. For example, 2a is one of five outputs of unit 2, and is fed to unit 4; when it leaves unit 4, it is referred to as output 4a. These output symbols are marked on the chassis for purposes of identification.

a. GENERAL THEORY OF THE RFO. *(See figure 2-2.)*—The crystal oscillator (unit 1) produces a 100-kc output, accurate to within 1.5 parts per million, which is fed to: one of the frequency multipliers (unit 2), a frequency converter (unit 5), the 10-kc step generator (unit 6), and the 100-kc step generator (unit 8). This output synchronizes the step generators and, through frequency multipliers, provides the higher input frequencies required by other units of the RFO. Another portion of the 100-kc output is fed to the zero adjust indicating circuit in unit 14 to enable the operator to check the output of the interpolation and frequency-shift oscillators. Another portion is fed to an oscilloscope test receptacle in unit 14 for servicing and checking.

(1) In unit 2 (frequency multiplier) the 100-kc output of the crystal oscillator is increased to 1 mc and then fed to unit 4 (frequency multiplier), unit 5 (frequency converter), unit 6 (the 10-kc step generator), unit 7 (frequency multiplier), and unit 10 (the 1-mc step generator). Unit 4 multiplies the 1-mc input from unit 2 and produces an 8-mc output, which is fed to unit 5 (frequency converter).

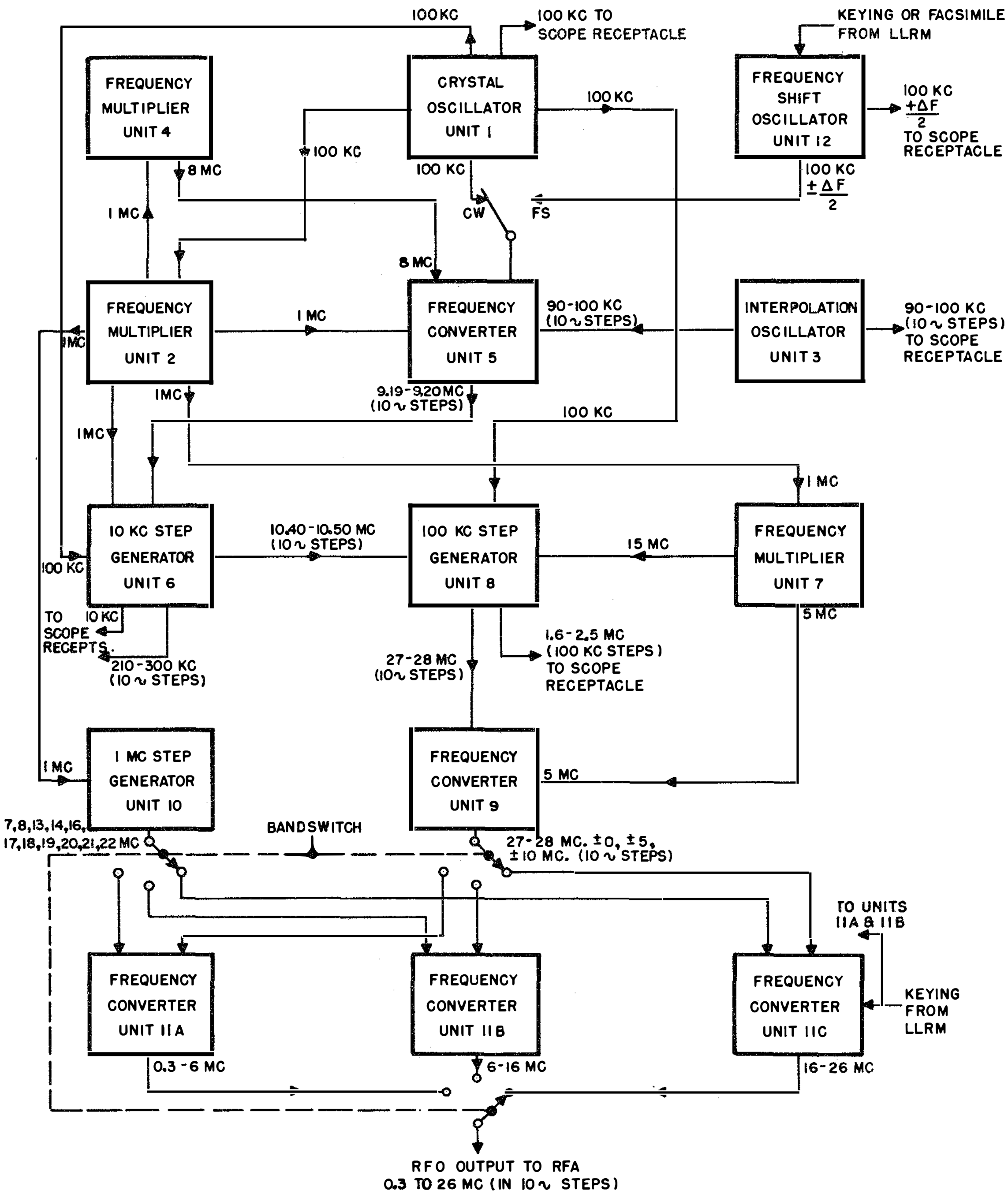


Figure 2—2. Radio Frequency Oscillator O—275/SRT (Radio Frequency Oscillator, RFO), Functional Block Diagram

(2) In addition to the 1-mc input from unit 2 and the 8-mc input from unit 4, the frequency converter (unit 5) receives outputs from the interpolation oscillator (unit 3) and either the crystal oscillator or the frequency-shift oscillator. The interpolation oscillator produces an output of 90 to 100 kc, adjustable in steps of 10 cps, 100 cps, and 1 kc. The major portion of this output is fed to unit 5 (frequency converter). Another portion is fed to an oscilloscope test receptacle for use in servicing and checking. The frequency-shift oscillator (unit 12) generates an output of 100 kc, frequency-modulated in accordance with signals from the LLRM. For FSK operation this output may be shifted at a 240-cps rate (corresponding to teletype at 600 words a minute), a maximum of $\pm$1,000 cps $\left(\frac{\Delta f}{2}\right)$ from the knob-set frequency. For facsimile operation the output frequency shift may be adjusted from +500 to +2,000 cps for a positive 20-volt signal from the facsimile equipment. See paragraph 2*f*(3) for a detailed explanation of the frequency-shift range. In addition, a one-radian

maximum phase modulation at a 200-cps rate may be added for reduction of fading effects. During frequency-shift keying or facsimile operation, the output of unit 12 is fed to the frequency converter (unit 5) to replace the 100-kc signal normally supplied by the crystal oscillator (unit 1). Another portion of the frequency-shift oscillator is fed to an oscilloscope test receptacle for use in servicing and checking. Unit 5 (frequency converter), consisting of a series of conventional mixers, tuned filters and an amplifier, mixes its four input frequencies to produce an output, adjustable in steps of 10 cps, from 9.19 to 9.2 mc for cw and phone or 9.19 to 9.2 mc $\pm \frac{\triangle f}{2}$ for frequency-shift telegraphy and 9.19 to 9.2 mc + $\triangle$f for facsimile operation.

(3) The output of unit 5 is fed to the 10-kc step generator (unit 6). This step generator, the major component of which is a phase-locked oscillator, receives, in addition, a 100-kc signal from the crystal oscillator and a 1-mc signal from unit 2. The 100-kc input is first used to produce outputs of 10 kc and 210 to 300 kc (in 10-kc steps) for the oscilloscope test receptacles. A portion of the last frequency is then mixed with the inputs from unit 2 and unit 5 to produce a final output of 10.4 to 10.5 mc (in steps of 10 cps), which is fed to the 100-kc step generator (unit 8).

(4) Unit 7 (frequency multiplier) receives a 1-mc signal from unit 2 and multiplies it to provide first a 5-mc signal for unit 9 (frequency converter) and then a 15-mc signal for the 100-kc step generator (unit 8). The 100-kc step generator has essentially the same design as unit 6, the 10-kc step generator. Unit 8 uses the 100-kc input from the crystal oscillator to produce an output of 1.6 to 2.5 mc (in 100-kc steps). A portion of this output is fed to an oscilloscope test receptacle for use in servicing and checking; the remainder is mixed with the inputs from unit 6 and unit 7 to produce an output of 27 to 28 mc (in steps of 10 cps), which is fed to the unit 9 frequency converter. Unit 9 mixes the 27- to 28-mc input from unit 8 with the 5-mc input from unit 7 to produce frequencies of 27 to 28 mc (±0, ±5 or +10 mc), adjustable in 10-cps steps. These frequencies are amplified by the remainder of unit 9 and then fed to one wafer of the bandswitch. Unit 10 (1-mc step generator) receives a 1-mc signal from unit 2 and passes it through a harmonic generator that produces frequencies of 7, 8, 13, 14, 16, 17, 18, 19, 20, 21, and 22 mc. These frequencies are amplified by the rest of unit 10 and then fed to the second wafer of the bandswitch.

(5) The outputs of unit 9 and unit 10 are fed to one of the three final converters (units 11a, 11b, and 11c), only one of which is used at a time. The output frequency desired determines which of the three converters will be used; the chosen unit is connected to the outputs of unit 9 and unit 10, and to the RFO mounting (unit 14) by the bandswitch. Unit 11a is used for frequencies between 0.3 and 6 mc; unit 11b for the 6- to 16-mc range, and 11c for outputs of 16 to 26 mc.

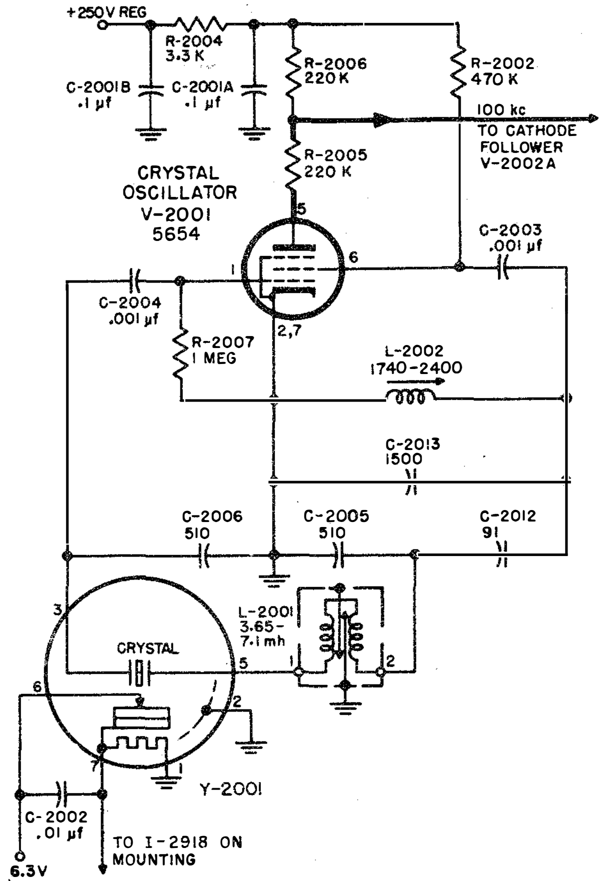


Figure 2—3. RFO Unit 1, Crystal Oscillator V—2001, Simplified Schematic

(6) The mounting (unit 14) serves as a rack into which the other units of the RFO are plugged. Unit 14, in turn, plugs into the transmitter group cabinet wiring. In addition to interunit cabling, unit 14 includes manual frequency controls, test points, the bandswitch for selecting the final frequency converter (unit 11a, 11b or 11c), oscilloscope test receptacles, an indicating circuit for adjusting the outputs of the interpolation and frequency-shift oscillators, a door interlock switch, heater and filament power supplies, and heater indicator lights.

(7) Control-Indicator C-1352/SRT, which mounts on the unit 14 front panel, contains the following controls and indicators for the manual tuning of the antenna tuning equipment: controls for manual setting of the effective length of the main tuning coil in the radio frequency tuner, a control for selecting a value of inductance or capacitance found in the antenna coupler to extend the range of tuning of the main coil when required, a control for bypassing the antenna tuning equipment, a control for adding an impedance transformer in the r-f transmission line in the radio frequency tuner, an indicator to record the position of the shorting ring on the main tuning coil in the radio frequency tuner, and an indicator to measure the standing-wave ratio existing on the r-f transmission line.

b. RADIO FREQUENCY OSCILLATOR Z-2001 (CRYSTAL OSCILLATOR, UNIT 1).—The crystal oscillator (unit 1) is one of the basic frequency sources of the transmitter. The output of unit 1, a crystal-controlled 100-kc signal, is processed by other subunits in the RFO to obtain higher frequencies. Other frequency sources in the RFO, such as the 10-kc step generator and the 100-kc step generator, are synchronized by the crystal oscillator and are thus locked to an accurate, crystal-controlled frequency standard. Two additional frequency sources, the interpolation oscillator and the frequency-shift oscillator, are provided with frequency generators that are not locked to the crystal oscillator. However, the output of these frequency converters may be compared with the output of the crystal oscillator by means of the zero adjust indicating circuit located in unit 14, employing an electron ray indicating tube. Adjustments are provided for obtaining minimum shadow angle on the electron ray tube, which indicates when the frequency of the interpolation oscillator or the frequency-shift oscillator is "in synch" with the crystal oscillator frequency. Unit 1 includes a crystal oscillator circuit and four cathode followers.

(1) CRYSTAL OSCILLATOR V-2001. — This stage (figure 2-3) is a modified electron-coupled Colpitts oscillator operating at a frequency of 100 kc with an accuracy of 0.00015 percent. To obtain maximum stability, the quartz crystal is contained in a plug-in unit, Y-2001, which includes a heating element and a thermostat. By this means, the crystal is maintained at a constant temperature of 70°C. (158°F.). When the crystal heater is on, the XTAL HEATER ON indicator light I-2918 on the mounting is energized by 6.3 volts applied from terminal 7 of Y-2001. As indicated on the transmitter group primary power diagram in Section 7, the oven in the crystal oscillator and those in the frequency-shift oscillator and the interpolation oscillator are all fed by a single, independent 110-volt, 60-cps primary power line. Minor tuning adjustments may be made by means of the two slugs of the permeability tuned inductor, L-2001. The bottom slug is factory-adjusted so that the top slug may be adjusted in the field for exactly 100 kc. The total range of the field adjustment is one cycle. L-2002 and C-2013 suppress parasitic oscillations. The output of V-2001, a triangular waveform having a high harmonic content, is coupled through C-2007 to the grid of cathode follower V-2002A.

(2) CATHODE FOLLOWERS V-2002 and V-2003.—The crystal oscillator output (figure 2-4) is distributed to other subunits of the RFO through a system of cathode followers. This prevents loading of the

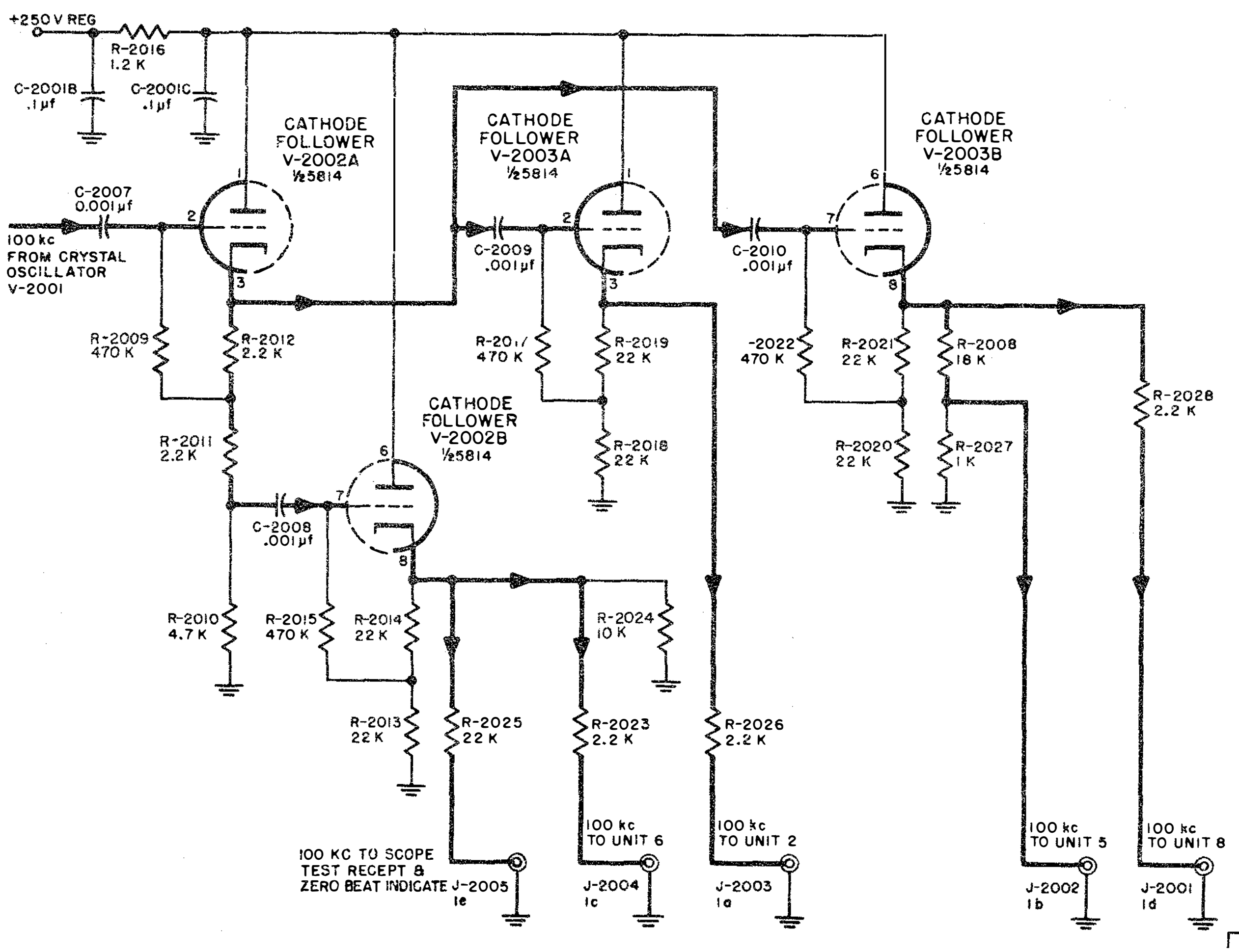


Figure 2-4. RFO Unit 1, Cathode Followers V-2002 and V-2003, Simplified Schematic

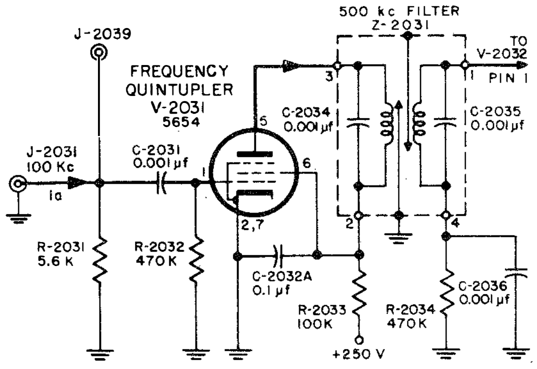


Figure 2—5. RFO Unit 2, Frequency Quintupler V—2031, Simplified Schematic

crystal oscillator and helps maintain its frequency stability. Cathode follower V–2002A receives the crystal oscillator output and distributes it to cathode followers V–2002B, V–2003A, and V–2003B, which, in turn, distribute the output to other subunits of the RFO. Thus, V–2002A serves as a buffer, or isolating, stage, which isolates the crystal oscillator from the output load. The 100-kc output of V–2002B is fed through isolating resistor R–2025 to the oscilloscope test receptacle in unit 14 (output 1e), and through isolating resistor R–2023 to unit 6 (output 1c). The 100-kc output of V–2003A is fed to unit 2 through isolating resistor R–2026 (output 1a). The 100-kc output of V–2003B is fed to voltage divider R–2008 and R–2027 and to unit 8 through isolating resistor R–2028 (output 1d). The portion of this signal that is developed across R–2027 is fed to unit 5 (output 1b). In this case, R–2008 serves as an isolating resistor. The 1-mc signal with which the 100-kc signal is mixed in unit 5 is of relatively low amplitude and is applied to the suppressor grid, whereas the 100-kc signal is applied to the control grid of the mixer. The 100-kc output to unit 5 is therefore reduced in amplitude to match the low amplitude of the 1-mc input to unit 5 and to compensate for the higher amplification of the 100-kc signal resulting from its application to the mixer control grid.

c. FREQUENCY MULTIPLIER Z–2034 (FREQUENCY MULTIPLIER, UNIT 2).—Unit 2 receives the 100-kc crystal-controlled output of unit 1, and, by means of multipliers and harmonic filters, produces a 1-mc signal, which is delivered to units 4, 5, 6, 7, and 10.

(1) FREQUENCY QUINTUPLER V–2031.—The 100-kc output (1a) of unit 1 is applied to the grid of V–2031 (figure 2–5) through J–2031, transmission-line terminating resistor R–2031, and grid-leak network R–2032 and C–2031. Test point J–2038 is provided to test the input (approximately 13 volts). Quintupler V–2031, operated class C, delivers 100 kc and harmonics to filter Z–2031. Frequencies other than the fifth harmonic, 500 kc, are attenuated by Z–2031.

(2) FREQUENCY DOUBLER V–2032. — This stage (figure 2–6), also operated class C, receives the 500-kc output of Z–2031 and delivers 500 kc and harmonics to a 1-mc filter comprising Z–2032 and Z–2033, capacity coupled by C–2038. Frequencies other than the second harmonic, 1 mc, are attenuated by Z–2032 and Z–2033. The output of Z–2033 is impressed across capacitance voltage divider C–2033 and C–2037.

(3) CATHODE FOLLOWERS V–2033 AND V–2034.—These cathode followers (figure 2–7) isolate the multipliers from the units to which the 1-mc output is fed. The 1-mc output of Z–2033 is applied to the cathode followers from the capacitance voltage divider, C–2033 and C–2037. Cathode follower outputs 2b and 2c are fed to mixers, and are therefore reduced by the voltage divider comprising R–2042, R–2036, and R–2037 and the 1K resistors at the inputs to units 5 and 6. Outputs 2a, 2d, and 2e are fed to multipliers and therefore require no reduction in amplitude.

d. FREQUENCY MULTIPLIER Z–2103 (FREQUENCY MULTIPLIER, UNIT 4).—Unit 4 receives the 1-mc output of unit 2, and by means of multipliers and harmonic filters produces an 8-mc signal, which is delivered to unit 5.

(1) FREQUENCY QUADRUPLER V–2101.—The 1-mc output (2a) of unit 2 is applied to the grid of V–2101 (figure 2–8). Test point J–2104 is provided to

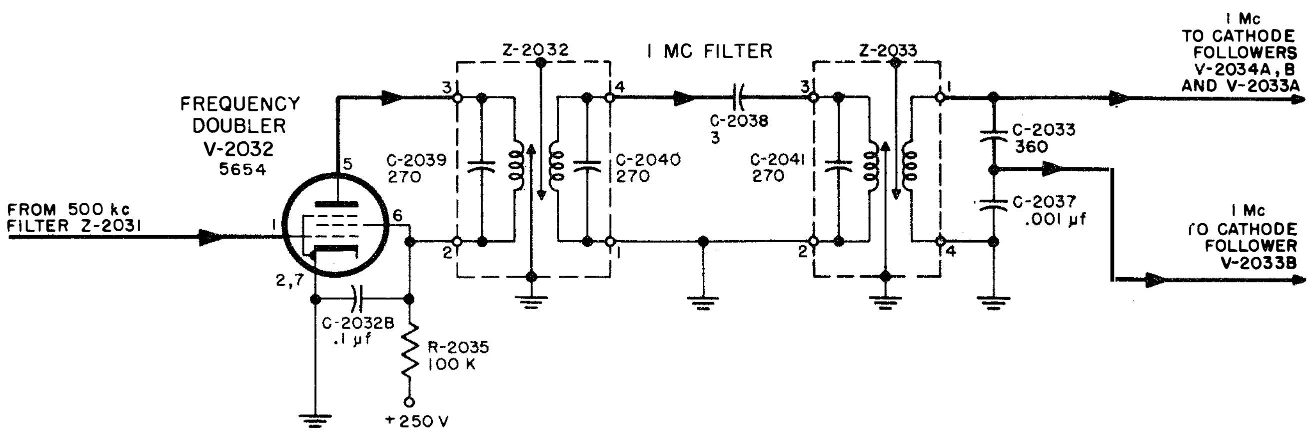


Figure 2—6. RFO Unit 2, Frequency Doubler V—2032, Simplified Schematic

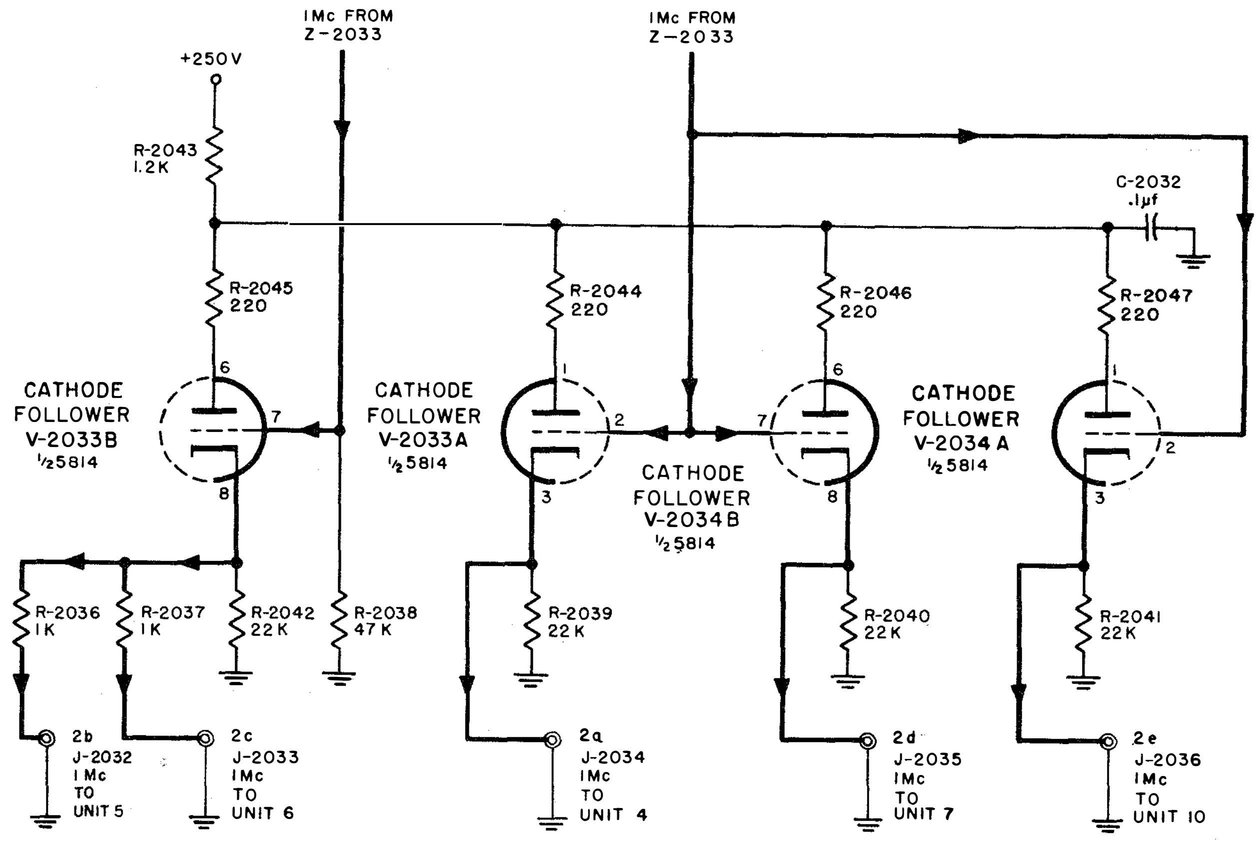


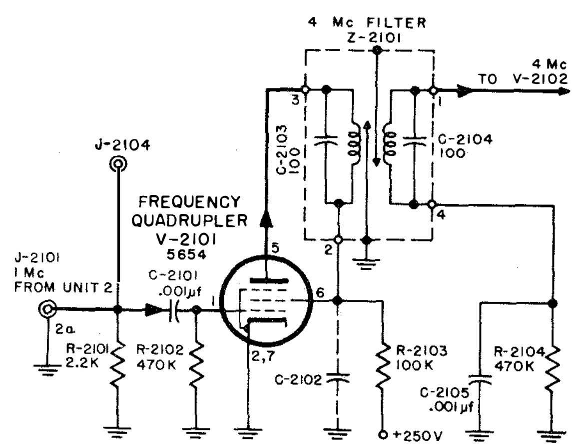
Figure 2–7. RFO Unit 2, Cathode Followers V–2033 and V–2034, Simplified Schematic

test this signal (approximately 8.8 volts) across terminating resistor R–2101. Quadrupler V–2101, operated class C, produces harmonics of 1 mc that are filtered by Z–2101 to attenuate all harmonics but the fourth (4 mc). The 4-mc output of Z–2101 is fed to the grid of doubler V–2102.

(2) FREQUENCY DOUBLER V–2102.—Doubler V–2102 (figure 2–9) receives the output of Z–2101 and delivers 4 mc plus harmonics to the 8-mc filter, Z–2102. This filter attenuates all frequencies other than 8 mc. The final output (4a) is fed to unit 5 after being reduced by capacitance voltage divider C–2108 and C–2109 to a level of approximately 1.2 volts. Test point J–2105 is provided to test output 4a.

e. RADIO FREQUENCY OSCILLATOR Z–2053 (INTERPOLATION OSCILLATOR, UNIT 3).—Unit 3 generates frequencies in the range of 90 to 100 kc, variable in steps of 10, 100, and 1,000 cycles. To obtain maximum stability, the main frequency-controlling elements are kept in an oven at a constant temperature of 70°C. (158°F.). The output frequency is varied by means of decade switches that place inductors and capacitors of the required size in the oscillator main tank circuit.

(1) OSCILLATOR V–2051.—The oscillator is an electron-coupled Hartley circuit (figure 2–10). The main tank circuit comprising C–2060, L–2051A and associated



NOTE: CAPACITORS SHOWN WITH DOTTED LINES ARE BUILT INTO TUBE SOCKETS AND ARE 0.001 µf.

Figure 2–8. RFO Unit 4, Frequency Quadrupler V–2101, Simplified Schematic

elements is located in the oven that is part of Z–2051. Because of variations among coils used for L–2051A, it is necessary to have specially matched trimmer coils L–2051B to make it possible to adjust the resonant frequency of the main tank circuit to 100 kc. L–2051B and the oven assembly constitute Z–2051. The oscillator frequency may be changed by switching additional in-

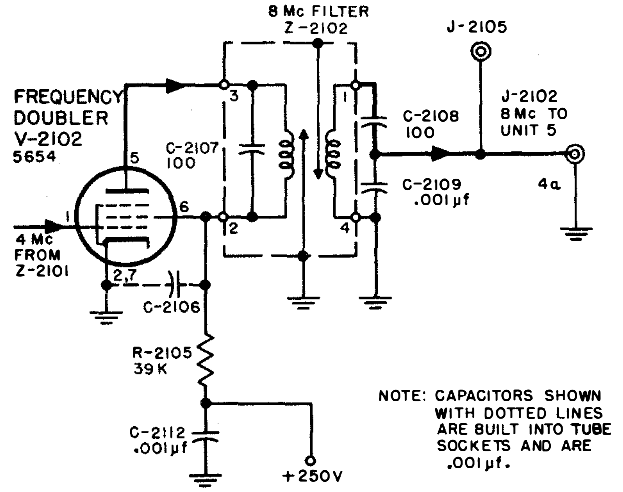


Figure 2–9. RFO Unit 4, Frequency Doubler V–2102, Simplified Schematic

ductors and capacitors in or out of the main tank circuit. This is accomplished by means of three decade switches, S–2051, S–2052, and S–2053, which are operated by controls on the RFO mounting (unit 14). For stability, V–2051 uses a regulated filament supply and a +250-volt regulated plate supply. To reduce interaction with other circuits via the power supply leads, a three-section plate decoupling filter, comprising R–2054, R–2055, and C–2064, is used.

(2) 1-KC STEPS.—Inductor L–2080 or any one of the inductors, L–2052 to L–2060, and any one of the corresponding capacitors, C–2066 and C–2051 to C–2059, may be placed in the main tank circuit by means of switch S–2051 (figure 2–9). In this way, the oscillator frequency may be changed in 1-kc steps. With switch S–2052 in position 9, S–2053 in position 10, and S–2051 in position 9, the main tank inductor, L–2051A, is series-connected to ground through contact 9 of S–2051B, inductors L-2060 through L–2052, inductor L–2080, trimmer L–2051B, contact 9 of S–2052B, and contact 10 of S–2053B. Meanwhile, with S–2051C on contact 9, the main tank capacitor, C–2060, is connected in parallel to C–2066 of the capacitor assembly, Z–2052. Under these conditions, the oscillator frequency is 100 kc. If S–2051 is now placed in position 8, L–2060 is shorted out through contact 8 of S–2051B, thus reducing the inductance in the tank circuit. This would result in a higher oscillator frequency if it were not for the fact that, at the same time, the main tank capacitor, C–2060, is connected in parallel, through S–2051C, to capacitor C–2059, located in capacitor assembly Z–2052. The value of C–2059 is so high that it more than compensates for the above-mentioned decrease in inductance. As a result of the increase in capacitance, the oscillator frequency is lowered to 99 kc. When S–2051 is placed in position 7, L–2060 and L-2059 are shorted out, but C–2060 is connected to an even higher capacitance than formerly, which more than compensates for the decrease in inductance, resulting in a still lower frequency, 98 kc. This process is repeated each time switch S–2051 is placed in a lower position, resulting in 1-kilocycle step decreases of the oscillator frequency until 91 kc is reached. This occurs when S–2051 is in position 0. At this time, all of the inductors, L–2052 through L–2060, are shorted out, and the tank inductor, L–2051A, is series-connected to ground through L–2080 and trimmer L–2051B. L–2080 is the mounting front panel INT. OSC. ZERO ADJ. control. It permits adjustment of the oscillator output when this output is compared on the ZERO BEAT INDICATOR electron ray tube with the crystal-controlled output of unit 1.

(3) 100-CYCLE STEPS.—The oscillator output may be changed in steps of 100 cycles by means of switch S–2052. With this switch in position 9, and S–2053 in position 10, the output of the 1-kc step switch, S–2051, is grounded through contact 9 of S–2052B and contact 10 of S–2053B. Under these conditions, the 100-cycle step switch has no effect on the oscillator frequency. However, when S–2052 is placed in position 8, all the inductors, L–2061 to L–2068, inclusive, are shorted out, and the signal from the 1-kc step switch is fed through L–2069 to ground. The additional inductance introduced by L–2069 decreases the oscillator frequency by 100 cycles. Similarly, when S–2052 is placed in position 7, another inductor, L–2068, is placed in the circuit, and the oscillator output is decreased by another 100 cycles. This process may be continued until S–2052 is placed in position 0 (with S–2053 still in position 10), and a total decrease of 900 cycles is obtained in the oscillator frequency. Thus, S–2052 makes available frequency changes up to 900 cycles, in 100-cycle steps. This range of frequency changes may be increased by 100 cycles by means of 10-cycle step switch S–2053.

(4) 10-CYCLE STEPS.—Similarly, when the 10-cycle step switch S–2053 is in position 9, L–2079 is added to the tank circuit. The additional inductance introduced by L–2079 decreases the oscillator frequency by 10 cycles. This process may be continued until S–2053 is in position 0. When this position is reached, S–2053 will have made available oscillator frequency changes up to 100 cycles, in 10-cycle steps.

(5) FREQUENCY SELECTION.—Suppose that it is desired to tune the oscillator to 94.28 kc with the 1-kc and 100-cycle step switches initially set at position 9 and the 10-cycle step switch set at position 10. As seen in paragraph 2*e*(2), this produces an output of 100 kc. The 1-kc step switch is placed in position 4, which reduces the oscillator output by 5 kc to 95 kc. The 100-cycle step switch is set to position 2, reducing the oscillator output by 700 cycles to 94.30 kc. Finally, the 10-cycle step switch is set to position 8, reducing the oscillator output by 20 cycles to the desired frequency of 94.28 kc. It can be seen that the output frequency of the oscillator will be 90 kc plus the values according to the position setting of the 1-kc, 100-cycle, and 10-cycle step switches respectively. The 1-kc step switch is controlled by the KC control knob (CC), the 100-cycle step switch by the 100~ control knob (DD), and the 10-cycle step switch by the 10~ control knob (EE). All three of these controls are located on the RFO front panel.

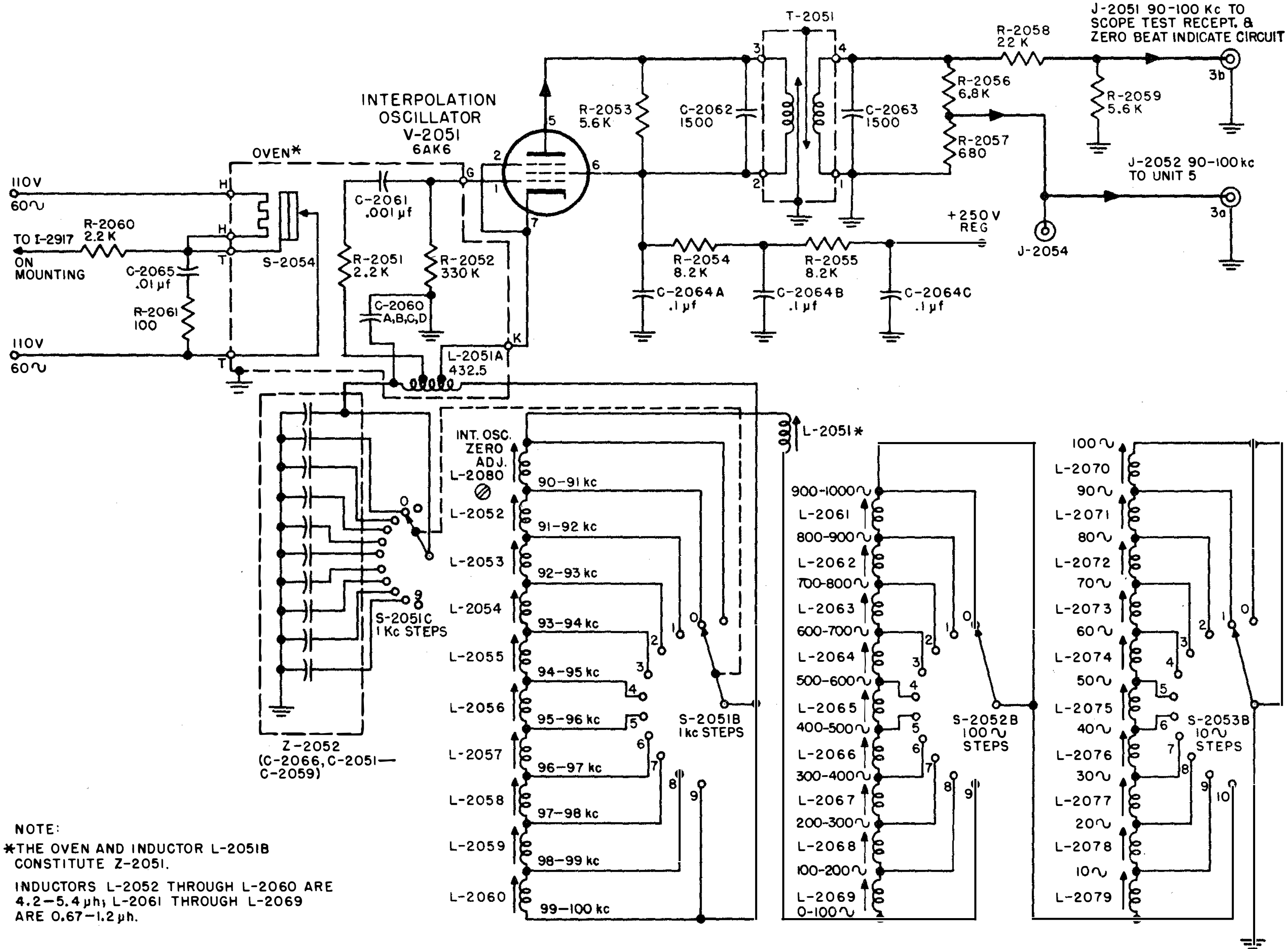


Figure 2–10. RFO Unit 3, Interpolation Oscillator V–2051, Simplified Schematic

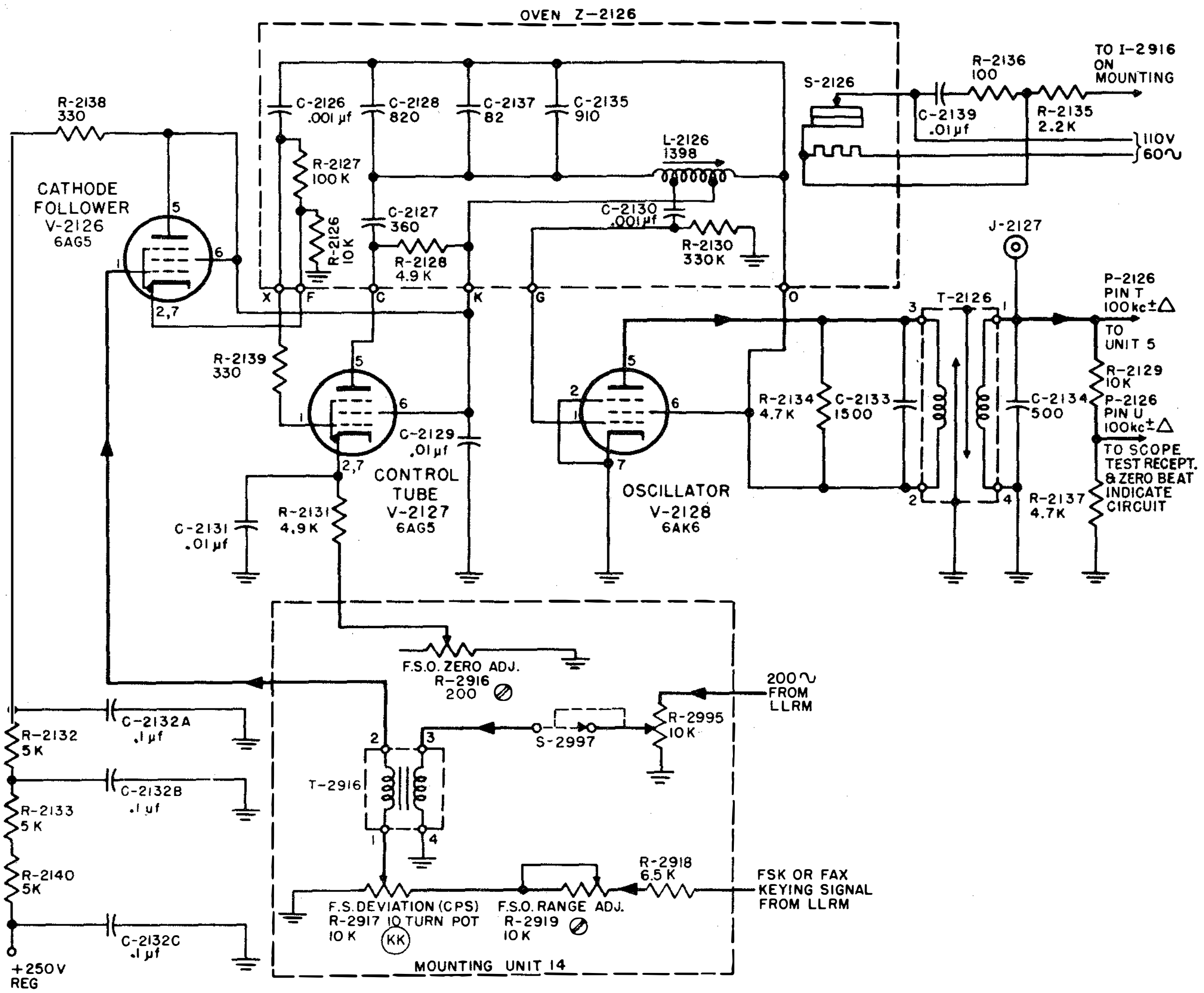


Figure 2–11. RFO Unit 12, Frequency Shift Oscillator, Simplified Schematic

(6) OUTPUT CIRCUIT.—Oscillator V–2051 is provided with a tuned output circuit comprising the tunable transformer, T–2051, and capacitors C–2062 and C–2063. Resistors R–2058, R–2059 and R–2056, R2057 are voltage dividers from which the two 90- to 100-kc outputs are tapped. These resistors widen the band pass by loading the output tank circuit. Output 3b, taken from the junction of R–2058 and R–2059, is fed to the oscilloscope test receptacle for use as an aid in servicing. Output 3a, taken from the junction of R–2056 and R–2057, is fed to unit 5. Test point J–2054 is provided for testing output 3a whose amplitude is approximately 0.3 volt.

(7) HEATER CIRCUIT.—The oven heater circuit includes thermostat S–2054 and the heater element located inside the oven, and R–2060, R–2061 and C–2065 located outside the oven. R–2061 and C–2065 constitute a spark-suppressor circuit. When the heater is on, the INT.-HEATER ON indicator light, I–2917, on the mounting front panel is energized via dropping resistor R–2060.

f. RADIO FREQUENCY OSCILLATOR Z–2127 (FREQUENCY SHIFT OSCILLATOR, UNIT 12).—This unit (figure 2–11) makes possible frequency-shift keying and facsimile operation of the transmitter. It includes a 100-kc oscillator that is capable of shifting its frequency ±1,000 cps from 100 kc at a 240-cps rate (corresponding to teletype at 600 words a minute) during FSK operation, or up to 2,000 cps, as determined by the amplitude of the photo input voltage, during facsimile operation.

(1) OSCILLATOR V–2128.—This stage is an electron-coupled 100-kc Hartley oscillator. To obtain stability, the frequency controlling tank circuit, comprising capacitors C–2128, C–2137, C–2135, tunable inductor L–2126, and associated elements, is located in an oven maintained at 70°C. (158°F.). Plug-in inductor L–2126 is a coarse frequency control. The tuned output tank, comprising T–2126, C–2133 and C–2134, filters the output and isolates the oscillator from the RFO subunits to which the oscillator output is connected. Load resistor R–2134 increases the band pass of the output tank.

(2) CONTROL TUBE V–2127.—The control tube circuit is essentially a part of the oscillator circuit. A portion of the oscillator output is coupled to the control grid of V–2127 by C–2126. This is equivalent to changing a reactive component in the tank, and will change the oscillator frequency. The frequency, however, may be adjusted to 100 kc (in the absence of frequency-shift or facsimile keying signals) by means of the coarse control, L–2126, and the fine control, F.S.O. ZERO ADJ., R–2916, which is located on the control panel and sets the cathode bias of the control tube. If the control tube grid voltage is now made more positive, the control tube delivers a larger reactive current to the tank, and the oscillator frequency increases. If the grid voltage is made less positive, the oscillator frequency decreases.

(3) CATHODE FOLLOWER V–2126.—The control tube grid circuit is connected to the output of cathode follower V–2126 via isolating resistor R–2127. By this means the oscillator frequency may be made to vary in accordance with the voltage variations at the cathode follower grid. The grid is returned to ground through the secondary winding of T–2916, and a portion of potentiometer R–2917. All these components through which the grid is grounded are located on the mounting front panel. The F.S. DEVIATION control (KK), R–2917, is calibrated directly in cycles per second deviation from the nominal carrier frequency. For FSK operation, control (KK) may be set to provide an oscillator frequency deviation $\left(\frac{\triangle f}{2}\right)$ up to ±500 cycles from the signal from V–1019 in the LLRM. The equipment FSK keying requirements specify a deviation adjustable to any value between zero and 500 cycles (minimum) on each side of the carrier for mark-and-space telegraph signals. Thus a 1,000-cps space-to-mark frequency shift, corresponding to a 500-cycle deviation on either side of the carrier, is provided when control (KK) R–2917 is set to its midposition (500). For facsimile transmission the equipment is required to have a total frequency shift ($\triangle$f) adjustable to any value between 500 and 2,000 cycles for a facsimile set output keying voltage of +20 volts dc in normal operation. This maximum shift is obtained by setting the RFO front panel controls to a frequency that is $\frac{\triangle f}{2}$ below the desired carrier frequency and adjusting the F.S. DEVIATION control (KK) until its dial reads 1/2 of the desired total shift $\left(\frac{\triangle f}{2}\right)$. For example, if a 2,000-cycle shift is desired for the maximum signal from the facsimile set, the RFO output frequency should be adjusted to be 1,000 cycles lower than the nominal carrier frequency and control (KK) should be adjusted to read 1000.

The F.S.O. RANGE ADJ. control, R–2919, may be set to make the deviation dial read correctly. Frequency-shift keying signals from V–1019 in the LLRM are applied to the cathode follower grid through R–2919, R–2917, and the secondary of T–2916. These signals, which are rectangular voltage pulses, may be phase-modulated by a 200-cycle signal (from V–1020 in the LLRM), which is applied across the T–2916 primary. The modulated keying pulses, impressed on the cathode follower grid, vary the reactive current in the control tube by varying its bias, and hence frequency-modulate the oscillator in accordance with the amplitude of the keying pulses at the grid of the cathode follower. The

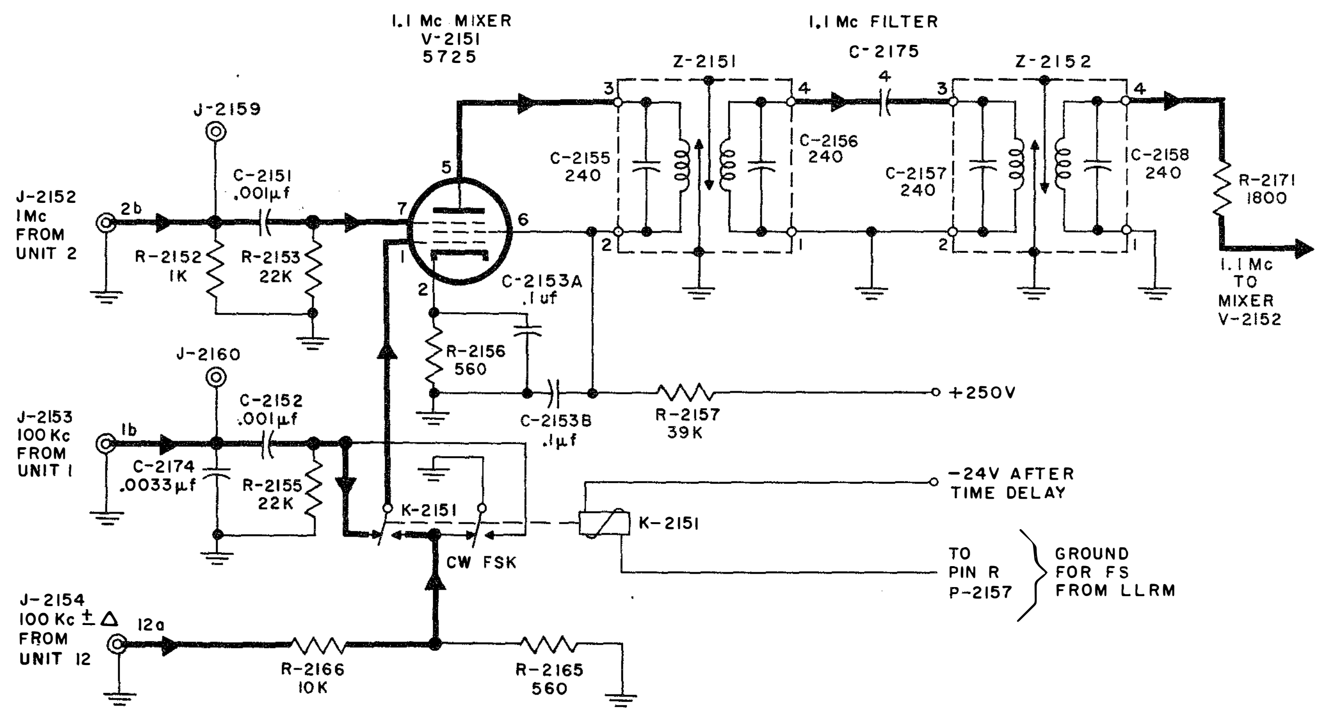


Figure 2–12. RFO Unit 5, 1.1-Mc Mixer V–2151, Simplified Schematic

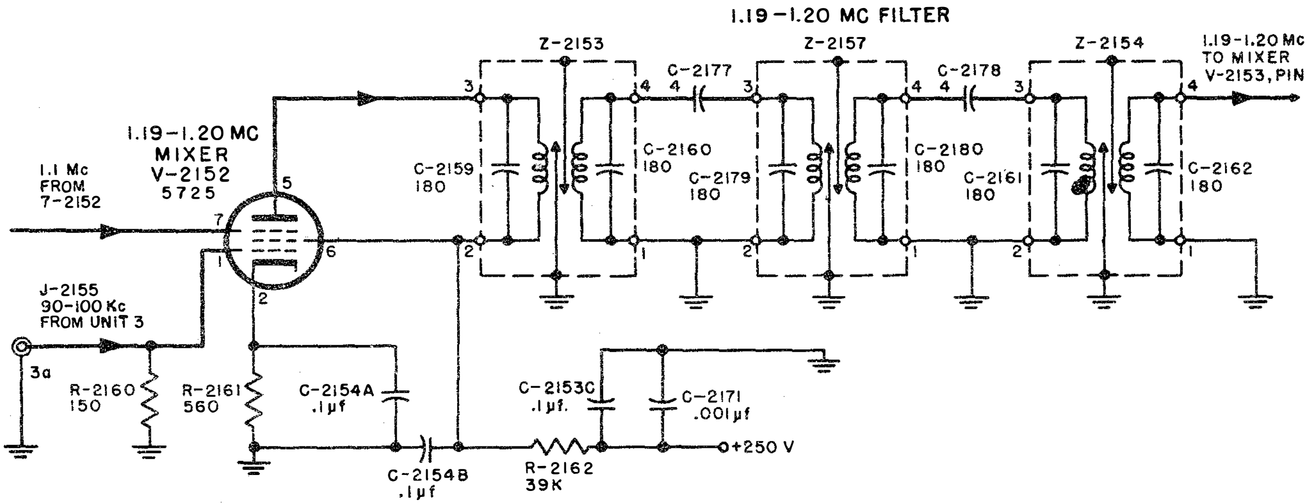


Figure 2—13. RFO Unit 5, 1.19- to 1.2-Mc Mixer V—2152, Simplified Schematic

phase-modulating signal varies the carrier phase ±1 radian from the nominal position at a fixed 200-cps rate. It is provided to minimize selective fading effects. The cathode follower isolates the oscillator circuit, and T–2916 isolates the cathode follower from the 200-cycle source in the LLRM.

(4) MISCELLANEOUS.—The heater is provided with a thermostat, S–2126. R–2136 and C–2139 constitute a spark suppressor circuit. R–2135 is a dropping resistor for the F.S. HEATER ON indicator light, I–2916, located on the mounting front panel. To obtain frequency stability and reduce interaction with other circuits via the power supply, a +250-volt regulated supply and a three-section plate decoupling capacitor, C–2132, are used. V–2126, V–2127, and V–2128 also use a regulated filament supply.

The output of unit 12 (100 kc $\pm\frac{\Delta f}{2}$ where $\frac{\Delta f}{2}$ represents frequency deviation) is fed to unit 5 and to the oscilloscope test receptacle in unit 14. Test point J–2127 is provided to test the output (approximately 12.3 volts). The presence of the control tube across the oscillator tank circuit makes the oscillator less stable; therefore, during c-w and phone operation, the crystal oscillator (unit 1) is used as the master frequency source in place of unit 12.

g. ELECTRONIC FREQUENCY CONVERTER Z–2158 (FREQUENCY CONVERTER, UNIT 5).—Unit 5 receives five frequencies from other subunits of the RFO, four of which are used at any given time, and mixes them to produce an output in the range of 9.19 to 9.2 mc, in 10-cycle steps, which is delivered to unit 6. The frequencies received are 1 mc from unit 2, 100 kc from unit 1, 100 kc ±△ from unit 12, 90 to 100 kc from unit 3, and 8 mc from unit 4. The 100-kc signal from unit 1 is used during c-w and phone operation only. During FSK and facsimile operation the 100-kc ±△ signal from unit 12 is used instead of the signal from unit 1. See paragraph 2*f* for a complete discussion of the output frequencies from unit 12 during FSK and facsimile operation.

(1) 1.1-MC MIXER V–2151.—Whenever SERVICE SELECTOR switch Ⓤ in the LLRM is in FSK or FAX position, relay K–2151 is energized from −25 volts after time delay to the "ground for F.S." line supplied from the LLRM (paragraph 7*c*(8)) and input 12a (100 kc ±△) from unit 12 is applied to the control grid of mixer V–2151 (figure 2–12) through R–2166 and the contacts of K–2151. With SERVICE SELECTOR switch Ⓤ in any other position, relay K–2151 is de-energized, and, as a result, input 12a is grounded through R–2166 and input 1b (100 kc from unit 1) is applied to the mixer control grid. The 1-mc input from unit 2 (2b) is applied to the mixer suppressor grid. The mixer output is filtered by Z–2151 and Z–2152. The resulting 1.1-mc signal is applied to the suppressor grid of the second mixer, V–2152.

(2) 1.19- TO 1.2-MC MIXER V–2152.—A 90- to 100-kc signal (3a) is applied to the control grid of the second mixer, V–2152 (figure 2–13). The mixer output is filtered by the sextuple-tuned filter combination, Z–2153, Z–2157, and Z–2154, whose output (1.19 to 1.2 mc) is applied to the control grid of the third mixer, V–2153.

(3) 9.19- TO 9.2-MC MIXER V–2153 AND AMPLIFIER V–2154.—An 8-mc signal (4a) from unit 4 is applied to the suppressor grid of mixer V–2153 (figure 2–14). The 9.19- to 9.2-mc output is filtered by Z–2155, amplified by V–2154, filtered again by Z–2156, reduced in amplitude by voltage divider C–2170 and C–2169, and fed to the output receptacle, J–2156, from which it is transmitted to unit 6. Test points J–2158, J–2159, and J–2160 are provided for testing inputs 4a (approximately 1.2 volts), 2b (approximately 1.2 volts) and 1b (approximately 0.36 volt), respectively. Test point J–2161 is provided for testing the output 5a (approximately 1.3 volts) of unit 5.

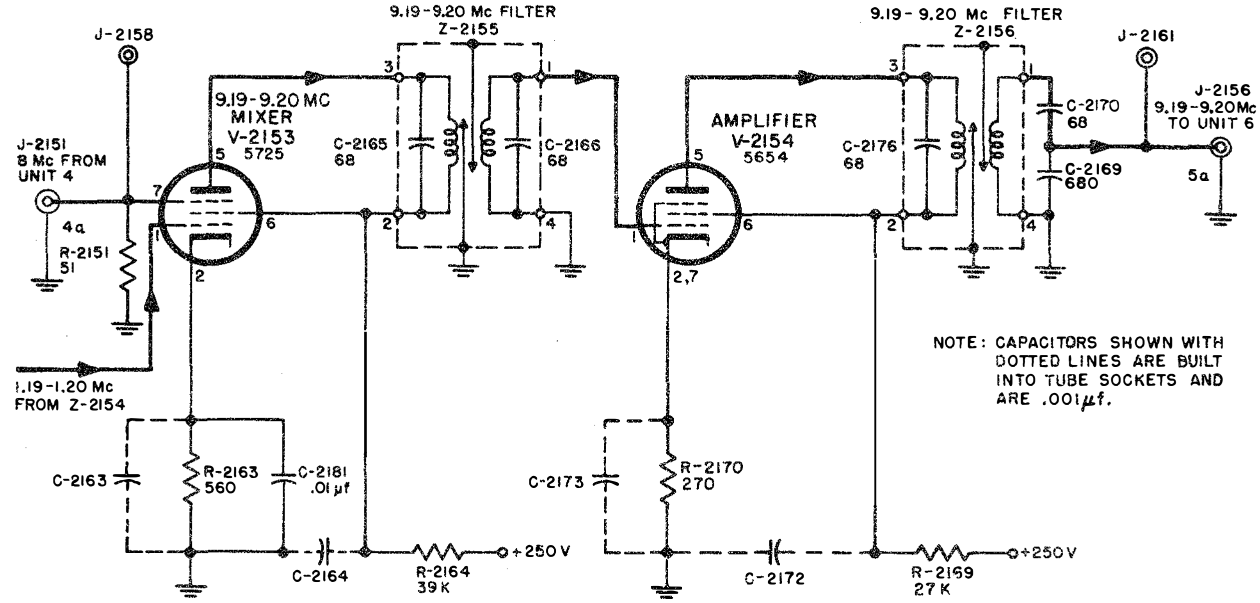


Figure 2–14. RFO Unit 5, 9.19- to 9.2-Mc Mixer V–2153 and Amplifier V–2154, Simplified Schematic

b. ELECTRONIC FREQUENCY CONVERTER Z–2204 (10-KC STEP GENERATOR, UNIT 6).—Unit 6 (figure 2–15) produces and feeds to unit 8 an output of 10.4 to 10.5 mc, variable in steps of 10 cps. In addition, it generates and feeds to the oscilloscope test receptacles a 10-kc output and an output of 210 to 300 kc, variable in steps of 10 kc. The unit contains a 10-kc step phase-locked oscillator comprising mixer V–2203, reactance tube V–2204, and oscillator V–2205. The output from these units is synchronized by the 100-kc output from the crystal oscillator (unit 1). To insure the stability of the generated frequencies, the three tubes of the phase-locked oscillator and V–2202, the blocking oscillator and shaper, use a regulated filament supply. The output of oscillator V–2205 (210 to 300 kc) is mixed with a 1-mc signal from unit 2 by mixer V–2206. The sum, 1.21 to 1.3 mc, is fed to mixer V–2207 and mixed with a 9.19- to 9.2-mc signal from unit 5. The sum, 10.4 to 10.5 mc, is fed to amplifiers V–2208 and V–2209 and then delivered to unit 8.

(1) ISOLATING AMPLIFIER V–2201.—The 100-kc signal (1*c*) from unit 1 is coupled by C–2201 to the grid of isolating amplifier V–2201 (figure 2–16). Test point J–2208 is provided for testing input 1*c* (approximately 7.4 volts). Amplifier V–2201 isolates blocking oscillator V–2202A from the crystal oscillator in unit 1, and provides sufficient output voltage to synchronize the blocking oscillator to exactly 1/10 of the crystal frequency.

(2) BLOCKING OSCILLATOR V–2202A AND SHAPER V–2202B. — When blocking oscillator V–2202A (figure 2–16) begins to conduct, plate current begins to flow through the plate winding of T–2201. This induces a positive voltage on the grid through transformer T–2201 and C–2204, and, as a result, the plate current increases further, inducing a larger positive voltage on the grid, etc. This cumulative action occurs very rapidly and continues until the tube is driven to saturation. At this point further increases in grid voltage do not affect the plate current. When there is no further change in plate current, there is no further induced positive voltage on the grid. This decreases plate current, thereby inducing a negative voltage on the grid through T–2201, thus decreasing the plate current still further. This cumulative action occurs very rapidly, driving the grid far below the cutoff point. Then, as C–2204 discharges to ground potential through R–2207, the grid voltage becomes less negative and, in free-running operation, returns to just above the cutoff point. Plate current begins to flow again, and the cycle repeats itself. The grid recovery time is determined by the R-C time constant on the charging network, C–2204 and R–2207.

The grid recovery time and the cutoff point are so chosen that only every tenth cycle from the isolating amplifier will arrive at the blocking oscillator plate at a time when the grid is sufficiently near the cutoff point to be raised above cutoff by the impressed signal. As a result, the blocking oscillator frequency is synchronized to exactly 1/10 of the isolating amplifier output frequency, or 1/10 of the crystal oscillator frequency. The blocking oscillator must be set at 10 kc or slightly lower for it to become synchronized at a 10-kc rate. If it is set slightly higher than 10 kc (that is, if the grid recovery time is decreased) the 100-kc pulse will come too late and the oscillator will have operated prematurely. The free-running frequency of the blocking oscillator may be varied by R–2210, by means of which the cutoff point may be raised or lowered.

The blocking oscillator synchronizes step oscillator V–2205. To obtain more stable control of the step oscillator, the wide pulses from the blocking oscillator

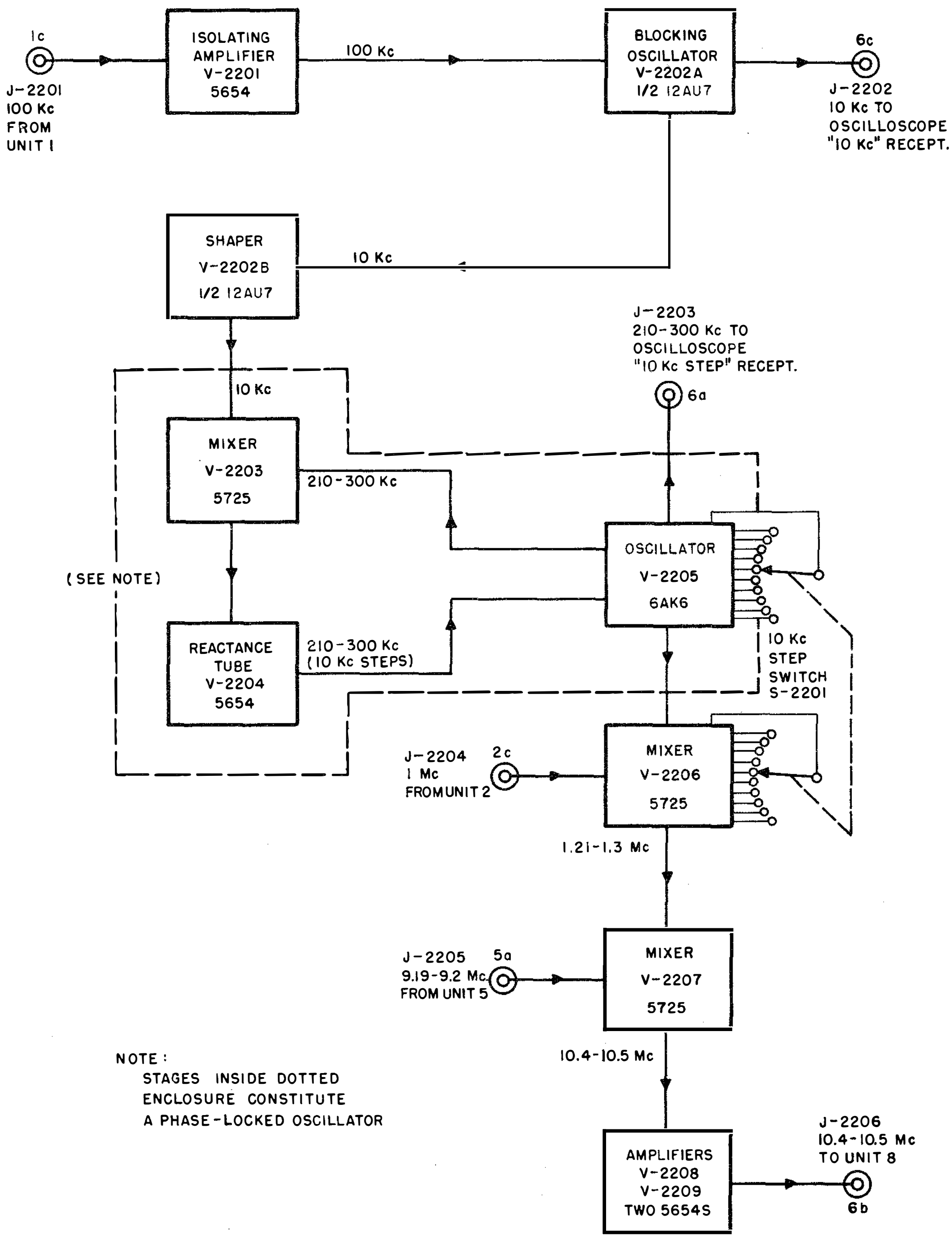


Figure 2—15. RFO Unit 6, Electronic Frequency Converter (10-Kc Step Generator), Block Diagram

are delivered through the peaking network, C–2290 and R–2211, and are narrowed to approximately 1 microsecond (5 volts amplitude) by a shaping circuit consisting of V–2202B and the damped-tuned circuit, T–2202 and CR–2201. Crystal CR–2201 allows only positive pulses to appear at the output of the shaper. The shaper output is applied from the secondary of T–2202 to the control grid of mixer V–2203. A portion of the blocking oscillator output (6c) is coupled through J–2202 to the 10-kc oscilloscope test receptacle in the mounting.

(3) STEP OSCILLATOR V–2205, MIXER V–2203 AND REACTANCE TUBE V–2204.—Step oscillator V–2205 generates frequencies in the range of 210 to 300 kc, in steps of 10 kc (figure 2–17). The oscillator is locked in to the synchronized 10-kc blocking oscillator, V–2202A, by means of mixer V–2203, a filter network, and reactance tube V–2204. The reactance tube corrects the oscillator if it drifts from the frequency to which it was tuned.

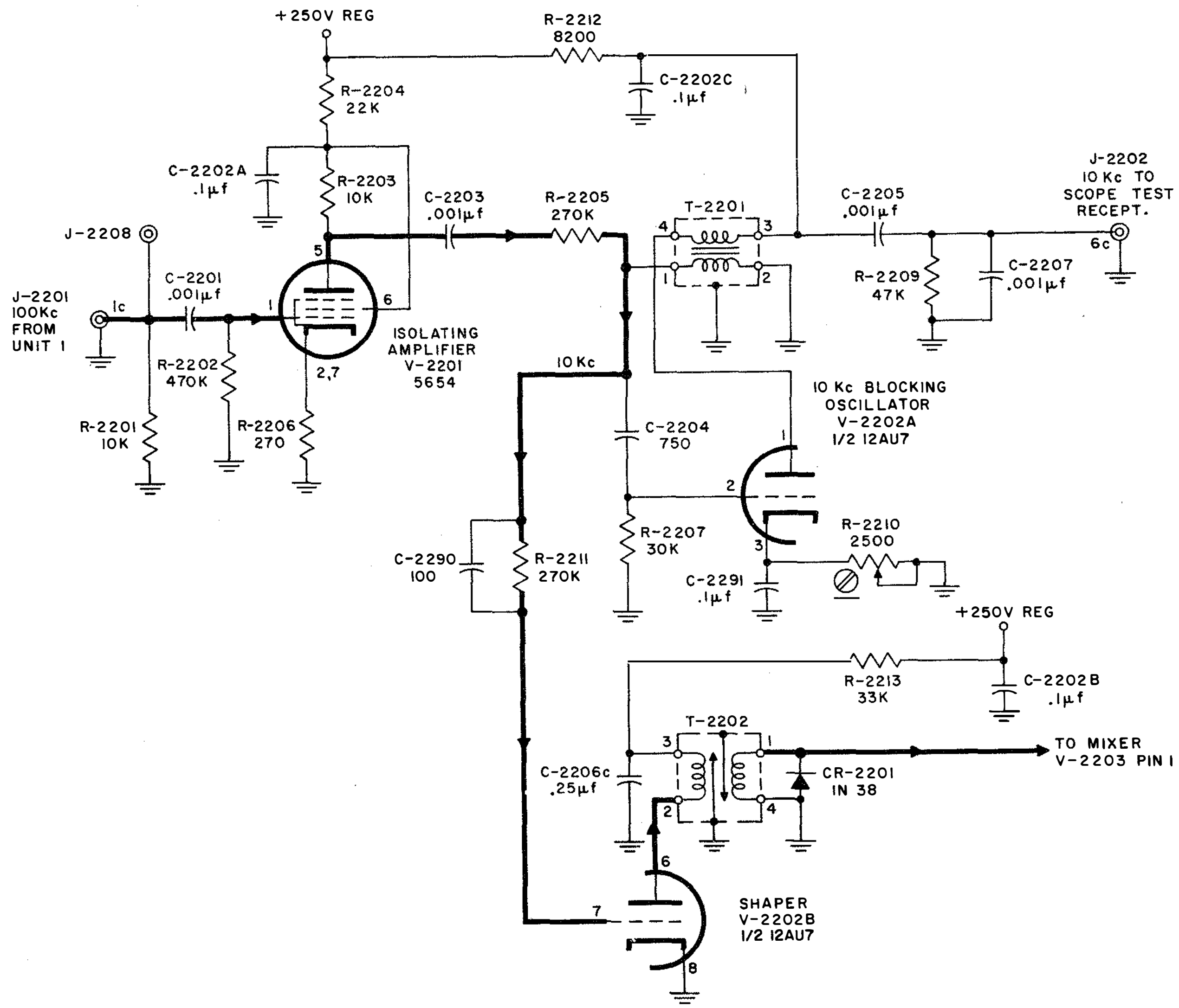


Figure 2—16. RFO Unit 6, Isolating Amplifier V—2201, Shaper V—2202B and 10-Kc Blocking Oscillator V—2202A, Simplified Schematic

(*a*) The 10-kc step oscillator is a modified Colpitts oscillator (figure 2–17). The tank circuit consists of Z–2201, C–2220, C–2287, and one or more of the inductors, L–2204 to L–2212, inclusive, selected according to the final output frequency desired for unit 6. Inductors L–2204 through L–2212 are wired to contacts of section D of the 10-kc decade step switch S–2201, which is, in turn, controlled by the 10 KC control knob ⒿⒿ, one of the frequency control knobs. When S–2201 (10 KC) is in position 0, all the inductors, L–2204 through L–2212, are included in the tank circuit, and the lowest oscillator frequency, 210 kc, is obtained. When S–2201 is in position 1, L–2204 is shorted. This reduces the inductance in the tank circuit and increases the oscillator frequency to 220 kc. When switch S–2201 is in position 2, both L–2204 and L–2205 are shorted, reducing the inductance in the tank circuit still further and consequently increasing the oscillator frequency to 230 kc. Thus the oscillator frequency may be increased in steps of 10 kc until (in position 9) inductors L–2204 to L–2212, inclusive, are all shorted. With only Z–2201 remaining in the tank circuit, the oscillator frequency is 300 kc. The oscillator frequency is thus adjustable from 210 to 300 kc, in 10-kc steps. The oscillator frequency may be adjusted to 300 kc by means of adjustable trimmer capacitor C–2219. Output 6a (210-300 kc) is fed to the 10-kc step oscilloscope test receptacle in unit 14.

(*b*) A portion of the 210- to 300-kc output is coupled by C–2216 to the suppressor grid of mixer V–2203. The 10-kc output of shaper V–2202B, rich in harmonics and synchronized with the 100-kc oscillator in unit 1, is applied to the mixer control grid. The mixer output contains d-c and a-c components. If the oscillator frequency is an exact multiple of 10 kc, the components consist of 10 kc and its harmonics in addition to the oscillator frequency (210 to 300 kc). The composite a-c signal is prevented from reaching the reactance tube, V–2204, control grid by a shunting capacitor, C–2208, a

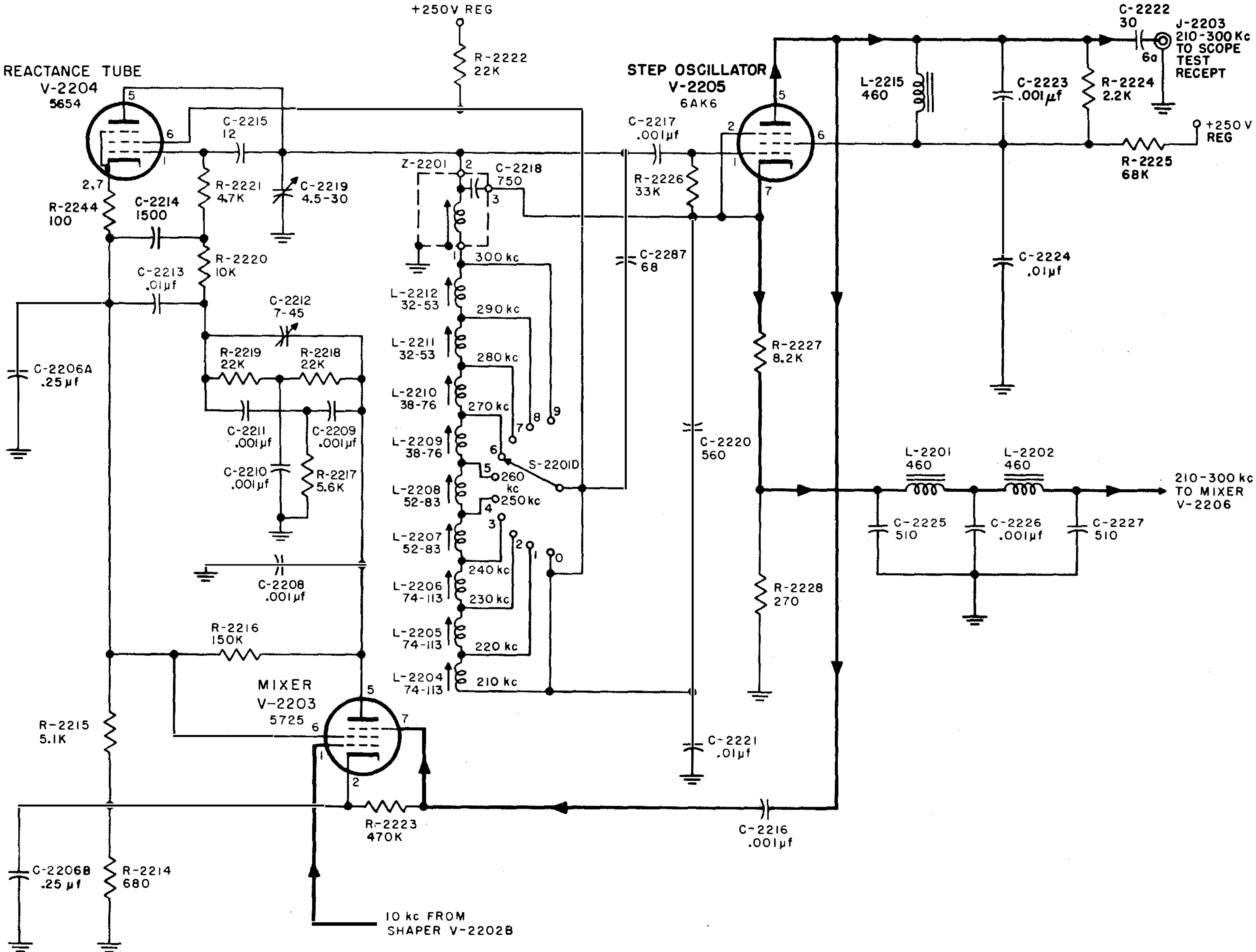


Figure 2–17. RFO Unit 6, Mixer V–2203, Step Oscillator V–2205, and Reactance Tube V–2204, Simplified Schematic

bridged-T 10-kc rejection filter (R–2217, C–2209, C–2211, C–2212, R–2218, R–2219, and C–2210) and a low-pass R-C filter (C–2213, R–2220, and C–2214). The bridged-T filter is used to insure that the strong 10-kc signal is adequately attenuated. The d-c component is a function of the tube operating point, the amplitude of the 10-kc and oscillator (210 to 300 kc) signals, and the phase relationship of the oscillator frequency to the 10-kc signal harmonic. Stabilized power supplies minimize changes due to the first two variables; only the phase relationship is important in determining the d-c component of the mixer output.

Resistor R–2216 is the plate load for V–2203. To provide direct coupling, the mixer plate and screen voltages are obtained from the reactance tube cathode current flow through R–2215. The d-c output of the mixer is applied to the control grid of the reactance tube, V–2204, where it determines the reactance tube mutual conductance operating point, *and hence the magnitude of the reactance controlled by V–2204 in the oscillator circuit.* The relative phase of the 10-kc and oscillator frequency voltages shift until the required reactance is contributed by V–2204 to maintain the desired frequency. If the oscillator frequency tends to increase, the phase displacement causes a change in the mixer d-c output which will increase the magnitude of the capacitive reactance contributed by V–2204 and hence tend to decrease the oscillator frequency. By this means the step oscillator, V–2205, is locked to the 10 kc.

(*c*) If the oscillator has not been locked in to 10 kc, the oscillator frequency will probably not be an exact multiple of 10 kc. In this case, the mixer output will contain, in addition to the d-c and a-c signals previously mentioned, the difference frequency between the oscillator output and the nearest harmonic of 10 kc. If this difference frequency is less than approximately 1.5 kc, it will pass through the 10-kc and low-pass filters and appear at the grid of the reactance tube. Frequencies above 1.5 kc will be reduced in amplitude by the low-pass filter and will have no effect. An a-c grid voltage, because of the difference frequency, is now superimposed symmetrically upon the d-c grid voltage, which established the locked-in frequency of the oscillator. This changes the reactive component of current de-

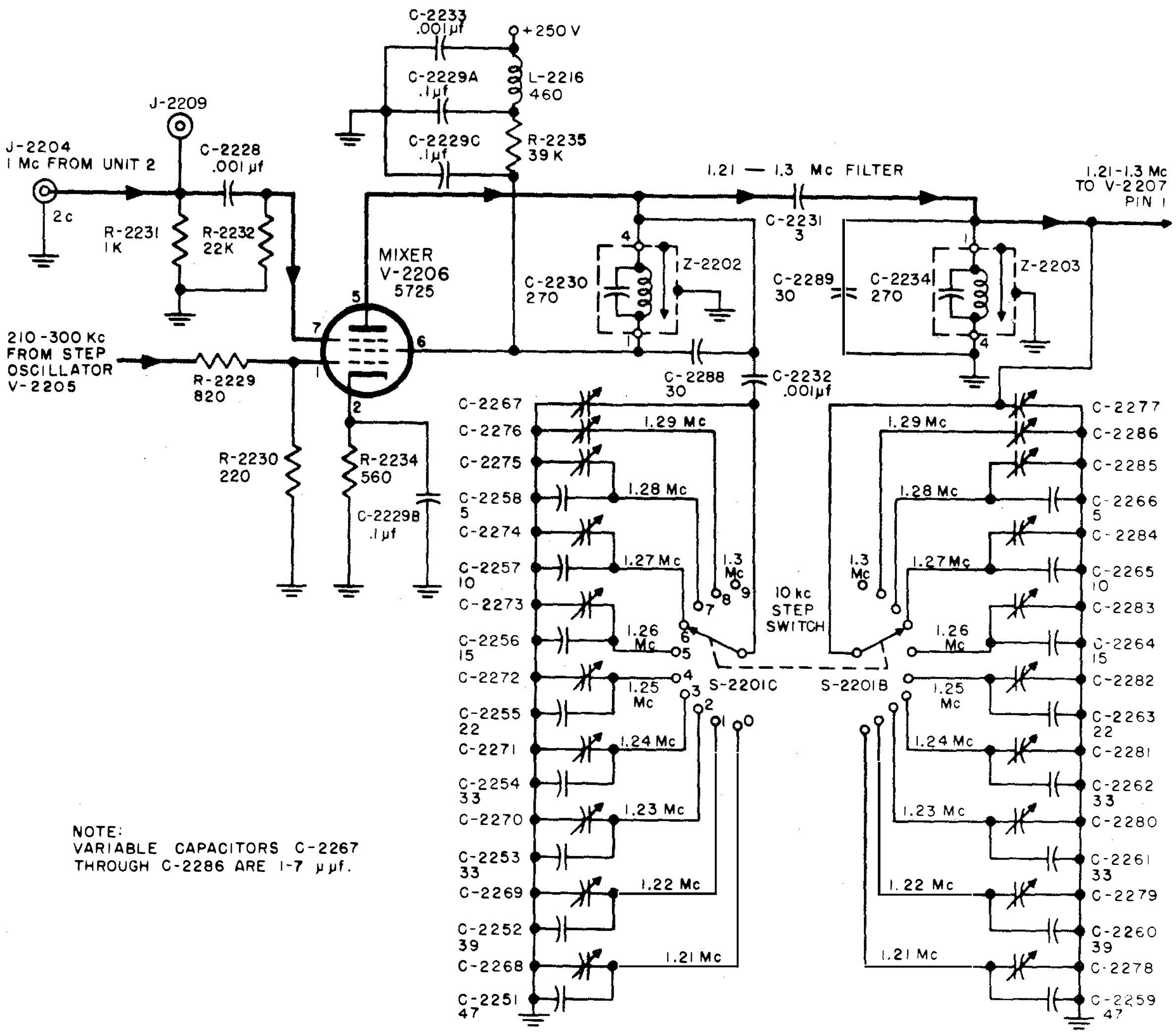


Figure 2–18. RFO Unit 6, Mixer V–2206, Simplified Schematic

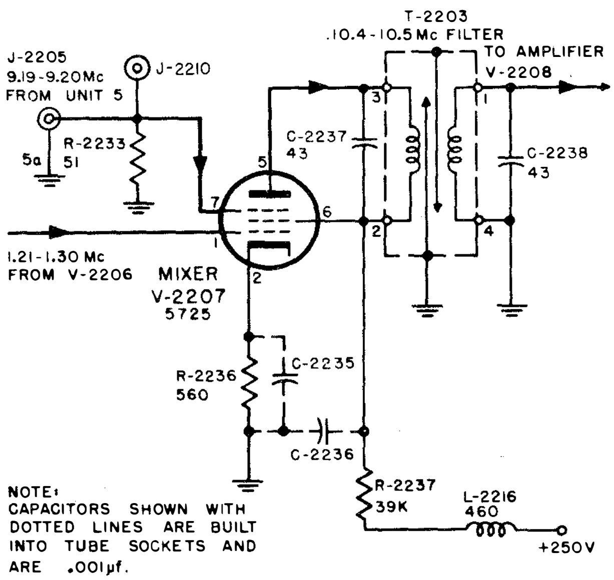


Figure 2—19. RFO Unit 6, Mixer V—2207, Simplified Schematic

livered by reactance tube V–2204 (which is connected across the tank circuit) in accordance with the a-c voltage caused by the difference frequency. As a result, the tank reactance is varied in the same manner, and the oscillator is frequency-modulated. The oscillator output is swept through a band of frequencies that include the locked-in frequency. As the locked-in frequency is approached, the difference frequency becomes smaller. When the locked-in frequency is reached, there is no longer a difference frequency. As a result, no a-c voltage is now superimposed on the original d-c grid voltage of the reactance tube. The oscillator is now restored to the original locked-in frequency that had been established by the original d-c grid voltage of the reactance tube. If, for example, it is desired to lock in the oscillator at 300 kc, switch S–2201 is placed in position 9 and the oscillator is adjusted to 300 kc (three times the crystal oscillator frequency) by means of capacitor C–2219.

The oscillator output is coupled to the 1.21- to 1.3-mc mixer V–2206 by the low-pass filter network L–2201, L–2202, C–2225, C–2226, and C–2227.

(4) 1.21- TO 1.3-MC MIXER V–2206.—This mixer (figure 2–18) receives two signals: the oscillator output (210 to 300 kc), which is applied to the control grid, and the 1-mc output (2c) from unit 2, which is applied to the suppressor grid. The oscillator output signal amplitude is reduced by the voltage divider, R–2229 and R–2230. The 1-mc signal is received through J–2204, load resistor R–2231, coupling capacitor C–2228, and resistor R–2232. Test point J–2209 is provided for testing output 2c (approximately 1.2 volts). Mixer V–2206 combines 1 megacycle with the oscillator output to produce frequencies in the range of 1.21 to 1.3 mc. The mixer is provided with a double-tuned output filter, consisting of Z–2202, C–2288, C–2267, Z–2203, C–2289, C–2277, and the capacitors switched in and out by sections C and B of 10-kc step switch S–2201, all of whose sections are ganged. Note that S–2201 is the same step switch that selects an oscillator frequency of 210 to 300 kc.

When step switch S–2201 is in position 1, capacitors C–2269, C–2252, C–2279, and C–2260 are used in the filter. Consequently, the filter is tuned to 1.22 mc (and the oscillator is tuned simultaneously to 220 kc). As the switch position step numbers are increased, the capacitance in the filter is decreased by an amount sufficient to increase the resonant frequency of the filter by 10 kc for each step. In switch position 9, the filter is tuned to 1.3 mc. This method of filtering permits the use of high-Q, sharply tuned circuits, which reject spurious frequencies. Capacitors C–2288 and C–2289 are ceramic capacitors used for temperature compensation. Variable capacitors C–2268 through C–2276 and C–2278 through C–2286 are trimmers for adjusting the filter to the proper frequency for each position of S–2201. Variable capacitors C–2267 and C–2277 are adjusted whenever V–2206 is replaced.

(5) 10.4- TO 10.5-MC MIXER V–2207.—The control grid of mixer V–2207 (figure 2–19) receives the 1.21- to 1.3-mc output of V–2206, and the suppressor grid receives 9.19 to 9.2 mc (5a) from unit 5 through J–2205 and load resistor R–2233. Test point J–2210 is provided for testing input 5a (approximately 1.3 volts). These two signals are mixed by V–2207 and the output, 10.4 to 10.5 mc, is filtered by the double-tuned filter, T–2203, C–2237 and C–2238, and is coupled through R–2242 to the control grid of amplifier V–2208.

(6) AMPLIFIERS V–2208 AND V–2209.—The filtered output of V–2207 is amplified by V–2208 (figure 2–20), filtered by double-tuned transformer T–2204, amplified again by V–2209, and filtered again by transformer T–2205. The final output (output 6b, 10.4 to 10.5 mc) is fed to unit 8 through J–2206. Test point J–2211 is provided for testing this output (approximately 0.8 volt).

(7) 10-KC STEP SWITCH S–2201.—Table 2–1, page 2–21, lists the circuit elements removed from the oscillator tank circuit and selected for the 1.21- to 1.3-mc filter for each position of S–2201. In this table, note that as switch S–2201 is moved from a lower- to a higher-numbered position, an additional inductor is removed (switched out) from the circuit by wafer D. For example, in position 3, L–2206 is removed in addition to L–2205 and L–2204.

i. FREQUENCY MULTIPLIER Z–2305 (FREQUENCY MULTIPLIER, UNIT 7).—Unit 7 receives 1 mc from unit 2 and multiplies this input by 5 and 15 to produce 5 mc for unit 9 and 15 mc for unit 8.

(1) FREQUENCY QUINTUPLER V–2301 AND AMPLIFIER V–2302.—The 1-mc signal (2d), received through J–2301, may be tested at test point J–2305 and is approximately 8.5 volts. The 1-mc signal is coupled by C–2301 to the grid of frequency quintupler V–2301

TABLE 2—1. FUNCTIONS OF 10-KC STEP SWITCH S—2201

POSITION	OUTPUT FROM UNIT 6 (kc)	REMOVED FROM OSCILLATOR TANK BY SECTION D	SELECTED BY	
			SECTION C	SECTION B
0	210	None	C–2268, C–2251	C–2278, C–2259
1	220	L–2204	C–2269, C–2252	C–2279, C–2260
2	230	L–2205*	C–2270, C–2253	C–2280, C–2261
3	240	L–2206*	C–2271, C–2254	C–2281, C–2262
4	250	L–2207*	C–2272, C–2255	C–2282, C–2263
5	260	L–2208*	C–2273, C–2256	C–2283, C–2264
6	270	L–2209*	C–2274, C–2257	C–2284, C–2265
7	280	L–2210*	C–2275, C–2258	C–2285, C–2266
8	290	L–2211*	C–2276	C–2286
9	300	L–2212*	None	None

* Removed in addition to preceding inductors in this column.

(figure 2–21). The quintupler distorts and amplifies the input, thus producing an output rich in harmonics. Double-tuned filter Z–2301 attenuates all frequencies in the output except the fifth harmonic, 5 mc. The 5-mc signal is applied to the control grid of amplifier V–2302 and coupled through C–2315 to the control grid of frequency tripler V–2303. The 5-mc signal is applied to the control grid of amplifier V–2302 and coupled through C–2315 to the control grid of frequency tripler V–2303. The 5-mc signal is amplified by V–2302 and filtered by the double-tuned filter, Z–2302. The 5-mc filtered output (7b) is reduced by divider C–2308 and C–2309, and fed to unit 9 through J–2302. Output 7b may be tested at J–2306 and is approximately 2.0 volts.

(2) FREQUENCY TRIPLER V–2303 AND AMPLIFIER V–2304.—Frequency tripler V–2303 (figure 2–22) receives through C–2315 a portion of the 5-mc output of V–2301. The tripler distorts and amplifies the input, producing an output that is rich in harmonics. Double-tuned filter Z–2302 attenuates all frequencies except the third harmonic (15 mc). The filter output is amplified by V–2304 and filtered again by Z–2304. The final 15-mc output (7a), reduced in amplitude by divider C–2322 and C–2323, is coupled by matching resistor R–2310 to J–2303 and fed to unit 8. Output 7a may be tested at J–2307 and is approximately 1.4 volts.

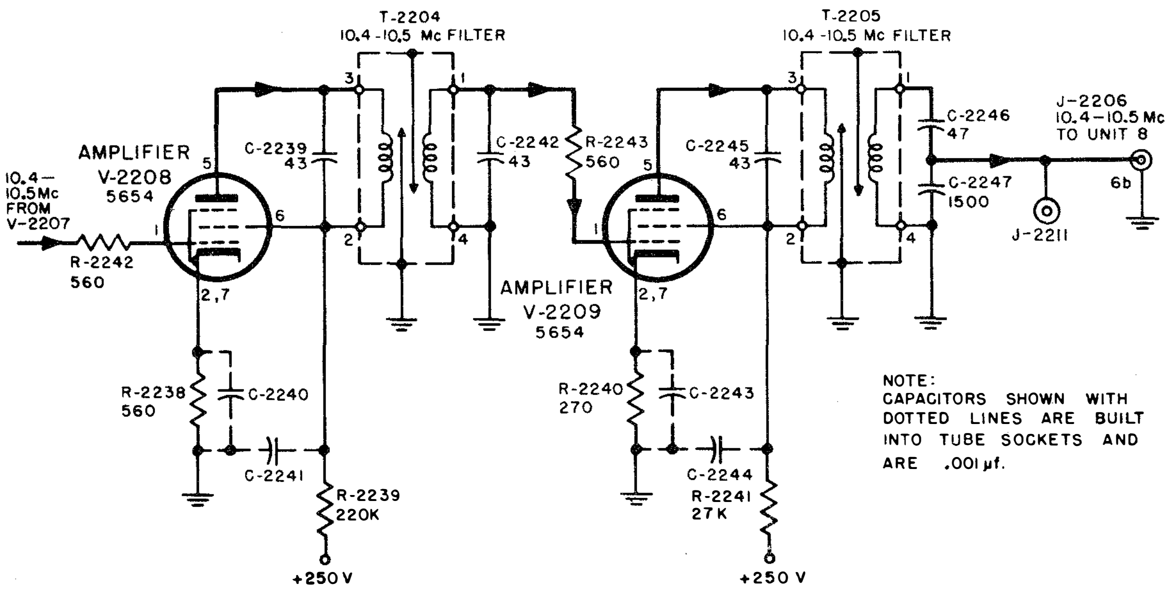


Figure 2—20. RFO Unit 6, Amplifiers V—2208 and V—2209, Simplified Schematic

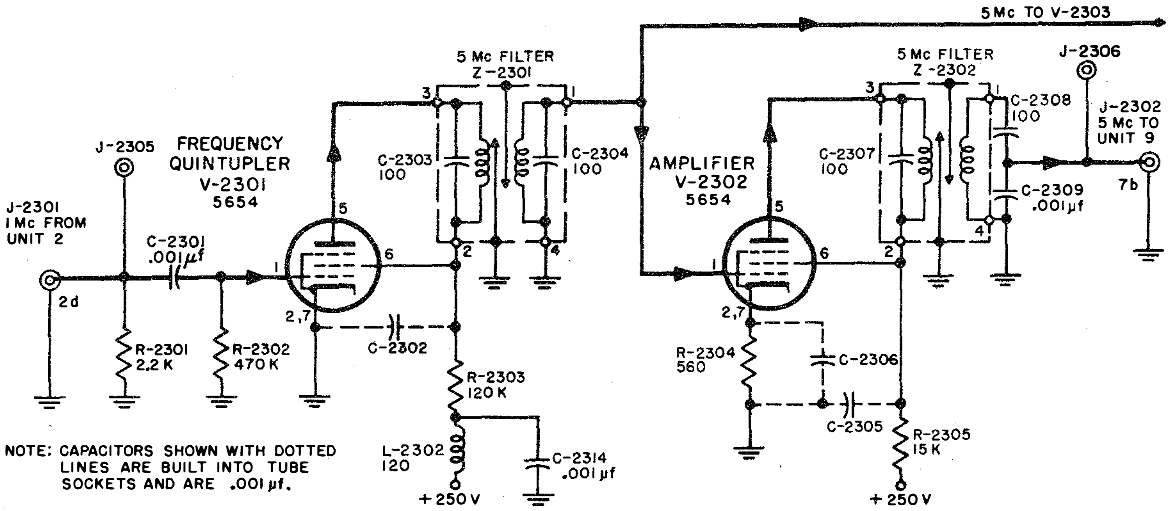


Figure 2–21. RFO Unit 7, Frequency Quintupler V–2301 and Amplifier V–2302, Simplified Schematic

j. ELECTRONIC FREQUENCY CONVERTER Z–2330 (100-KC STEP GENERATOR, UNIT 8).—Unit 8 (figure 2–23) is similar to unit 6 and includes a 1.6- to 2.5-mc phase-locked oscillator that may be tuned in steps of 100 kc. This oscillator is locked in to the 100-kc crystal-controlled oscillator in unit 1. The 1.6- to 2.5-mc oscillator output is mixed with 15 mc obtained from unit 7, thus making available frequencies in the range of 16.6 to 17.5 mc. These frequencies are then mixed with 10.4 to 10.5 mc obtained from unit 6. The resulting range of frequencies, 27 to 28 mc, available in steps of 100 kc, 10 kc, and 10 cps, is amplified, filtered, and fed to unit 9. The regulated B+ supply of unit 8 is decoupled by capacitor C–2328. For stability, V–2327, V–2328, and V–2329 use a regulated filament supply.

(1) CLIPPER V–2326A AND SHAPER V–2326B.—The 100-kc output (1d) of unit 1 is received at J–2326, and is coupled by capacitor C–2326 to the grid of clipper V–2326A (figure 2–24). Test point J–2333 is provided for testing the input (approximately 8.1 volts) to J–2326. V–2326A clips the positive and negative peaks of the 100 kc to form approximately a square wave. To obtain more accurate control of the 1.6- to 2.5-mc oscillator, the clipped output pulse is coupled by C–2327 to shaper V–2326B, which narrows the pulse by means of the ringing coil of transformer T–2326. The pulse is coupled by the secondary of T–2326 to the control grid of mixer V–2327. Rectifier CR–2326 prevents negative overshoot.

(2) OSCILLATOR V–2329, MIXER V–2327, AND REACTANCE TUBE V–2328.—Oscillator V–2329 is a modified Colpitts oscillator operating in the range of 1.6 to 2.5 mc, in steps of 100 kc (figure 2–25). This circuit is similar to the 210- to 300-kc oscillator, V–2205 in unit 6 (see paragraph 2*b* (3)), except that different circuit constants are used in the tank circuit to obtain a different range of frequencies (in steps of 100 kc in-

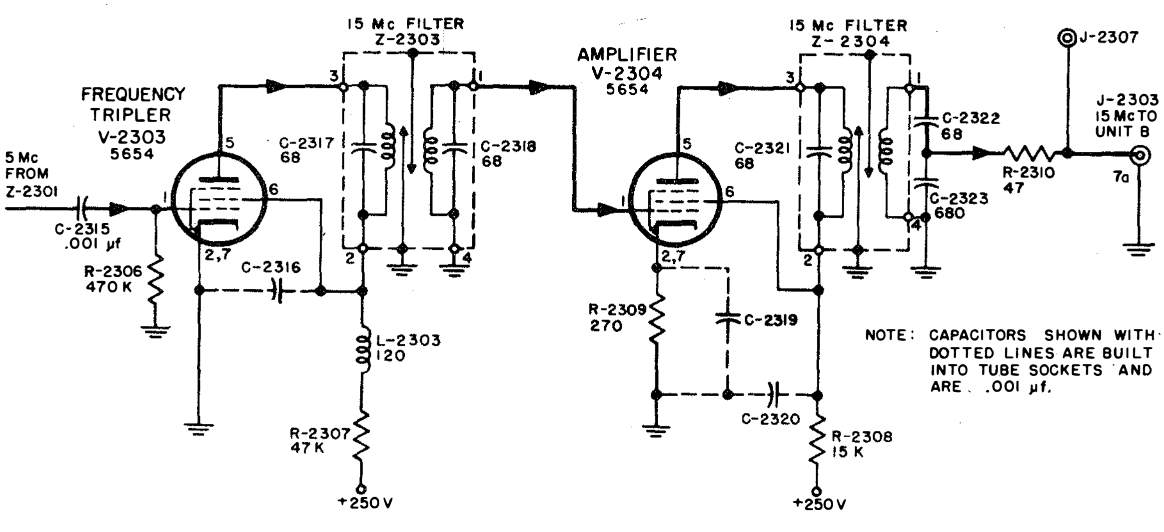


Figure 2–22. RFO Unit 7, Frequency Tripler V–2303 and Amplifier V–2304, Simplified Schematic

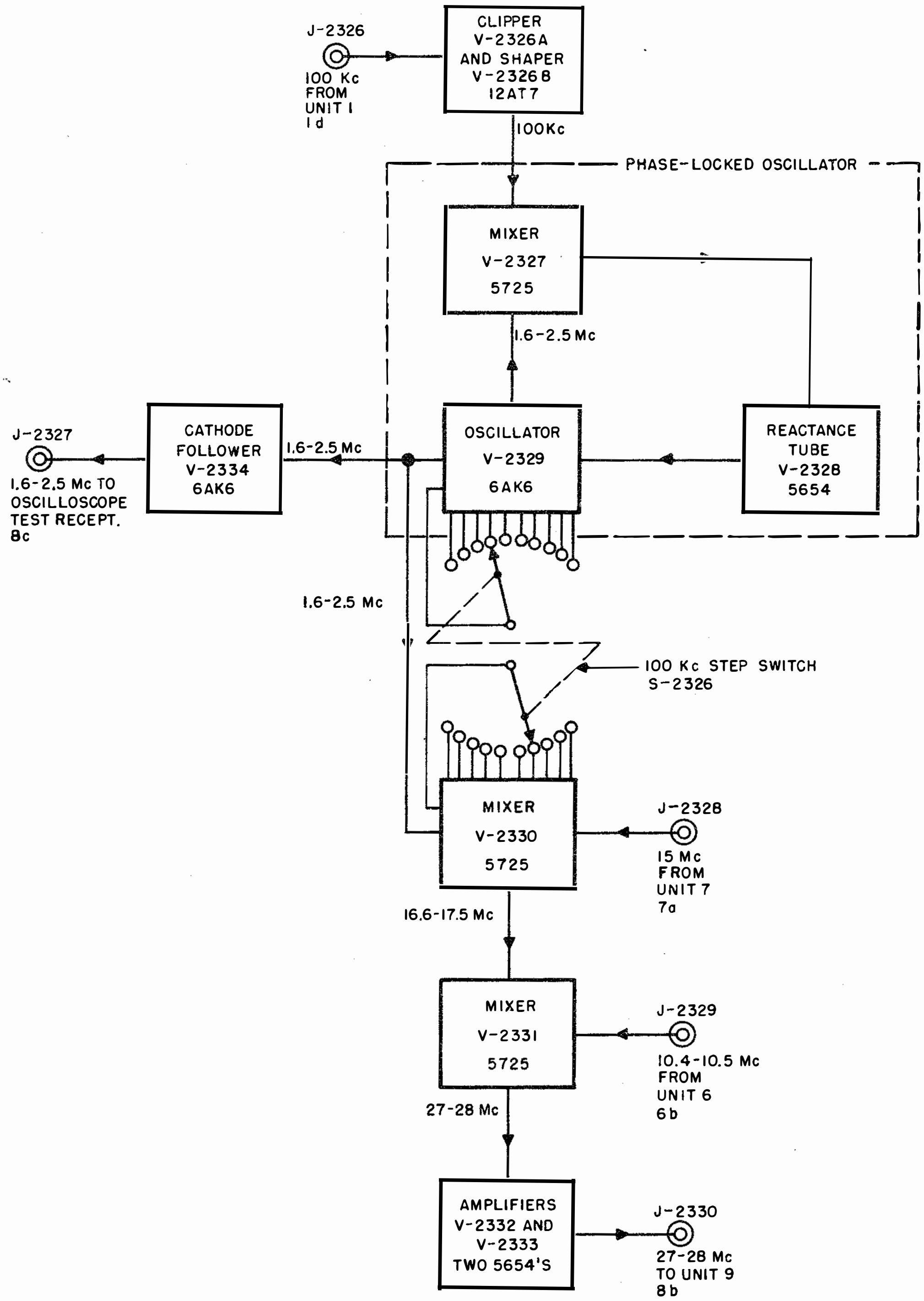


Figure 2—23. RFO Unit 8, Electronic Frequency Converter (100-Kc Step Generator), Block Diagram

stead of 10 kc). Inductors L–2327 to L–2335, inclusive, are selected for the tank circuit by section G of the 100-kc step switch, S–2326, which is controlled by the 100 KC frequency selection knob ⒽⒽ.

The oscillator output is coupled by C–2343 to the suppressor grid of mixer V–2327. The mixer and reactance tube control the oscillator frequency in the same way as the corresponding tubes in unit 6 (that is, V–2327 mixes 100-kc pulses from V–2326B with the oscillator output, and V–2328 corrects the oscillator for frequency drift), except that the rejection filter is tuned to 100 kc instead of 10 kc (see paragraph 2*b*(3)(*a*)). The oscillator output is coupled to the control grid of mixer V–2330 by a low-pass filter consisting of L–2336, L–2337, C–2347, C–2348, and C–2349.

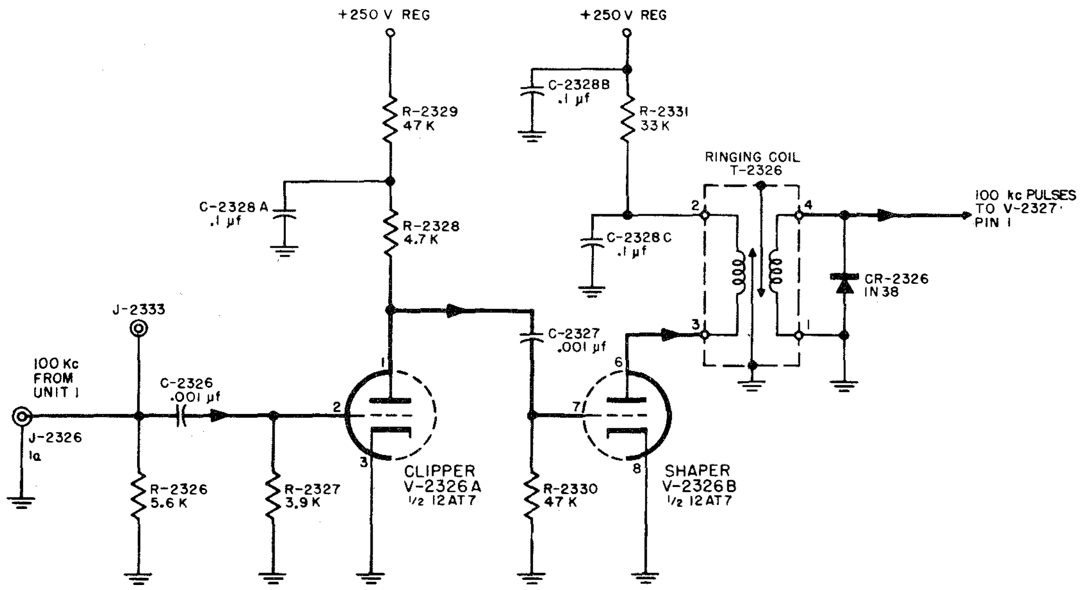


Figure 2–24. RFO Unit 8, Clipper V–2326A and Shaper V–2326B, Simplified Schematic

(3) CATHODE FOLLOWER V–2334.—A portion of the oscillator output is fed to cathode follower V–2334 (figure 2–25). This cathode follower isolates the oscillator, lowers the impedance level, and transmits 1.6 to 2.5 mc (output 8a) to the 100 KC STEP oscilloscope test receptacle in unit 14.

(4) 16.6- TO 17.5-MC MIXER V–2230.—The oscillator output is applied to the control grid of V–2330 (figure 2–26), and the 15-mc signal (7a) from unit 7 is applied to the suppressor grid. The 15-mc signal (approximately 1.3 volts) is received at J–2328 and may be tested by means of test point J–2334. The mixer output, 16.6 to 17.5 mc, is filtered by the double-tuned circuit comprising L–2338, C–2353, C–2405, L–2339, C–2357, C–2406 and the capacitors selected by sections E and F of S–2326, the 100-kc step switch. The [illegible] of this filter is similar to that of the unit 6 filter.

(5) 27- TO 28-MC MIXER V–2331.—The filtered output of V–2330 is applied to the suppressor grid of V–2331 (figure 2–27). The control grid receives 10.4 to 10.5 mc (6b) from unit 6 through J–2329; the magnitude of this input (approximately 0.8 volt) may be checked at test point J–2335. The mixer output, 27 to 28 mc, is filtered by the double-tuned filter, Z–2327, and then is applied to the control grid of amplifier V–2332.

TABLE 2–2. FUNCTIONS OF 100-KC STEP SWITCH S–2326

POSITION	OUTPUT FROM UNIT 8 (mc) IN 10-CPS STEPS	REMOVED FROM OSCILLATOR TANK BY SECTION G	CAPACITORS SELECTED FOR OUTPUT MIXER FILTER	
			SECTION F	SECTION E
0	27.0–27.1	None	C–2362, C–2358	C–2371, C–2360
1	27.1–27.2	L–2327	C–2363, C–2359	C–2372, C–2361
2	27.2–27.3	L–2328*	C–2364	C–2373
3	27.3–27.4	L–2329*	C–2365	C–2374
4	27.4–27.5	L–2330*	C–2366	C–2375
5	27.5–27.6	L–2331*	C–2367	C–2376
6	27.6–27.7	L–2332*	C–2368	C–2377
7	27.7–27.8	L–2333*	C–2369	C–2378
8	27.8–27.9	L–2334*	C–2370	C–2379
9	27.9–28.0	L–2335*	C–2356	C–2404

* Removed in addition to preceding inductors in this column.

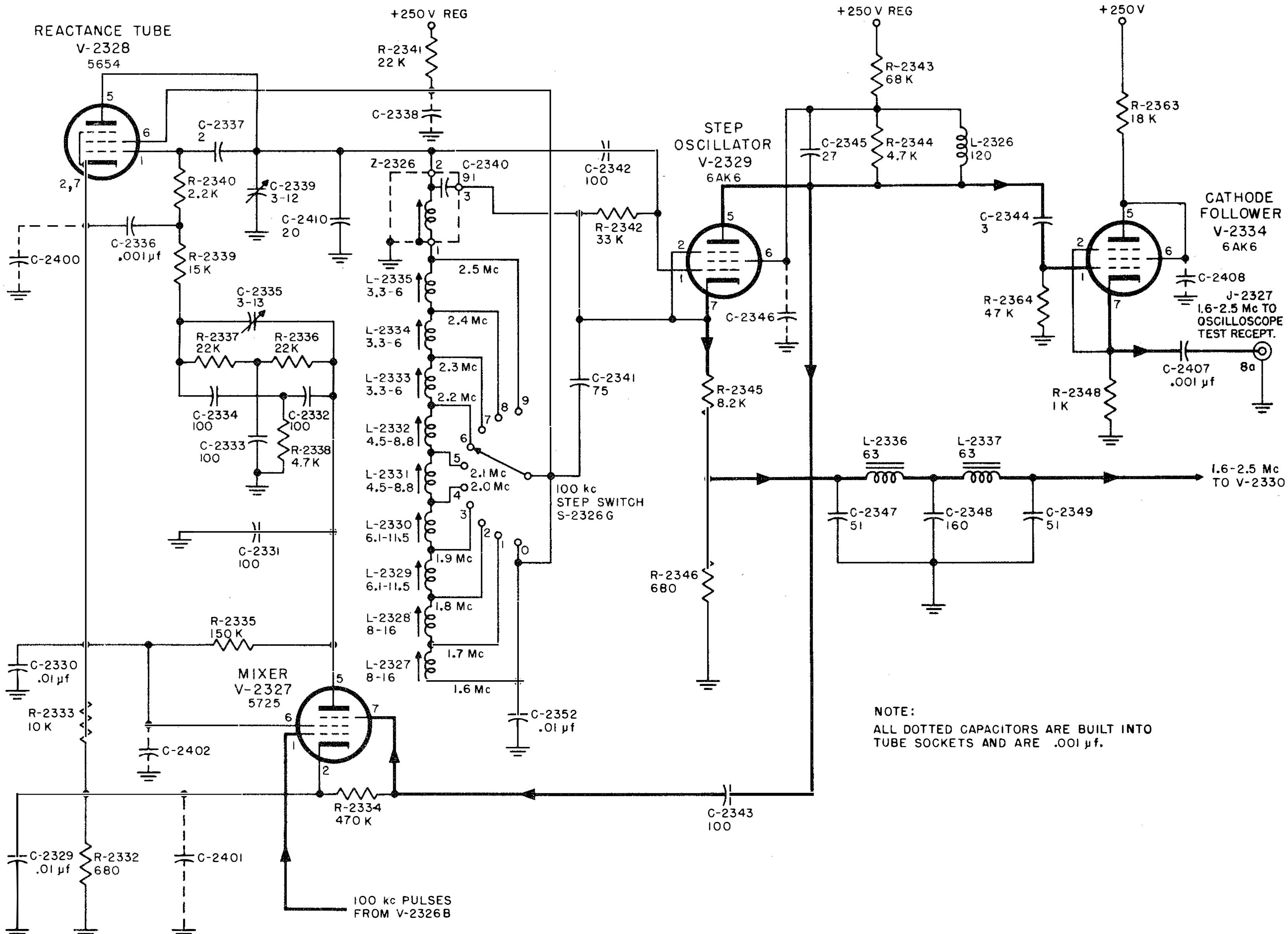


Figure 2—25. RFO Unit 8, Mixer V—2327, Step Oscillator V—2329, Reactance Tube V—2328 and Cathode Follower V—2334, Simplified Schematic

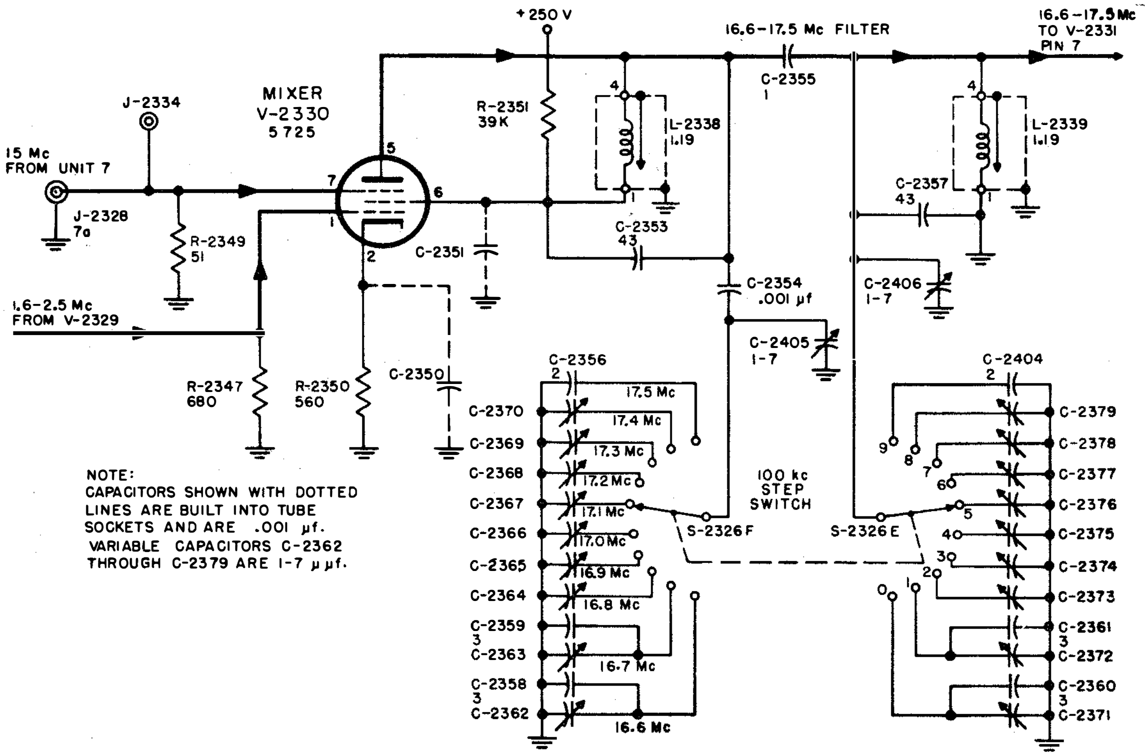


Figure 2—26. RFO Unit 8, Mixer V—2330, Simplified Schematic

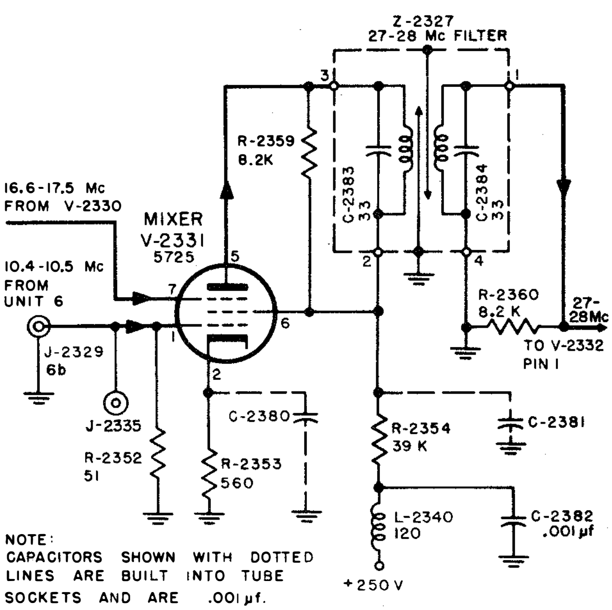


Figure 2—27. RFO Unit 8, Mixer V—2331, Simplified Schematic

(6) AMPLIFIERS V-2332 AND V-2333.—The filtered 27- to 28-mc signal is amplified by V-2332 (figure 2-28), filtered by the double-tuned filter, Z-2328, amplified by V-2333, and filtered again by Z-2329 to reject spurious frequencies. The final 27- to 28-mc output signal (8b), reduced by divider C-2392 and C-2393, is fed to unit 9 through J-2330. Output 8b (approximately 1.2 volts) may be tested at test point J-2336.

(7) 100-KC STEP SWITCH S-2326.—The positions of S-2326, together with the corresponding final output frequencies of unit 8 and the circuit elements selected to obtain these frequencies, are given in table 2-2, page 2-24. As S-2326 is switched from its lowest- to its highest-numbered position, the listed inductors are removed by switch section G.

k. ELECTRONIC FREQUENCY CONVERTER Z-2426 (FREQUENCY CONVERTER, UNIT 9).—Unit 9 receives 27 to 28 mc (in steps of 10 cps) from unit 8 and 5 megacycles from unit 7. The second harmonic of the 5-mc signal provides a 10-mc frequency. These frequencies are then mixed as shown in the following table.

TABLE 2—3. UNIT 9 MIXER OUTPUTS

MIXED FREQUENCIES (mc)	MIXER OUTPUT (mc)
(27 to 28), −5	22 to 23
(27 to 28), ±0	27 to 28
(27 to 28), +5	32 to 33
(27 to 28), +10	37 to 38

The mixer output is filtered four times and amplified three times, and then sent to unit 11A, 11B, or 11C, depending on the desired final RFO output frequency.

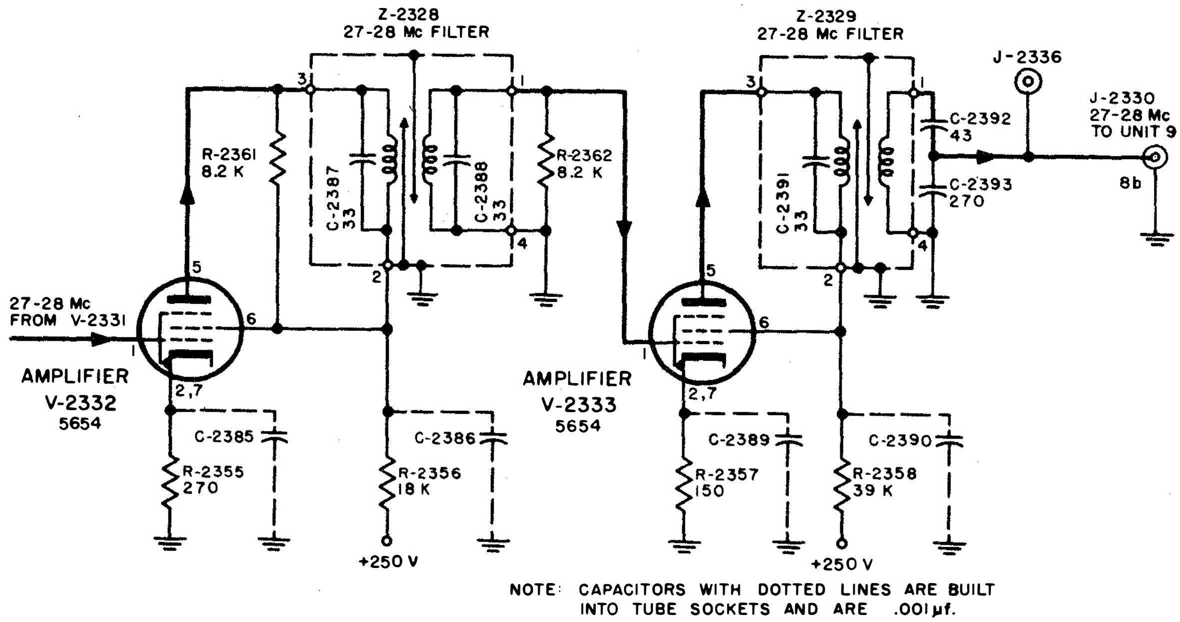


Figure 2—28. RFO Unit 8, Amplifiers V—2332 and V—2333, Simplified Schematic

(1) MIXER V–2426.—The 27- to 28-mc output (8b) of unit 8 is applied through J–2426 to the suppressor grid of mixer V–2426 (figure 2–29). The 5-mc output (7b) of unit 7, which is rich in harmonics, is applied to the control grid through J–2427 and the front of wafer B of 5-mc step switch S–2426. Test points J–2430 and J–2431 are provided for testing inputs 8b (approximately 1.2 volts) and 7b (approximately 1.9 volts), respectively. The 5-mc signal is adjusted to the proper level for efficient mixing by R–2454, R–2440, and wafer B (the gain compensation section) of S–2426, the 5-mc step switch, which is set by the Ⓐ KNOB frequency selection control on the mounting front panel. When an output of 27 to 28 mc is chosen, the mixer grid is shorted to ground. In the amplifier V–2427 grid circuit, the proper components for the chosen frequency are selected by the C wafers of S–2426 and S–2427. The output of V–2426 contains a band of frequencies 1 mc wide. Wafer C of the 5-mc step switch, S–2426, selects one of the four filters, each of which has a pass-

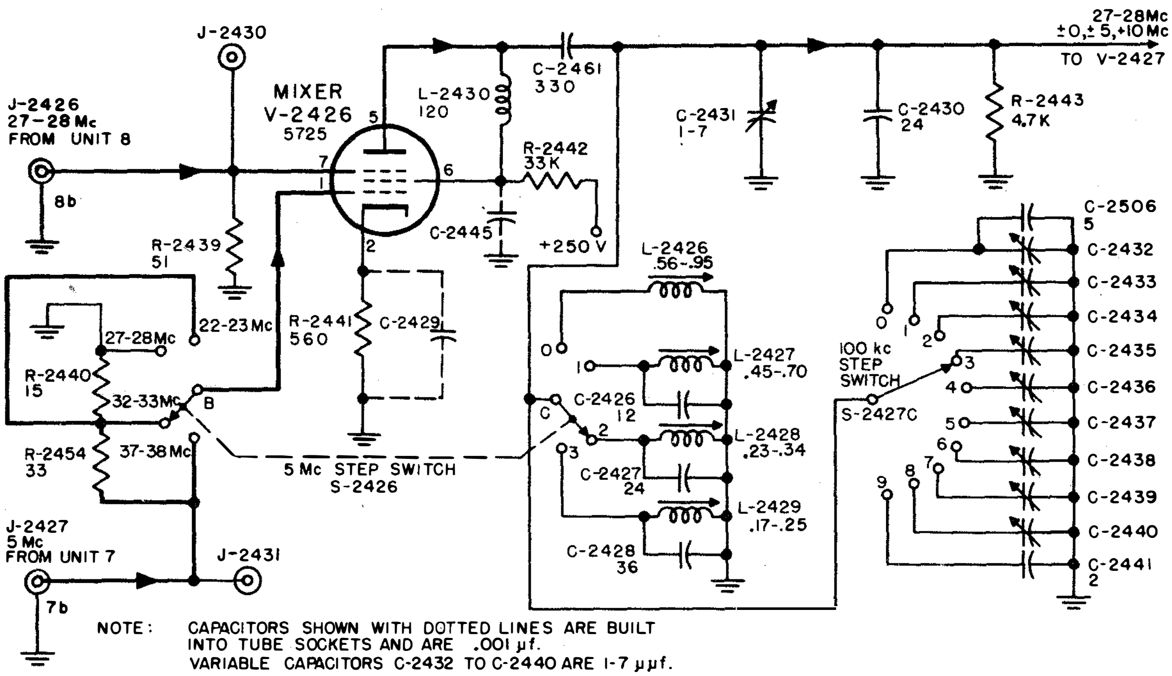


Figure 2—29. RFO Unit 9, Mixer V—2426, Simplified Schematic

The final output (9), 27 to 28 mc ±0, ±5, +10 mc, is transmitted through J–2428 to unit 11A, 11B or 11C, depending on the desired output frequency of the RFO, which is selected by the bandswitch S–2996 in unit 14. Test point J–2432 is provided for testing output 9a (approximately 1.6 volts). The B+ supply of unit 9 is decoupled by a filter network comprising L–2446, C–2499, C–2500, C–2501, R–2452, and R–2453.

(4) 5-MC STEP SWITCH S–2426.—Table 2–4, page 2–29, shows the positions of switch S–2426, the frequency range obtained for each position, and the components switched in or out of the filters or the amplifier dropping-resistor network, as the switch is rotated from the lowest- to the highest-numbered position.

(5) 100-KC STEP SWITCH S–2427.—The table below shows the positions of switch S–2427, the frequency obtained for each position, and the components switched in or out of the filters or the amplifier dropping-resistor network, as the switch is rotated from the lowest- to the highest-numbered position. Switch S–2426 gives a frequency range of 1 megacycle for each of its four positions. Switch S–2427 selects a 100-kc range within the 1-mc range selected by S–2426.

l. FREQUENCY MULTIPLIER Z–2526 (1-MC STEP GENERATOR, UNIT 10).—This unit receives the 1-mc output of unit 2 and multiplies this output to 7, 8, 13, 14, 16, 17, 18, 19, 20, 21, or 22 mc. It employs a harmonic generator, and a system of amplifiers with tuned filters in their plate circuits. The tuned filters are selected by the ⓑⓑ KNOB control on the mounting front panel. The output of unit 10 is fed to unit 11A, 11B, or 11C, depending on the desired final output frequency of the RFO.

(1) HARMONIC GENERATOR V–2526. — The 1-mc output (2e) of unit 2 (figure 2–31) is received at J–2526, and applied, across R–2526, to the harmonic generator control grid. Test point J–2529 is provided for testing input 2e (approximately 8.6 volts). V–2526 is operated class C. Its low plate and screen voltage causes limiting of the signal input. Because of this combined action, harmonic generator V–2526 distorts the input greatly; as a result, the output is rich in harmonics. The B+ supply of unit 10 is decoupled by filter C–2548, C–2549, and R–2529 to prevent r-f voltage from leaking back to the power supply.

(2) AMPLIFIERS V–2527, V–2528, AND V–2529. —Amplifier V–2527 is similar to the harmonic generator (figure 2–32). The harmonic generator output is coupled to the amplifier grid by C–2532. The amplifier distorts and amplifies the harmonic generator output. The amplifier output is very rich in harmonics and therefore very suitable for use in deriving the frequencies desired in the final output of unit 10. The grid circuit of V–2528 consists of a tuned filter comprising C–2526 and any one of the inductors, L–2526 to L–2536, inclusive, as chosen by section F of 1-mc step switch S–2526. This switch is controlled by the ⓑⓑ KNOB control on the mounting. Switch S–2526 may be set in any one of 11 positions, numbered from 0 to 10. In position 0, inductor L–2526 is selected. Its value is such that the plate filter circuit will be tuned to the seventh harmonic of 1 megacycle, and the plate circuit of V–2527 will attenuate all frequencies other than 7 megacycles. With S–2526 in position 1, all frequencies other than 8 megacycles will be attenuated (figure 2–32), etc. To prevent the next high-gain amplifier (V–2528) from oscillating, load resistor R–2532 is provided in the filter circuit and R–2534 is provided in series with the grid of amplifier

TABLE 2—5. FUNCTIONS OF 100-KC STEP SWITCH S–2427

POSITION	FREQUENCY RANGE (kc)	RESISTORS REMOVED BY SECTION B	FILTER CIRCUIT COMPONENTS SELECTED BY			
			SECTION C	SECTION D	SECTION E	SECTION F
0	0–100	None	C–2506, C–2432	C–2507, C–2448	C–2508, C–2464	C–2509, C–2479
1	100–200	R–2430	C–2433	C–2449	C–2465	C–2480
2	200–300	R–2431*	C–2434	C–2450	C–2466	C–2481
3	300–400	R–2432*	C–2435	C–2451	C–2467	C–2482
4	400–500	R–2433*	C–2436	C–2452	C–2468	C–2483
5	500–600	R–2434*	C–2437	C–2453	C–2469	C–2484
6	600–700	R–2435*	C–2438	C–2454	C–2470	C–2485
7	700–800	R–2436*	C–2439	C–2455	C–2471	C–2486
8	800–900	R–2437*	C–2440	C–2456	C–2472	C–2487
9	900–1000	R–2438*	C–2441	C–2457	C–2473	C–2488

* Removed in addition to preceding resistors in this column.

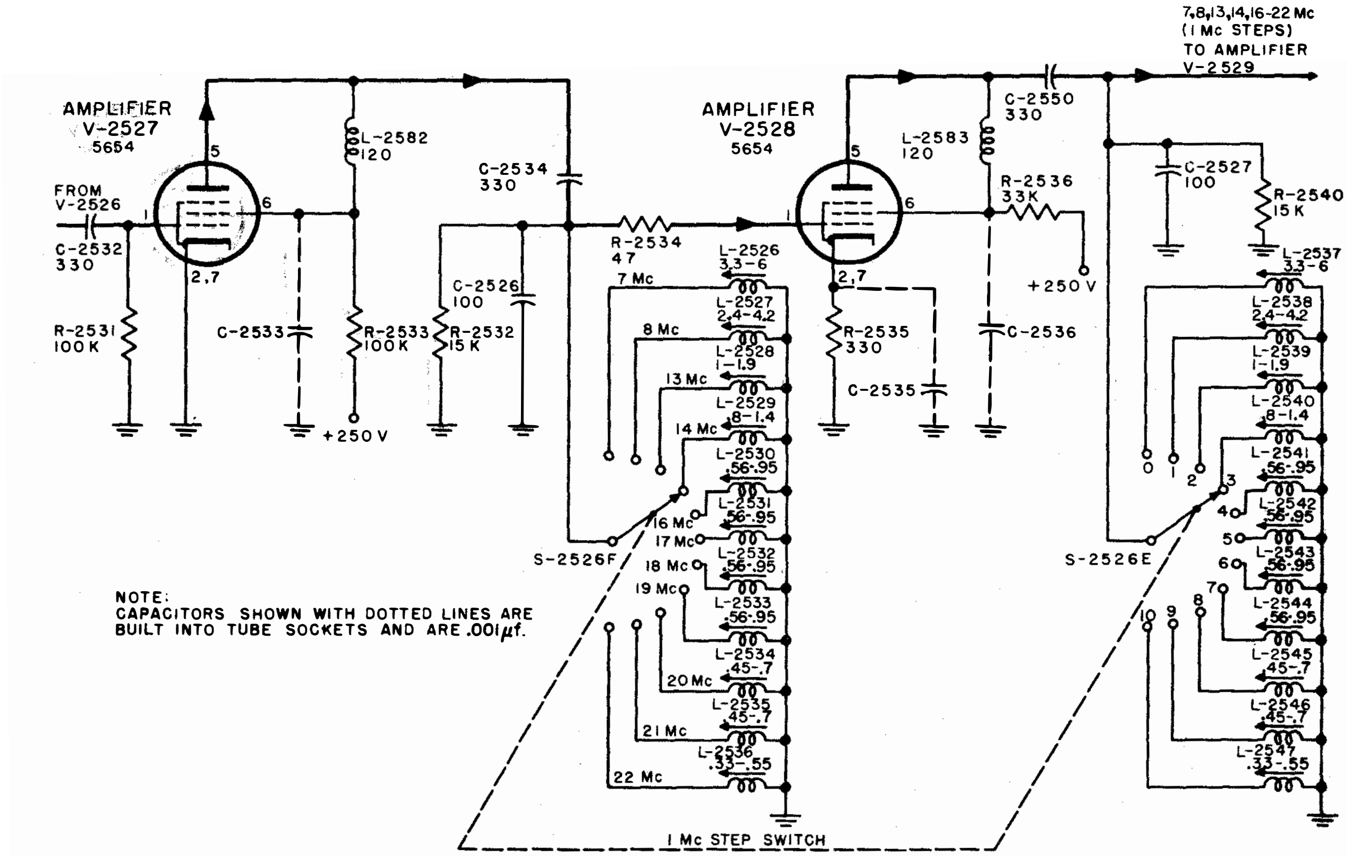


Figure 2—32. RFO Unit 10, Amplifiers V—2527 and V—2528, Simplified Schematic

TABLE 2—6. FUNCTIONS OF 1-MC STEP SWITCH S-2526

POSITION	OUTPUT FREQUENCY (mc) UNIT 10	FILTER COILS SELECTED BY				
		SECTION F	SECTION E	SECTION D	SECTION C	SECTION B
0	7	L–2526	L–2537	L–2548	L–2559	L–2570
1	8	L–2527	L–2538	L–2549	L–2560	L–2571
2	13	L–2528	L–2539	L–2550	L–2561	L–2572
3	14	L–2529	L–2540	L–2551	L–2562	L–2573
4	16	L–2530	L–2541	L–2552	L–2563	L–2574
5	17	L–2531	L–2542	L–2553	L–2564	L–2575
6	18	L–2532	L–2543	L–2554	L–2565	L–2576
7	19	L–2533	L–2544	L–2555	L–2566	L–2577
8	20	L–2534	L–2545	L–2556	L–2567	L–2578
9	21	L–2535	L–2546	L–2557	L–2568	L–2579
10	22	L–2536	L–2547	L–2558	L–2569	L–2580

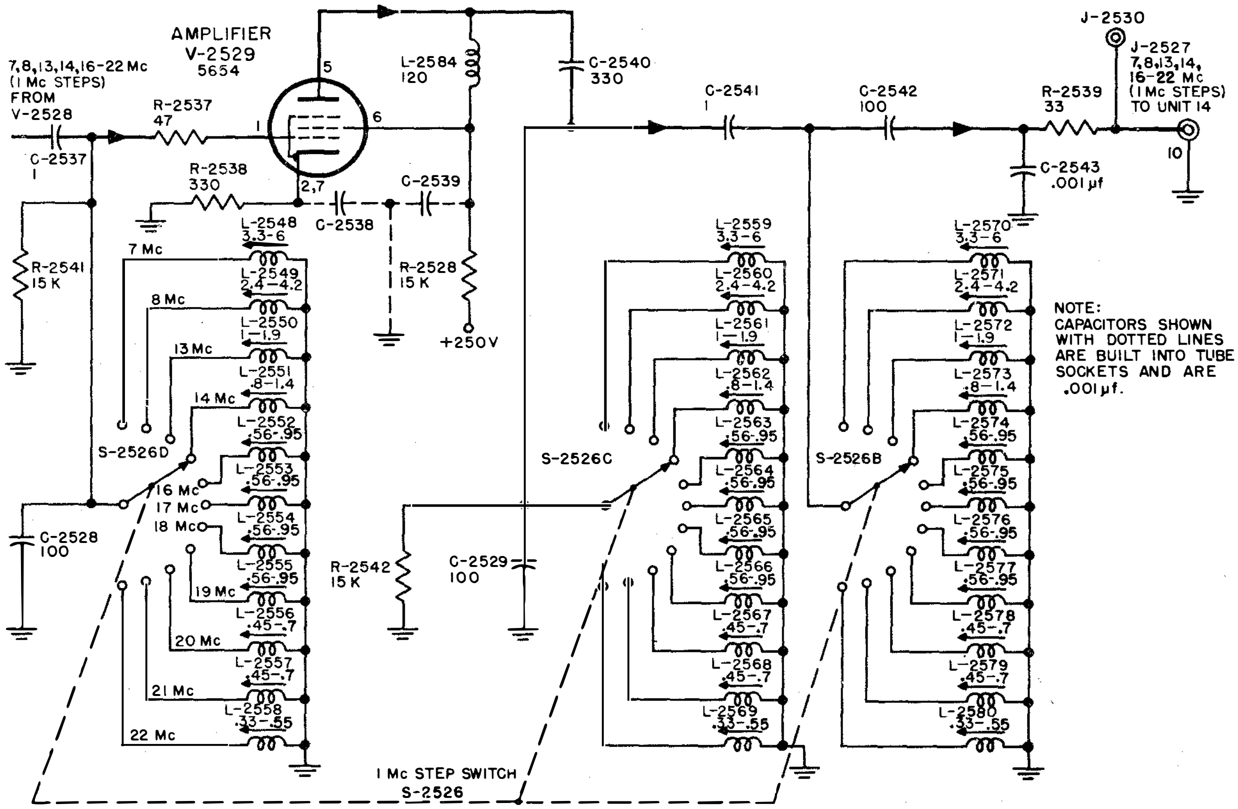


Figure 2—33. RFO Unit 10, Amplifier V—2529, Simplified Schematic

V–2528. The signal is coupled to V–2528 by C–2534. The output of V–2528 is coupled to V–2529 by C–2550. Amplifiers V–2528 and V–2529 are similar to amplifier V–2527. Amplifier V–2529 is provided with a double-tuned input filter circuit in which inductors L–2537 through L–2547 are selected by section E of S–2526 (figure 2–32) and inductors L–2548 through L–2558 are selected by section D of S–2526 (figure 2–33). Amplifier V–2529 has, in addition, a double-tuned output filter circuit. The frequency of the input filter is controlled by sections D and E of S–2526 and the frequency of the output filter is controlled by sections C and B of S–2526. The final output of unit 10 is reduced in amplitude by the divider C–2542 and C–2543, and is applied to unit 11A, 11B, or 11C, which is selected by the bandswitch, S–2996 in unit 14, through coupling resistor R–2539 and receptacle J–2527. Test point J–2530 is provided for testing output 10 (approximately 0.4 volt).

(3) 1-MC STEP SWITCH S–2526.—Table 2–6, page 2–31, lists the positions of the ganged sections of step switch S–2526 and the corresponding filter inductors and frequencies selected by the switch.

m. ELECTRONIC FREQUENCY CONVERTER Z–2626 (FREQUENCY CONVERTER, UNIT 11A).—Units 11A, 11B, and 11C are the final frequency converters in the RFO. When the transmitter is set to operate on a frequency in the range of 0.3 to 6 mc, the bandswitch, S–2996 in unit 14, selects unit 11A as the recipient of the output from units 9 and 10. Unit 11A then mixes the frequencies received from units 9 and 10, and delivers a frequency in the range of 0.3 to 6 mc to the RFA. Similarly, when the transmitter is set to operate on a frequency in the range of 6 to 16 mc, unit 11B is selected to receive the outputs of units 9 and 10. When a frequency in the range of 16 to 26 mc is desired, unit 11C is selected as the final frequency converter.

TABLE 2—7. RFO OUTPUT TO RFA

FINAL FREQUENCY CONVERTER SELECTED BY S–2996	OUTPUT OF UNIT 9 (mc)	OUTPUT OF UNIT 10 (mc)	FREQUENCY CONVERTER OUTPUT TO RFA (mc)
Unit 11A	22–23 or 27–28	18, 19, 20, 21, or 22	0.3–6
Unit 11B	22–23, 27–28, 32–33, or 37–38	13, 14, 16, 17, 18, 19, 20, or 22	6–16
Unit 11C	22–23, 27–28, 32–33, or 37–38	7, 8, 13, 14, 16, 17, 20, or 21	16–26

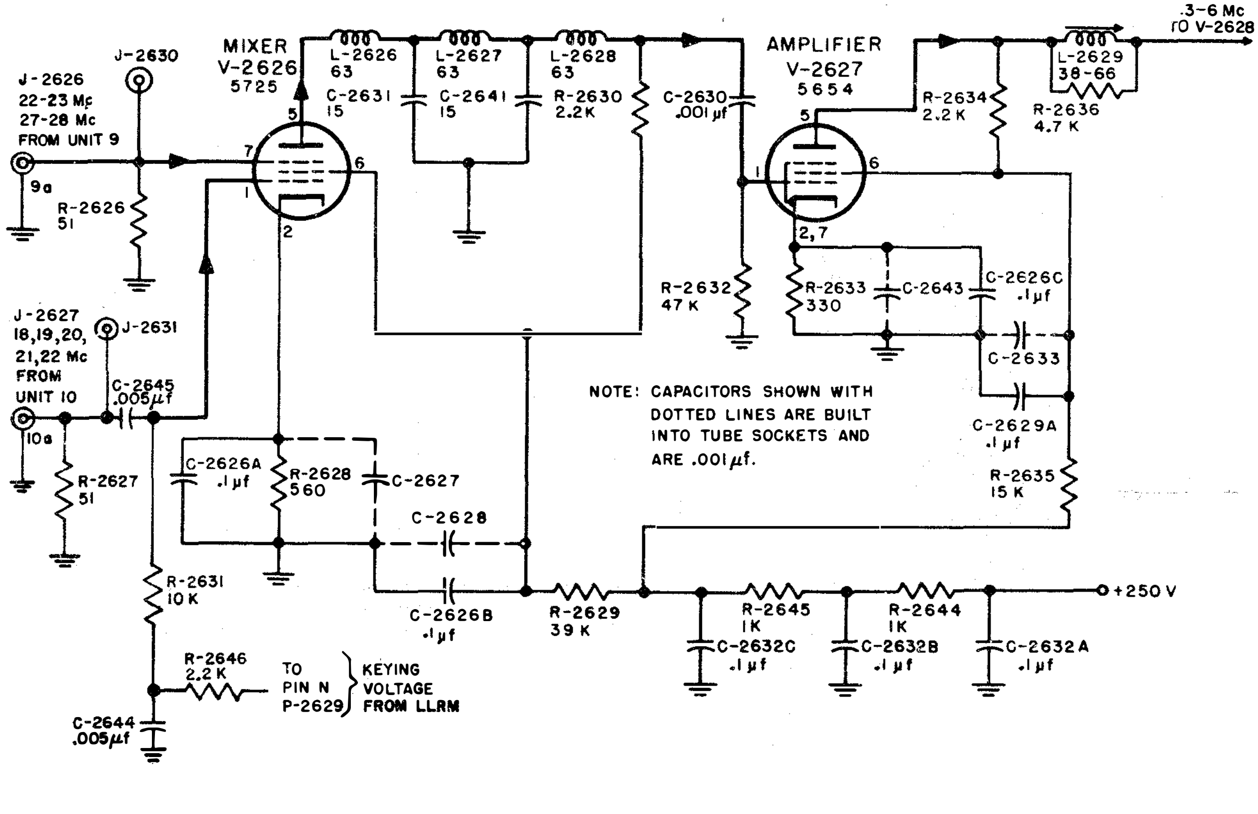


Figure 2–34. RFO Unit 11A, Mixer V–2626 and Amplifier V–2627, Simplified Schematic

The preceding table shows the RFO frequency output bands, the corresponding outputs from units 9 and 10, and the final frequency converter selected by S-2996. A more detailed table, including the step-switch positions in units 9 and 10, is given in table 2–14. Unit 11A consists of a mixer, two amplifiers, filters, and a cathode follower output stage.

(1) MIXER V–2626.—The output (10a) of unit 10 is applied from J–2627 to the control grid of mixer V–2626 (figure 2–34) through coupling capacitor C–2645. The output (9a) of unit 9 is applied from J–2626 to the mixer suppressor grid. Test points J–2630 and J–2631 are provided for testing inputs 9a (approximately 1.4 volts) and 10a (approximately 0.3 volt), respectively. Mixer V–2626 produces an output in accordance with the frequency settings on the mounting front panel. For example, if the desired output is from zero to one megacycle, the mixer will receive 22 to 23 mc from unit 9 and 22 mc from unit 10. A low-pass filter, comprising L–2626, L–2627, L–2628, C–2631, and C–2641, extends the high-frequency response to six megacycles. R2626 and R–2627 are terminating resistors for the inputs from units 9 and 10. The output of the keying circuit of the low level radio modulator (see paragraph 7*c*(7)) is connected to the control grid of V–2626 through a decoupling filter comprising C–2644 and R–2646 and grid resistor R–2631. In FSK and facsimile operation a permanent ground is applied and V–2626 conducts as explained above. In hand-key and machine-key operation the keying signal, zero for mark and —35 volts for space, is applied to the control grid. The zero potential during mark allows V–2626 to conduct, while the –35 volts during space cuts V–2626 off and accordingly cuts off any output from the RFO. In phone operation, –35 volts is applied to the grid of V–2626 when the press-to-talk button is not depressed, cutting off the RFO in the same manner as the space signal. This keying function is introduced to insure that the key-up radiation of the transmitter remains below the maximum allowable level of 400 micromicrovolts.

(2) AMPLIFIERS V–2626 AND V–2628. — The mixer output is amplified by V–2627 and V–2628 (figures 2–34 and 2–35). These amplifiers are identical and are provided with video compensation (L–2629 and L–2630) to extend the high-frequency limit. In addition to the decoupling filter, comprising C–2632, R–2645, and R–2644, which serves all of the stages in unit 11A, the mixer and amplifiers are further decoupled from the B+ power supply by capacitors C–2626 and C–2629.

(3) CATHODE FOLLOWER V–2629.—To obtain sufficient drive (approximately two volts) for the RFA, a cathode follower output stage, V–2629 (figure 2–35), working into an impedance of approximately 50 ohms, is used as the output stage. Filter L–2631 attenuates spurious frequencies. The output (11a) is coupled by C–2642 to J–2628 and test point J–2632.

n. ELECTRONIC FREQUENCY CONVERTER Z–2651 (FREQUENCY CONVERTER, UNIT 11B).—Receptacle J–2651 receives the 13-, 14-, 16-, 17-, 18-,

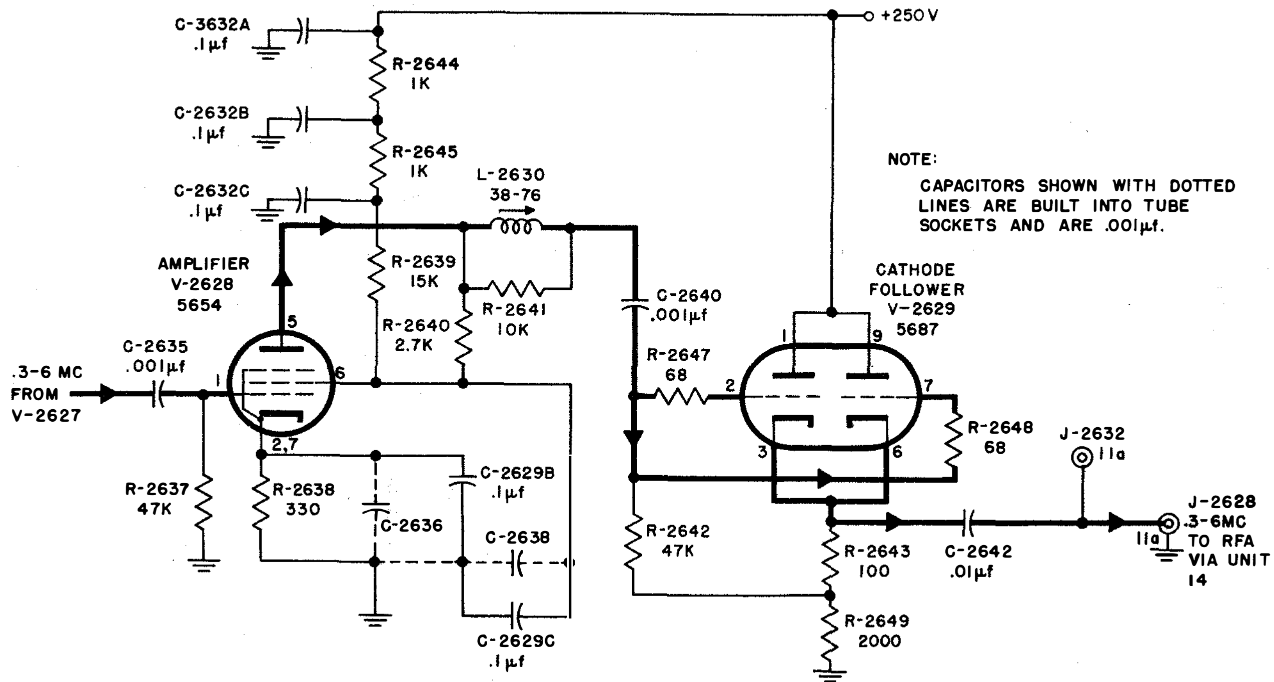


Figure 2—35. RFO Unit 11A, Amplifier V—2628 and Cathode Follower V—2629, Simplified Schematic

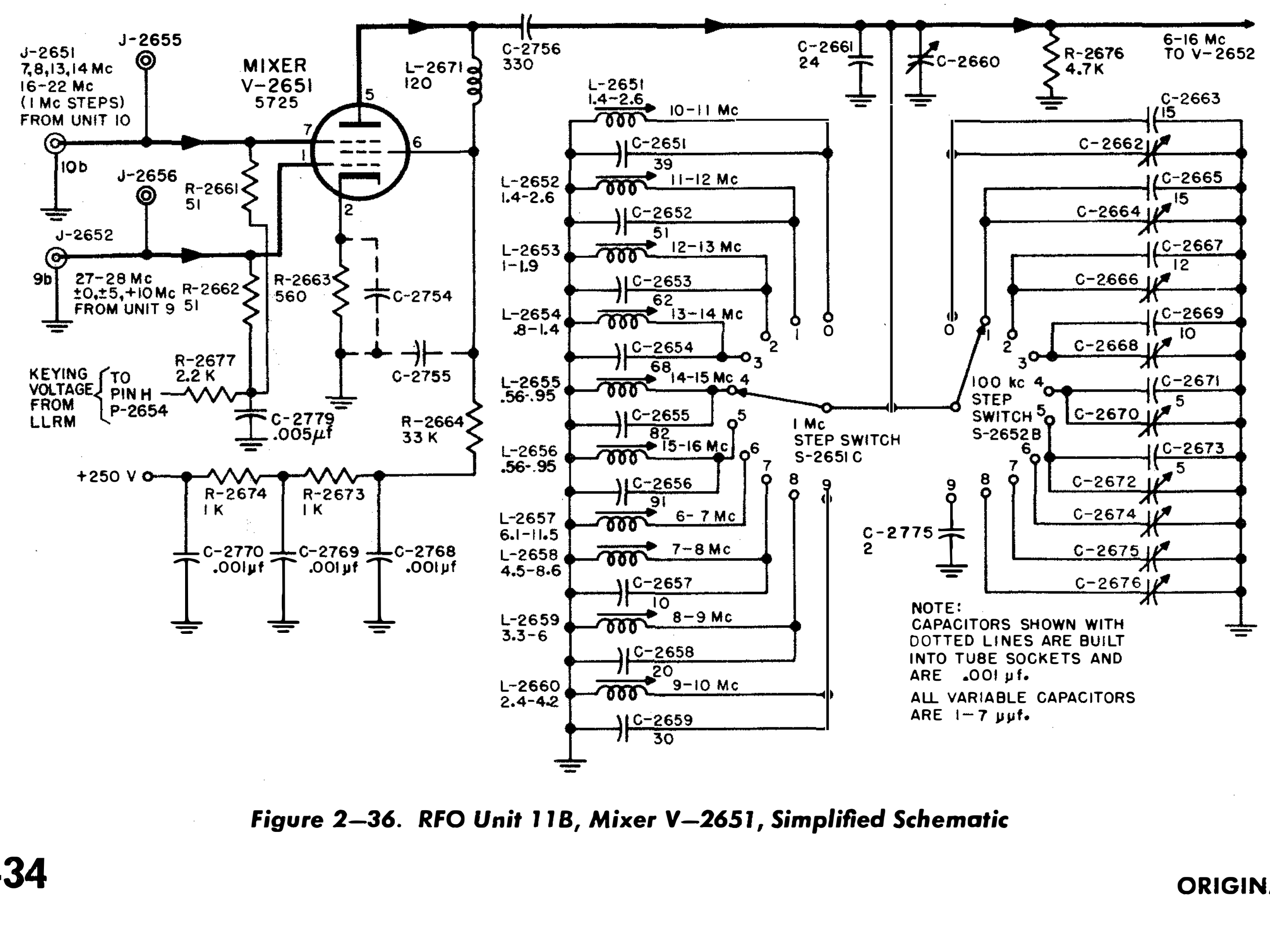


Figure 2—36. RFO Unit 11B, Mixer V—2651, Simplified Schematic

TABLE 2–8. FUNCTIONS OF 1-MC STEP SWITCH S–2651

POSITION	FREQUENCY RANGE (mc)	RESISTORS REMOVED BY SECTION B	FILTER CIRCUIT COMPONENTS SELECTED BY			
			SECTION C	SECTION D	SECTION E	SECTION F
6	6–7	None	L–2657	L–2667	L–2681	L–2691
7	7–8	R–2656	L–2658, C–2657	L–2668, C–2684	L–2682, C–2707	L–2692, C–2734
8	8–9	R–2657*	L–2659, C–2658	L–2669, C–2685	L–2683, C–2708	L–2693, C–2735
9	9–10	R–2658*	L–2660, C–2659	L–2670, C–2686	L–2684, C–2709	L–2694, C–2736
0	10–11	R–2659*	L–2651, C–2651	L–2661, C–2678	L–2675, C–2701	L–2685, C–2728
1	11–12	R–2651*	L–2652, C–2652	L–2662, C–2679	L–2676, C–2702	L–2686, C–2729
2	12–13	R–2652*	L–2653, C–2653	L–2663, C–2680	L–2677, C–2703	L–2687, C–2730
3	13–14	R–2653*	L–2654, C–2654	L–2664, C–2681	L–2678, C–2704	L–2688, C–2731
4	14–15	R–2654*	L–2655, C–2655	L–2665, C–2682	L–2679, C–2705	L–2689, C–2732
5	15–16	R–2655*	L–2656, C–2656	L–2666, C–2683	L–2680, C–2706	L–2690, C–2733

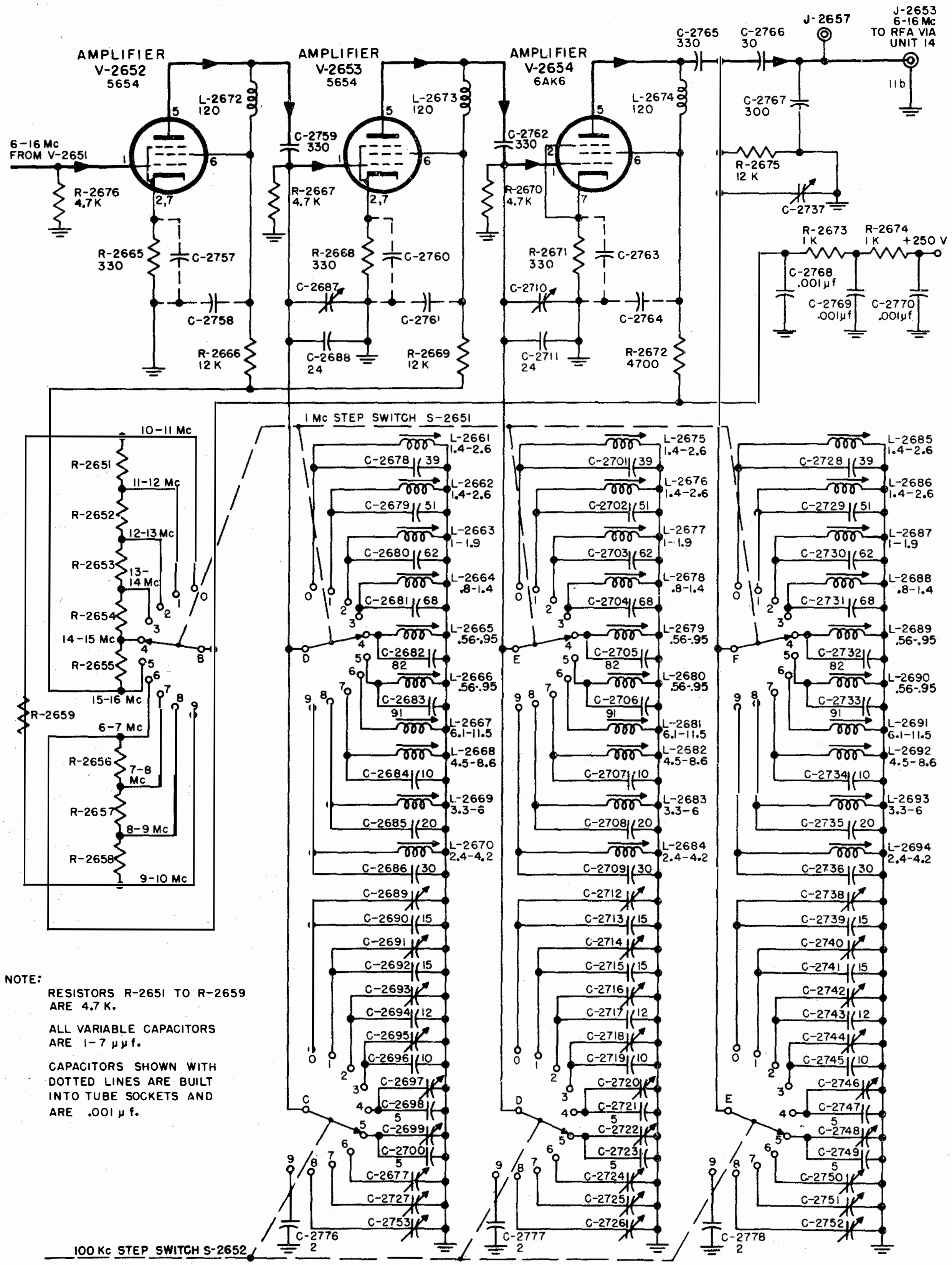
* Removed in addition to preceding resistors in this column.

19-, 20-, or 22-mc signal (10b) from unit 10. Test point J–2655 is provided for testing input 10b (approximately 0.4 volt). Receptacle J–2652 receives the 22- to 23-, 27- to 28-, 32- to 33-, or 37- to 38-mc signal (9b) from unit 9. Test point J–2656 is provided for testing input 9b (approximately 1.4 volts). These signals are mixed by V–2651, and amplified by V–2652, V–2653, and V–2654. A 1-mc step switch, S–2651, and a 100-kc step switch, S–2652, are provided to tune the filters for each stage as required to provide the desired bandwidth and to reject spurious frequencies.

(1) MIXER V–2651.—The inputs from units 10 and 9 are applied, respectively, to the suppressor and control grids of the mixer, V–2651 (figure 2–36). The frequencies of these inputs are determined by the settings on the mounting front panel. For example, to select 12 mc, the (AA) KNOB control is set at 2 and the (BB) KNOB control is set at 8. As a result, input 9b is 32 to 33 mc and input 10b is 20 mc. Mixer V–2651 combines these inputs to produce an output of 12 to 13 mc. The 1-mc step switch, S–2651, selects the proper tuned filter circuit for the mixer. This switch is controlled by the MC control knob (GG). For an output frequency setting of less than 10 mc, control (GG) is set to the megacycle value of the frequency; for outputs of 10 mc or higher, control (GG) is set to the second figure of the megacycle value. Therefore, in the case of 12-mc value, control (GG) is set at 2. To provide for the wide bandwidth requirements, 100-kc step switch S–2652 changes the capacitance in parallel with the 1-mc step filters so that each 1-mc filter may be tuned in 100-kc steps. R–2676, shunted across the circuit, also increases bandwidth. Switch S–2652 is controlled by the 100 KC knob (HH). Paragraph 2*r*(2) provides a complete description of the functioning of the above-mentioned frequency control knobs. The suppressor and control grids are connected through resistors R–2661 and R–2662 respectively, and the decoupling filter comprising R–2667 and R–2779 to the keying circuit output of the LLRM in the same manner as the mixer V–2626 in unit 11A.

(2) AMPLIFIERS V–2652, V–2653, AND V–2654. —These amplifiers (figure 2–37) are identical except that V–2652 and V–2653 are provided with dropping resistors R–2651 through R–2659, which are wired to contacts of section B of switch S–2651. By changing the screen and plate voltage at different frequencies, the gain of these amplifiers is varied, and approximately equal output is obtained for all frequencies. The interstage filters for these amplifiers are selected and tuned by S–2651 and S–2652 in the same manner as for the mixer. The final 6- to 16-mc output (11b) is coupled by the voltage divider, C–2766 and C–2767, to J–2653. Test point J–2657 is provided for testing output 11b (approximately 2.4 volts). The entire B+ supply is decoupled by a filter network composed of C–2768, C–2769, C–2770, R–2673, and R–2674.

(3) 1-MC STEP SWITCH S–2651.—The above table shows the filter networks selected by the 1-mc step switch, S–2651, and the dropping resistors successively removed from the amplifier circuits as the switch is rotated progressively from positions 6 to 9 and then from 0 to 5.



NOTE:

RESISTORS R-2651 TO R-2659 ARE 4.7 K.

ALL VARIABLE CAPACITORS ARE 1-7 µµf.

CAPACITORS SHOWN WITH DOTTED LINES ARE BUILT INTO TUBE SOCKETS AND ARE .001 µ f.

Figure 2-37. RFO Unit 11B, Amplifiers V-2652, V-2653 and V-2654, Simplified Schematic

TABLE 2—9. FUNCTIONS OF 100-KC STEP SWITCH S—2652

POSITION	FREQUENCY RANGE (kc)	FILTER CIRCUIT CAPACITORS SELECTED BY			
		SECTION B	SECTION C	SECTION D	SECTION E
0	0–100	C–2662, C–2663	C–2689, C–2690	C–2712, C–2713	C–2738, C–2739
1	100–200	C–2664, C–2665	C–2691, C–2692	C–2714, C–2715	C–2740, C–2741
2	200–300	C–2666, C–2667	C–2693, C–2694	C–2716, C–2717	C–2742, C–2743
3	300–400	C–2668, C–2669	C–2695, C–2696	C–2718, C–2719	C–2744, C–2745
4	400–500	C–2670, C–2671	C–2697, C–2698	C–2720, C–2721	C–2746, C–2747
5	500–600	C–2672, C–2673	C–2699, C–2700	C–2722, C–2723	C–2748, C–2749
6	600–700	C–2674	C–2677	C–2724	C–2750
7	700–800	C–2675	C–2727	C–2725	C–2751
8	800–900	C–2676	C–2753	C–2726	C–2752
9	900–1000	C–2775	C–2776	C–2777	C–2778

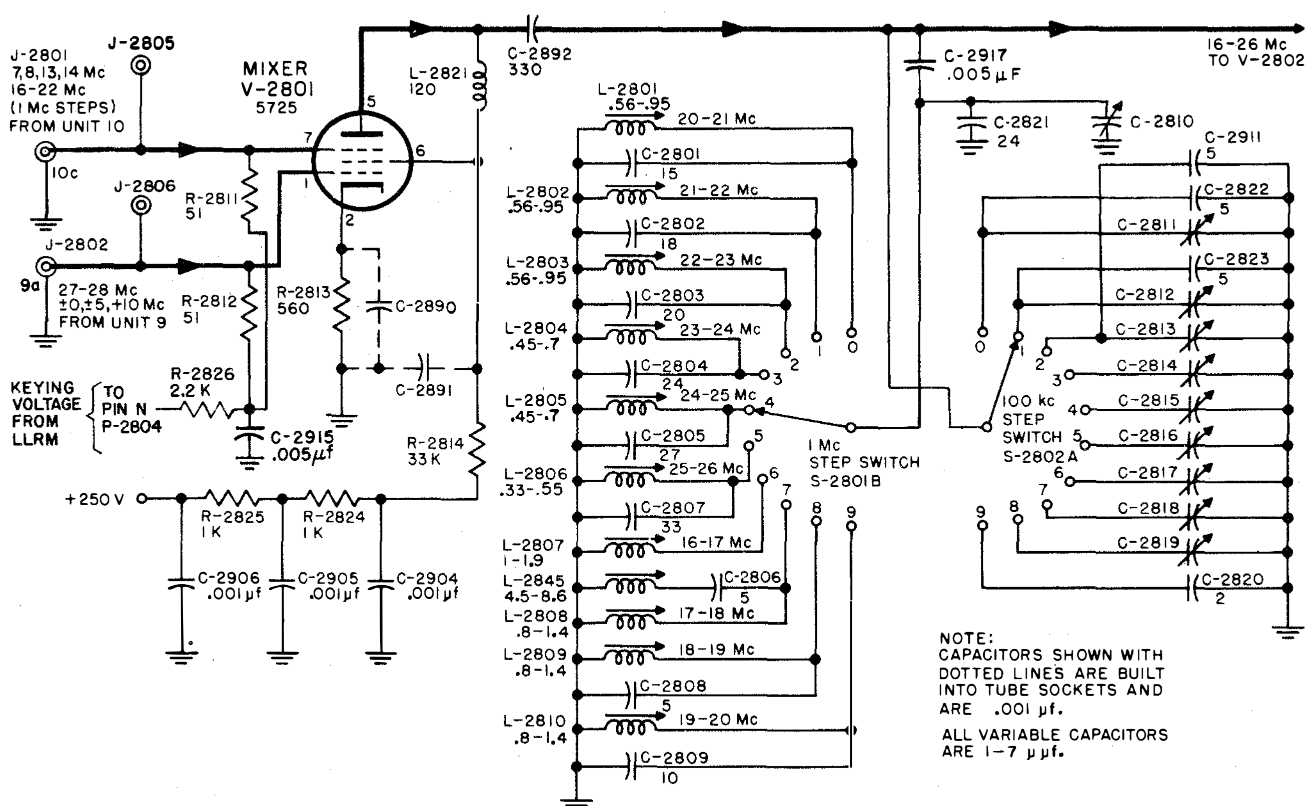


Figure 2—38. RFO Unit 11C, Mixer V—2801, Simplified Schematic

TABLE 2—10. FUNCTIONS OF 1-MC STEP SWITCH S–2801

POSITION	FREQUENCY RANGE (mc)	RESISTORS REMOVED BY SECTION A	FILTER CIRCUIT COMPONENTS SELECTED BY			
			SECTION B	SECTION C	SECTION D	SECTION E
6	16–17	None	L–2807	L–2817	L–2827	L–2837
7	17–18	R–2806	L–2845, L–2808, C–2806	L–2846, L–2818, C–2829	L–2828	L–2838
8	18–19	None*	L–2809, C–2808	L–2819, C–2841	L–2829, C–2863	L–2839, C–2885
9	19–20	R–2808*	L–2810, C–2809	L–2820, C–2842	L–2830, C–2864	L–2840, C–2886
0	20–21	R–2809*	L–2801, C–2801	L–2811, C–2824	L–2841, C–2847	L–2831, C–2869
1	21–22	R–2801*	L–2802, C–2802	L–2812, C–2825	L–2842, C–2848	L–2832, C–2880
2	22–23	R–2802*	L–2803, C–2803	L–2813, C–2826	L–2843, C–2849	L–2833, C–2881
3	23–24	R–2803*	L–2804, C–2804	L–2814, C–2827	L–2844, C–2850	L–2834, C–2882
4	24–25	R–2804*	L–2805, C–2805	L–2815, C–2828	L–2825, C–2861	L–2835, C–2883
5	25–26	None	L–2806, C–2807	L–2816, C–2830	L–2826, C–2862	L–2836, C–2884

* Removed in addition to preceding resistors in this column.

(4) 100-KC STEP SWITCH S-2652.—Table 2–9, page 2–37, shows the frequency ranges and capacitors switched into the 1-mc filter circuits by the 100-kc step switch, S-2652. Switch S-2652 selects a 100-kc range within the 1-mc range selected by switch S-2651.

o. ELECTRONIC FREQUENCY CONVERTER Z-2801 (FREQUENCY CONVERTER, UNIT 11C).—This unit is similar to unit 11B. It differs in frequency range (16 to 26 mc) and components required for this range. The keying input from the LLRM is fed to both the mixer, V–2801, and the first of the amplifier stages, V–2802. The step switches, S–2801 and S–2802, are mechanically coupled to the step switches in unit 11B.

(1) MIXER V–2801. — The suppressor of mixer V–2801 (figure 2–38) receives from J–2801 the 7-, 8-, 13-, 14-, 16-, 17-, 20- or 21-mc signal (10c) from unit 10. Test point J–2805 is provided for testing input 10c (approximately 0.4 volt). The control grid receives 22 to 23 mc, 27 to 28 mc, 32 to 33 mc, or 37 to 38 mc (9c) from unit 9. Test point J–2806 is provided for testing input 9c (approximately 1.2 volts). These signals are mixed in accordance with the (AA) KNOB and (BB) KNOB controls. For example, if the (AA) KNOB and (BB) KNOB controls are both set to 3 (23 mc), unit 9 delivers 37 to 38 mc to unit 11C and unit 10 delivers 14 mc. Under these circumstances, mixer V–2801 delivers an output of 23 to 24 mc. (See paragraph 2*r*(2).) Resistors R–2811 and R–2812 connect the suppressor and screen grids to the LLRM keying circuit through the decoupling filter comprising R–2826 and C–2915.

(2) AMPLIFIERS V–2802, V–2803, AND V–2804. —These amplifiers (figure 2–39) are similar to the corresponding amplifiers in unit 11B with the exception that LLRM keying is fed to the control grid of V–2802. The LLRM keying input is connected first through the same decoupling network employed in the input to V–2801, then through additional decoupling components R–2827 and C–2916 to grid resistor R–2815. The final 16- to 26-mc output (11c), which has been filtered four times to reject spurious frequencies, is fed to J–2803 at a level of approximately two volts rms. Test point J–2807 is provided for testing this output. The B+ supply for the entire unit is decoupled by C–2904, C–2905, C–2906, R–2824, and R–2825.

(3) 1-MC STEP SWITCH S–2801.—Table 2–10, above, shows the filter network components selected by the 1-mc step switch, S–2801, and the dropping resistor switched out of the amplifier circuits, as this switch is rotated progressively from positions 6 to 9 and then from 0 to 5.

(4) 100-KC STEP SWITCH S–2802.—The following table shows the frequency ranges and the capacitors selected for the 1-mc filter circuits by the 100-kc step switch, S–2802. Switch S–2802 selects a 100-kc range within the 1-mc range selected by switch S–2801.

p. ELECTRICAL EQUIPMENT RACK Z–2901 (MOUNTING, UNIT 14).—The mounting (unit 14) is the rack into which the subunits of the RFO are plugged. It contains the manual frequency controls, the

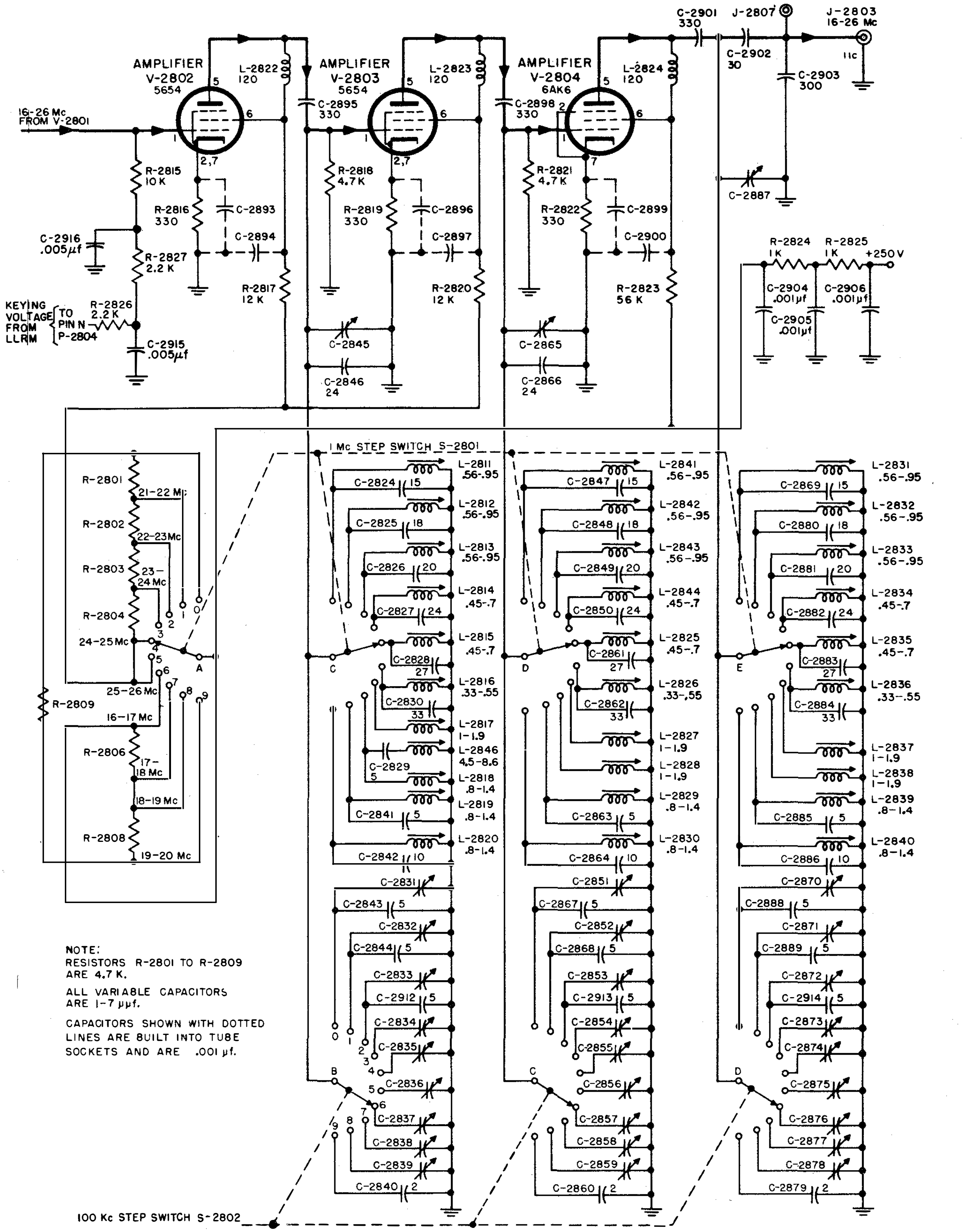


Figure 2—39. RFO Unit 11C, Amplifiers V—2802, V—2803, and V—2804, Simplified Schematic

TABLE 2–11. FUNCTIONS OF 100-KC STEP SWITCH S–2802

POSITION	FREQUENCY RANGE (kc)	FILTER CIRCUIT CAPACITORS SELECTED BY			
		SECTION A	SECTION B	SECTION C	SECTION D
0	0–100	C–2811, C–2822	C–2831, C–2843	C–2851, C–2867	C–2870, C–2888
1	100–200	C–2812, C–2823	C–2832, C–2844	C–2852, C–2868	C–2871, C–2889
2	200–300	C–2911, C–2813	C–2912, C–2833	C–2913, C–2853	C–2914, C–2872
3	300–400	C–2814	C–2834	C–2854	C–2873
4	400–500	C–2815	C–2835	C–2855	C–2874
5	500–600	C–2816	C–2836	C–2856	C–2875
6	600–700	C–2817	C–2837	C–2857	C–2876
7	700–800	C–2818	C–2838	C–2858	C–2877
8	800–900	C–2819	C–2839	C–2859	C–2878
9	900–1000	C–2820	C-2840	C–2860	C–2879

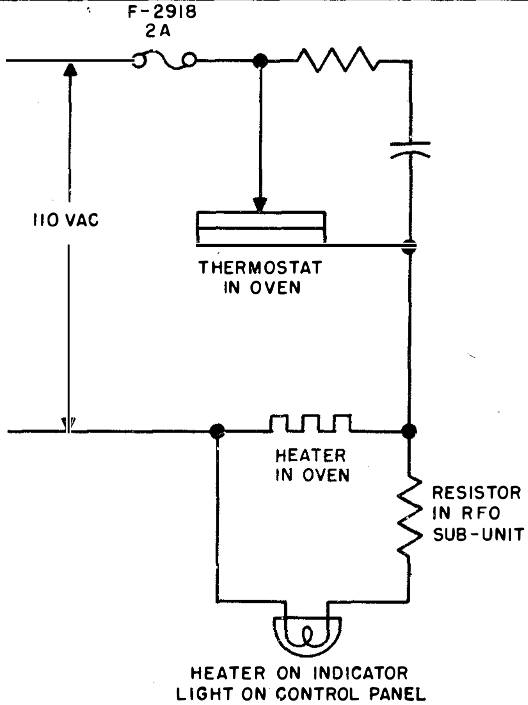


Figure 2–40. RFO Oscillator Heater Circuit, Generalized Schematic

bandswitch, S–2996, the filament and crystal oven heater supplies, heater indicator lights, the frequency-shift oscillator input circuits, zero adjust indication circuit, units 3 and 12 adjustment controls, door switch S–2920, test points for supply voltages, oscilloscope test receptacles, interconnecting wiring for the RFO units, and access wiring interconnecting the receptacles for the antenna tuning control indicator to the cabinet wiring. The manual frequency control and bandswitch S–2996 are discussed under selection of frequencies (paragraph 2*r*), the frequency-shift oscillator input circuit and adjustment is covered in paragraph 2*f*, unit 3 adjustment is described in paragraph 2*e* and the door switch is a component of the "500 W disable" circuit covered in the RFA (paragraph 10*e*(1)). The filament and oven heater are shown in the primary power distribution diagram provided in Section 7.

(1) HEATER INDICATOR LIGHTS.—The heater indicator light circuits are shown in figures 2–3, 2–10, and 2–11. A generalized circuit is illustrated in figure 2–40.

(2). TEST POINTS.—The following table lists the test points on unit 14.

TABLE 2–12. UNIT 14 TEST POINTS

TEST PINS ON SOCKET XV–2916	VOLTAGE PRESENT
Pin 1	Ground
Pin 2	6.3 V AC, Reg, Fil
Pin 3	6.3 V AC, Unreg, Fil
Pin 4	+250 V DC, Reg
Pin 5	+250 V DC, Unreg
Pin 6	–24 V DC, after TD
Pin 7	Keying Voltage to unit 12
Pin 8	Keying Voltage to units 11A, 11B and 11C

(3) OSCILLOSCOPE TEST RECEPTACLES. — A set of oscilloscope test receptacles are brought out on the front of the mounting. These receptacles provide signals from certain of the subunits that can be con-

nected to a standard test oscilloscope for servicing and checking purposes. Table 2–13 lists these receptacles, the signal carried, and the subunit from which the signal is obtained.

TABLE 2–13. OSCILLOSCOPE TEST RECEPTACLES

TEST RECEPTACLE	SIGNAL	
	FREQUENCY	FROM SUBUNIT
J–2929	10 kc	6
J–2930	210–300 kc in 10-kc steps	6
J–2931	100 kc	1
J–2932	1.6–2.5 mc in 100-kc steps	8
J–2933	100 kc	3 (Int Osc)
J–2934	100 kc $\pm \frac{\Delta F}{2}$	12 (FS Osc)

(4) ZERO ADJUST INDICATING CIRCUIT.—The zero adjust indicator circuit (figure 2–41) provides a means for comparing the 100-kc output from the frequency-shift oscillator (unit 12) or the 100-kc output from the interpolation oscillator (unit 3) with the standard 100-kc signal from the crystal-controlled oscillator (unit 1). The outputs from unit 3 and unit 12 are connected to the ZERO ADJUST switch ⓩ, S–2917. In the INT. OSC. position the signal from unit 3 is connected to the circuit. When S–2917 is set at the F.S. OSC. position, the signal from unit 12 is fed to the circuit. The signal to be compared is connected to the plate of crystal rectifier CR–2920 while the standard 100-kc signal from unit 1 is coupled through C–2927 to the cathode of CR–2920. The two frequencies are mixed with CR–2920, diode detecting the resultant sum of the two frequencies and the difference between the two frequencies (beat frequency), across the load resistor, R–2968. The network comprised of R–2967 and C–2928 is a low-pass filter which will bypass the high order frequencies, passing only the beat frequency to the triode grid of electron ray tube V–2917. V–2917 gives a visual indication of when the measured frequency is at the same frequency as the standard. As discussed above, the signal applied to V–2917 will fluctuate at the beat frequency, which means the current flowing in the triode section of V–2917 will fluctuate in a corresponding manner and therefore the triode plate voltage, which is also the voltage applied to the ray-control electrode, will vary and the shadow angle on the target will open and close at the beat frequency. The effect of regulating the INT. OSC. ZERO ADJ. control, L–2080, or the F.S.O. ZERO ADJ. control, R–2916, can be determined by the shadow appearing on the target of V–2917, a zero beat (or constant shadow angle) indicating that an output of 100 kc has been obtained.

Note

If the beat frequency is high, the rapid fluctuations of the shadow angle on V–2917 will appear merely as a blur. Care should be taken to distinguish this from a zero beat condition.

q. CONTROL-INDICATOR C–1352/SRT (CONTROL-INDICATOR). — The control-indicator is designed for front-panel mounting on unit 14 of the RFO and contains all controls and indicators required for remote manual tuning of the two major units comprising the antenna tuning equipment, namely, Radio Frequency Tuner TN–229/SRT and Antenna Coupler CU–372/SRT. The control-indicator contains seven controls and

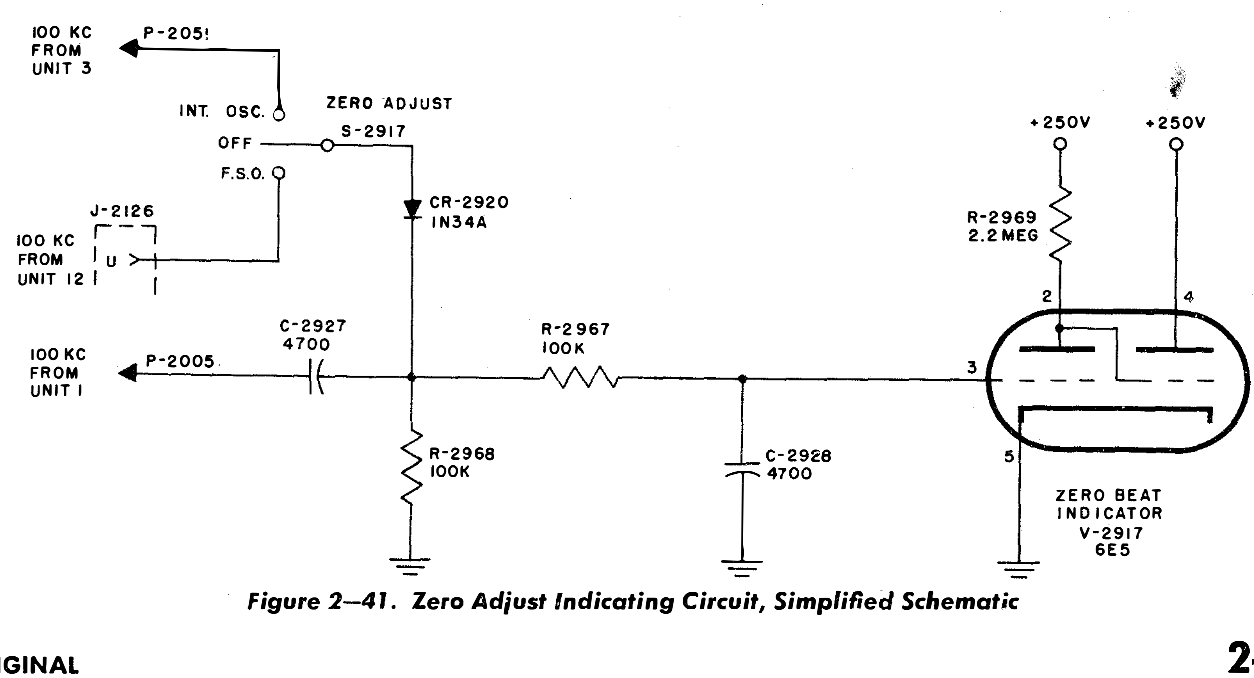


Figure 2–41. Zero Adjust Indicating Circuit, Simplified Schematic

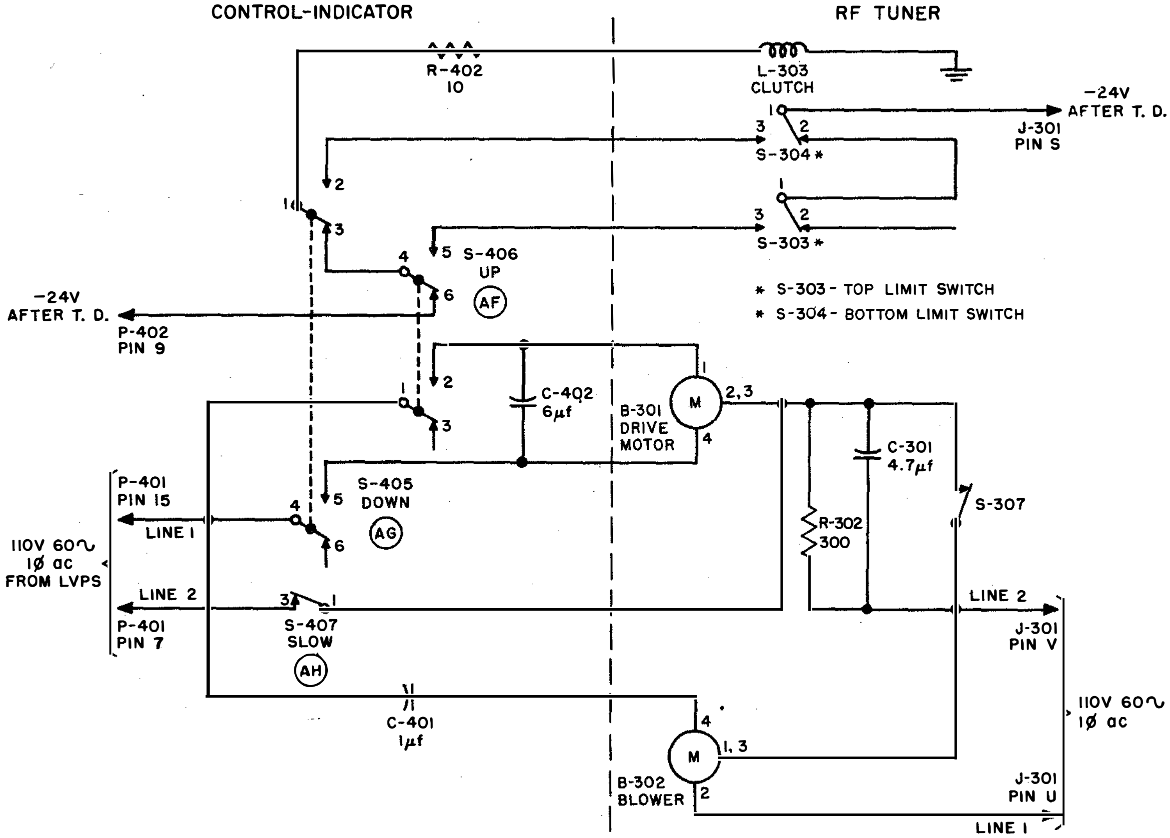


Figure 2—42. R-F Tuner Drive Motor Control Circuit, Simplified Schematic

two indicating meters required to manually tune the antenna tuning equipment. There are two auxiliary controls that are used to calibrate one of the indicating meters.

(1) DRIVE MOTOR CONTROL CIRCUIT.—The drive motor control circuit (figure 2–42) controls the operation of the drive motor in the radio frequency tuner, which, in turn, positions the shorting ring on the main tuning coil.

(*a*) The drive motor, B–301 in the radio frequency tuner, is a split phase induction motor that can be run in either direction, depending on which phase has the phase-shifting capacitor in series with it. Depressing the DOWN (AG) switch, S–405, applies 110-volt, 60-cycle, single-phase power through contacts 4 and 5 of S–405 and contacts 1 and 3 of S–407 to the drive motor. This source of a-c power comes from the low voltage power supply and is available only when the transmitter bay is energized. With this connection, phase shifting capacitor C–402 is introduced in series with the winding of the drive motor, which will provide driving torque to produce motor rotation in the direction that causes the shorting ring to move down on the main tuning coil. If the UP (AF) switch, S–406, had been depressed instead of the DOWN (AG) switch, a-c power would have been delivered to the down motor through contacts 1 and 2 of S–406. This connection would place phase shifting capacitor C–402 in series with the other winding of the drive motor, causing driving torque in the opposite direction, which would move the shorting ring up on the main tuning coil.

(*b*) A speed governor, S–307, is attached to the shaft of the drive motor and is set to open at approximately 500 rpm. As long as the SLOW (AH) switch, S–407, is not operated, the action of the governor, S–307, is bypassed as one side of the a-c supply is fed directly to the drive motor through contacts 1 and 3 of S–407. When the SLOW (AH) switch is depressed, the a-c line is connected to the drive motor through the governor, S–307. To energize the drive motor, either the UP (AF) or DOWN (AG) switch must also be depressed to connect on the other side of the a-c line to the motor. As long as the motor is receiving at less than 500 rpm, the contacts of S–307 remain closed and full driving torque is applied. When motor speed reaches 500 rpm, and the governor contacts open, the network comprised of R–302 and C–301 is introduced into the a-c line in series with the motor windings. The impedance of this network is sufficiently high compared with the motor winding impedance to effectively remove power from the motor at the time of opening of the governor at 500 rpm. The SLOW (AH) control is used for fine tuning control about the optimum tuning point.

(*c*) In the mechanical connection between the drive motor and the shorting ring in the radio frequency tuner, there is a solenoid operated clutch. When the clutch solenoid is operated, the clutch disengages. The UP Ⓐⓕ switch and DOWN Ⓐⓖ switch each are double-pole switches. One pole of each switch is used for drive motor control, as described in the previous paragraph, and the other pole is used for control of the clutch. If neither the UP Ⓐⓕ nor the DOWN Ⓐⓗ switch is operated, —24 volts after time delay is supplied through contacts 4 and 6 of S-406 and contacts 1 and 3 of S-405, through limiting resistor R-402 to the clutch solenoid, L-303 in the radio frequency tuner, disengaging the drive motor from the shorting ring. As soon as either S-405 or S-406 is operated, this circuit is broken and the clutch re-engages.

(*d*) To prevent damage to the equipment by running the tuning motor until the shorting ring goes to the limit of its travel and jams at either the top or bottom of the travel, a bottom limit switch, S-304, and a top limit switch, S-303, are included in the radio frequency tuner. S-304 is operated when the shorting ring reaches the top allowable limit of its travel, and S-303 operates when the bottom allowable limit is reached. Assume that the shorting ring is being moved up on the main tuning coil by virtue of having the UP Ⓐⓕ switch, S-406, operated. When the top limit is reached, S-303 operates and —24 volts after time delay is applied through contacts 1 and 2 of nonoperated S-304, contacts 1 and 3 of nonoperated S-405, through limiting resistor R-402 to the clutch solenoid L-303. This will disengage the clutch, stopping the upward motion of the shorting ring even though the tuning motor remains energized. Conversely, if the shorting ring is moving down because of the DOWN Ⓐⓖ switch, S-405, being operated, and the bottom limit is reached, the clutch solenoid will be energized again from —24 volts after time delay through contacts 1 and 3 of operated bottom limit switch S-304 and contacts 1 and 2 of S-405 and limiting resistor R-402.

(*e*) Capacitor C-401, which is also located in the control indicator, is located in one side of the a-c line supplying the blower, B-302, in the radio frequency tuner. C-401 acts as the phase shifting capacitor required to develop driving torque for the blower.

(2) ANTENNA TRANSFER Ⓐⓔ SWITCH S-402, CONTROL CIRCUIT.—The ANTENNA TRANSFER Ⓐⓔ switch S-402 (figure 2-43) is a double-pole, double-throw toggle switch with an off position. The three positions are designated TUNER IN, BYPASS, and REMOTE. One pole of this switch provides the remote control for the positioning of an electromagnetic actuator, B-3502 in the antenna coupler. The second pole of S-402 controls the operation of relay K-401.

(*a*) The actuator, B-3502, operates from 110-volt, 60-cycle, single-phase ac, applying a rotary motion to its drive shaft. Mounted on the shaft is a positioning cam. The actuator drives the rotor of the bypass switch in the antenna coupler. A detailed explanation of the functioning of the bypass switch is contained in the section covering the antenna coupler (paragraph 17*c*(1)) but for the purpose of this discussion it suffices to say that, in one position of the bypass switch, the two components of the antenna tuning equipment are in the r-f transmission line, and in the other position of the switch, they are both bypassed and the antenna is connected directly to the transmitter bay of the AN/SRT-14, 15 or 16.

(*b*) Actuator B-3502 receives its power from the oven heater supply of the transmitter bay, this supply being uninterrupted by any of the controls of the

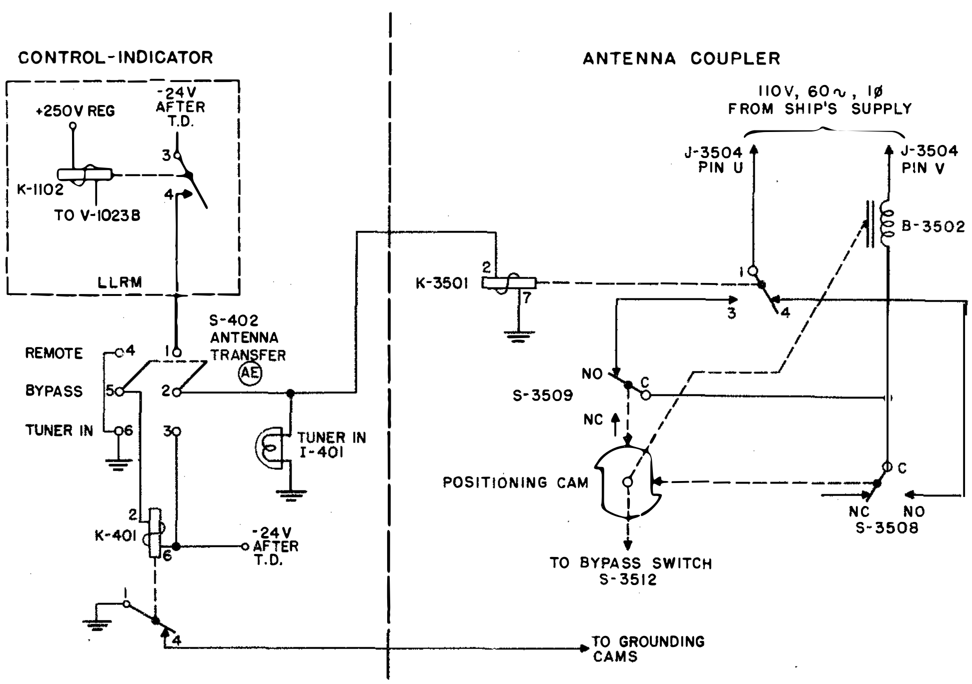


Figure 2-43. Antenna Transfer Ⓐⓔ Switch S-402, Control Circuit, Simplified Schematic

AN/SRT–14, 15, and 16. One side of the supply is fed directly to the actuator winding. The other side is delivered first to the contacts of relay K–3501, and then through the contacts of either microswitch S–3509 or S–3508 to the other side of the actuator winding. The roller actuators of the two switches, S–3508 and S–3509, ride on the positioning cam.

(*c*) With the ANTENNA TRANSFER Ⓐⓔ switch, S–402, in the TUNER IN position, –24 volts after time delay is supplied to relay K–3501, through contacts 2 and 3 of S–402, causing it to operate. Power is supplied to actuator B–3502 through contacts 1 and 3 of K–3501 and C of NO contacts of S–3509. The actuator will rotate until the positioning cam reaches the point where the roller of S–3509 drops into the notch of the cam, causing S–3509 to open and disrupt the power to the actuator winding. The relative mounting positions of S–3509 and the positioning cam are such that at this position of rotation of the actuator shaft, the bypass switch is in the position where the antenna tuning components are switched into the r-f line.

(*d*) Figure 2–43 shows the actuator in the BYPASS position with S–3508 resting in the cam notch and S–3509 riding on the cam ring. It can be seen that if ANTENNA TRANSFER Ⓐⓔ switch S–402 were now placed in the BYPASS position, a-c power for the actuator would be supplied through the contacts 1 and 4 of the now nonoperated K–3501 to the NO contacts of S–3508 where an open circuit exists, and the actuator would not be energized. However, if the positioning cam were in the TUNER IN position when ANTENNA TRANSFER Ⓐⓔ switch S–402 was placed in the BYPASS position, the winding of actuator B–502 would be energized, as a circuit would now be completed through contacts NO and C of S–3508. The actuator would continue to rotate until the position of the bypass switch, where the antenna tuning equipment is switched out of the r-f line, was reached. At this point the notch in the positioning cam would be at the position of switch S–3508 and contacts NO and C would open, de-energizing the actuator winding.

(*e*) The third position of the ANTENNA TRANSFER Ⓐⓔ switch, S–402, is designated REMOTE. In this position, relay K–3501 is connected to the output of the ATU bypass transfer circuit located in the low level radio modulator. A complete discussion of the function of this circuit is found in paragraph 7*g*. The resultant output is that when relay K–1102 is operated, —24 volts after time delay is supplied through contacts 3 and 4 of K–1102, through contacts 1 and 2 of S–402 in the REMOTE position, to relay K–3501 in the antenna coupler. This produces the same result as described in the previous paragraph when S–402 is in the TUNER IN position. When K–1102 in the low level radio modulator is not energized, the —24 volts after time delay is no longer connected to K–3501, which is the same condition as if S–402 were in the BYPASS position.

(*f*) When primary power is de-energized in the transmitter bay of the AN/SRT–14, 15 and 16, the source of —24 volts after time delay is also removed. Under such a condition the actuator will drive to the bypass position regardless of the setting of ANTENNA TRANSFER Ⓐⓔ switch S–402, as relay K–3501 will not be energized. However, a-c power remains, as this source is not affected by the primary power controls of the transmitter bay.

(*g*) Whenever —24 volts after time delay is fed to K–3501, which is the condition for the TUNER IN position, the TUNER IN indicator, I–401, will be illuminated by the same potential to designate that the antenna tuning equipment is in the r-f transmission line.

(*h*) The second pole of S–402, with S–402 either in TUNER IN or REMOVE position, closes a ground circuit to the winding of relay K–401 through either contacts 5 and 6 or 4 and 5 of S–402. As the other side of the winding of K–401 is connected to –24 volts after time delay, K–401 is operated when S–402 is in either TUNER IN or REMOTE. In BYPASS position, S–402 breaks the ground circuit to K–401, and K–401 does not operate. In BYPASS, with K–401 not operated, a ground is forwarded to the grounding cams in the antenna coupler through contacts 1 and 4 of K–401. In TUNER IN and REMOTE, this ground is not present, as K–401 is operative, opening its contacts 1 and 4. The function of this ground is covered in paragraph 17*c*(3) concerning the antenna coupler.

(3) ANTENNA COUPLER LOADING Ⓐⓓ SWITCH S–404 CONTROL CIRCUIT.—The ANTENNA COUPLER LOADING Ⓐⓓ SWITCH, S–404 (figure 2–44), is a six-position selector switch whose function is to control the positioning of another actuator, B–3501, in the antenna coupler. This actuator in turn positions the loading switch in the antenna coupler. The loading switch selects the loading component that might be needed to properly tune the antenna system. A detailed description of the functioning of the loading components is found in the section covering the antenna coupler (paragraph 17*c*(2)).

The 110-volt, 60-cycle, single-phase, a-c supply to energize the winding of actuator B–3501 originates in the low voltage power supply and is present only when the transmitter bay is energized. One side of this supply is fed directly to one side of the actuator winding. The other side of the a-c supply is connected to the rotor contact 11 of the ANTENNA COUPLER LOADING Ⓐⓓ switch, S–404. With S–404 in the DIRECT position, the a-c connection is fed through contact 13 of S–404, through contacts NO and C of microswitch S–3505 to the other side of the actuator winding. The actuator will rotate until the roller actuator of S–3505 falls into the notch of the positioning cam, which will open contacts NO and C of S–3505, breaking the a-c supply to the actuator. There are six positions for the actuator rotor that correspond to the six positions of the loading switch

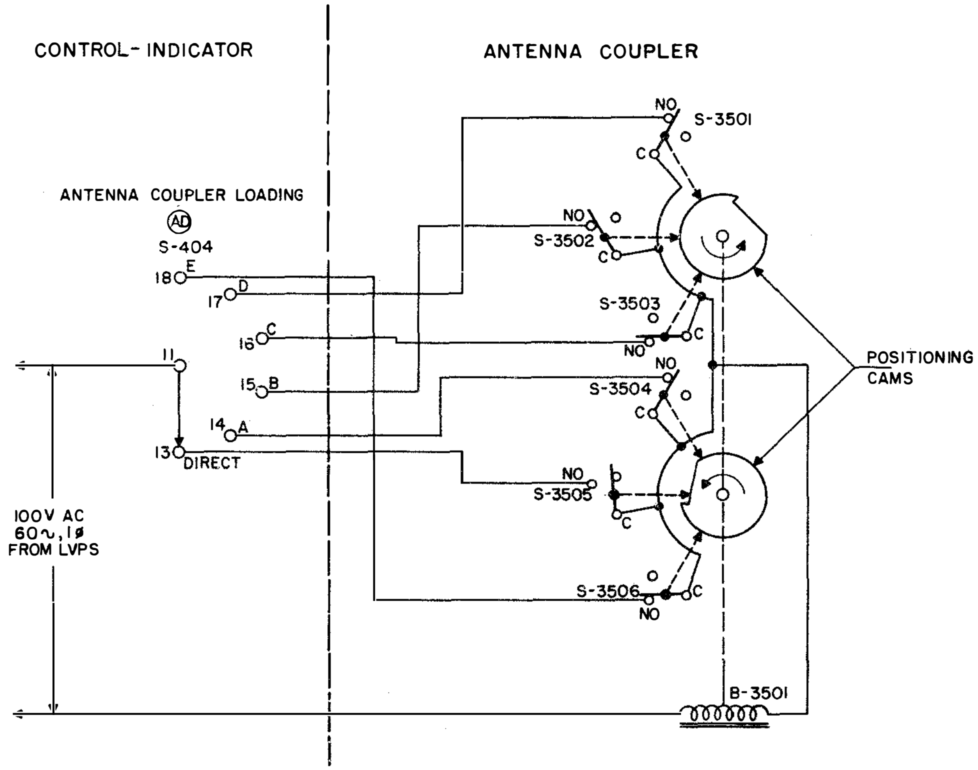


Figure 2—44. Antenna Coupler Loading (AD) Switch S—404, Control Circuit, Simplified Schematic

that the actuator drives. For convenience of the mounting of the six positioning microswitches, S–3501 through S–3506, two positioning cams are employed. Table 2–14 shows the various positions of S–404 and the positioning microswitch in the antenna coupler that is employed for each position of S–404.

TABLE 2—14. FUNCTIONS OF ANTENNA COUPLER LOADING (AD) SWITCH S—404

POSITION OF S—404	POSITION MICROSWITCH EMPLOYED
DIRECT	S–3505
A	S–3504
B	S–3502
C	S–3503
D	S–3501
E	S–3506

(4) TRANSFORMER (AC) SWITCH S–403 CONTROL CIRCUIT.—TRANSFORMER (AC) switch S–403 (figure 2–45) functions in the same manner as ANTENNA COUPLER LOADING (AD) switch S–404, described in the previous paragraph. S–403 controls the position of actuator B–303 in the radio frequency tuner; B–303 in turn positions the transformer switch in the tuner that connects or removes an impedance transformer in series with the r-f transmission line. The requirement of the impedance transformer is discussed in paragraph 17*b*(2).

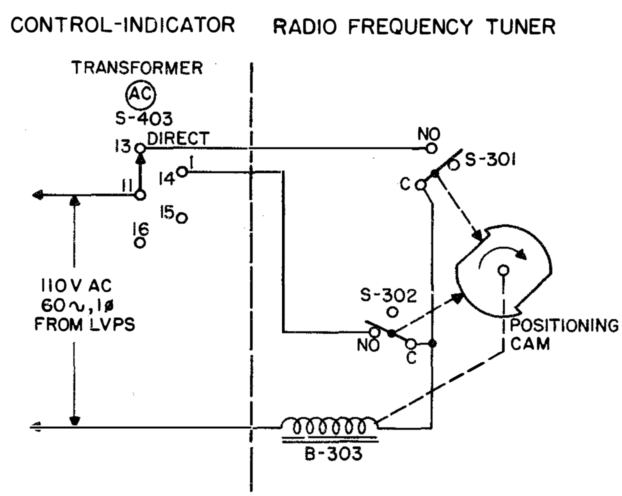


Figure 2—45. Transformer (AC) Switch S—403, Control Circuit, Simplified Schematic

With S–403 in the DIRECT position, one side of the 110-volt, a-c line is fed through contacts 11 and 13 of S–403, through the contacts NO and C of S–301 to one side of the winding of actuator B–303. The other side of the actuator is connected directly to the other side of the a-c line. B–303 now rotates until the roller actuator of S–301 falls into the notch of the positioning cam, at which point the NO and C contacts of S–301 open, breaking the ac. The transformer switch, S–308, which is driven by B–303, is now in the position where the im-

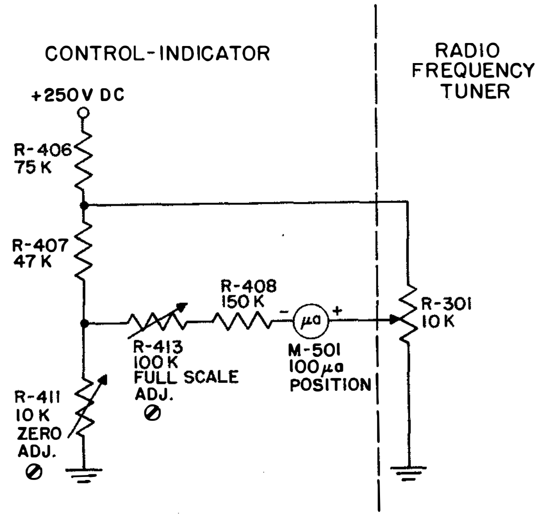


Figure 2—46. Position Indicator Circuit, Simplified Schematic

pedance transformer is not in the circuit. Placing S–403 in the 1 position will again energize B–301 through S–302, and B–303 will rotate until the actuator for S–302 falls in the notch of the positioning cam. This corresponds to the position of S–308 where the impedance transformer is in the circuit.

(5) POSITION INDICATOR CIRCUIT. — The POSITION indicator, M–402 (figure 2–46), gives an indication of the position of the shorting ring on the main tuning coil of the radio frequency tuner. To accomplish this a potentiometer, R–301 in the tuner, is geared to the same drive mechanism in the tuner that positions the shorting ring. The gear ratio is such that full excursion of the shorting ring will produce about 70 percent of full rotation of R–301. R–301 is part of a voltage divider network from +250 volts dc to ground, comprised mainly of R–406, R–407, R–411, and R–301. The values are such that the potential at the high end of R–301 is about +25 volts, with the low end grounded. As R–301 only travels 70 percent of its full rotation, when the shorting ring is driven to the top limit of its travel, the arm of R–301, which is connected to one side of POSITION meter M–402, will be at about +21 volts. When the ring is at the bottom limit, the arm of R–301 will be about +4 volts. With the arm of R–301 at the low limit, the value of R–411 is adjusted so the potential at the junction of R–407, R–411, and R–413 is the same as at the arm of R–301 (approximately +4 volts), at which point no current will flow through M–301, and the indication will be zero. With the arm of R–301 at the high end of the travel, there will be a potential of approximately 17 volts across the combination of limiting resistors R–413, R–408, and M–301. R–413 is adjusted for full-scale reading on M–301. By making both the low-scale and high-scale adjustments, accurate positioning of the shaft of R–301 with respect to the traverse of the shorting ring is eliminated, it being necessary only to ensure the total traverse lies between the limit stops of the potentiometer. Both R–411 and R–413 are screw-driver adjustments on the front panel of the control indicator and are designated ZERO ADJ and FULL SCALE ADJ respectively.

(6) SWR INDICATOR CIRCUIT.—The SWR indicator circuit (figure 2–47) is used in conjunction with voltages supplied to it from the SWR monitor circuit, which is a component of the load adjusting unit (see paragraph 15*b*). The input to the SWR indicator circuit from the SWR monitor consists of two voltages of opposite polarity, one proportional to the voltage of the "reflected" wave and the other proportional to the "incident" wave as measured on the r-f output line of the transmitter. Across the input there is a tapped divider consisting of R–410, R–415, R–414, and R–412. The values of these components are such that if the standing wave on the r-f line is 8:1, the potential at the junction of the R–410 and R–415 is zero; accordingly, the 8:1 position of the SWR CALIBRATE switch, S–408, is connected to this point and the SWR BALANCE meter, M–410, would be at the center null position. If the standing-wave ratio is less than 8.1, with S–408 set at the 8:1 position, the SWR BALANCE meter M–401 will read to the left of the null position (green area) and, conversely, if the ratio is higher than 8:1, M–401 will read to the right of the null position (red area). Similarly, the voltage at the junction of R–415 and R–414 will be zero when the standing-wave ratio is 4:1. With the SWR CALIBRATE switch, S–408, set at the 4:1 position, which is connected to the junction of R–415 and R–414, M–401 will again read at the center null position for a value of 4:1 SWR. A 2:1 value of standing-wave ratio will give a zero potential at the junction of R–414 and R–412; consequently, the 2:1 position of S–408 is connected to this point. R–416 is a limiting resistor of sufficient size to limit the current flowing through M–401 to a value below its safe limit value of 5 ma when the transmitter is in 500-watt operation. R–409 is the damping resistor for M–401. S–408 has an OFF position that disconnects the SWR BALANCE meter, M–401, from the circuit.

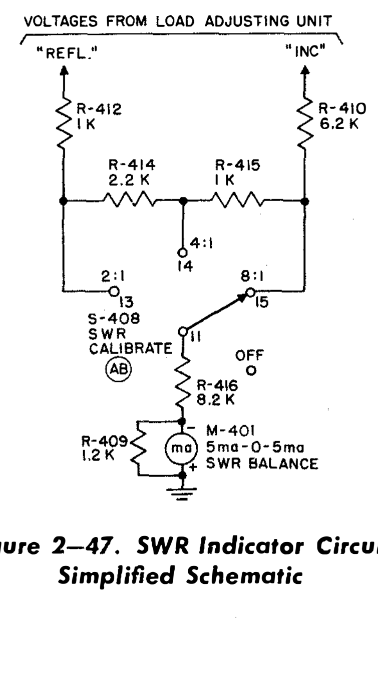


Figure 2—47. SWR Indicator Circuit, Simplified Schematic

r. CONTROL OF FREQUENCIES.—The set-up of frequencies in the RFO can be accomplished manually by a series of nine control knobs, located behind a transparent door on the front panel of the RFO. These controls are designated as follows: Ⓐⓐ KNOB control, ⒷⒷ KNOB control, BAND control knob ⒻⒻ, MC control knob ⒼⒼ, 100 KC control knob ⒽⒽ, 10 KC control knob ⒿⒿ, KC control knob ⒸⒸ, 100∼ control knob ⒹⒹ, and 10∼ control knob ⒺⒺ.

(1) MECHANICAL LINKAGES.—The control knobs are mechanically connected to shafts of the corresponding rotary switches in the RFO subunits by employing a system of chain drives. The mechanical linkages employed are shown in figures 2-48 through 2-54. The 10∼ control knob ⒺⒺ, the 100∼ control knob ⒹⒹ, and the KC control knob ⒸⒸ are mounted directly on the shafts of the 10∼ step switch, S-2053, the 100∼ step switch, S-2052, and the 1-kc step switch, S-2051, respectively, located in unit 3. The 10 KC control knob ⒿⒿ is connected by a chain to the shaft of the 10-kc step switch, S-2201, located in unit 6. The 100 KC control knob ⒽⒽ is connected by a chain to a shaft on which is mounted the 100-kc step switch, S-2326 in unit 8. This shaft, in turn, mounts a continuous chain that drives two additional shafts. On the first of these shafts is mounted the 100-kc step switch, S-2427 in unit 9; on the second, the 100-kc step switch, S-2652 in unit 11B, and the 100-kc step switch, S-2802 in unit 11C, are mounted. The MC control knob ⒼⒼ is chain-connected to a shaft on which 1-mc step switch S-2651 in unit 11B and 1-mc step switch S-2801 in unit 11C are mounted. BAND control knob ⒻⒻ chain-drives the shaft of bandswitch S-2996 located on unit 14. ⒷⒷ KNOB control chain-drives the shaft of 1-mc step switch S-2526 in unit 10. Ⓐⓐ KNOB control is chain-connected to a shaft connected to unit 9, where this shaft, in turn, is chain-connected to the shaft of the 5-mc step switch, S-2426.

(2) MECHANICAL SELECTION OF A FREQUENCY.—To set up a frequency, the above-mentioned control knobs permit the manual selection of any frequency in 10-cycle steps between 0.3 mc to 26 mc. The dial reading corresponding to the 100 KC control knob ⒽⒽ down through the 10∼ control knob ⒺⒺ designates directly the significant figures of the frequency setting through the 100 KC setting. The selection of the correct megacycle setting requires the regulating of the Ⓐⓐ KNOB control, the ⒷⒷ KNOB control, the BAND control knob ⒻⒻ, and the MC control knob ⒼⒼ. Ⓐⓐ and ⒷⒷ select the frequency of the outputs of units 9 and 10 respectively according to the megacycle setting of the frequency desired. The outputs of units 9 and 10 are fed to unit 11A or 11B or 11C as determined by the proper setting of the bandswitch S-2996 controlled by BAND control ⒻⒻ. The MC control knob ⒼⒼ controls the tuning in units 11B and 11C. The following table shows the settings of Ⓐⓐ, ⒷⒷ, ⒻⒻ, and ⒼⒼ according to the megacycle value of the RFO output frequency. In all instances the positions of the control knobs correspond to the positions of switches they control.

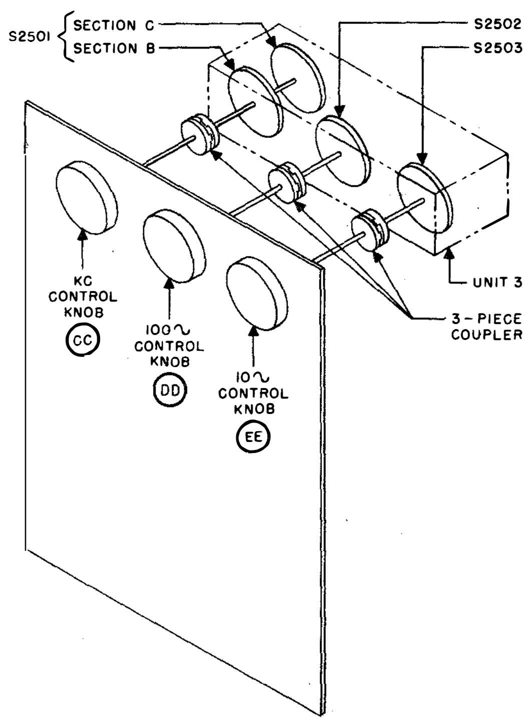


Figure 2-48. 10∼ ⒺⒺ, 100∼ ⒹⒹ, KC ⒸⒸ Controls, Mechanical Linkages

TABLE 2-15. FINAL OUTPUT FREQUENCIES AND Ⓐⓐ, ⒷⒷ, ⒻⒻ, AND ⒼⒼ CONTROL POSITIONS

RFO OUTPUT FREQ (mc)	Ⓐⓐ CONTROL POSITION	ⒷⒷ CONTROL POSITION	ⒻⒻ CONTROL POSITION	ⒼⒼ CONTROL POSITION
0.3-1	0	10	0.3-6 mc	*
1-2	0	9		*
2-3	0	8		*
3-4	0	7		*
4-5	0	6		*
5-6	1	10		*
6-7	0	4	6-16 mc	6
7-8	1	8		7
8-9	0	3		8
9-10	0	2		9
10-11	1	5		0
11-12	1	4		1
12-13	2	8		2
13-14	2	7		3
14-15	2	6		4
15-16	3	10		5
16-17	3	9	16-26 mc	6
17-18	3	8		7
18-19	2	3		8
19-20	1	1		9
20-21	3	5		0
21-22	3	4		1
22-23	0	1		2
23-24	3	3		3
24-25	3	2		4
25-26	2	0		5

* In the 0.3- to 6-mc band the position of ⒼⒼ is immaterial.

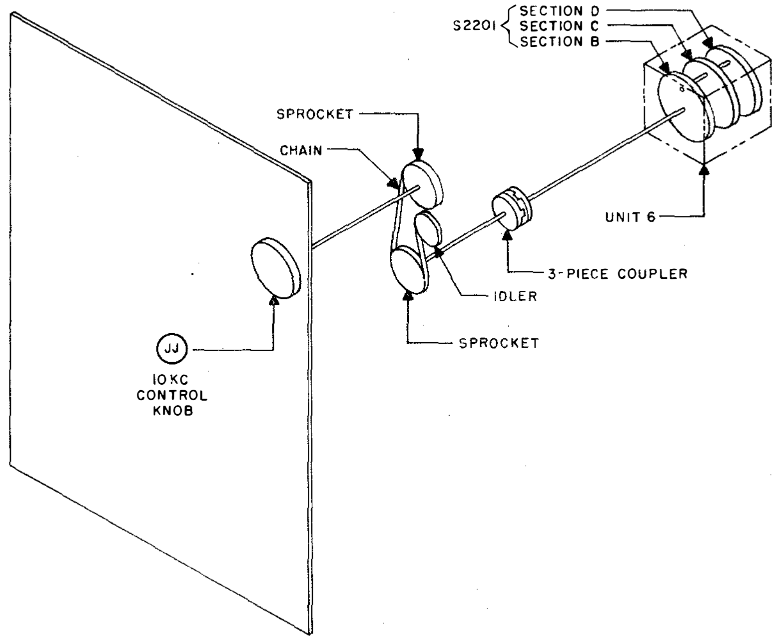


Figure 2—49. 10 KC (JJ) Control, Mechanical Linkages

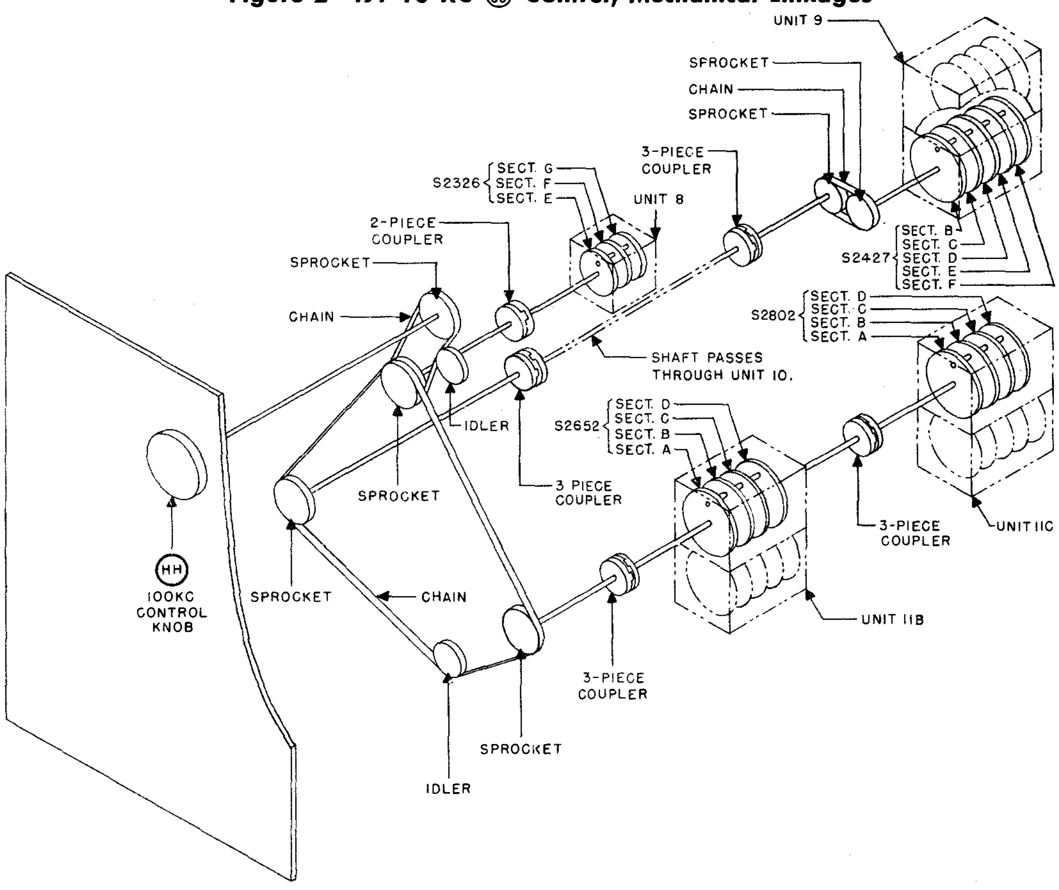


Figure 2—50. 100 KC (HH) Control, Mechanical Linkages

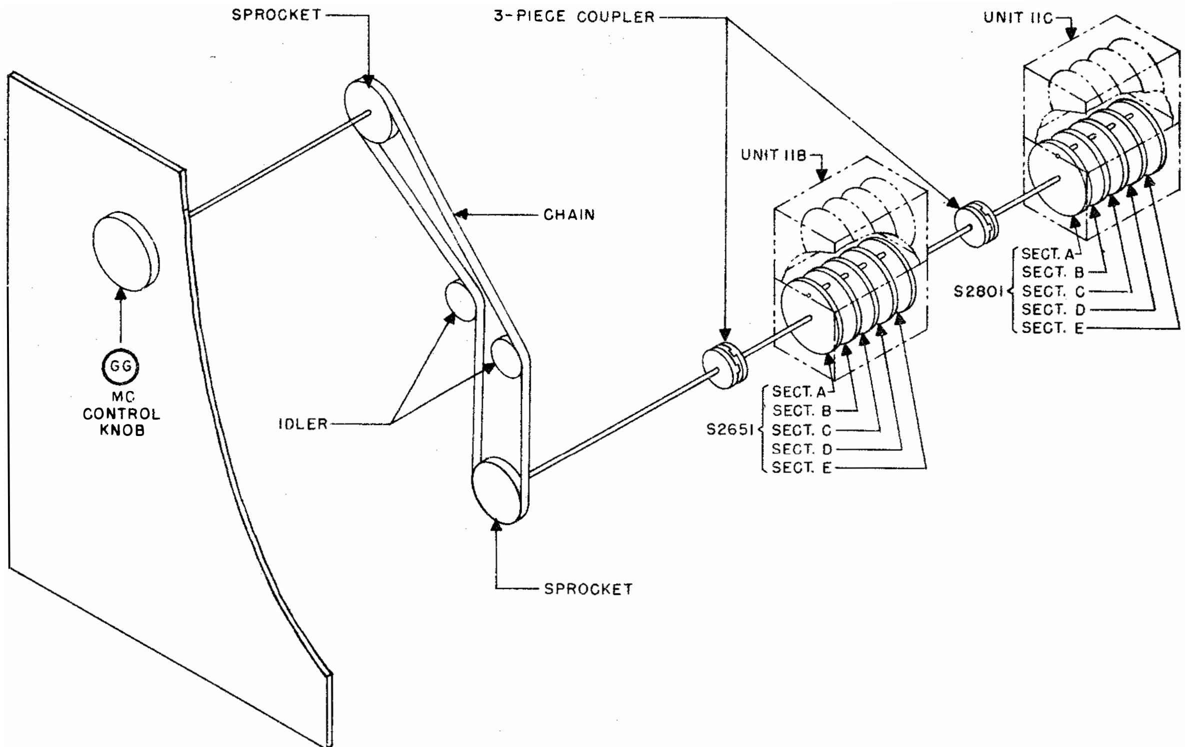


Figure 2—51. MC Ⓖ Control, Mechanical Linkages

(3) PRODUCTION OF A SAMPLE FREQUENCY.—To illustrate the operation of the subunits and the controls of the RFO, assume a sample frequency of 23.57619 mc is desired at the RFO output (figure 2–131).

(*a*) MANUAL OPERATION.—The first step in setting up a new frequency is to open the transparent door covering the control knobs. Opening this door also opens the door switch S–2920, which restores the transmitter output to the 100-watt level if transmission was taking place at the 500-watt level when the transparent door was opened (see paragraph 10*e*(1)). For the sample frequency of 23.57619 mc, the 10∼ control knob Ⓔ is set at 9, the 100∼ control knob Ⓓ at 1, the KC control knob Ⓒ at 6, 10 KC control knob Ⓙ at 7, and the 100 KC control knob Ⓗ at 5. So far, these settings have determined the output frequency through the 100-kc level. As described in the previous paragraph, controls Ⓐ, Ⓑ, Ⓕ, and Ⓖ must be set to determine the megacycle value of the output frequency. To set up 23 mc, table 2–15 shows that Ⓐ should be set at 3, Ⓑ at 3, Ⓕ at 16-26 mc, and Ⓖ at 3. The above setting of the nine controls has now completed the selection of the sample frequency of 23.57619 mc after which the transparent door is closed, restoring the door switch, S–2920.

Note

To set up the highest frequency (26 mc), the control knobs must be set for 25, 999, 9910 with the 10∼ control knob Ⓔ in the 10 position.

(*b*) SUBUNIT FUNCTIONING.—The crystal oscillator (unit 1) produces a 100-kc signal that is delivered to units 2, 5, 6, and 8 (figure 2–131). The frequency multiplier (unit 2) receives this 100-kc output and produces a 1-mc signal that is delivered to units 4, 5, 6, 7, and 10. The frequency multiplier (unit 4) receives this 1-mc signal and produces an 8-mc signal that is delivered to unit 5. The frequency converter (unit 5) contains three mixers, an amplifier, and filters. The 1-mc signal from unit 2 and the 100-kc signal from unit 1 (in c-w operation) are delivered to the first mixer and filter. (In frequency-shift and facsimile operation, the 100 kc delivered to the first mixer in unit 5 is taken from unit 12 rather than from unit 1, and varies by a frequency $\left(\pm \frac{\Delta f}{2} \text{ for FSK or } +\Delta f \text{ for FAX}\right)$.) The 1-mc and 100-kc signals are added in the first mixer of unit 5, and the 1.1-mc sum is fed to the second mixer and filter. The output of unit 3 is also fed to the second mixer in unit 5. This output can be varied from 90 to 100 kc in 1-kc, 100-cps, and 10-cps steps by 1-kc step switch S–2051, 100-cps step switch S–2052, and 10-cps step switch S–2053. For a sample frequency of 23.57619 mc, S–2051 is in position 6, S–2052 in position 1, and S–2053 in position 9, and the output of unit 3 is therefore 96.19 kc. The 1.1-mc and 96.19-kc signals are added in the second mixer and the sum, 1.19619 mc, is fed to the third mixer in unit 5. The third mixer in unit 5 also receives an 8-mc signal from unit 4. These two signals (1.19619 mc and 8 mc) are added in the third mixer, and the sum, 9.19619 mc, is fed to the second mixer in unit 6.

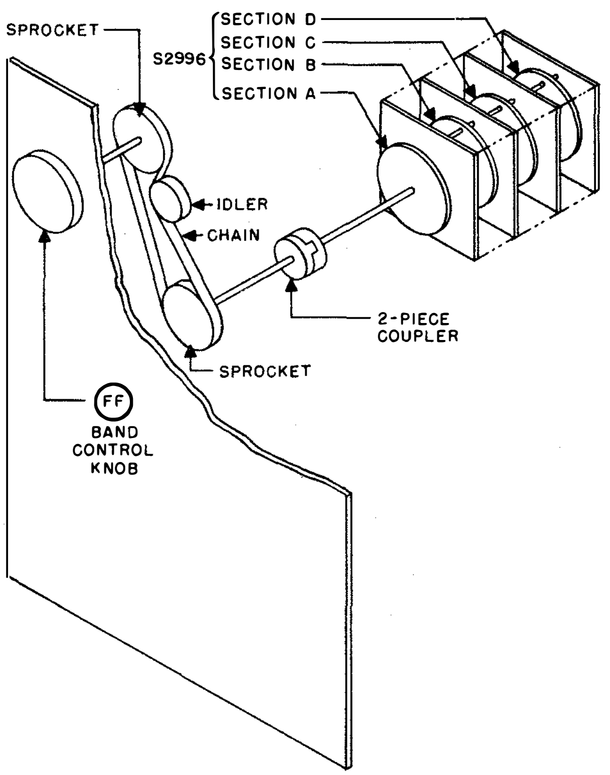


Figure 2—52. BAND Ⓕ Control, Mechanical Linkages

The 10-kc step generator (unit 6) contains a divider circuit, a phase-locked oscillator, two mixers, filters, and amplifiers. Unit 1 delivers 100 kc to the divider, whose output of 10 kc is fed to the phase-locked oscillator for synchronization. The output of this oscillator can be varied from 210 to 300 kc in 10-kc steps by 10-kc step switch S–2201. For the sample frequency 23.57619 mc, S–2201 is in position 7, and the 280-kc output of the oscillator is fed to the first mixer in unit 6. This mixer also receives a 1-mc signal from unit 2, and the sum, 1.28 mc, is fed to the second mixer in unit 6. The second mixer also receives 9.19619 mc from unit 5 and adds these two signals. The sum, 10.47619 mc, is fed to amplifiers and filters in unit 6, and then delivered to the second mixer in unit 8.

The 100-kc step generator (unit 8) contains a phase-locked oscillator, two mixers, filters, and amplifiers. Unit 1 delivers 100 kc to the phase-locked oscillator for synchronization. The output of this oscillator can be varied from 1.6 to 2.5 mc in 100-kc steps by 100-kc step switch S–2326. For the sample frequency 23.57619 mc, S–2326 is in position 5 and the 2.1-mc output of the oscillator is fed to the first mixer in unit 8. This mixer also receives a 15-mc signal from the frequency multiplier (unit 7) and the sum, 17.1 mc, is fed to the second mixer in unit 8. The second mixer also receives 10.47619 mc from unit 6, and the sum, 27.57619 mc, is fed to amplifiers and filters in unit 8 and then to the mixer in unit 9.

The frequency converter (unit 9) contains a mixer, amplifiers, filters, and two step switches. The mixer receives 27.57619 mc from unit 8 and 5 megacycles from unit 7. Step switch S–2426, which is set by the Ⓐ KNOB control, determines whether the signal from unit 8 is increased or decreased by the 5-mc output of unit 7 or increased by the second harmonic (10 mc) of this output, or remains unchanged. For the sample frequency, 23.57619 mc, S–2426 is in position 3, and the second harmonic (10 mc) of the 5-mc signal from unit 7 is added to the output of unit 8. The sum, 37.57619 mc, is fed to amplifiers and filters in unit 9 and then to one section of the bandswitch, S–2996. It should be noted that the 100-kc step switch, S–2427 in unit 9, always takes the same position as the 100-kc step switch, S–2326 in unit 8, as they are both controlled by the 100 KC control knob Ⓗ. In this case, it is in position 5.

The 1-mc step generator (unit 10) contains a harmonic generator, amplifiers, filters, and 1-mc step switch S–2526. The harmonic generator receives 1 megacycle from unit 2 and can produce 1 of 11 frequencies (7, 8, 13, 14, 16, 17, 18, 19, 20, 21, or 22 mc) as determined by the position of S–2526, which is set by the Ⓑ KNOB control. For sample frequency 23.57619 mc, S–2526 is in position 3, and the 14-mc output of the harmonic generator is delivered to the amplifiers and filters and then to another section of bandswitch S–2996.

Bandswitch S–2996 determines to which frequency converter chassis (unit 11A, 11B, or 11C) the signals from units 9 and 10 are delivered and from which chassis the final r-f output is taken. For 23.57619 mc, these signals are delivered to unit 11C, as this frequency is in

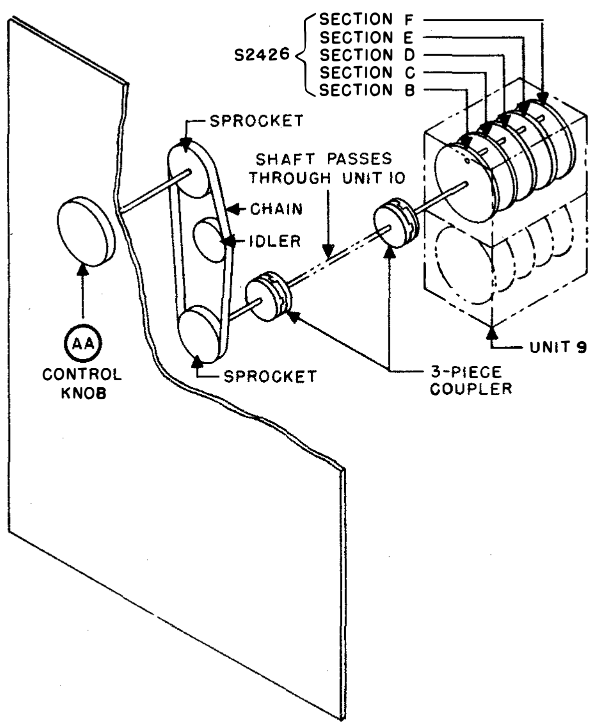


Figure 2—53. Ⓐ Control, Mechanical Linkages

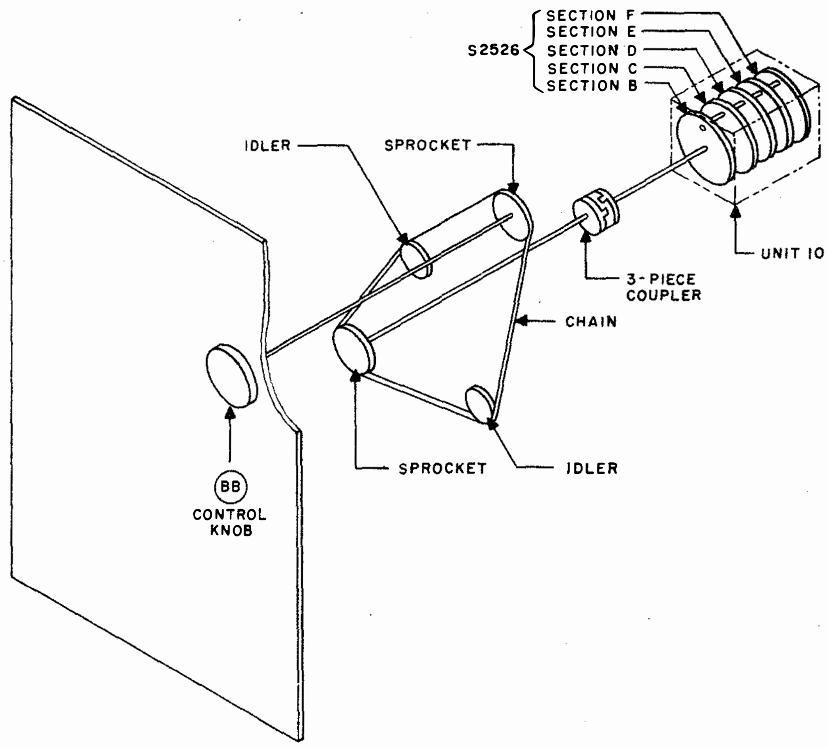


Figure 2–54. (BB) Control, Mechanical Linkages

the 16- to 26-mc band. The 14-mc signal from unit 9 is subtracted from the 37.57619-mc signal from unit 10 in the mixer in unit 11C. The difference, 23.57619 mc, is fed through amplifiers, filters, and a third section of S–2996 to the RFA. The frequency converter (unit 11C) has two step switches, S–2801 and S–2802. S–2801 is ganged to S–2651 in unit 11B, and both are set by the MC control knob (GG), which is in position 3 for the sample frequency. S–2802 and S–2652 in unit 11B are ganged together and are set by the 100 KC control knob (HH), which is in position 5 for the sample frequency. Unit 11A is used for frequencies between 0.3 and 6 megacycles; unit 11B for frequencies between 6 and 16 mc; and unit 11C for frequencies between 16 and 26 mc as determined by the range of tuning of the filter circuits in the respective units.

3. POWER SUPPLIES.

The low voltage power supply (LVPS), medium voltage power supply (MVPS), and high voltage power supply (HVPS) provide a major portion of the power required to operate the transmitter bay of Radio Transmitting Sets AN/SRT–14, 15 and 16. The LVPS receives single-phase power delivered to the transmitter bay from the ship's supply. Input single-phase power must be 110 volts ac, 60 cycles. The HVPS (part of AN/SRT–15 and 16) receives all three-phase power delivered to the transmitter bay. This input power may be either 220 or 440 volts ac, 60 cycles, three phase.

4. POWER SUPPLY PP–1094/SRT (LOW VOLTAGE POWER SUPPLY, LVPS).

a. GENERAL.—The LVPS receives 110-volt a-c, 60-cycle, single-phase power from the ship's supply. The LVPS, in turn, delivers 110-volt a-c, 60-cycle, single-phase power to the MVPS, the radio frequency oscillator (RFO), the low level radio modulator (LLRM), the radio frequency amplifier (RFA), and the mounting. The LVPS also supplies the following d-c voltages: +250 volts to the RFO, +300 volts to the RFA and LLRM, −220 volts to RFA and LLRM, and −24 volts for motor and control circuit functions.

b. INPUT CIRCUIT.—The input circuit of the LVPS (figure 2–55) receives 110-volt a-c, 60-cycle, single-phase power through receptacle J–3003, where five sets of contacts in parallel are used to insure adequate current-carrying capacity. EMERGENCY SWITCH (HH) S–3001 controls all power to the LVPS. When switch S–3001 is closed, power is applied through fuses F–3007 and F–3008 to the start-stop circuit and through fuses F–3005 and F–3006 to the main power transformer. Power is also applied through fuses F–3001 and F–3002 and CABINET HEATER switch (NN) S–3002 to the space heaters in the mounting, the presence of voltage across the space heaters being indicated by CABINET HEATER indicator light I–3003. (In an AN/SRT–16 installation, the heaters of the two transmitter groups are individually energized by the CABINET HEATER switches in each group.) In addition, a fused 100-volt a-c, 60-cycle, single-phase line, through fuses F–3003 and F–3004, is supplied.

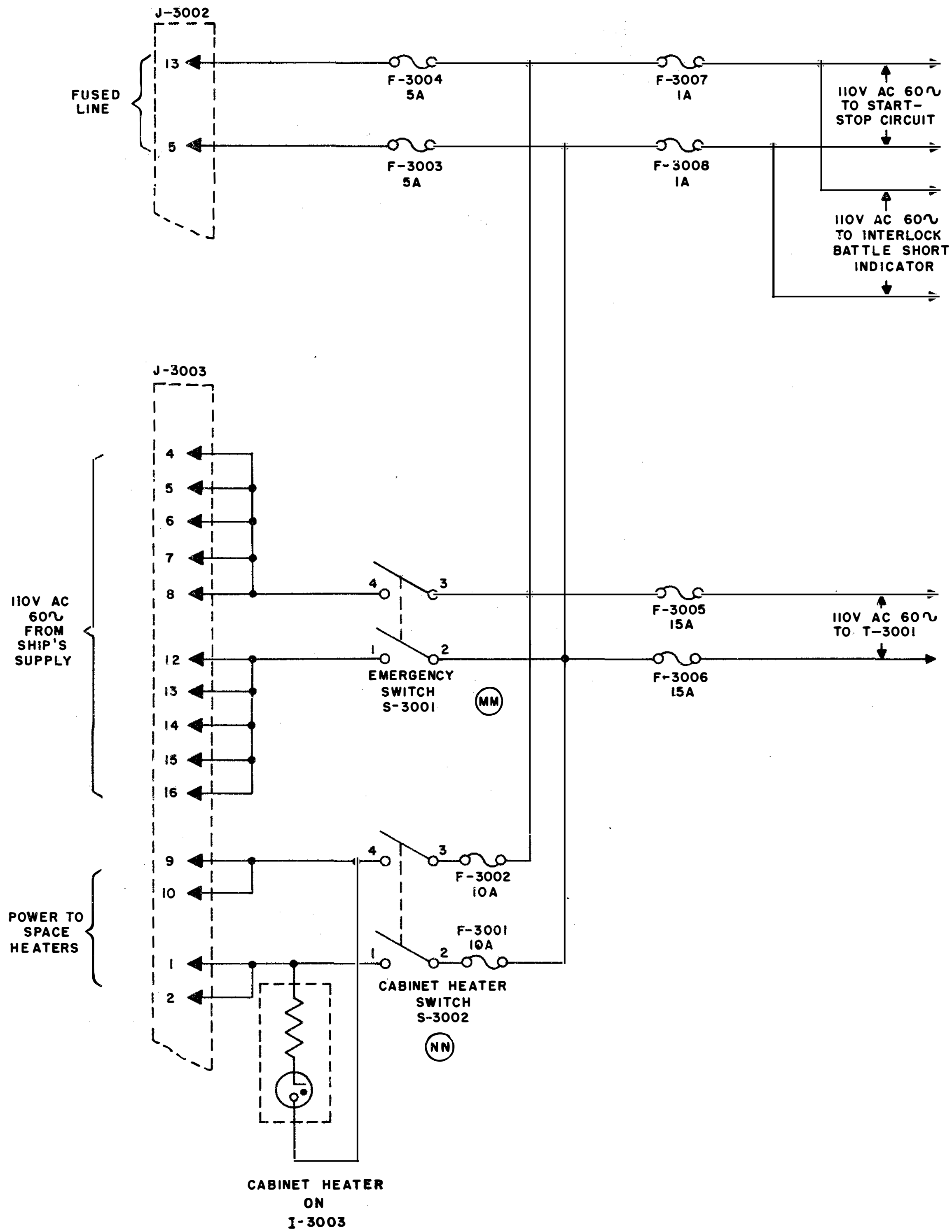


Figure 2—55. Input Circuit of LVPS, Simplified Schematic

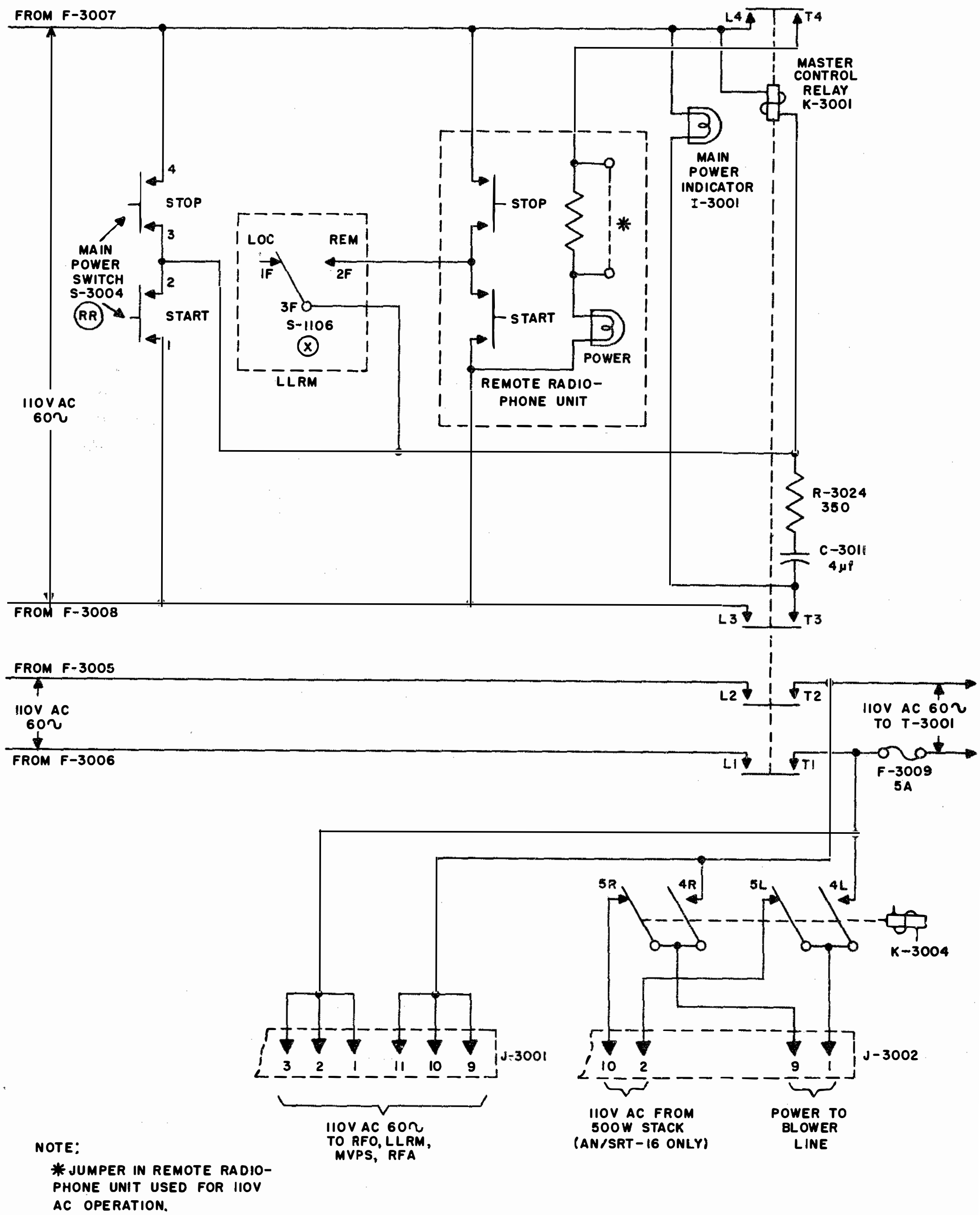


Figure 2–56. Start-Stop Circuit, Simplified Schematic

c. START-STOP CIRCUIT.—The start-stop circuit (figure 2–56) in the LVPS controls power to the transmitter bay. When EMERGENCY SWITCH (MM) S–3001 is closed, power is applied throughout the transmitter bay by depressing the START push button on the MAIN POWER switch (RR), S–3004. The master control relay, K–3001, is connected across the line through the closed contacts of the START push button and through the LOCAL position of the LOCAL-REM. switch (X), S–1106, which is located in the LLRM. When K–3001 energizes, contacts L3 and T3 close, so that, when the START button is released, resistor R–3024 and capacitor C–3011 are added in series with the winding of K–3001 across the line. The combination of R–3024 and C–3011 provides a series impedance with the winding of K–3001, with power factor correction sufficient to insure adequate holding current flowing through K–3001 during the "power on" condition. The MAIN POWER INDICATOR light, I–3001, is also connected across the line through contacts L3 and T3 of K–3001.

Contacts L1, T1 and L2, T2 of energized relay K–3001 apply 110 volts ac to main power transformer T–3001, RFO, LLRM, MVPS, RFA, antenna coupler, and contacts 4L and 4R of K–3004. T–3001 is protected by fuse F–3009. K–3004 is energized after the —24-volt time delay (paragraph 4*d*), which applies 110-volt a-c power through contacts 4L, 3L and 4R, 3R to the blower motors in the mounting. In the AN/SRT–16, it is necessary that the blowers in both mountings be energized when either the right or left transmitter group, or both, are on. In right transmitter group operation or with both groups in operation, the blowers in both groups, which are paralleled, receive power as described above. In left group operation only, K–3004 in the right group is not energized and the blowers now receive power from the left group LVPS through contacts 4L, 3L and 4R, 3R of K–3004 in the left group and contacts 5L, 6L and 5R, 6R of K–3004 in the right group.

If a remote radiophone unit is employed, contacts L4, T4 of energized K–3001 connect the line across the POWER indicator. This indicates that the master control relay in the LVPS is energized, with the transmitter group either in local or remote operation. The voltage-dropping resistor in series with the POWER indicator is shorted out for 110-volt operation. For remote operation of the transmitter group, the LOCAL-REM. switch Ⓧ, S–1106 in the LLRM, is placed in the REM. position, which puts the master control relay in the LVPS under control of the START-STOP switch on the radiophone unit instead of the MAIN POWER-START-STOP switch on the LVPS.

To shut down the transmitter group, the STOP button of the MAIN POWER switch Ⓡⓡ, S–3004, is depressed, which puts a short across K–3001, de-energizing it. Depressing the STOP button does not place a short across the line because of the presence of R–3024 and C–3011. De-energizing K–3001 opens its holding contacts L3, T3; opens contacts L1, T1 and L2, T2 which removes power from T–3001, RFO, LLRM, RFA, MVPS, antenna coupler, and the blower motors, and opens contacts L4, T4, which extinguishes the POWER indicator in the radiophone unit. The opening of contacts L3, T3 also extinguishes MAIN POWER INDICATOR I–3001.

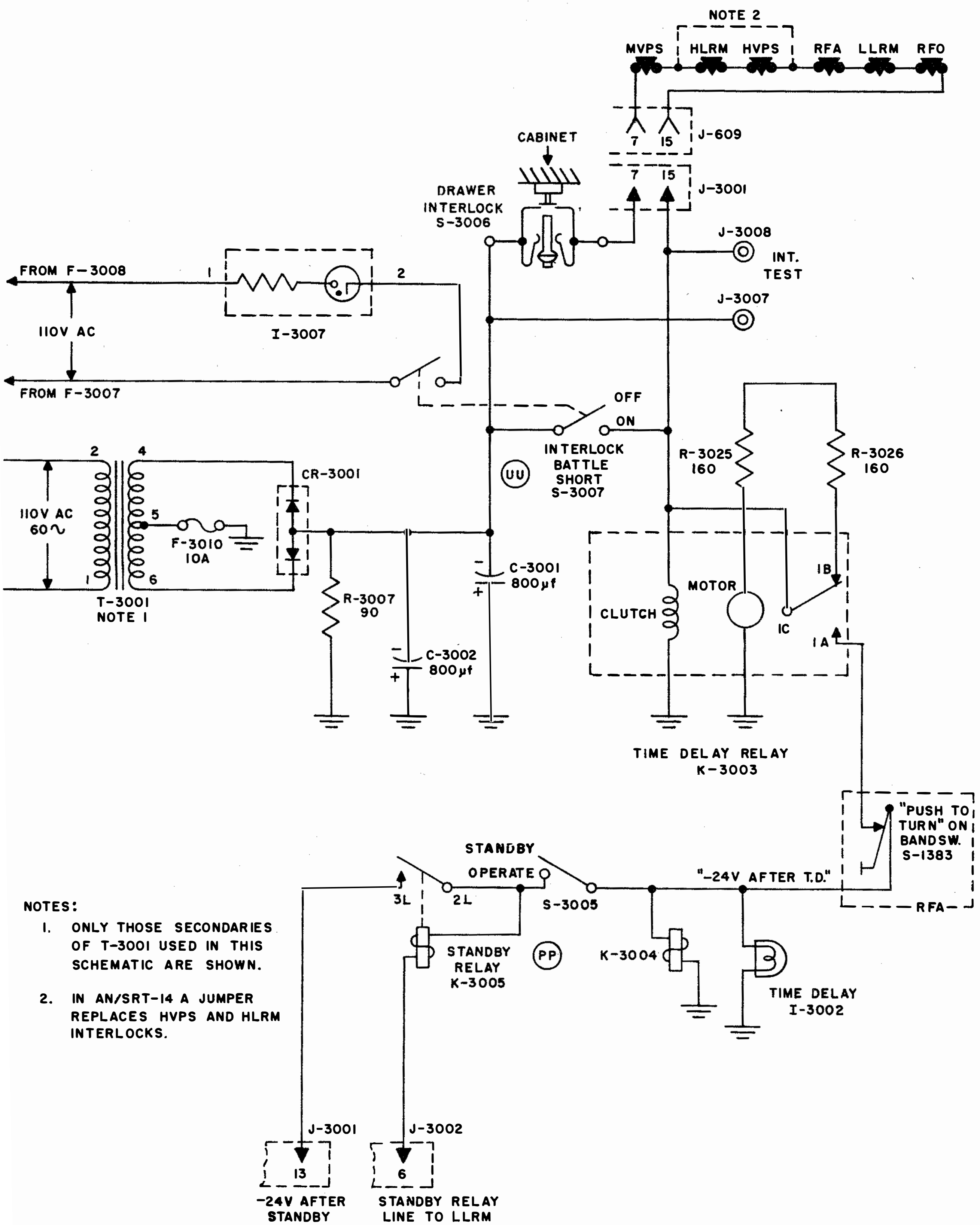
d. INTERLOCK CIRCUIT AND —24-VOLT D-C SUPPLY.—The —24-volt d-c supply is taken from the secondary terminals 4 and 6 (48 volts rms) of T–3001, through the full-wave metallic rectifier, CR–3001, and is filtered by C–3001, C–3002, and R–3007. This supply is returned to ground through fuse F–3010 and center-tap terminal 5 of T–3001. (See figure 2–57.)

The output of the filtered —24-volt supply is fed to the time delay relay, K–3003, through the interlocks of the LVPS, MVPS, RFA, LLRM, RFO and, in the AN/SRT–15 and AN/SRT–16, the HVPS and HLRM. All interlocks are similar to the interlock in the LVPS shown in detail in figure 2–57. As the chassis of any major unit in the transmitter group in the AN/SRT–14, 15 and 16 may be pulled out without disconnecting the chassis from the cabinet wiring, the interlock switch, S–3006, is a drawer interlock. When the chassis is completely seated in the cabinet, this interlock is shorted. If the plug of the cabinet wiring is correctly mated to the cabinet wiring receptacle, the circuit will be advanced through all the interlocks and return to K–3003. The drawer interlock may be shorted out when the chassis is in the "out" position by means of a push button incorporated in the interlock. As a protective measure, this push button is manually restored when the chassis is reseated in the cabinet. The INTERLOCK BATTLE SHORT Ⓤⓤ, S–3007, bypasses the drawer interlocks when it is in the ON position by connecting the output of the filtered —24-volt supply directly to the time delay relay. When S–3007 is ON, the INTERLOCK BATTLE SHORT indicator, I–3007, is energized by 110 volts ac, through the closed contacts of S–3007. Receptacle J–3007 and J–3008, designated INT. TEST, are provided to test the continuity of the interlocks by measuring with the probes of a standard test ohmmeter.

WARNING

The INTERLOCK BATTLE SHORT Ⓤⓤ, S–3007, should be used as an emergency measure only. Before any major unit chassis is removed from the cabinet, the INTERLOCK BATTLE SHORT Ⓤⓤ should be thrown to OFF. Failure to do this will mean that the normal action of the drawer interlock will be bypassed and the equipment can be energized with the chassis in the "out" position.

The filtered —24-volt supply is delivered through the interlocks or battle shorts to the motor and clutch of the time delay relay, K–3003. After approximately 30 seconds, K–3003 operates its contacts, which supplies the voltage described as "—24 volts after T.D." Through contacts 1C and 1A this supply is delivered first to the "push to turn" switch, S–1383, on the bandswitch of the RFA, from where it is fed to RFA, LLRM, MVPS and returned to the LVPS (and to HLRM and HVPS in the AN/SRT–15, 16). Operating the bandswitch while the transmitter is on will momentarily open "—24 volts after T.D.," which, in turn, de-energizes the control circuits and takes the transmitter off the air. When contacts 1C and 1B of K–3003 open, the motor is de-energized, but the clutch remains energized, holding the motor shaft in the energized position. The "—24 volts after T.D." energizes relay K–3004 whose contacts complete the circuits for the +300-, +250- and —220-volt supplies as well as applying 110-volt a-c power to the blower motors in the mounting. When STANDBY-OPERATE switch Ⓟⓟ S–3005 is in the OPERATE position, "—24 volts



NOTES:

1. ONLY THOSE SECONDARIES OF T-3001 USED IN THIS SCHEMATIC ARE SHOWN.
2. IN AN/SRT-14 A JUMPER REPLACES HVPS AND HLRM INTERLOCKS.

Figure 2—57. Interlock Circuit and —24-Volt D-C Supply, Simplified Schematic

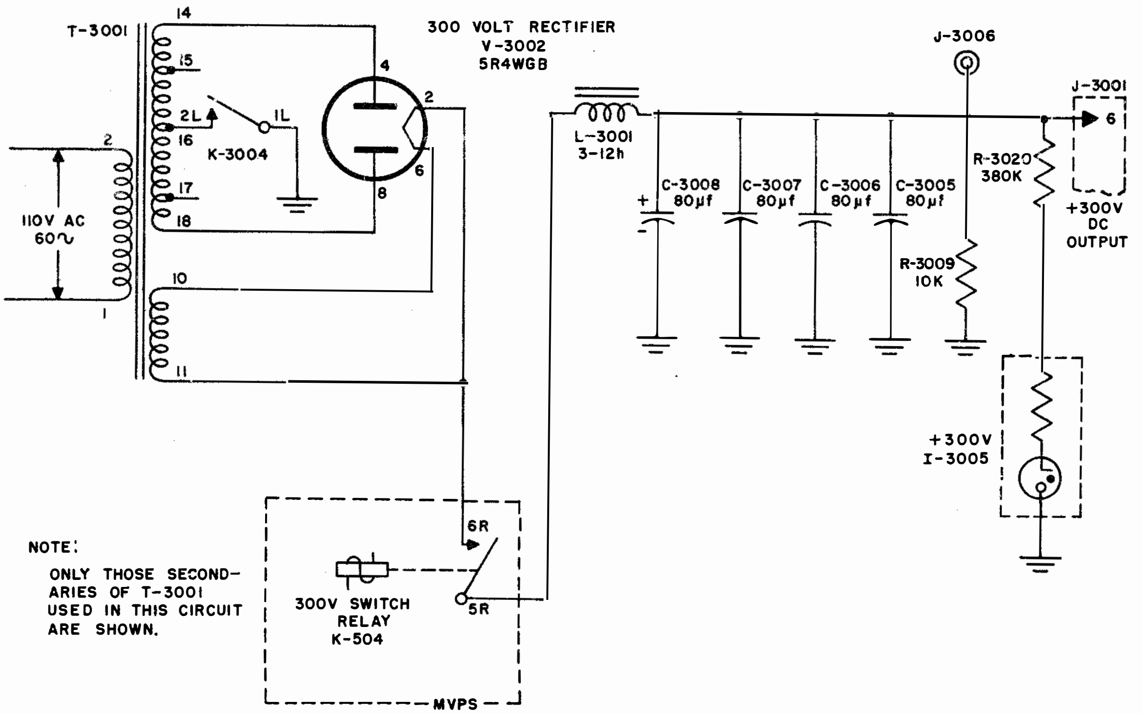


Figure 2–58. +300-Volt D-C Supply, Simplified Schematic

after T.D." is applied to stand-by relay K-3005. Depending on the mode of operation (see paragraph 7*c*(1)), which is controlled in the LLRM, K-3005 will energize, providing another source of —24-volt d-c power. This is known as "—24 V after standby" and is supplied to MVPS (and HLRM and HVPS in the AN/SRT-15, 16). TIME DELAY indicator I-3002 denotes presence of "—24 volts after T.D."

e. +300-VOLT D-C SUPPLY.—The +300-volt rectifier, V-3002 (figure 2–58), is a conventional full-wave rectifier. The plate voltage is taken from terminals 14 and 18 (840 volts rms) on T-3001. Part of this secondary winding is also used for the 250-volt unregulated supply. The supply has a ground return through the center tap terminal 16 and contacts 2L and 1L of K-3004, which is energized when the 30-second time delay runs out. This allows time for the rectifier filaments to reach operating temperature before V-3002 begins to conduct. The rectified voltage is taken from the cathode and is fed to a single choke input filter through the contacts 5R and 6R of 300 V switch relay K-504, which is located in the MVPS. K-504 is energized when the 500-volt supply in the MVPS is energized. As the 300-volt supply is primarily a screen voltage supply and the 500-volt supply is basically a plate voltage supply in the LLRM and RFA, the action of K-504 insures that plate voltage is present when screen voltage is applied, thus preventing damage to the screens of the respective tubes they supply. The single choke input filter of the 300-volt supply consists of L-3001, C-3005, C-3006, C-3007, and C-3008. R-3009 acts as a bleeder for the filter capacitors and also improves regulation. R-3020 is a dropping resistor for the +300 V indicator I-3005, which denotes the presence of the +300-volt supply. The +300-volt output, rated at 200 ma, is delivered to the RFA and LLRM. J-3006 provides a test point for measuring this supply.

f. +250-VOLT D-C UNREGULATED SUPPLY.—The +250-volt rectifier, V-3001 (figure 2–59), is a conventional full-wave rectifier. The plate voltage is taken from terminals 15 and 17 (740 volts rms) on T-3001. This secondary winding is also used for the +300-volt supply. The supply has a ground return through the center-tap terminal 16 and contacts 2L and 1L of K-3004, as described in the previous paragraph. The rectified voltage is taken from the cathode of V-3001 and passed through the double choke input filter comprised of L-3003, C-3004A, and C-3004B. R-3008 is a bleeder for the filter capacitors and improves regulation. R-3019 is a dropping resistor for the +250 V indicator, I-3004, which denotes the presence of the +250-volt unregulated supply. This supply, which is rated at 200 ma, is delivered to the RFO. J-3004 provides a test point for measuring this supply.

g. —220-VOLT D-C SUPPLY.—The —220-volt rectifier, V-3003 (figure 2–60), is a conventional full-wave rectifier with a negative voltage output. Plate voltage for V-3003 is taken from terminals 19 and 21 (590 volts rms) of T-3001. To obtain a negative output, the cathode is connected to ground and the rectified voltage is taken from the center-tap terminal 20 and through contacts 2R and 1R of K-3004, which closes after the time delay. The rectified voltage is filtered by a single choke input filter consisting of L-3002 and C-3010. The resistance network, consisting of R-3010, R-3011,

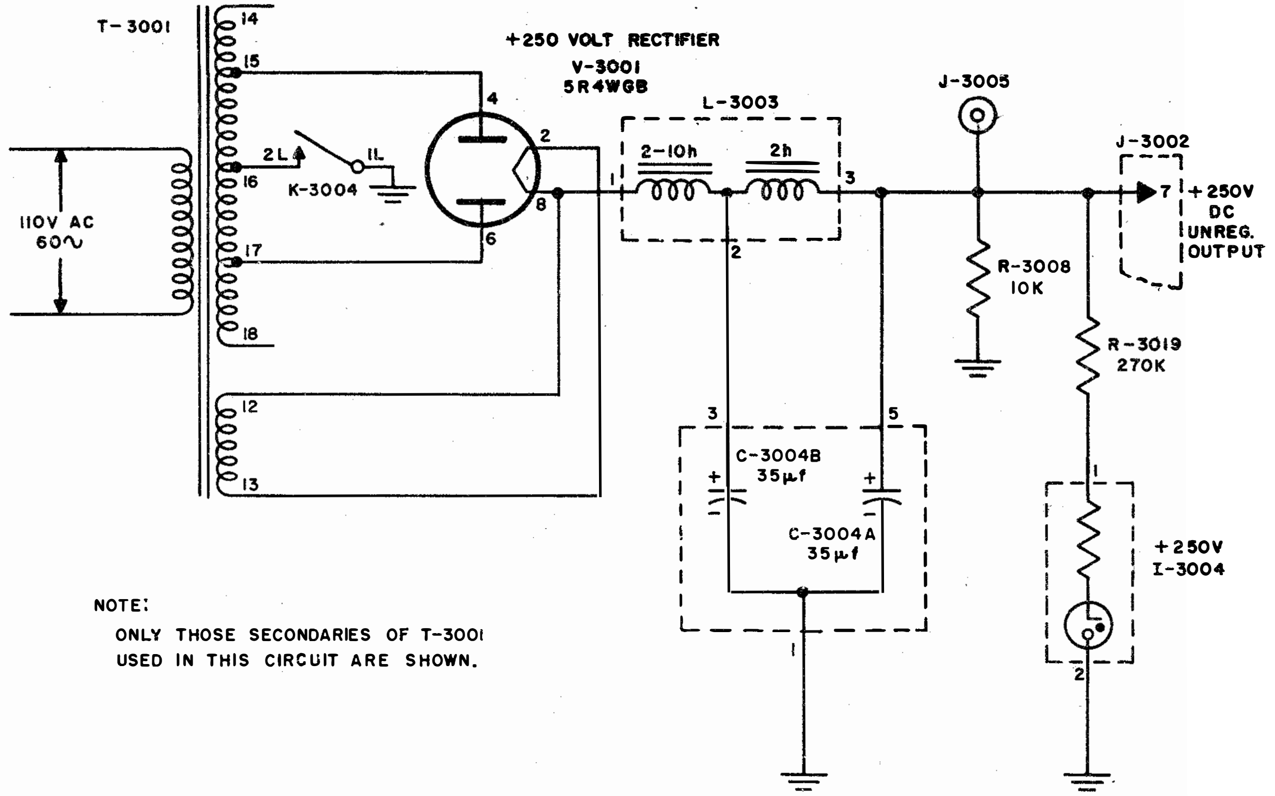


Figure 2—59. +250-Volt D-C Unregulated Supply, Simplified Schematic

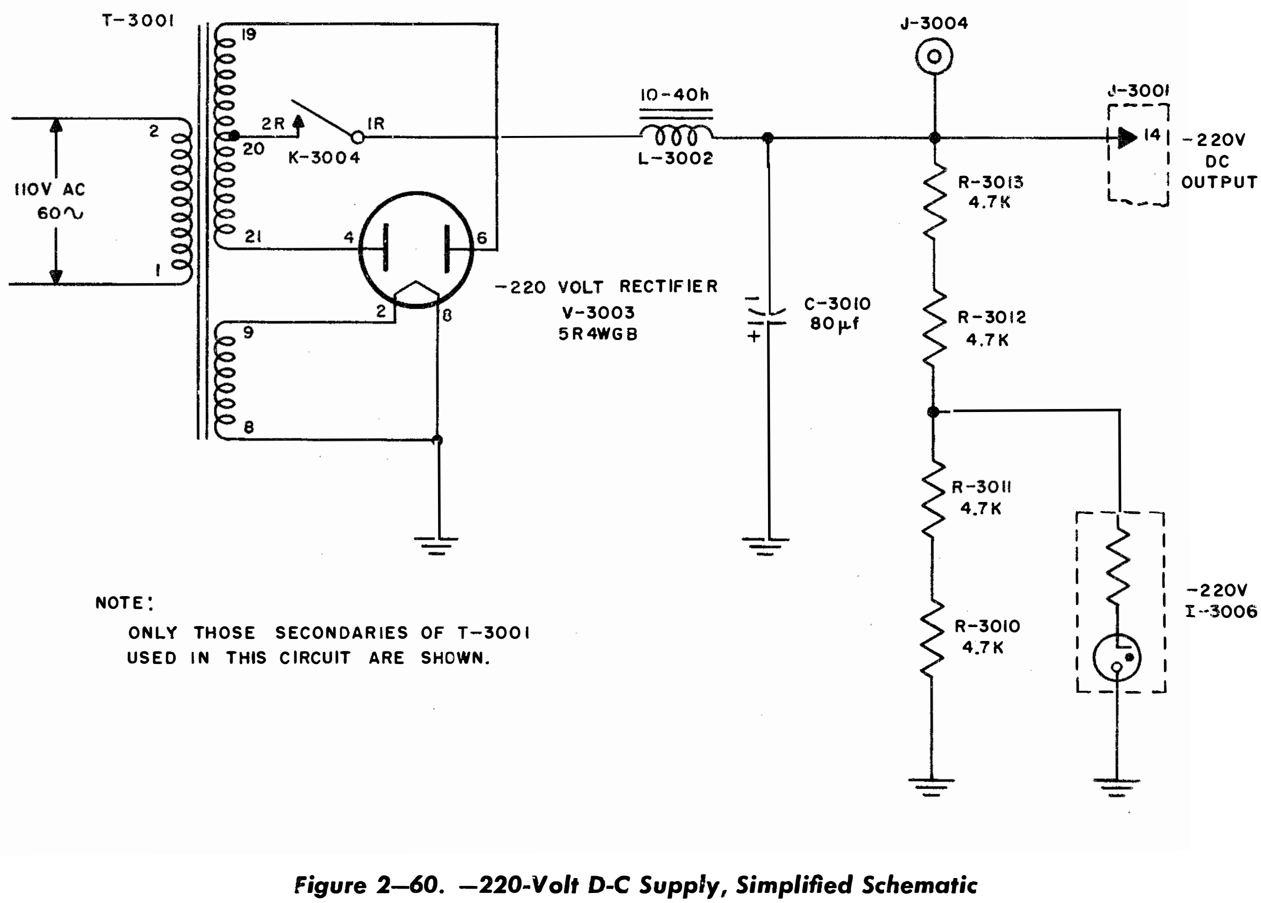


Figure 2—60. —220-Volt D-C Supply, Simplified Schematic

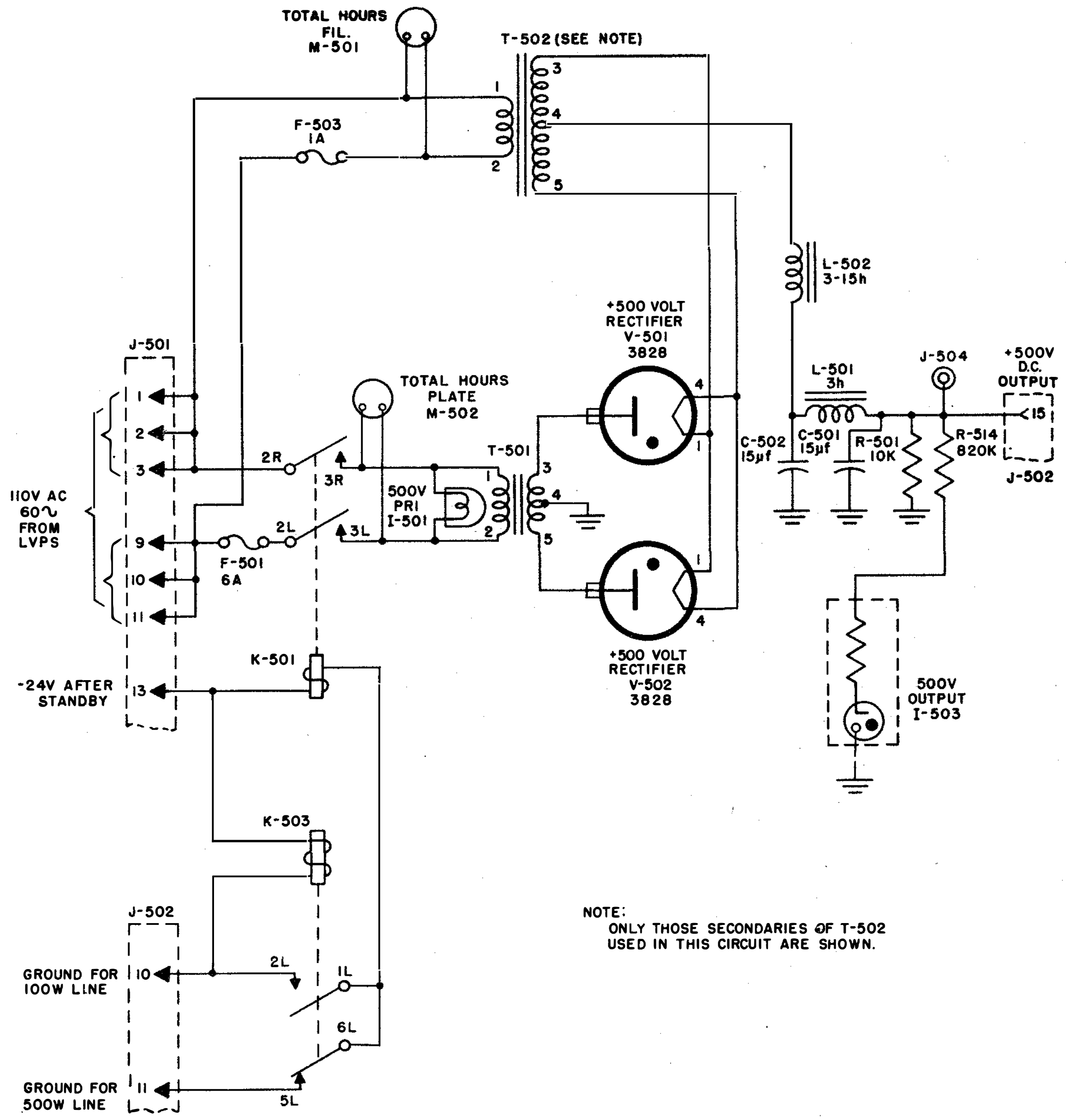


Figure 2–61. +500-Volt D-C Supply, Simplified Schematic

R–3012 and R–3013, comprises a bleeder for the supply. This network also is a voltage divider, the center point of which is a tap for the –220 V indicator, I–3006, which denotes the presence of the –220-volt supply. J–3005 provides a test point for measuring this supply.

5. POWER SUPPLY PP–1095/SRT (MEDIUM VOLTAGE POWER SUPPLY, MVPS).

a. GENERAL.—The medium voltage power supply (MVPS) receives 110-volt a-c, 60-cycle, single-phase power from the LVPS and supplies +500 volts dc to the LLRM and RFA, and +1,050 or +1,300 volts dc to the RFA. In addition to the rectifier circuits, the MVPS contains a switching relay to insure +500-volt d-c supply is available before +300 volts dc is applied.

b. +500-VOLT D-C SUPPLY.—When the START button of the MAIN POWER switch ®, S–3004, on the LVPS is depressed, 110-volt a-c, 60-cycle, single-phase power is delivered to the filament transformer, T–502 (figure 2–61), whose primary is protected by fuse F–503. One secondary of T–502 supplies filament voltage to the +500-volt rectifiers, V–501 and V–502.

At the same time, a-c power is delivered through fuse F–501 to the contacts of relay K–501, which must be energized before power is applied to the +500-volt plate voltage tranformer, T–501. K–501 is energized from the "–24 V after standby" line and receives ground through the contacts of relay K–503. K–503 is energized from the "–24 V after standby" line and the "ground for 100 W" line.

If the transmitter group is operating at the 100-watt level and the STANDBY-OPERATE switch ⓅⓅ, S–3005 on the LVPS, is on OPERATE, the "–24 V after standby" line will be energized after the time delay is complete; also the "ground for 100 W" line will be connected and the "ground for 500 W" line will be opened. Therefore, K–503 will energize and K–501 will energize through contacts 1L and 2L of K–503 to "ground for 100 W" line. Energized K–501 supplies plate voltage for the +500-volt d-c supply through its contacts 2R, 3R and 2L, 3L and plate transformer T–501.

If the transmitter group is in 500-watt operation (AN/SRT–15 and 16 only), the "ground for 100 W" line will be opened and the "ground for 500 W" line will be completed. Thus K–503 will not be energized and K–501 now receives its ground through contacts 5L and 6L of K–503 and the "ground for 500 W" line. In 500-watt operation the 500 volts dc becomes primarily a screen supply and this transfer of ground, as described before, is to make sure that screen voltage will not be applied before the high voltage plate supply, which is also under control of the "ground for 500 W" line.

If the STANDBY-OPERATE switch ⓅⓅ is in STANDBY, on either 100-watt or 500-watt operation, the +500-volt d-c supply will not energize as the "–24 V after standby" line will be open and K–501 cannot be energized. This, in turn, will prevent a-c power from being applied to the plate transformer.

When 110-volt a-c power is applied to the primary of T–501 as described above, it is indicated by the 500 V PRI indicator, I–501, which is connected across the T–501 primary. The secondary of T–501 supplies 620 volts rms to the plates of rectifier tubes V–501 and V–502, which are connected to form a full-wave rectifier. The rectified voltage, taken from the center-tap terminal 4 of filament transformer T–502, is filtered by a double choke input filter comprised of L–502, C–502, L–501, and C–501. Resistor R–501 acts as a bleeder for the supply. Resistor R–514 is a dropping resistor for the 500 V OUTPUT indicator, I–503, which denotes the presence of the +500-volt d-c output. The output is rated at 364 ma and is supplied to the LLRM and RFA. J–504 provides a test point for measuring the +500-volt supply.

Two elapsed time indicators, TOTAL HOURS-FIL, M–501, and TOTAL HOURS-PLATE, M–502, are provided to indicate total time filament and plate power are on. M–501 is connected across the primary of the filament transformer, T–502, and M–502 is connected across the primary of the 500-volt plate transformer, T–501. As noted in the previous paragraphs, the filament transformer receives power as soon as the START button is pushed, regardless of "stand-by" or "operate" condition. However, T–501 receives power only when in the "operate" condition. Therefore, the reading of M–502 will give total time plate power is on, and the reading of M–501 shows the total time filament power is supplied. Both indications read to tenths of an hour.

c. 300-VOLT SWITCH RELAY.—The 300-volt switch relay, K–504 (figure 2–62), assures that +300-volt d-c supply of the LVPS does not come on before the +500-volt d-c supply of the MVPS, as explained in paragraph 4*e*. When the +500-volt d-c supply comes on, it is applied across the dropping resistors, R–519, R–520, R–521, and R–522, in series with the 300-volt switch relay, K–504. Capacitor C–505 is in parallel across K–504 through its normally closed contacts 1R and 2R, which makes K–504 slow operating. When K–504 operates, C–505 is removed from the circuit and resistor R–523 is placed across C–505 through contacts 3R and 4R of K–504 to allow C–505 to discharge without arcing at the contacts. When K–504 is energized, contacts 5R and 6R close, completing the +300-volt d-c supply circuit in the LVPS.

d. +1,050/+1,300-VOLT D-C SUPPLY.—The +1,050/+1,300-volt rectifier (figure 2–63) is used only in 100-watt transmission. The output to the RFA is +1,300 volts except during phone operation when it is reduced to +1,050 volts. When the START button of the MAIN POWER switch ⓇⓇ, S–3004 on the LVPS, is depressed, 110-volt a-c, 60-cycle, single-phase power is delivered to the filament transformer, T–502, whose primary is protected by fuse F–503. One secondary of T–502 supplies filament voltage to the +1,050/+1,300-volt rectifiers, V–503 and V–504.

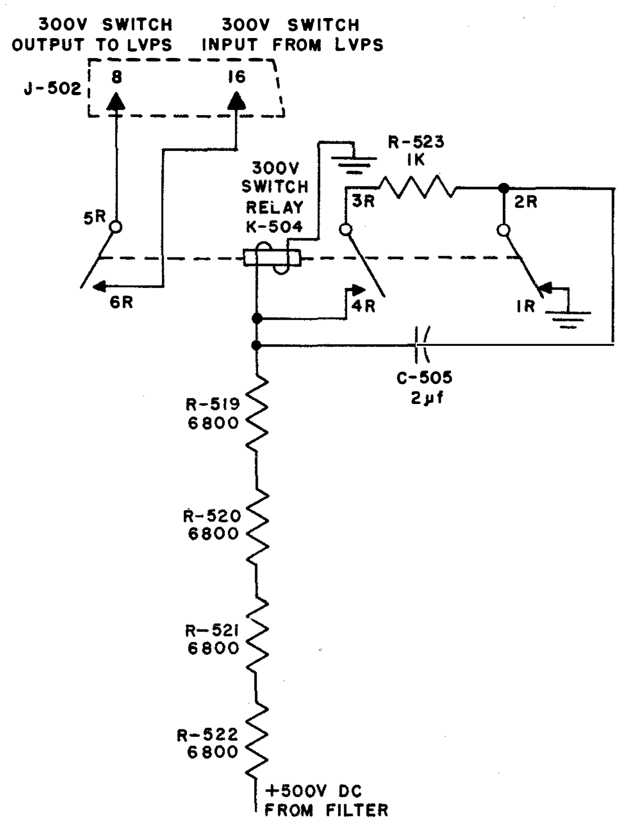


Figure 2–62. 300-Volt Switch Relay, Simplified Schematic

At the same time, a-c power is delivered through fuse F–502 to the contacts of relay K–503. K–503 must be energized before power is applied through the contacts of relay K–502 to the +1,050/+1,300-volt plate voltage transformer, T–503. As described in paragraph 5*b*, K–503 is energized only in 100-watt operation and if the STANDBY-OPERATE switch, S–3005 on the LVPS, is in OPERATE.

If the transmitter group is in other than phone operation, the "ground for phone" line is opened and relay K–502 cannot operate. Therefore, when K–503 is energized, 110-volt a-c power is applied through contacts 1R, 2R and 3L, 4L of K–503 and contacts 1L, 2L of K–502 to terminals 1 and 2 of the plate transformer primary which produces 3,160 volts rms at the secondary terminals 4 and 6. When rectified and filtered, this produces the +1,300-volt supply.

When the transmitter group is in phone operation the "ground for phone" line is prepared and relay K–502 energizes from "–24 V after TD" line. Energized K–502 now applies 110 volts ac to terminals 1 and 3 of the plate transformer primary, which increases the number of turns employed in the primary. This produces the effect of reducing the secondary to primary turns ratio, reducing the secondary voltage at terminals 4 and 6 to 2,480 volts rms. When rectified and filtered, this produces the +1,050-volt supply. The lesser voltage is used during phone operation because the power amplifier plate voltage is amplitude-modulated by the audio output of either the LLRM or HLRM. If the voltage were not reduced, the peaks of the amplitude-modulated plate voltage of the power amplifier would exceed its peak voltage rating.

As relay K–502 operates only during phone operation, a circuit advances "ground for 500 W" line through the contacts 2R and 3R of K–502, when it is energized, to the HLRM for use in controlling the output of the HLRM during phone operation as described in paragraph 9*b*.

The energizing of relay K–503 also supplies 110 volts ac to the 1300 V PRI. indicator, I–502. As this indication is not under control of relay K–502, it indicates power applied to the plate transformer, T–503, for either the +1,050-volt or the +1,300-volt output.

Rectifier tubes V–503 and V–504 are connected as a full-wave rectifier. The rectified voltage is taken from filament, pin 4, of each tube and filtered by a double choke input filter comprised of L–504, C–504, L–503, C–503. Resistors R–502 and R–513 are bleeder resistors. Resistors R–515, R–516, R–517, and R–518 form a voltage divider to which 1300 V OUTPUT indicator I–504 is connected. The output is rated at +1,050 volts, 150 ma, and +1,300 volts, 180 ma, and is supplied to the RFA.

6. POWER SUPPLY PP–1096/SRT (HIGH VOLTAGE POWER SUPPLY, HVPS).

a. GENERAL. — The high voltage power supply (HVPS) is used only in the AN/SRT–15 and 16 for 500-watt transmission. This unit receives either 220-

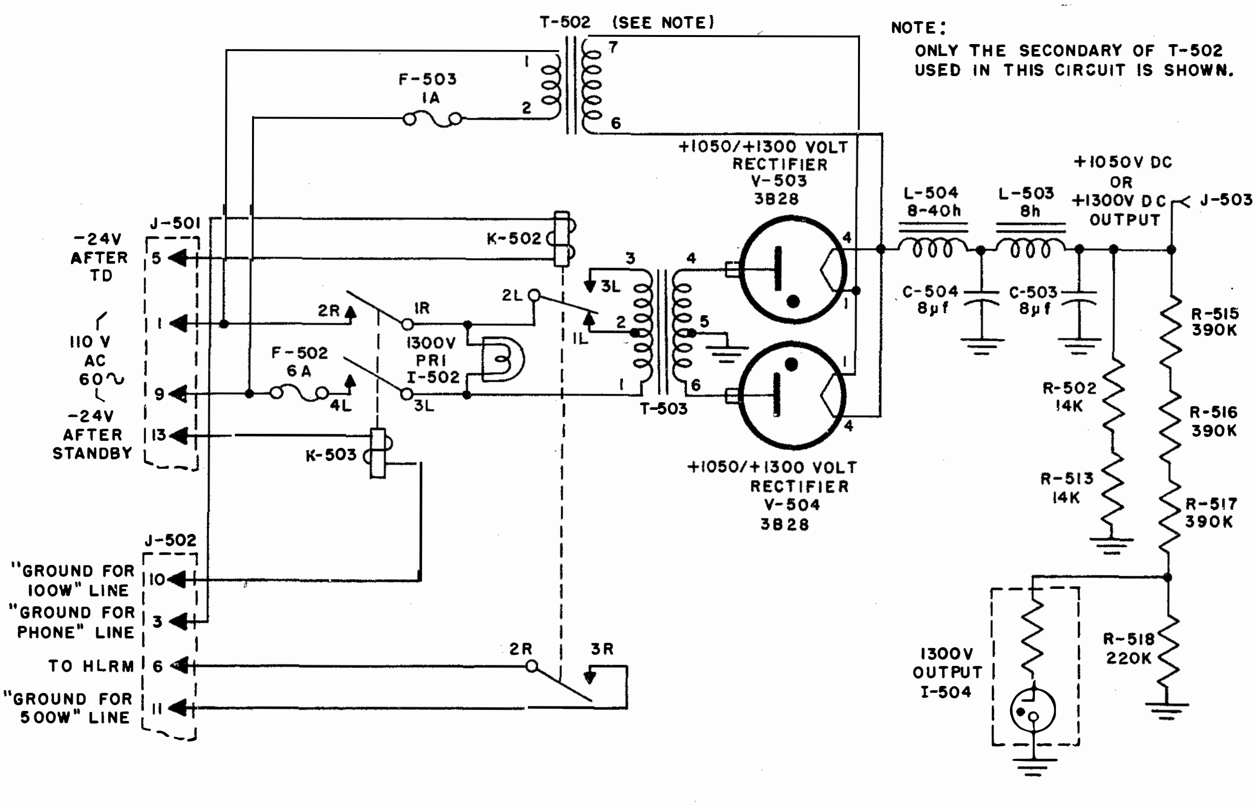


Figure 2–63. +1,050/+1,300-Volt D-C Supply, Simplified Schematic

NOTES:

* FOR 440V INPUT POWER, FUSES F-1501 THROUGH F-1505 (3.5 AMP) ARE USED; FOR 220V INPUT POWER, FUSES F-1506 THROUGH F-1510 (6.25 AMP) ARE USED.

FOR 220V INPUT POWER, R-1505, R-1506, R-1507 ARE SHORTED ON E-1503. ONLY THOSE TERMINALS OF E-1503 THAT APPLY TO THIS CIRCUIT ARE SHOWN.

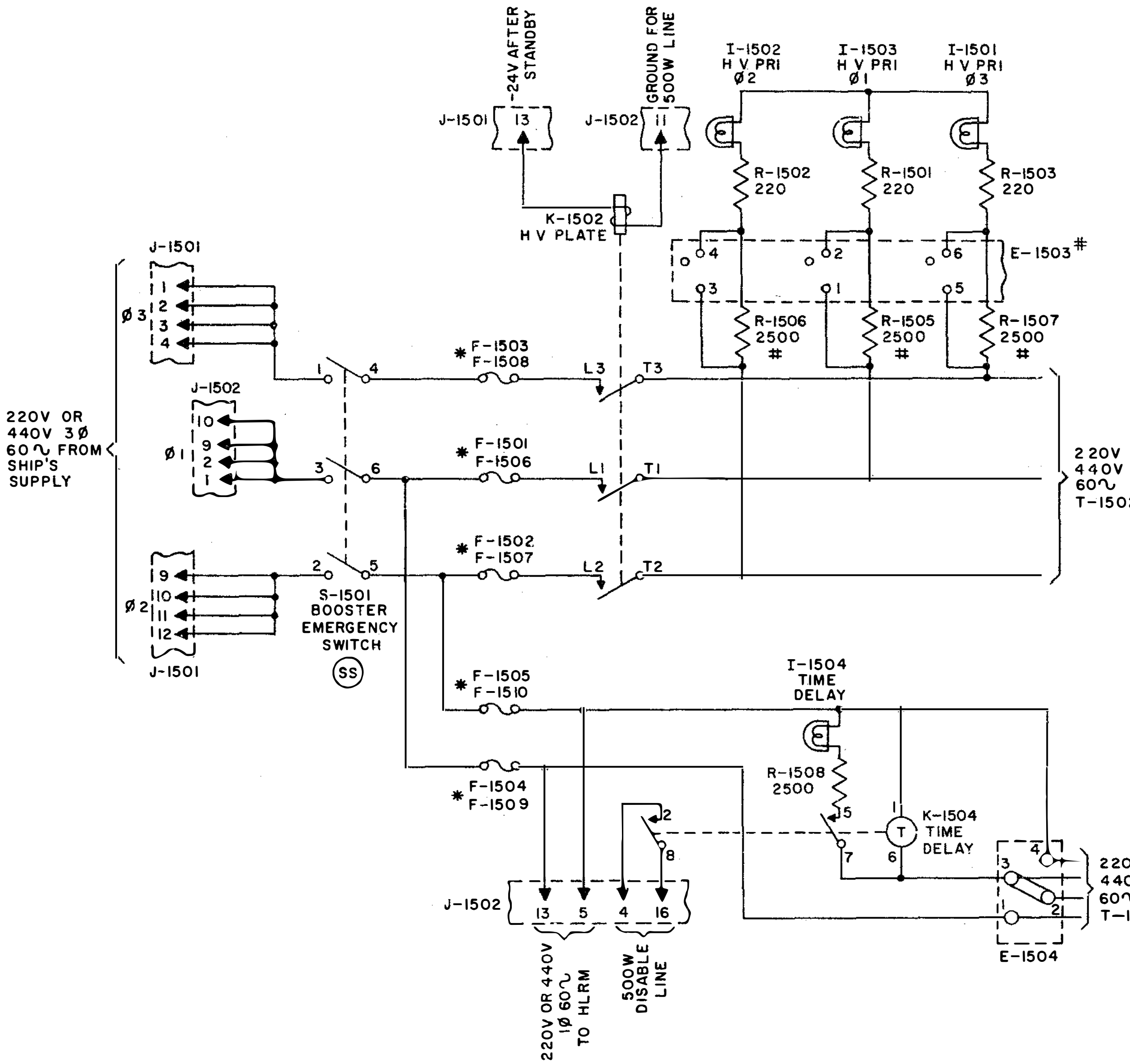


Figure 2–64. Input Circuit of HVPS, Simplified Schematic

volt or 440-volt a-c, 60-cycle, three-phase power from the ship's supply and has an output of either +3,000 volts dc or +2,400 volts dc, which is supplied to the HLRM.

b. INPUT CIRCUIT.—The HVPS receives from the ship's supply either 440 volts or 220 volts, three phase, at 60 cycles (figure 2–64). Power to the HVPS is controlled by BOOSTER EMERGENCY SWITCH (SS) S-1501. The three-phase line supplies voltages to both the plate transformer, T-1502, and the filament transformer, T-1501. The filament transformer is connected across one phase of the input and is fused by F-1504 and F-1505 or F-1509 and F-1510. For 440-volt input, 3.5-amp fuses F-1504 and F-1505 are used, and for 220-volt input, 6.25-amp fuses F-1509 and F-1510 are used. Power is connected to T-1501 through terminal board E-1504. With 440-volt input (figure 2–65), a link is placed between terminals 2 and 3 of E-1504, which places the two primaries of T-1501 in series across the line. With 220-volt input (figure 2–66), links are placed between terminals 1 and 3 and between 2 and 4, which places the two transformer primaries in parallel. In either case, the voltage across either one of the two primaries (terminals 1 and 2 or 3 and 4 of T-1501) is 220 volts.

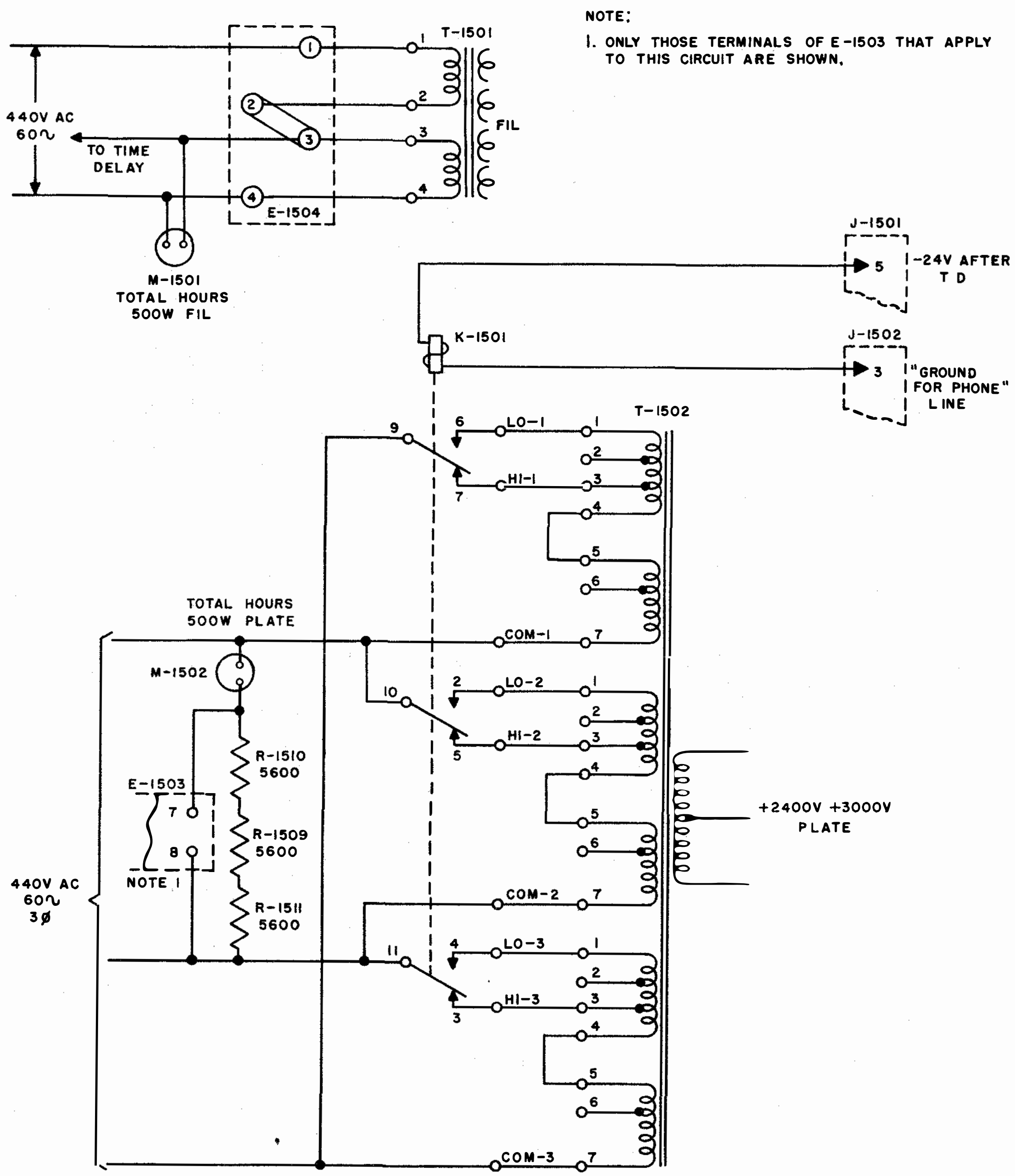


Figure 2—65. Transformer T—1502 Primary and Meter Connections for 440-Volt Input

The motor of the time delay relay K–1504 is connected across terminals 3 and 4 of E–1504, which is at 220 volts with either 220-volt or 440-volt input. As soon as the BOOSTER EMERGENCY SWITCH ⓢⓢ, S–1501, is closed, 220 volts is applied to the motor of K–1504. After approximately 30 seconds, K–1504 closes its two sets of contacts. Contacts 5 and 7 place TIME DELAY indicator I–1504 and dropping resistor R–1508 across 220 volts. Contacts 2 and 8 prepare the "500 W disable" line, which disables the 500-watt operation controls, including application of power to the plate transformer, T–1502, until the filaments of the HVPS have had time to reach operating temperature. When contacts 2 and 8 of K–1504 close and if the other conditions are met, the transmitter group can be placed in 500-watt operation (see paragraph 10*e*(1)). The "ground for 500 W" line is now completed, and if the STAND-BY-OPERATE switch ⓟⓟ, S–3005 in the LVPS, is in OPERATE, the "–24 V after standby" line will be energized, and high voltage plate relay K–1502 will be energized. Contacts L1 and T1, L2 and T2, and L3 and T3 of K–1502 connect 220-volt or 440-volt three-phase

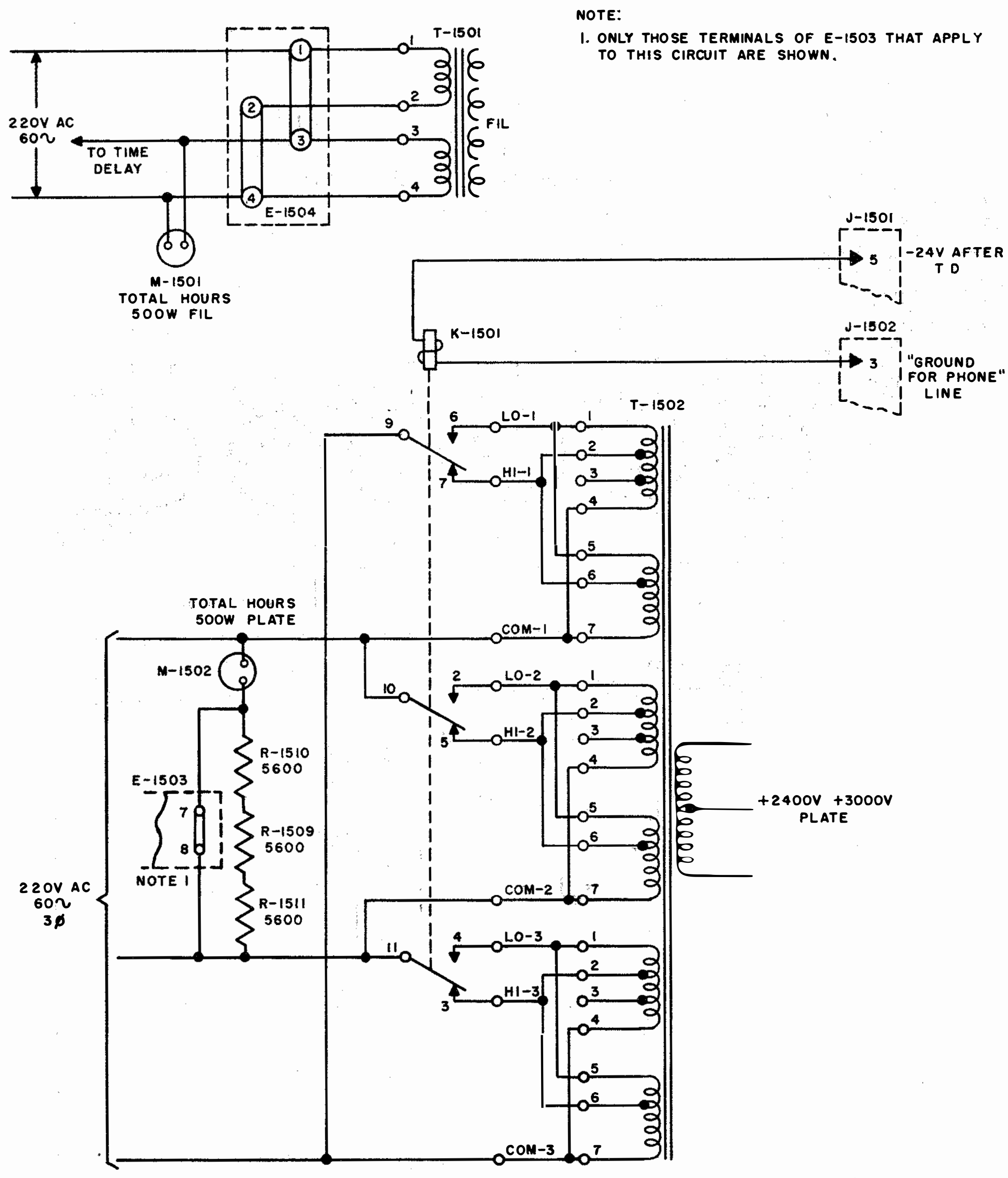


Figure 2—66. Transformer T—1502 Primary and Meter Connections for 220-Volt Input

power to plate transformer T–1502 through fuses F–1501, F–1502, and F–1503 or F–1506, F–1507, and F–1508. These fuses are 3.5 amp (F–1501 through F–1503) for 440-volt input, and 6.25 amp (F–1506 through F–1508) for 220-volt input.

When contacts L1 and T1, L2 and T2, and L3 and T3 of K–1502 close, three-phase power is connected to indicators H.V. PRIMARY-ϕ (I–1503), H.V. PRIMARY-ϕ2 (I–1502), and H.V. PRIMARY-ϕ3 (I–1501), which are wye-connected across the phases and indicate the presence of voltage at the primary of the plate transformer, T–1502. Resistors R–1501, R–1502, R–1503, R–1505, R–1506, R–1507 are dropping resistors for the indicators. With 220-volt input, R–1505, R–1506, R–1507 are shorted by connecting links between terminals 1 and 2, 3 and 4, 5 and 6 on E–1503. If one phase is open, the indicator for that phase will not light; if two or all three phases are open, none of the indicators will light.

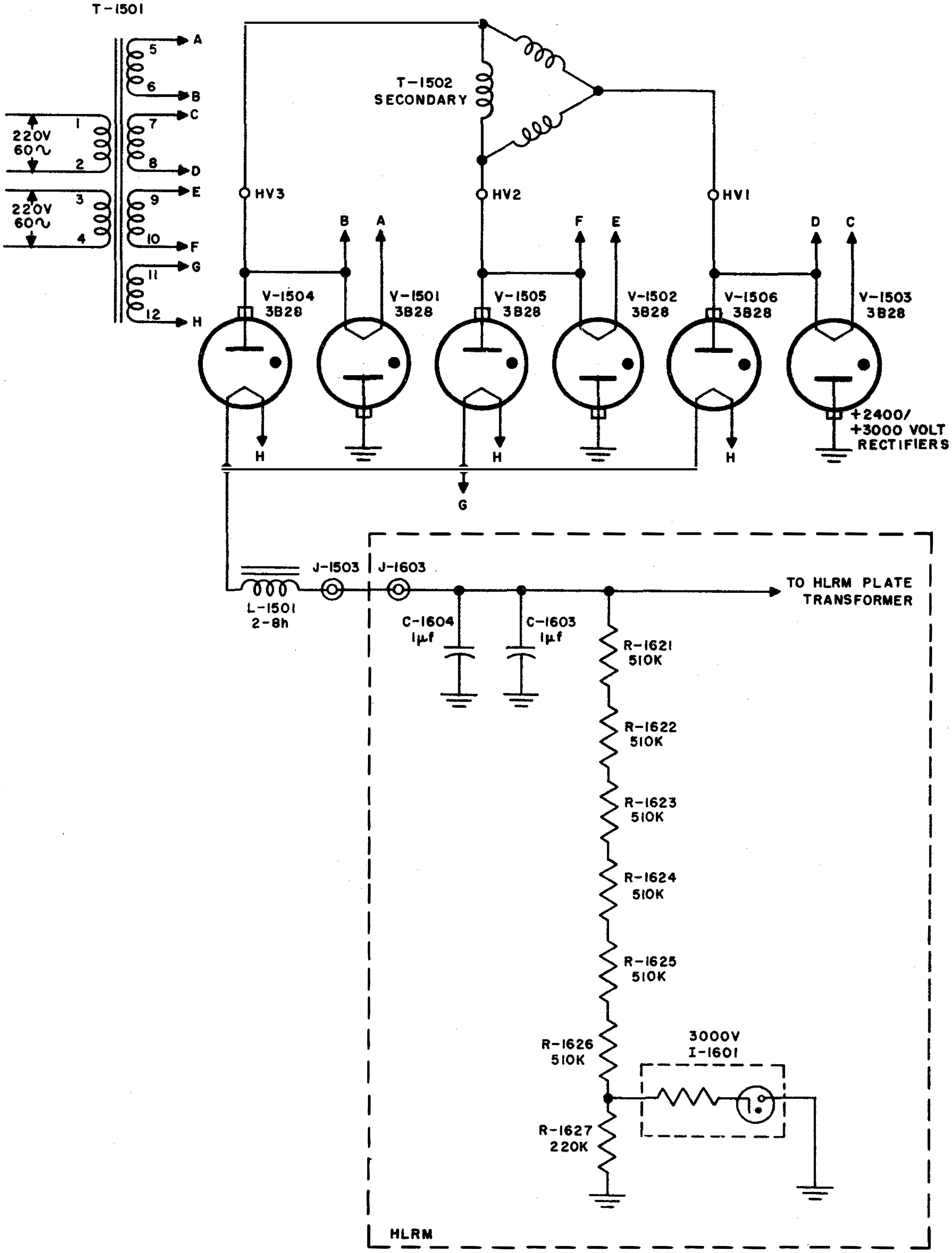


Figure 2—67. +2,400/+3,000-Volt D-C Supply, Simplified Schematic

Two elapsed time indicators, TOTAL HOURS-500 W-FIL (M–1501) and TOTAL HOURS-500 W-PLATE (M–1502) (figures 2–65 and 2–66), are provided to indicate total time the transmitter group operates at 500 watts. M–1501 is connected across 220 volts in parallel with one primary winding of the filament transformer, T–1501, and thus records total time power is applied to the HVPS filaments. M–1502 is connected across one of the phases of the line in parallel with primary 2 of the plate transformer, T–1502, and, accordingly, records total time plate power is applied to the HVPS. Resistors R–1509, R–1510, R–1511 are dropping resistors for M–1502 with 440-volt input. With 220-volt input, these resistors are shorted by connecting links between terminals 7 and 8 on E–1503.

c. +2,400/+3,000-VOLT SUPPLY.—The +2,400/+3,000-volt rectifier circuit may have a three-phase input of either 440 volts or 220 volts. Figures 2–65 and 2–66 show the primary connections of T–1501 and T–1502 for each voltage. The primary of filament transformer T–1501 has two windings. Links on terminal board E–1504 connect the primary windings of T–1501, either in parallel (220-volt input) or in series (440-volt input). The primary of plate transformer T–1502 has six windings, arranged in a delta connection with two windings in each phase. With a 440-volt input (figure 2–65), these two windings are placed in series, and with a 220-volt input (figure 2–66) they are in parallel; therefore, there is always 220 volts across each winding. The primary connections of T–1502 are changed by means of links on a terminal board mounted on the transformer.

Relay K–1501 is energized during phone operation and reduces the output of the supply from +3,000 volts at 355 ma to +2,400 volts at 560 ma by decreasing the turns ratio of plate transformer T–1502. The voltage output is reduced during phone operation because it is amplitude-modulated by the audio output of the HLRM. Therefore, the power output of the RFA is smaller during phone operation.

The secondary of T–1502 is delta-connected (figure 2–67). Each winding develops 2,260 volts rms when the transmitter is on cw, and 1,835 volts rms when the transmitter is on phone. Six half-wave rectifiers, V–1501 through V–1506, are connected as a three-phase full-wave rectifier. There are always two tubes conducting.

If we assume that point HV–1 is positive and HV–2 is negative, rectifiers V–1506 and V–1502 are conducting. Electron flow is from HV–2 through V–1502 to ground, then through the load and back through V–1506. When the polarity of this phase reverses (HV–1 negative, HV–2 positive), rectifiers V–1503 and V–1505 conduct. Electron flow is now from HV–1 through V–1503 to ground, then through the load and back through V–1505. Therefore, this phase gives two current peaks for each cycle. Similarly, each of the other two phases gives two current peaks for each cycle, but at different times because of the 120° phase angle between each phase voltage (figure 2–68). This develops six

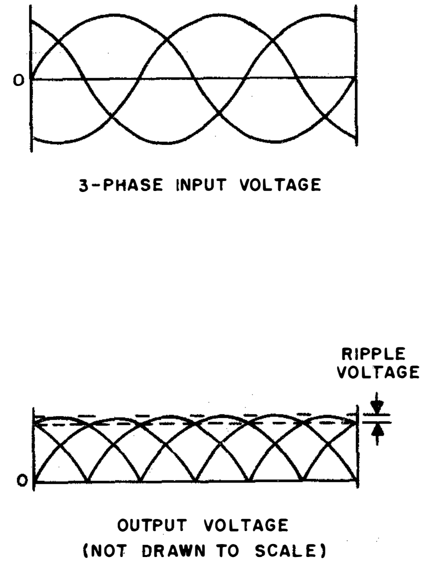


Figure 2–68. +2,400/ +3,000-Volt Rectifier Input and Output, Voltage Wave Forms

current peaks through the load during the time for one cycle. The ripple frequency at the output of the rectifiers will therefore be six times the input frequency, or 360 cps. Since the ripple frequency is so high, filter capacitors C–1603 and C–1604 may be smaller than would be required for a single-phase, full-wave rectifier because less filtering is required.

Except for the input choke, L–1501, the filter and voltage divider resistors are located in the HLRM because of space limitations in the HVPS. The single choke input filter consists of L–1501, L–1604, and C–1603. Resistors R–1621 through R–1627 form a voltage divider from which the 3,000 V indicator, I–1601, receives its operating voltage, and they also act as bleeders for the +3,000-volt supply.

Filament transformer T–1501 has four secondaries, of which three are 5-ampere windings and one a 15-ampere winding. The 15-ampere winding (terminals 11 and 12) supplies filament power to V–1504, V–1505, and V–1506. Rectifiers V–1501, V–1502, and V–1503 each employ a separate 5-ampere filament winding. This difference in the ratings of the secondary windings must be carefully observed when replacing transformer T–1501.

The +3,000-volt output is supplied to the HLRM in 500-watt level for cw, frequency-shift, and facsimile operation, while +2,400 volts is supplied to the HLRM at the 500-watt level for phone operation.

7. RADIO MODULATOR MD–229/SRT (LOW LEVEL RADIO MODULATOR, LLRM).

a. GENERAL.—The low level radio modulator (LLRM) consists of an audio amplifier chain, a keying circuit, the LOCAL-REM switch (x), S–1106, a regulated +250-volt power supply, a —12-volt power supply and an ATU bypass transfer circuit (figure 2–130).

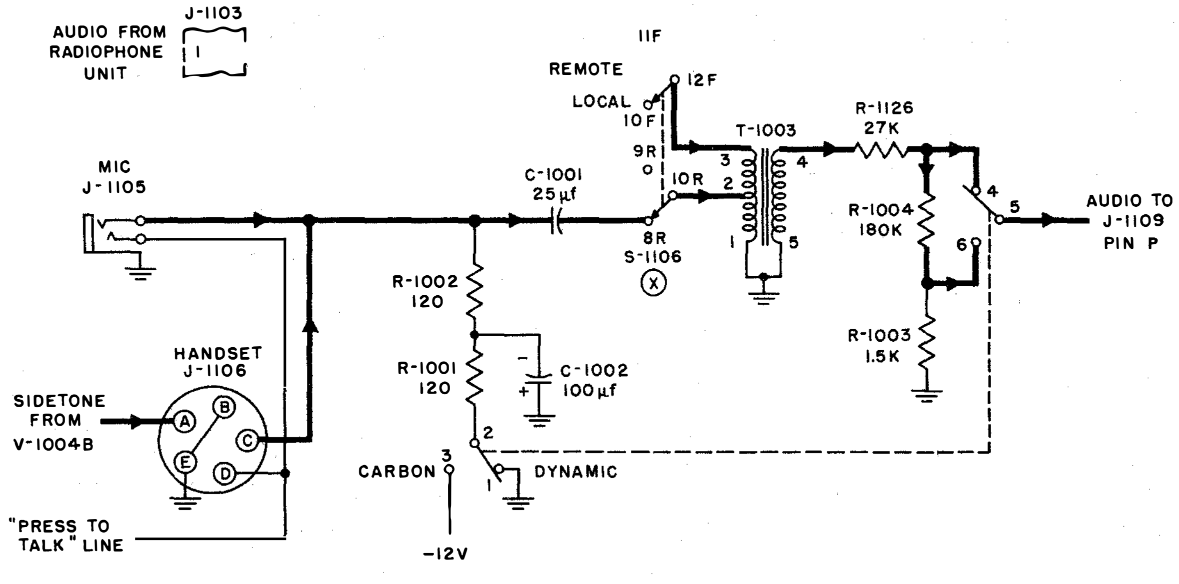


Figure 2—69. Audio Input Circuit, Simplified Schematic

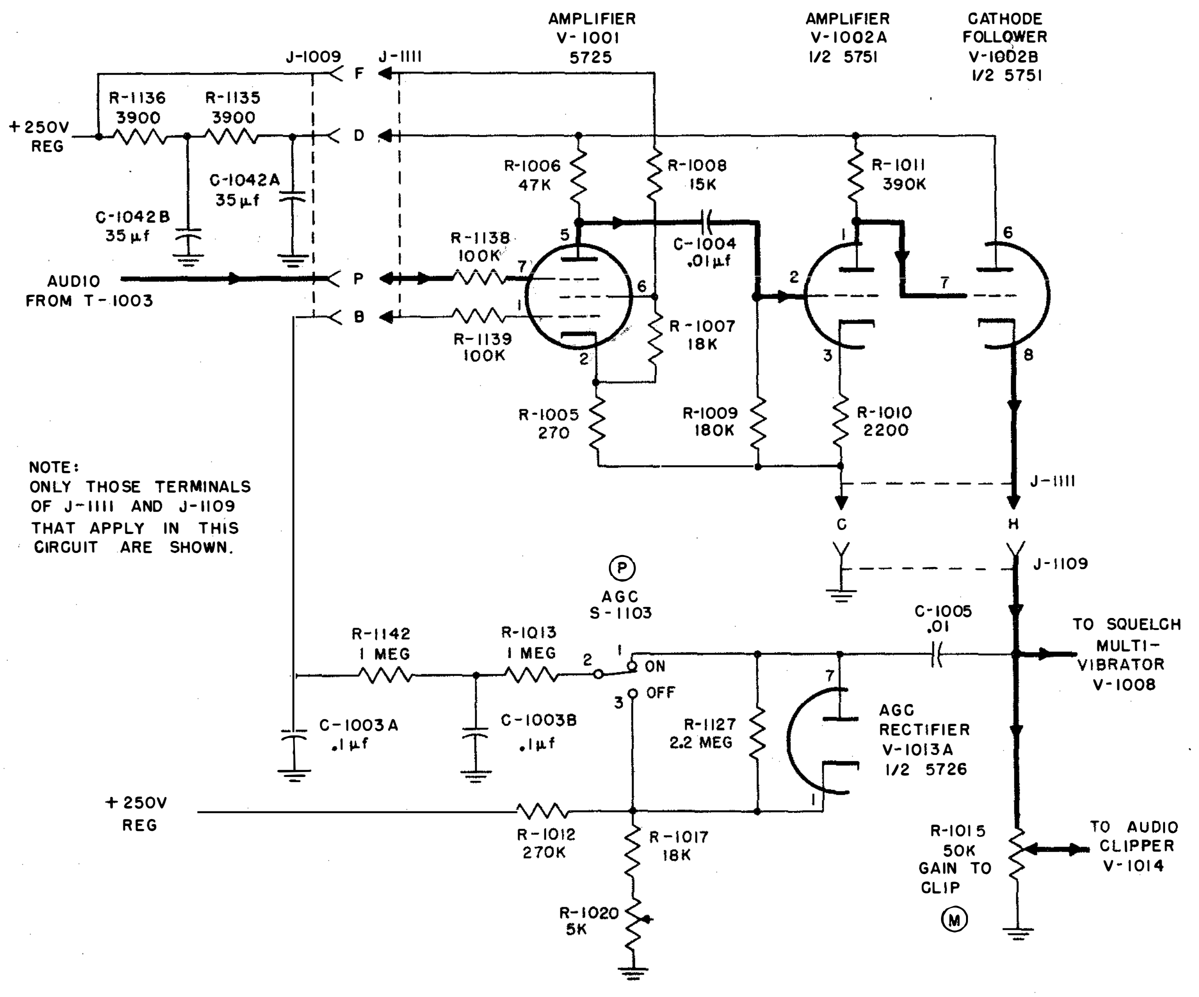


Figure 2—70. Audio Amplifiers V—1001 and V—1002A, Cathode Follower V—1002B and AGC Rectifier V—1013A, Simplified Schematic

b. AUDIO AMPLIFIER CHAIN.—The audio amplifier chain receives a signal locally from either a carbon or dynamic microphone or remotely from a radiophone unit when the transmitter group is in phone operation. In 100-watt operation, this signal is amplified to a level suitable for 100 percent amplitude modulation of the plate of the power amplifier in the radio frequency amplifier. In 500-watt operation there is a secondary output of the audio amplifier chain, which is fed to the high level radio modulator for further amplification. The circuitry is designed to minimize the effects of noise, microphonics, and other interferences which tend to obscure the clarity of the audio signal.

(1) AUDIO INPUT CIRCUIT.—An audio input may be received locally through the HANDSET jack, J–1106, or the MIC. jack, J–1105 (figure 2–69). The signal is coupled to the 35-ohm tap (terminal 2) of the input transformer, T–1003, through capacitor C–1001 and contacts 8R and 10R of the LOCAL-REM switch Ⓧ, S–1106, in the LOCAL position. If the input is from a carbon microphone, −12 volts to energize the microphone is supplied through contacts 2 and 3 of the DYNAMIC-CARBON switch Ⓨ, S–1102, and the filter network comprised of resistors R–1001 and R–1002 and capacitor C–1002. With dynamic microphone input, the −12 volts is disconnected and the filter network is tied to ground. The impedance of the filter network is high enough to not seriously shunt the 35-ohm termination of the microphone line. When the audio signal comes from a remote radiophone unit, it is connected across the full 600-ohm primary of T–1003 (terminals 1 and 3) through contacts 11F and 12F of switch Ⓧ S–1106 in the REM position. The output of transformer T–1003 (terminals 4 and 5) is connected to a voltage divider network comprised of resistors R–1126, R–1004, and R–1003 to ground. To compensate for the fact that the signal level from a carbon microphone is higher than from a dynamic microphone, the output to the following stage for dynamic mircrophone input is taken from a higher tap on the voltage divider by means of DYNAMIC-CARBON switch S–1102. With DYNAMIC phone input, the output to the following stage is taken from the junction of R–1126 and R–1004, through contacts 4 and 5 of DYNAMIC-CARBON switch Ⓨ S–1102 in the DYNAMIC position, while, for carbon microphone input, the output is taken from the junction of R–1004 and R–1003 through contacts 6 and 5 of DYNAMIC-CARBON switch Ⓨ S–1102 in the CARBON position. The comparative signal levels, as determined by the values of the voltage-divider resistors, are such that the following amplifier stage will not be overdriven, causing distortion.

(2) AUDIO AMPLIFIERS V–1001 AND V–1002A, CATHODE FOLLOWER V–1002B AND AGC RECTIFIER V–1013A.—The output from T–1003 is fed to a two-stage audio preamplifier consisting of V–1001 and V–1002A (figure 2–70). The preamplifier feeds a cathode follower V–1002B, whose function is to match the high-impedance output of the preamplifier to the low impedance of the clipper stage that follows. The cathode follower output is also fed to the AGC circuit, which is a negative feedback to the first stage of the preamplifier, V–1001, causing V–1001 to have a constant output level over a large range of input amplitudes.

(*a*) AUDIO AMPLIFIERS V–1001 AND V–1002A.—Connections between the audio amplifiers, V–1001 and V–1002A, that are mounted on the subchassis and associated components on the main LLRM chassis are made through a male connector, J–1111, mounted on the subchassis, and a mating female connector, J–1109, mounted on the main chassis. The audio output from T–1003 is connected to the suppressor grid, pin 7 of V–1001, through the "P" pins of J–1109 and J–1111 and grid resistor R–1138. The AGC control voltage is applied to the control grid, pin 1 of V–1001, through the "B" pins of J–1109 and J–1111 and grid resistor R–1139. The voltage-divider network, comprised of resistors R–1008, R–1007 and R–1005, connected from the +250-volt regulated supply to ground, besides supplying screen grid voltage also places a cathode-biasing potential of approximately two volts on V–1001. During no-signal condition, the AGC circuit causes the control grid to draw a small amount of current so that control grid to cathode voltage is approximately zero. The total suppressor grid to cathode bias potential is approximately −4 volts, which is a sum of the power bias potential and the self-biasing caused by no-signal tube current flow. This keeps the tube operating in the linear portion of its characteristic. The effect of supplying the signal to the suppressor grid and the AGC control to the control grid is to produce a highly sensitive AGC control without requiring high input signal strength as compared to the AGC voltage, which would be needed to prevent distortion when AGC and signal voltages are both applied to the control grid. A complete description of the AGC action follows in paragraph 7*b*(2)(*c*). The output of V–1001 is fed to a high-gain triode V–1002A, which is a standard audio amplifier using degenerative feedback through cathode resistor R–1010 for improved fidelity.

(*b*) CATHODE FOLLOWER V–1002B. — To match the relatively high output impedance of V–1002A to the low impedance of the diode clipper stage, a cathode follower V–1003A is introduced. The plate of V–1002A, pin 1, is directly connected to the grid, pin 7, of V–1002B to provide a large enough signal voltage swing across the cathode resistor, R–1015. R–1015 is a potentiometer, so that the amplitude of the signal coupled to the following clipper stage may be controlled. This is identified as the GAIN TO CLIP control Ⓜ. The full signal developed across R–1015 is also coupled to the squelch circuit and to the AGC circuit.

(*c*) AGC RECTIFIER V–1013A. — The signal from V–1003A is coupled to the AGC circuit through capacitor C–1005. A voltage-divider network consists of R–1012, R–1017, R–1020 from +250 volts to ground so that the junction of R–1012 and R–1017 is at +20 volts. This point is tied to the cathode, pin 1, of the AGC

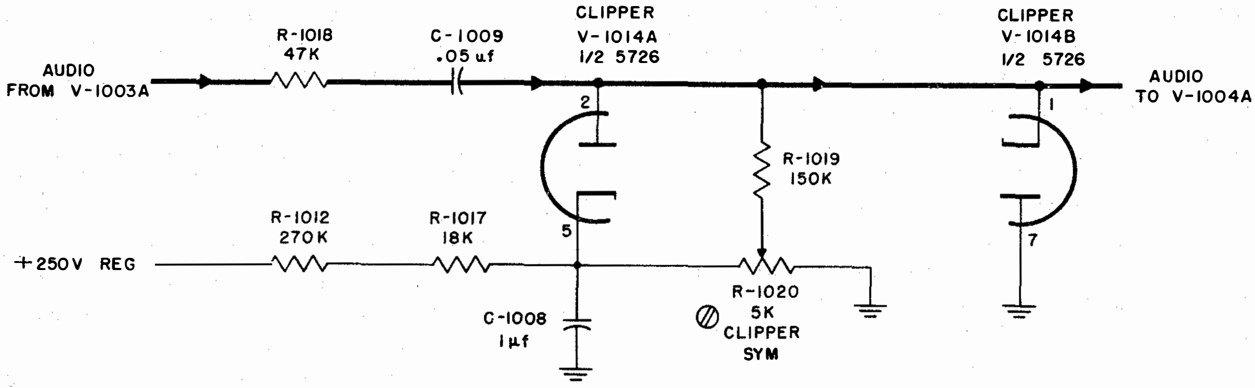


Figure 2—71. Clipper V—1014, Simplified Schematic

rectifier, V–1013A, and to resistor R–1127; then through contacts 1 and 2 of the AGC switch, Ⓟ, S–1103, in the ON position, resistors R–1013 and R–1142 through the "B" contacts of J–1109 and J–1111 to R–1139, and then to the control grid of the first amplifier, V–1001. This tends to make the V–1001 grid draw current, but because of the large values of R–1127, R–1013, R–1142, and R–1139, this current is so small that, effectively, the grid to cathode potential of V–1001 is zero volts. As the cathode of V–1001 is biased at no signal to approximately +4 volts to ground, the grid to ground voltage is also +4 volts. Effectively there is a voltage-divider action at no signal across R–1127, R–1013, R–1142, and R–1139 from +20 volts to +4 volts, so that the junction between R–1127 and R–1013, at which point the plate of the AGC rectifier, V–1013A (pin 7), is tied, is at +12 volts. Therefore, during no-signal condition, the plate of the AGC rectifier is approximately —8 volts with respect to its cathode. Whenever a positive peak of the audio exceeds 8 volts, the AGC rectifier will conduct and any additional peak signal voltage will build up a charge across capacitor C–1005. During the negative portions of the signal, the voltage across C–1005 is connected through the two-section filter comprised of R–1013, C–1003B, R–1142, and C–1003A, through the AGC switch Ⓟ, S–1103, in the ON position to the control grid of V–1001. The polarity of this voltage across C–1005 is negative with respect to ground. As C–1005 is connected to the control grid of V–1001, the voltage developed across it tends to increase the bias on V–1001, decreasing its gain. The higher the signal voltage appearing across the output of the cathode follower, the larger will be the negative bias built across C–1005. The bias developed by the AGC circuit, of course, cannot completely counteract its cause, which is increased signal strength. However, the gain of V–1001 is controlled so that a 30-db range of input will cause less than a 10-db range of output. The AGC may be turned off by placing the AGC switch Ⓟ, S–1103, in the OFF position. This removes the AGC rectifier from the circuit and connects the +20-volt tap on the voltage divider directly to the grid of V–1001 through contacts 2 and 3 of S–1103 and resistors R–1013 and R–1142, which keeps the control grid-to-cathode potential at approximately zero volts.

(3) CLIPPER V–1014.—This stage (figure 2–71) limits the audio signal amplitude to prevent overmodulation of the carrier by excessively strong signals. The clipper, V–1014, is a double diode. The plate of the first half, pin 7, is connected to ground and the cathode of the second section is tied to +4 volts at the junction of R–1017 and R–1020, which is part of a voltage divider from regulated +250 volts to ground, consisting of R–1012, R–1017, and R–1020. The cathode of the first half, pin 1, and the plate of the second half, pin 2, are tied together and held at a d-c potential of between +4 volts and zero, depending on the setting of potentiometer R–1020, which is adjustable to allow for a difference in characteristics between the two halves of V–1014. If the two halves are exactly similar, the setting of the arm of R–1020 is +2 volts. The audio signal from the cathode follower is coupled by capacitor C–1009 to the junction of pins 1 and 2 of V–1014. Effectively, the cathodes of both halves are approximately two volts more positive than their respective plates, with the signal being fed to the plate of one half and the cathode of the other half. When the positive peak of the audio signal reaches +2 volts, the plate of the second half of V–1014 becomes positive with respect to its cathode, and the second half of V–1014 conducts, clipping the positive swing of the signal to a maximum of two volts, the additional signal peak above two volts appearing across resistor R–1018. The same reasoning holds when the negative swing of the audio signal reaches two volts, with the first half of V–1014 conducting in this case instead of the second half. As mentioned above, the CLIPPER SYM. potentiometer, R–1020, is adjusted so that any difference in plate current characteristics of the two halves of V–1014 can be regulated to make sure that the positive and negative peaks of the audio signal are clipped at the same voltage level. The clipper output is developed across resistor R–1019 and coupled to audio amplifier V–1004A.

(4) AUDIO AMPLIFIERS V–1004A AND V–1002B.—The output of the clipper is coupled through capacitor C–1010 to audio amplifier V–1004A (figure 2–72), which amplifies the signal and couples it through capacitor C–1041 to band-pass filter network Z–1001, which passes frequencies in the range of 200 cps to 4,500

cps. This filter cuts out the high-frequency harmonics of the audio signal, which were introduced by the clipper action in the previous stage, as well as noise frequencies outside of the band of the filter. The output of the filter is applied across potentiometer R–1032, which is known as the % MOD Ⓝ control. In 100-watt operation, the LLRM delivers 50 watts to the RFA to modulate the carrier, while during 500-watt operation the LLRM delivers 6 watts to the HLRM. For this reason the output of the potentiometer, R–1032, is fed to a voltage-divider chain under control of gain change relay K–1104. During 100-watt operation the entire output is coupled to the following stage through contacts 7R and 8R of unenergized K–1104. In 500-watt operation, K–1104 is energized and the output of R–1032 is applied across the network of R–1050, R–1049, and the 500 W. AUDIO LEVEL variable resistor, R–1048, to ground. The tap on the network at the junction between R–1050 and R–1049 is now coupled to the following stage through contacts 9R and 8R of energized K–1104. Depending on the setting of R–1048, the audio signal fed to amplifier V–1002B in 500-watt operation is 30 percent to 50 percent of the signal output from R–1032. The output of R–1032 is adjusted for 100 percent modulation of the carrier in either 100-watt or 500-watt operation. The setting of R–1048 is a fine control for adjusting for 100 percent modulation in 500-watt operation. With SERVICE SELECTOR switch ⓤ S–1101 in any other position than PHONE, any signal output from amplifier V–1004A will be grounded through contacts of S–1101E front. In addition to being coupled to V–1002B, the signal from V–1004A is under control of the keying relay, K–1101, when SERVICE SELECTOR switch S–1101 is in the PHONE position, through contacts 12 and 6 of S–1101F rear. In phone operation, keying relay K–1101 is energized when the press-to-talk button on the phone is depressed. The signal is grounded through contacts 1R and 2R of K–1101 when it is not energized. The signal is coupled to amplifier V–1003A through capacitor C–1015.

In addition to the audio signal being coupled to the grid of V–1003A, there is a negative bias from the squelch circuit, V–1008 and V–1013B, which is sufficient to cut off V–1003A if the level of audio signal is not high enough. The output of V–1003A is coupled through C–1016 to phase inverter V–1003B and sidetone amplifier V–1004B. The various conditions that must be met before there is an output from V–1003A are: SERVICE SELECTOR switch ⓤ S–1101 in PHONE position, press-to-talk button on phone depressed, and squelch circuit receiving an audio signal of sufficient level.

(5) SQUELCH CIRCUIT.—To prevent transmission of noise when the audio signal is not present, the squelch circuit prevents amplification by the audio chain by biasing the grid of audio amplifier V–1002B below cutoff unless there is an audio signal. The squelch circuit consists of a multivibrator, V–1008, a crystal rectifier, CR–1002, and limiter V–1013B.

(*a*) SQUELCH MULTIVIBRATOR V–1008.—The audio signal as developed at the output of the cathode follower, V–1003A, is coupled through capaci-

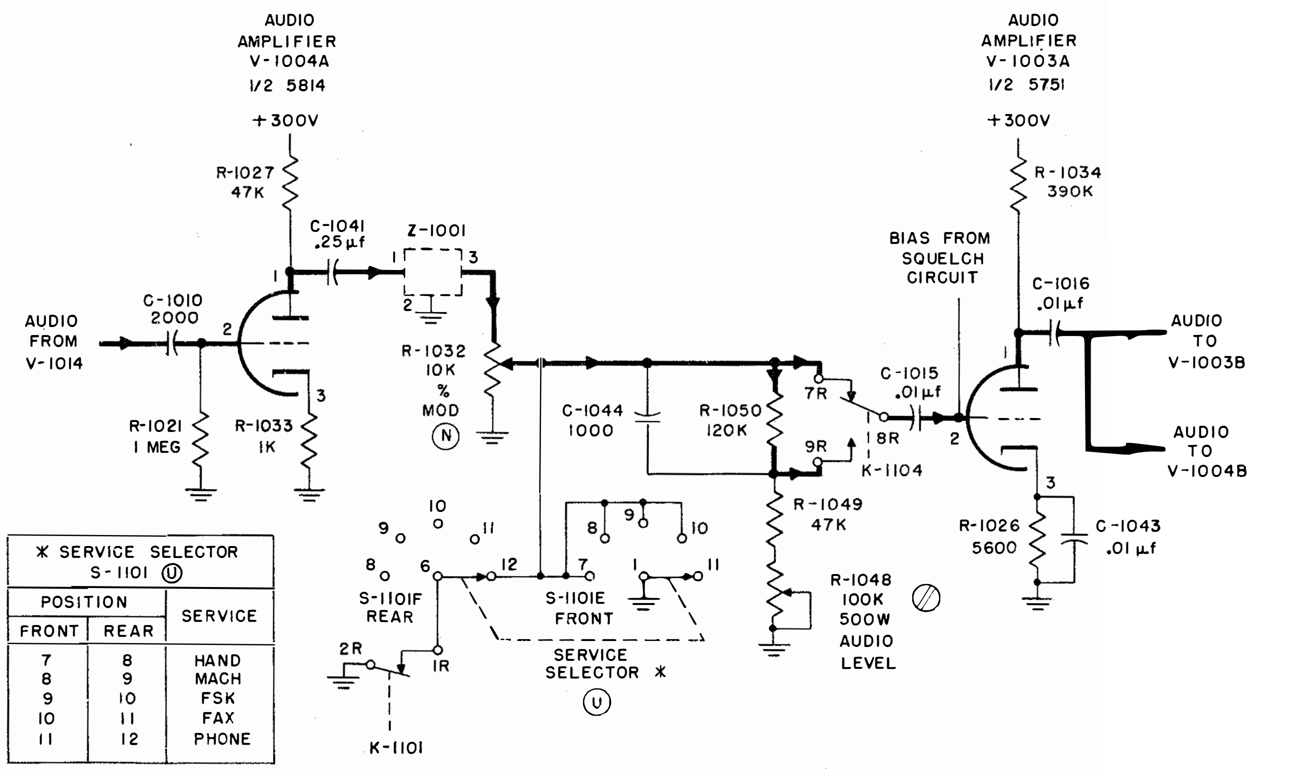


Figure 2—72. Audio Amplifiers V—1004A and V—1003A, Simplified Schematic

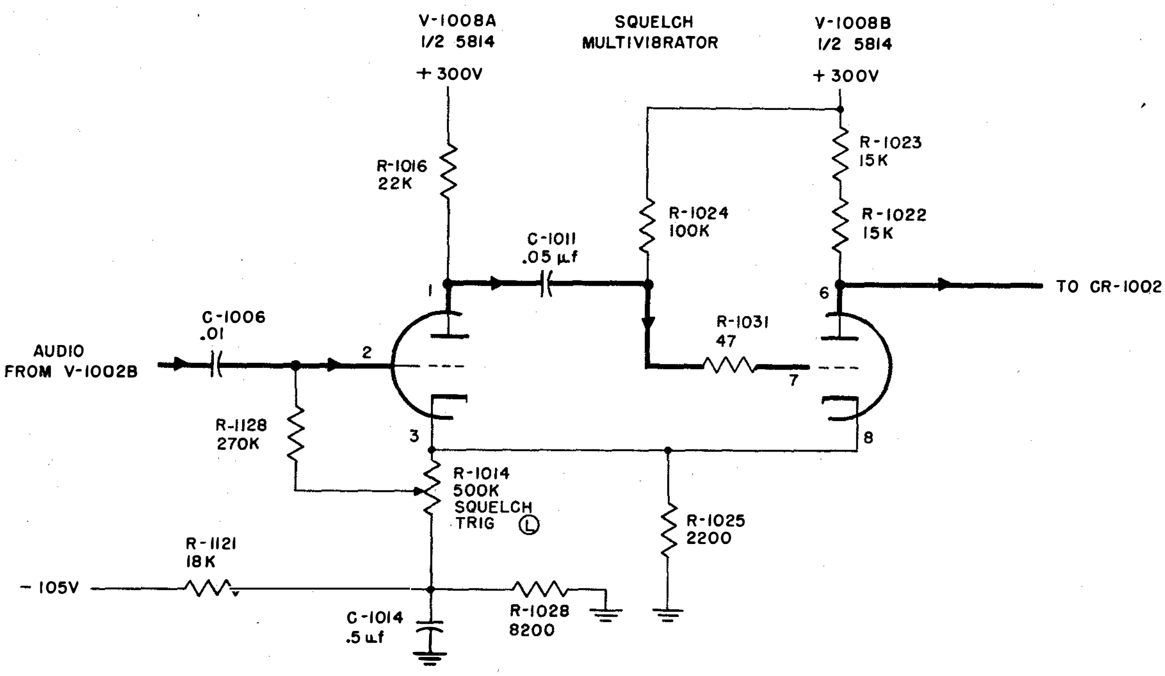


Figure 2—73. Squelch Multivibrator V—1008, Simplified Schematic

tor C–1006 to the grid of V–1008A, pin 2 (figure 2–73). Resistors R–1121, R–1028, R–1014, and R–1025 form a divider network from −105 volts to ground. This produces a potential of −30 volts at the junction of R–1121, R–1014, and R–1028. R–1014 is the SQUELCH TRIG. control Ⓛ, the arm of which is tied to the grid of V–1008A through grid-leak resistor R–1128. With control Ⓛ turned all the way down, the grid of V–1008A is at −30 volts, but V–1008B, whose grid is tied to +300 volts through R–1024 and R–1031, conducts heavily, causing a positive voltage across cathode resistor R–1025 of about +20 volts. As R–1025 is a common cathode resistor for both V–1008A and V–1008B, the voltage across it, together with the −30 volts on the grid, biases V–1008A well below cutoff. Turning the SQUELCH TRIG. control Ⓛ up gradually reduces the grid-to-cathode bias on V–1008A. The audio signal coupled to the grid of V–1008A must be large enough to overcome the grid-to-cathode bias to affect the operation of the squelch multivibrator. When the positive peaks of the signal are above the minimum level established by the SQUELCH TRIG. control Ⓛ, R–1014, signal is applied to the control grid of V–1008A; this tube begins to conduct, causing its plate voltage to decrease. The decrease of plate voltage of V–1008A is coupled through capacitor C–1011 to the grid of V–1008B, pin 7, which causes the current in V–1008B to decrease, which, in turn, increases the plate voltage of V–1008B, pin 6. The decrease in plate current of V–1008B also reduces the bias voltage developed across R–1025, causing V–1008A to conduct even more. The above action is rapidly accumulative until V–1008B is cut off. The resultant is that a positive pulse appears at the plate of V–1008B for every positive peak of audio signal above the minimum level. These pulses are coupled to the squelch rectifier, CR–1002. Resistor R–1031 in the grid circuit of V–1008B is a parasitic suppressor.

(*b*) SQUELCH RECTIFIER CR–1002 AND LIMITER V–1013B.—Positive pulses from the squelch multivibrator are coupled to the squelch rectifier CR–1002 through capacitor C–1012 (figure 2–74). Resistors R–1121 and R–1028 form a voltage divider from −105 volts to ground so that there is −30 volts present at the junction of R–1121 and R–1028. When there are no positive pulses, this negative voltage is connected to the grid of audio amplifier V–1003A, pin 2, through R–1030, the high back-resistance of the crystal rectifier CR–1002, R–1029, and R–1129, which biases V–1003A below cutoff. When there are positive pulses, they appear across R–1030 and CR–1002 conducts. C–1013, R–1029, and C–1052 act as filter network to the output to the grid of V–1003A. The filtering action is such that voltage on the grid of V–1003A becomes the value of the pulse superimposed on the d-c negative bias, which will raise the grid of V–1003A above cutoff, allowing it to amplify the audio signals being received from amplifier V–1004A. The time constants involved in the filter components are so large with respect to the period of even the lowest audio signal, the bias on V–1003A will be essentially constant and at the level needed to keep V–1003A operating in the linear portion of its characteristic. A further safeguard of this is given by the action of the limiter diode, V–1013B. If the positive pulses received from the multivibrator should be of high enough amplitude to raise the resultant voltage applied to V–1002B grid above ground, the plate of V–1013B becomes more positive than its cathode, which

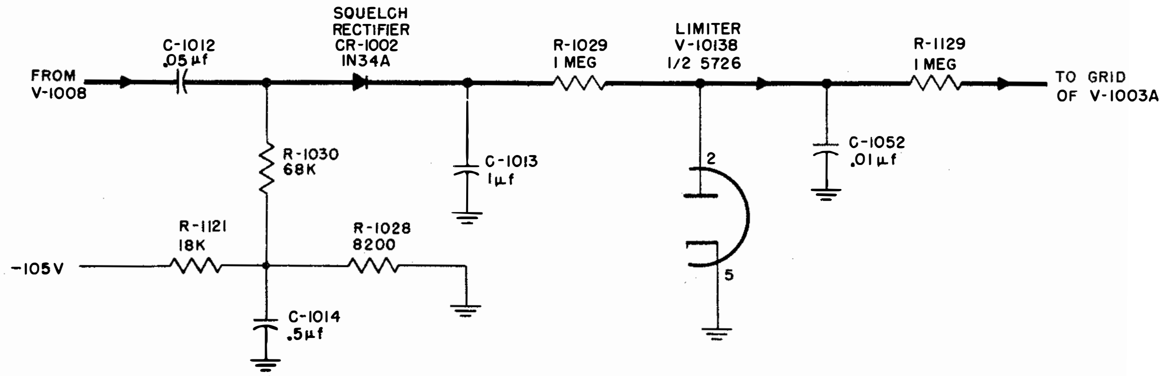


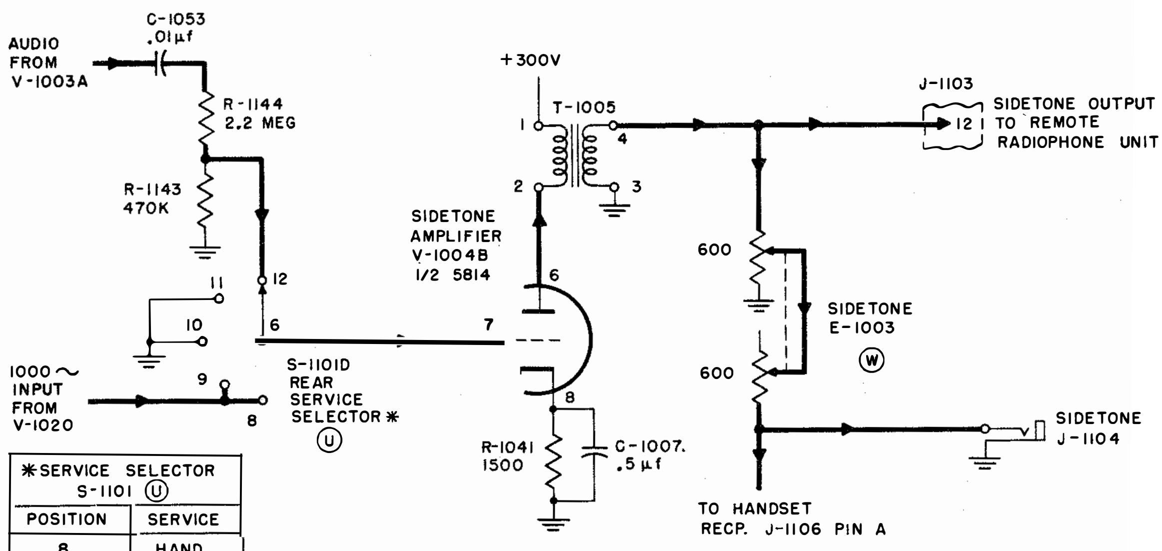
Figure 2–74. Squelch Rectifier CR–1002 and Limiter V–1013B, Simplified Schematic

is grounded. It conducts heavily, limiting the voltage applied to V–1003A to a maximum of zero volts with respect to ground. Additional peak voltages above ground appear across resistor R–1029.

(6) SIDETONE AMPLIFIER V–1004B.—For monitoring purposes, the output of audio amplifier V–1003A is coupled through C–1053 (figure 2–75) to a voltage divider comprised of R–1144 and R–1143. A reduced portion of this signal, obtained from the junction of R–1144 and R–1143, is connected through contacts 12 and 6 of S–1101D rear, when SERVICE SELECTOR switch Ⓤ S–1101 is in the PHONE position, to the grid of sidetone amplifier V–1004B. The output of V–1004B is coupled by an output transformer, T–1005, to three monitoring outputs: the HAND SET receptacle, J–1106, the SIDETONE jack, J–1104, and to the remote radiophone unit. The output to J–1106 and J–1104 is under control of SIDETONE attenuator Ⓦ E–1003, which is an L-pad. Besides acting as volume control for the sidetone output, E–1003 also acts as an impedance matching network which presents a constant impedance to the output transformer, T–1005, independent of the setting of E–1003. Full sidetone output is supplied to the radiophone unit, which is equipped with its own L-pad.

An additional audio signal is applied to V–1004B during hand-key and machine-key operation through S–1101D rear contacts 8 and 6 when SERVICE SELECTOR Ⓤ is in BAND and contacts 9 and 6 when in MACH, and is amplified in a similar manner. Paragraph 7c(8) discusses this signal and its purpose.

(7) AUDIO OUTPUT CIRCUIT.—The audio output circuit receives the audio signal from amplifier V–1003A. The signals are fed to a phase inverter which produces two signals of equal amplitude, but opposite phase. These two signals are coupled to a push-pull cathode follower stage which acts as a driver for the



✱SERVICE SELECTOR S-1101 Ⓤ	
POSITION	SERVICE
8	HAND
9	MACH
10	FSK
11	FAX
12	PHONE

Figure 2–75. Sidetone Amplifier V–1004B, Simplified Schematic

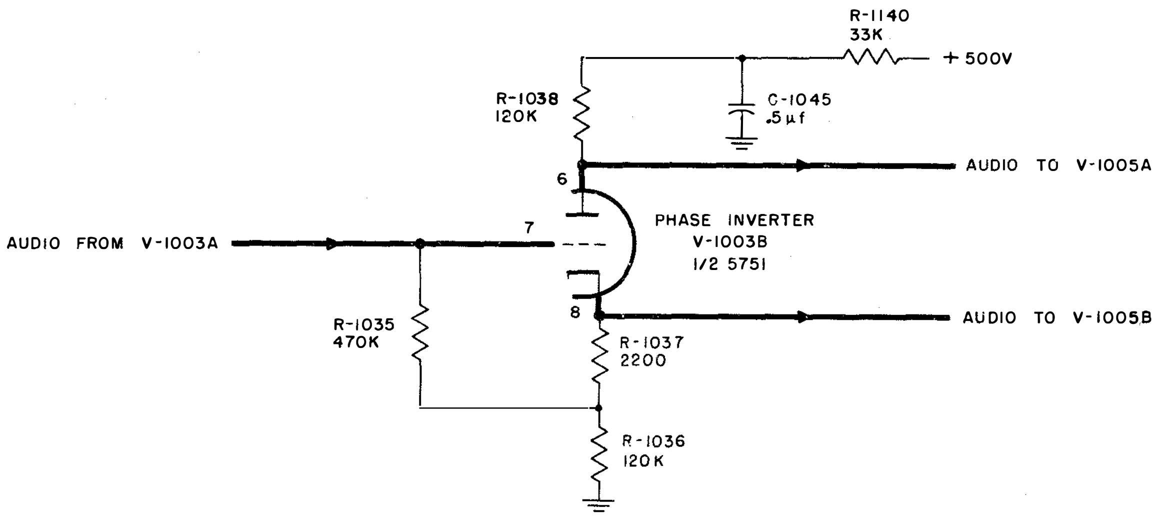


Figure 2–76. Phase Inverter V–1003B, Simplified Schematic

push-pull power amplifiers that constitute the last stage of amplification of the audio amplifier chain. In the AN/SRT–14, the final audio output is fed directly to the RFA. In the AN/SRT–15 and 16 there are audio outputs of two levels, depending on the power level at which the transmitter is working: 100 watts or 500 watts. In 500 watts, the 6-watt audio output from the LLRM is fed to HLRM for further amplification. In 100 watts, the 50-watt audio output from the LLRM is fed to the HLRM, where it is switched through to the RFA.

(*a*) PHASE INVERTER V–1003B. — The audio signal from V–1003A is fed to the grid of phase inverter V–1003B (figure 2–76). One output is taken from the cathode and one from the plate. Values of plate load resistor R–1038 and cathode resistors R–1037 and R–1036 are equal so that the two output voltages will be of equal amplitude, though opposite in phase. The amount of degenerative bias as established by connecting the grid, through R–1035, to the junction of cathode resistors R–1037 and R–1036 is such that the amplitude of the two outputs is approximately the same as the input level of the signal to this stage. R–1140 and C–1045 decouple this stage from the +500-volt plate supply.

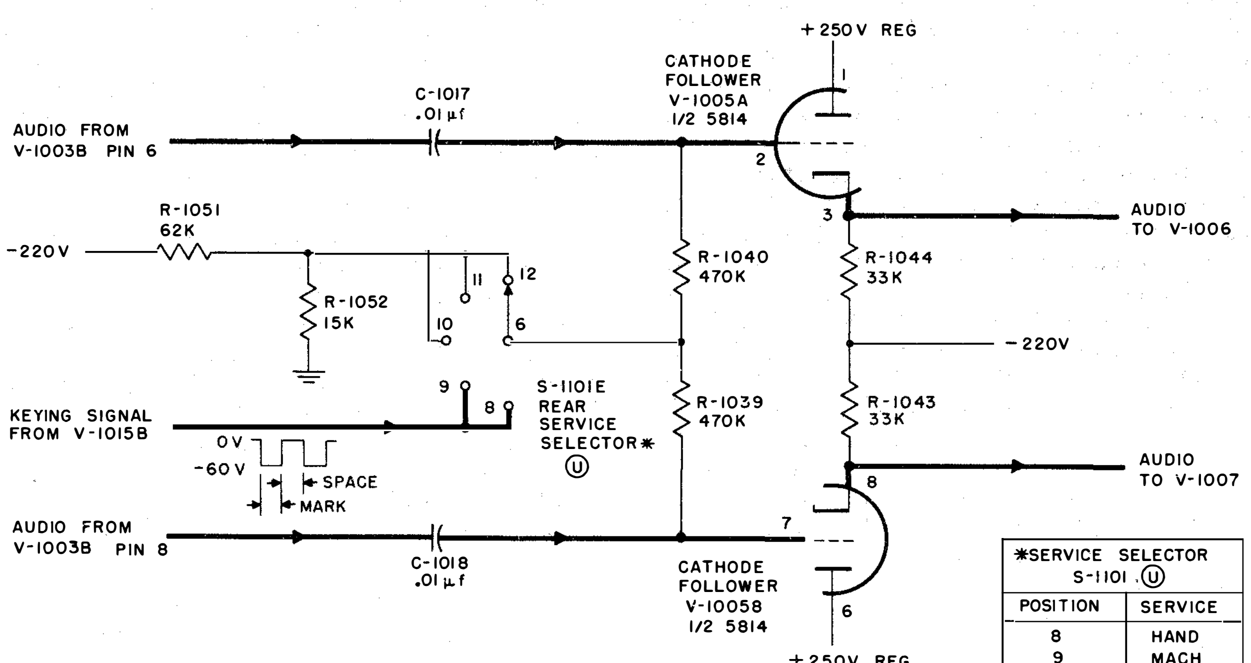
(*b*) PUSH - PULL CATHODE FOLLOWERS V–1005A AND V–1005B.—The push-pull cathode followers V–1005A and V–1005B (figure 2–77) act as drivers for the push-pull power amplifiers, V–1006 and V–1007. As the power amplifier stage acts as a class AB_2 push-pull amplifier, the push-pull cathode follower tubes supply energy to a low impedance during the portion of the cycle that the grids of the power amplifier draw current. With the SERVICE SELECTOR switch Ⓤ, S–1101, in the PHONE position, the voltage divider action of R–1051 and R–1052 from —220 volts to ground puts a d-c potential of —40 volts on the grids of the push-pull cathode followers, through contacts 12 and 6 of S–1101E rear. As the tubes are returned to —220 volts, the cathode followers conduct during no-signal conditions so that the potentials at the cathodes are approximately —40 volts. The cathodes are tied directly to the grids of the power amplifiers, which sets the d-c bias of the power amplifiers. Signals of equal amplitude but opposite phase from the phase inverter are coupled to the grids of the push-pull cathode follower, V–1005A, pin 2, and V–1005B, pin 7, through capacitors C–1017 and C–1018 respectively. When the signal reaches –40 volts in amplitude, the grids of the power amplifiers go positive with respect to their cathodes and start to draw grid current, presenting an impedance to the cathode followers of approximately 1,000 ohms during the portion of the signal cycle that drives the grids of the power amplifiers positive. The cathode followers can supply the grid current to this low impedance for the maximum signal peak of +10 volts power amplifier grid-to-cathode voltage, derived from a 50-volt peak signal impressed on a —40-volt bias, without requiring the grid of the cathode followers to go positive. This means that the required driving energy can be supplied to the power amplifier while maintaining a high impedance to the input audio signal by the use of the cathode followers.

The normal function of the audio amplifier chain during hand-key and machine-key operation is inoperative. Therefore, the push-pull cathode followers coupled with the power amplifiers are used for an auxiliary function during these two modes of operation. The fact that the power amplifiers use +500 volts for a plate supply is utilized to provide a dumping circuit to eliminate transient voltage variations imposed on the +500-volt power supply (see paragraph 5*b*) when the transmitter is keyed. As the input to the push-pull cathode followers is the first point at which a control of the action of the push-pull amplifiers can be introduced, the dumping control is fed to the grids of the cathode followers through SERVICE SELECTOR switch Ⓤ

S-1001E rear when in either the HAND or MACH position. The +500-volt supply provides plate voltage for the IPA and screen voltage for the PA (the latter in 500 watts only) in the RFA (paragraphs 10*c*(2) and 10*d*(2)). In space condition the RFA is keyed off and the IPA plate current and PA screen current are at a minimum, while in mark they are at maximum. If these sudden changes in load current drawn from the +500-volt supply are not modified, transient voltages will appear across the filter chokes, L-501 and L-502 (figure 2-61). At the start of mark condition, the polarity of the transient voltage will be such as to oppose the sudden increase in current, thus causing a dip in the power supply output voltage. Conversely, at the start of space condition, the transient voltage will be aiding, opposing the sudden decrease in current, thus increasing the supply output voltage. The function of the dumping circuit is to provide a load during space condition only, to compensate for the reduction in load current when the IPA is keyed off. Thus the load to the +500-volt supply will be approximately equal during mark and space, eliminating the cause of the transient voltages. This is accomplished by supplying a keying voltage from the keying circuit (paragraph 7*c*(5)) of —65 volts during mark and zero volts during space to the grids of the push-pull cathode followers. These voltages are followed approximately at the cathodes, which are tied directly to the grids of power amplifiers. During space, with the grids at zero, the power amplifiers conduct, while during mark the power amplifiers are biased below cutoff by the —65 volts. During space, when the tubes conduct, the voltage developed across the common cathode resistor, R-1045, acts as a degenerative bias so that the two tubes draw 120 ma total from the +500-volt supply, which is equivalent to the reduction caused by keying of the RFA.

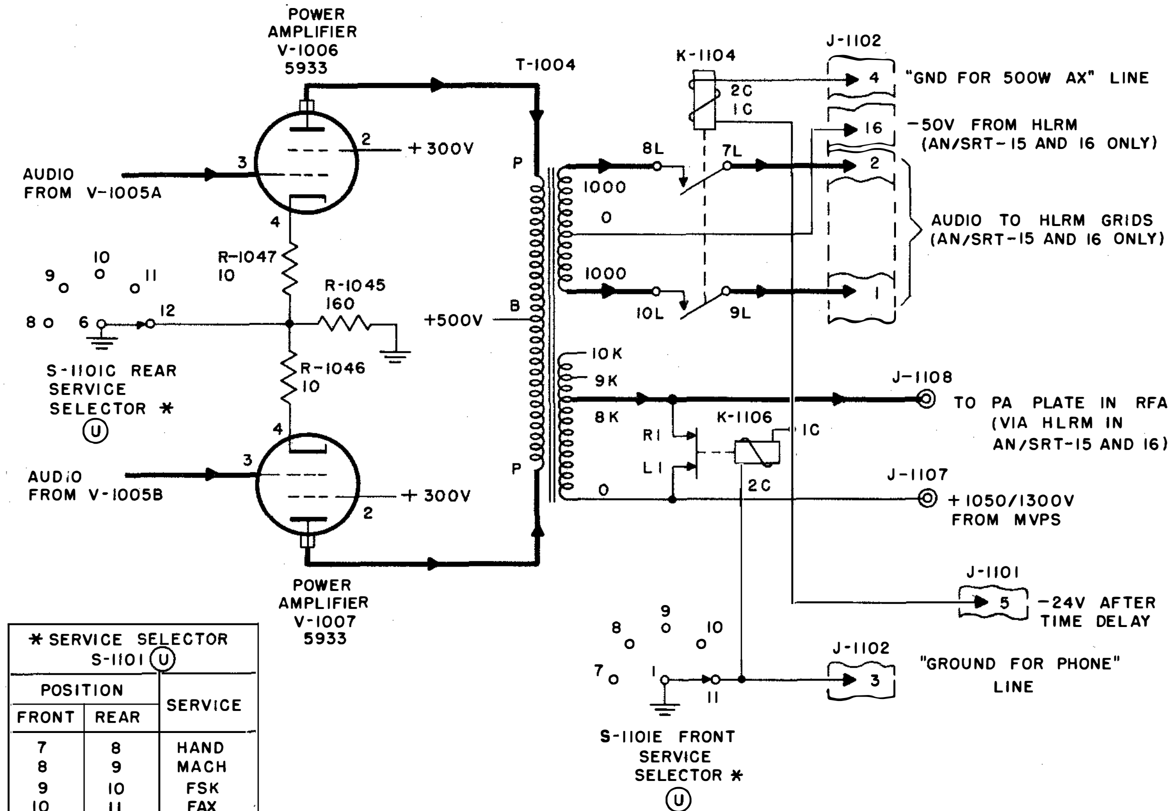
(*c*) POWER AMPLIFIERS V-1006 AND V-1007.—The control grids of the power amplifiers, V-1006 and V-1007, pins 3 (figure 2-78), are tied directly to the cathodes of the preceding cathode follower stage. As stated in the preceding discussion, the no-signal grid bias on the control grids of the power amplifiers is approximately —40 volts. With a screen voltage of +300 volts and a plate supply of +500 volts through the primary of modulation transformer T-1004, this value of bias is such that this stage operates as a class AB_2 push-pull amplifier, which provides high power outputs with high plate efficiency and low distortion. With the SERVICE SELECTOR switch Ⓤ, S-1101, in the PHONE position, the common cathode resistor, R-1045, to ground is shorted out through contacts 6 and 12 of S-1101C rear. In the HAND and MACH positions, R-1045 is in the circuit, adding degeneration so the push-pull amplifiers operate at the proper current drain values required for the dumping action.

Modulation transformer T-1004 is provided with two secondaries: one, the 50-watt secondary, is used only during 100-watt operation of the transmitter group; the other, the 6-watt secondary, is used only during 500-watt operation. The output of the 6-watt secondary is connected through contacts 7L, 8L and 9L, 10L of energized relay K-1104 to grids of the amplifiers in the HLRM. Negative bias of 50 volts for the HLRM



✱SERVICE SELECTOR S-1101 Ⓤ	
POSITION	SERVICE
8	HAND
9	MACH
10	FSK
11	FAX
12	PHONE

Figure 2-77. Push-Pull Cathode Followers, V-1005A and V-1005B, Simplified Schematic



* SERVICE SELECTOR S-1101 Ⓤ		
POSITION		SERVICE
FRONT	REAR	
7	8	HAND
8	9	MACH
9	10	FSK
10	11	FAX
11	12	PHONE

Figure 2–78. Power Amplifiers V–1006 and V–1007, Simplified Schematic

grids is supplied from the HLRM through the center tap on the 6-watt secondary. K–1104 energizes from "–24 V after time delay" to the "ground for 500 W" AX line. Therefore, in the AN/SRT–14 (see Note in paragraph 10*e*(1)), and in the AN/SRT–15 and 16 in 100-watt operation, K–1104 is unenergized, and the output of the 6-watt secondary is open circuit. Unless relay K–1106 is energized, the 50-watt secondary of T–1004 is short-circuited by contacts L1, R1 of K–1106, and plate voltage (+1,050/+1,300 volts) is delivered through these contacts to the final amplifier in the RFA. In the AN/SRT–14, this plate voltage is delivered directly to the RFA, while in the AN/SRT–15 and 16, it is delivered to the RFA via a switch in the HLRM. With SERVICE SELECTOR switch Ⓤ S–1101 in the PHONE position, K–1106 is operated from ground through contacts 1 and 11 of S–1101E front to "–24 V after time delay". This source of ground potential is known as the "ground for phone" line and is also utilized in the control circuits of the RFA, MVPS, and HVPS. With K–1106 energized, the short is removed from the 50-watt secondary and the plate supply voltage to the RFA is amplitude-modulated by the 50-watt audio signal.

c. KEYING CIRCUIT.—In hand-key operation, the keying circuit accepts keying signals and produces signals which turn the carrier on and off. In machine key, keying signals are sent to the keying circuit from teletype or other machine-key equipment, which also turns the carrier on and off. In both hand-key and machine-key operation, an audio oscillator produces an audio signal for aural monitoring of the keying signal. In FSK operation keying signals are received by the keying circuit from machine-key equipment, and signals are produced that control the operation of the frequency-shift oscillator in the RFO, and the audio oscillator produces a signal to phase-modulate the carrier to eliminate selective fading effects. In phone operation the press-to-talk button on the phone sends keying signals to this circuit, which also produces signals to turn the carrier on and off. The keying circuit consists of the keying relay, K–1101, press-to-talk relay K–1107, buffer V–1015A, keying control V–1016, keying multivibrator V–1017, dumping cathode follower V–1015B, limiter V–1018, keyer V–1019, and audio oscillator V–1020. The outputs of the keying circuit and their functions are listed in table 2–16.

(1) KEYING INPUT CIRCUIT.—SERVICE SELECTOR switch Ⓤ S–1101A rear (figure 2–80) selects the keying input to the keying circuit. In hand-key and phone operation, the keying signals are introduced through the action of the keying relay, K–1101. With the LOCAL-REM switch Ⓧ S–1106 in the REM position, the keying line from a remote radiophone unit is connected to the keying relay through contacts 8F and 9F of S–1106. When a hand key is used, ground

TABLE 2–16. FUNCTIONS OF KEYING CIRCUIT OUTPUTS

OUTPUT	DELIVERED TO	FUNCTION
RF keying signal	Buffer in RFA and output of RFO	To key the carrier
FSK keying signal	FS oscillator in RFO	Control frequency of FSO
Keying signal to dumping circuit	LLRM	Load compensation for +500-volt power supply
200-cycle signal	FS oscillator in RFO	Phase-modulate the FSO
1,000-cycle signal	Sidetone amplifier in LLRM	Monitoring of keying signals

is put on the keying line when the key is down (mark) and removed when the key is up (space). The presence of ground on the keying line actually operates the antenna switching relay, K–1306 in the RFA, which, in turn, operates the keying relay, K–1101. A discussion of this action is found in paragraph 10*e*(2). For the purpose of this discussion, it serves to say that the keying relay, K–1101, follows the presence or absence of ground on the keying line. When in phone operation, the press-to-talk button also supplies ground to the keying line when it is depressed. If the phone is connected locally, S–1106 is in the LOCAL position and the ground from press-to-talk button or the key operates K–1107 from the well-filtered –12-volt d-c supply. With K–1107 operated, ground is fed to K–1101 through contacts 5L and 4L of K–1107, and contacts 7F and 9F of S–1106. The TEST KEY Ⓣ, S–1108, parallels the keying line so that the depressing of S–1108 also supplies a ground to operate K–1101. With SERVICE SELECTOR Ⓤ in FSK or FAX, the keying line is connected to the RFO output stage and the RFA buffer stage through contacts 16 and 6 or 11 and 6 of S–1101B rear. The purpose of this connection is covered in paragraph 7*c*(7).

Two gas tube voltage regulators, V–1021 and V–1022, supply a regulated –105-volt and a regulated +105-volt supply respectively for use in the keying circuit. With –105 volts connected to 4R of K–1101, +105 volts is applied to contact 6R of K–1101. In hand-key operation, when the key is depressed (mark), K–1101 operates and +105 volts is connected through contacts 6R and 5R of K–1101, resistor R–1074, contacts 8 and 6 of S–1101A rear, contacts 10R and 8R of S–1107 Ⓥ in the OPER position and resistor R–1075 to ground. When the key is up (space), K–1101 is not energized and –105 volts is now applied through contacts 4R and 5R of K–1101 and through the same network as mentioned above. Resistors R–1074 and R–1075 act as a voltage divider, with the output, to the buffer stage following, being taken from their junction. The resultant is that mark and space voltages of +85 volts and –85 volts, respectively, are supplied at the grid of the buffer for hand-key operation. In phone operation the same operation takes place except that the press-to-talk button takes the place of the hand key with the result that the +85 volts appears at the grid of the buffer when press to talk is depressed and –85 volts when press to talk is released.

In machine-key and FSK operation, the source of keying signal is from a machine keyer (figure 2–79). In neutral keying this signal varies from zero for space to a minimum of +30 volts for mark, while in polar keying the signal varies between a negative signal for space and a positive signal for mark of equal amplitude (whose amplitude is a minimum of 30 volts). These signals are fed directly to the grid of the buffer stage through contacts 9 and 6, for MACH operation, or contacts 10 and 6, for FSK operation, of S–1101A rear and through contacts 10R and 8R of S–1107 in the OPER position.

A permanent mark or space signal can be produced at the grid of the buffer by the action of S–1107. Setting this switch to MARK connects +105 volts to the grid of the buffer through contacts 11R and 8R of S–1107. In SPACE, S–1107 connects –105 volts, through its contacts 9R and 8R, to the buffer grid.

In addition to providing keying voltages for the keying circuit, the keying relay also controls the action of the stand-by relay, K–3005, in the LVPS. The operation of K–3005, in turn, provides the "–24 V after standby" which controls the operation of the MVPS, HVPS, and HLRM, the latter two in the AN/SRT–15 and 16 only (see paragraphs 9*b*, 4*d*, 5*b*, 5*d* and 6*b*). The ground potential to operate K–3005 is furnished through the PUSH TO TURN switch, S–1110, and contacts 3R and 2R of energized K–1101. In hand-key operation only, the action of K–1101 in controlling relay K–3005 is bypassed by a permanent ground supplied for the stand-by relay line through contacts 1 and 7 of SERVICE SELECTOR switch Ⓤ S–1101A front. As the power supplies controlled by K–3005 cannot follow the keying signals, this ground keeps them energized at all times. In other modes of transmission, the transmitter cannot go on the air unless K–1101 is energized, supplying the ground to operate K–3005. In machine-key, FSK

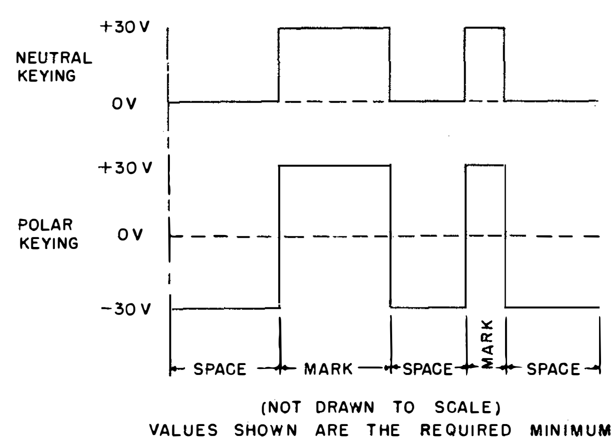
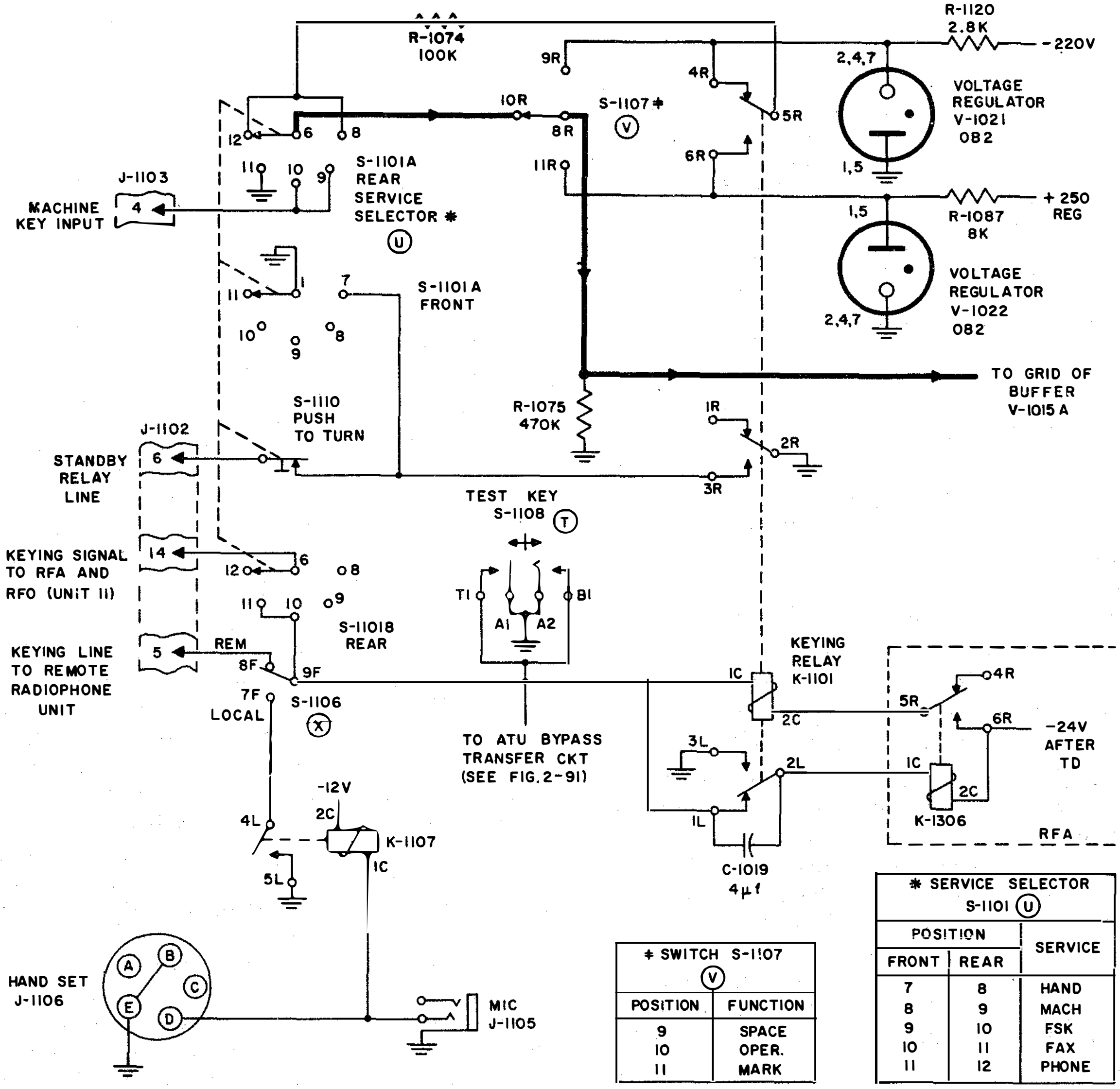


Figure 2–79. Machine Keying Input Signals, Voltage Wave Forms



+ SWITCH S-1107 (V)	
POSITION	FUNCTION
9	SPACE
10	OPER.
11	MARK

* SERVICE SELECTOR S-1101 (U)		
POSITION		SERVICE
FRONT	REAR	
7	8	HAND
8	9	MACH
9	10	FSK
10	11	FAX
11	12	PHONE

Figure 2–80. Keying Input Circuit, Simplified Schematic

and facsimile transmission, a ground is supplied over the keying line from the remote radiophone unit that energizes K–1101 and provides a "standby-operate" control from the remote radiophone unit. In phone operation, K–1101 is operated only when the press-to-talk button is depressed, either locally or remotely. This means that the power supplies controlled by K–3005, which, in turn, is controlled by K–1101, are on, in phone operation, only when press to talk is depressed.

(2) BUFFER V–1015A. — The buffer, V–1015A (figure 2–81), is a cathode-follower stage whose purpose is to isolate the action of the keying control and the keying multivibrator, which follow, from the keying input signals. The cathode of V–1015A is power biased to –40 volts by the voltage-divider action of R–1083, R–1082, and R–1079 from the regulated +105 volts to the regulated –105 volts. The keying voltages for the different modes of operation as defined in the previous paragraphs are connected to the grid, pin 2, of V–1015A and are reproduced approximately at the cathode, pin 3, with the following exception: because of the –40 volts power bias on the cathode, any negative keying signals applied to the grid larger than approximately 45 volts will drive V–1015A to cutoff, with the resultant that the maximum amplitude of a negative keying signal appearing at the cathode is about 40 volts.

(3) KEYING MULTIVIBRATOR V–1017 AND KEYING CONTROL V–1016.—Keying multivibrator V–1017 (figure 2–81) is a flip-flop multivibrator. In the key-up (space) condition V–1017B conducts, causing current to flow through the common cathode resistor R–1089, the voltage developed across R–1089 being sufficient to cut off V–1017A. Keying control V–1016B assures that V–1017B conducts and V–1017A is cut off during space. The plate of V–1016B is connected to the junction of R–1085 and R–1084 in the grid circuit of V–1017A. Disregarding the action of V–1016B, this

would be at about +5 volts during space with V–1017B conducting. The cathode of V–1016B during neutral keying is tied to the cathode of the buffer through contacts 2 and 1 of NEUT.-POLAR switch Ⓡ S–1105 in the NEUT. position. During space this point is at +4 volts for neutral machine keying or –40 volts for hand keying. As these values are at or below the normal +5 volts to which the plate of V–1016B is tied, V–1016B conducts, effectively tying the junction of R–1085 and R–1084 to the space voltage appearing at the buffer cathode. This means that the grid circuit of V–1017A, during space, is at a lower potential than the grid circuit of V–1017B, causing the desired condition of having V–1017A cut off and V–1017B conducting. The same action occurs in polar keying, except that keying control V–1016B is connected so that its cathode goes to about +4 volts when the grid of the buffer is at –30 volts. This is accomplished by connecting the cathode of V–1016B to the tap of potentiometer R–1082 through contacts 2 and 3 of S–1105 in the POLAR position. This potentiometer is known as the POLAR SPACE control and is part of a voltage divider consisting of R–1083 and R–1082 connected from regulated +105 volts to the cathode of the buffer. In space, with a –30-volt keying signal on the grid, the cathode will be about –27 volts. The setting of R–1082 will be such that to tap will be about +4 volts. Determination of the exact setting of R–1082 is covered in a succeeding paragraph covering conditions met when the keying signal changes from mark to space. With the multivibrator in the space condition, there is +100 volts on the plate on V–1017B and +235 volts on the plate of V–1017A.

As the keying signal changes from space to mark the potential of the buffer cathode starts to rise. As it reaches +5 volts, in neutral keying, or –27 volts in polar keying, keying control V–1016B no longer conducts and has no effect on the grid of V–1017A, which rises to about +10 volts. This still is not high enough to overcome the bias potential set up in the common cathode resistor, R–1089. As the mark potential rises higher, keying control V–1016A comes into action. The cathode of V–1016A is tied to the grid of V–1017A, which is at +10 volts. The plate of V–1016A is connected to the tap of potentiometer R–1079, which is the cathode resistor in the buffer circuit with one end tied to the buffer cathode and the other connected to regulated –105 volts. This potentiometer is known as the NEUTRAL-POLAR-MARK control. For keying control V–1016A to conduct, its plate must be +10 volts or higher. As

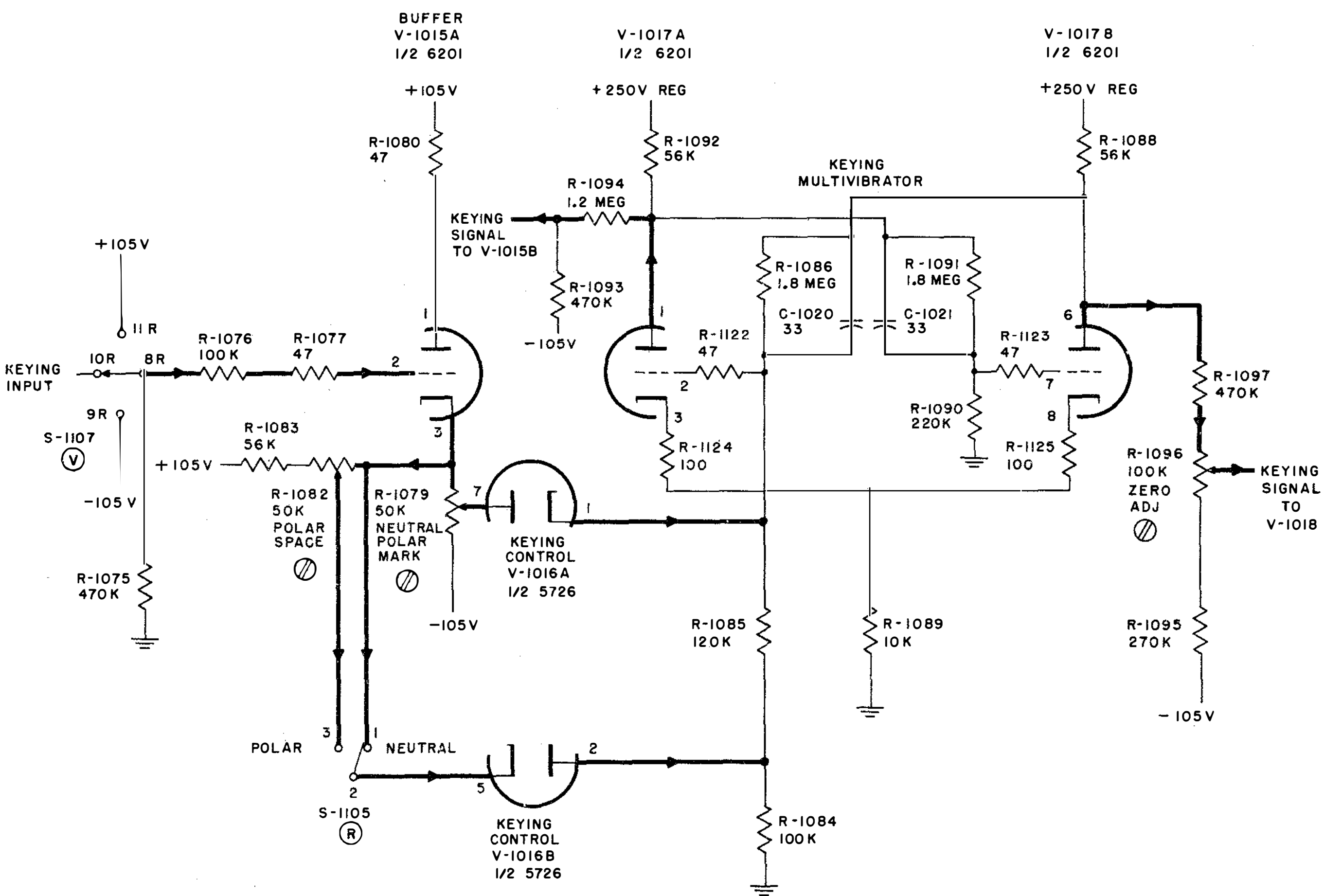


Figure 2–81. Cathode Follower V–1015A, Keying Control V–1016 and Keying Multivibrator V–1017B, Simplified Schematic

the mark voltage increases at the cathode of the buffer, the tap of R–1079 will reach +10 volts and V–1016A will conduct. As V–1016A conducts, it effectively ties the grid of V–1017A to the tap of R–1079. The tap of R–1079 is set so that as the mark signal reaches +30 volts at the grid of the buffer, the voltage at the tap, hence at the grid of V–1017A, will be sufficient to overcome the bias potential on the common cathode resistor R–1089, causing V–1017A to conduct. As V–1017A conducts, its plate voltage decreases. This decrease is coupled to the grid of V–1017B through the R-C network C–1021 and R–1091, reducing conduction in V–1017B, which increases the plate voltage of V–1017B. This increase is coupled through C–1020 and R–1086 to the grid of V–1017A, making the grid more positive and thereby increasing conduction in V–1017A still further. This action is rapidly cumulative and continuous until V–1017B is cut off and V–1017A is saturated. The multivibrator remains in this stage (V–1017B cut off, V–1017A conducting) as long as the positive (mark) keying signal appears at the buffer. The rapid change of voltage has been passed to the grid of V–1017A by C–1020. Now, with the keying signal remaining positive (mark), the grid of V–1017A returns to the steady state value of approximately +24 volts as C–1020 charges through the R-C network. This minimum grid voltage is still sufficient to keep V–1017A conducting heavily and V–1017B cut off. In mark the plate of V–1017B is at +235 volts and the plate of V–1017A is at +70 volts.

As the keying voltage changes from mark to space, for the multivibrator to return to the space condition described previously, the potential of the grid of

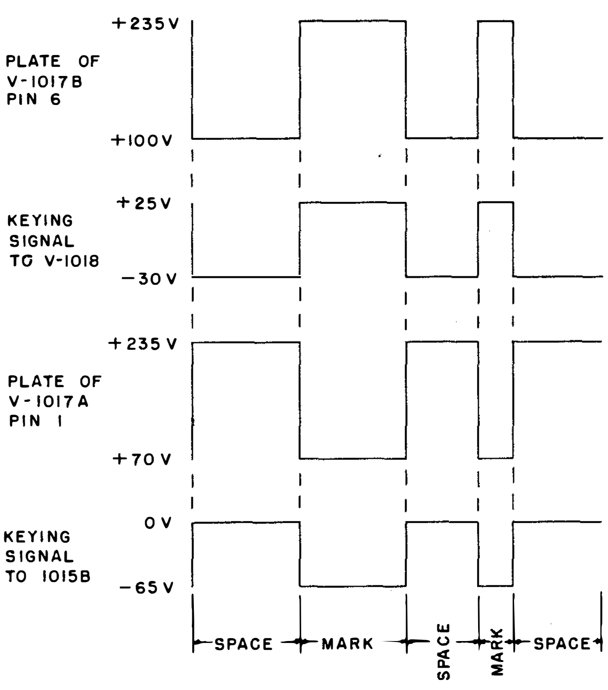


Figure 2–82. Keying Multivibrator Voltage Wave Forms, for Hand-Key and Machine-Key Operation

V–1017A must be lowered enough to cause reduction in the current flow of V–1017A, which will cause the resulting cumulative flip-flop. During the mark condition, the junction of R–1085 and R–1084, to which the plate of keying control V–1016B is connected, returns to about +11 volts. Therefore, when the keying signal reduces to a point where the cathode of V–1016B, which is tied to the cathode of the buffer in neutral keying and to the POLAR SPACE control R–1082 in polar keying, goes below +11 volts, V–1016B conducts, lowering the grid potential of V–1017A. In neutral keying, when the keying signal reduces to about +7 volts, V–1016B will conduct enough to lower the V–1017A grid below the saturation point and the flip flop will take place. In polar keying, the POLAR SPACE control R–1082 is set so that when the negative (space) keying signal reaches about −28 volts, the keying control, V–1016B, conducts enough to lower the grid potential of V–1017A below the saturation value and the multivibrator returns to the space condition.

(4) KEYING MULTIVIBRATOR OUTPUTS. — The keying multivibrator, V–1017, has two outputs, one developed in the plate circuit of V–1017A, and the other, which is out of phase with reference to the first, developed in the plate circuit of V–1017B. Figure 2–82 shows the voltage wave forms at the two plates of V–1017 and the output voltages developed from them. The keying voltage obtained in the plate circuit of V–1017A is fed to the dumping cathode follower for use in the dumping function of the push-pull cathode followers in the audio amplifier chain of the LLRM to compensate for the reduction in load on the +500-volt power supply in space. The keying voltage developed in the plate circuit of V–1017B is fed to the limiter stage, thence to the keyer stage. In hand-key, machine-key, and phone operation, this keying voltage is limited to one value and is fed jointly to the buffer in the RFA and to the output stage of the RFO for the keying of the carrier. In FSK operation, this keying voltage is limited to a different value and is fed to the frequency-shift oscillator in the RFO.

(*a*) KEYING SIGNAL TO DUMPING CIRCUIT.—A keying signal of zero volts for space and −65 volts for mark is delivered to the dumping cathode follower, V–1015B. This range of voltages is obtained from a voltage divider connected from the plate of V–1017A through resistors R–1094 and R–1093 to regulated −105 volts. The output is taken from the junction of R–1094 and R–1093. In space, the plate of V–1017A is +235 volts and in mark it is +70 volts.

(*b*) KEYING SIGNAL TO LIMITERS AND KEYER.—A keying signal of approximately +25 volts for mark and −35 volts for space is delivered to the limiters and the keyer stages following. This range of voltages is obtained from a voltage divider from the plate of V–1017B, through R–1097, ZERO ADJ. control R–1096, and R–1095 to regulated −105 volts. In mark, the plate of V–1017B is +235 volts and in space it is +100 volts. The output is taken from the tap of the

ZERO ADJ. control R–1096, which is set so the output space voltage is about –30 volts, which will make the output mark voltage about +25 volts. This is made adjustable to compensate for variances in the voltages appearing at the plate of V–1017B because of variances in characteristics of tubes that might be used in this application.

(5) DUMPING CATHODE FOLLOWER.—Keying signals to the dumping circuit are fed to the dumping cathode follower, V–1015B (figure 2–83), before being passed on to the push-pull cathode followers. The action of the dumping cathode follower is to provide a low impedance to the input to the push-pull cathode follower to reduce the time constant so the waveshape is not destroyed. The signal is fed to the grid of V–1015B from the multivibrator and controlled by the waveshaping capacitor, C–1022. R–1078 and R–1081 are parasitic suppressors. The output is taken directly from the cathode of V–1015B, with the voltages following closely to the input, which is zero volts for space and –65 volts for mark. The keying signals are connected to the push-pull cathode followers through SERVICE SELECTOR switch Ⓤ S–1101E rear in the HAND and MACH positions. In FSK and FAX operation, the transmitter group is "on the air" continuously; thus no load compensation is required. In phone operation, load compensation is not required as the +500-volt supply is turned off when press to talk is up by the action of the keying relay, K–1101 (paragraph 7*c*(1)). A complete discussion of the dumping function is given in paragraph 7*b*(7)(*b*).

(6) LIMITER V–1018.—The keying signal from V–1017B, which is +25 volts for mark and –30 volts for space, is delivered to the limiter, V–1018A and V–1018B (figure 2–84). The keying signal is applied across a value of capacitance that is selected by the KEYING RATE switch Ⓢ, S–1109. The time constant involved in charging and discharging this capacitance gives the required rise and decay time to the keying signal waveshape. The faster the keying rate, the shorter is the decay and rise time, hence the smaller the value of capacitance. For any given keying rate, the decay and rise time of the pulses when the transmitter is in either HAND or MACH, c-w transmission should be longer than for FSK in order that the bandwidth of the side bands transmitted be kept to a minimum. Therefore, in HAND and MACH positions of the SERVICE SELECTOR Ⓤ, a second set of waveshaping capacitors comprised of C–1046, C–1047, C–1048, and C–1049 is connected in parallel, to lengthen the time constant, with the set of capacitors comprised of C–1023, C–1024, C–1025, and C–1026. The connection is made through S–1101F front contacts 7 and 1 for HAND or contacts 8 and 1 for MACH operation. Table 2–17 shows the value of capacitance and the capacitors employed for the various services and the different keying rates.

The plate, pin 7, of limiter V–1018A is tied to the tap of a potentiometer, R–1098. In FSK operation R–1098, known as the (–) LIMIT KEYER OUT control, is

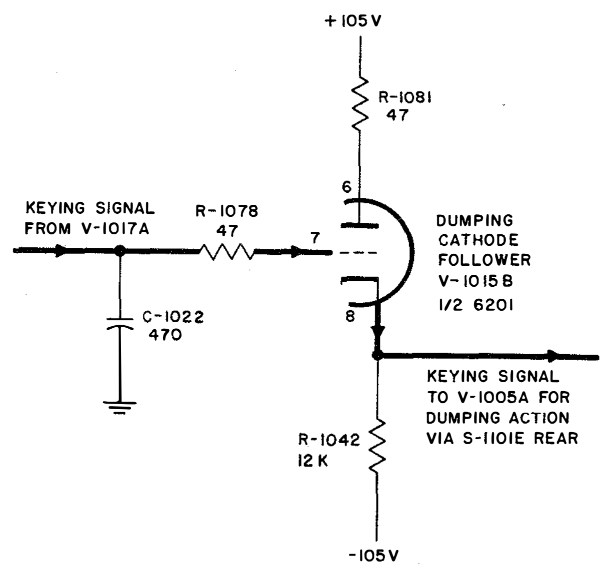
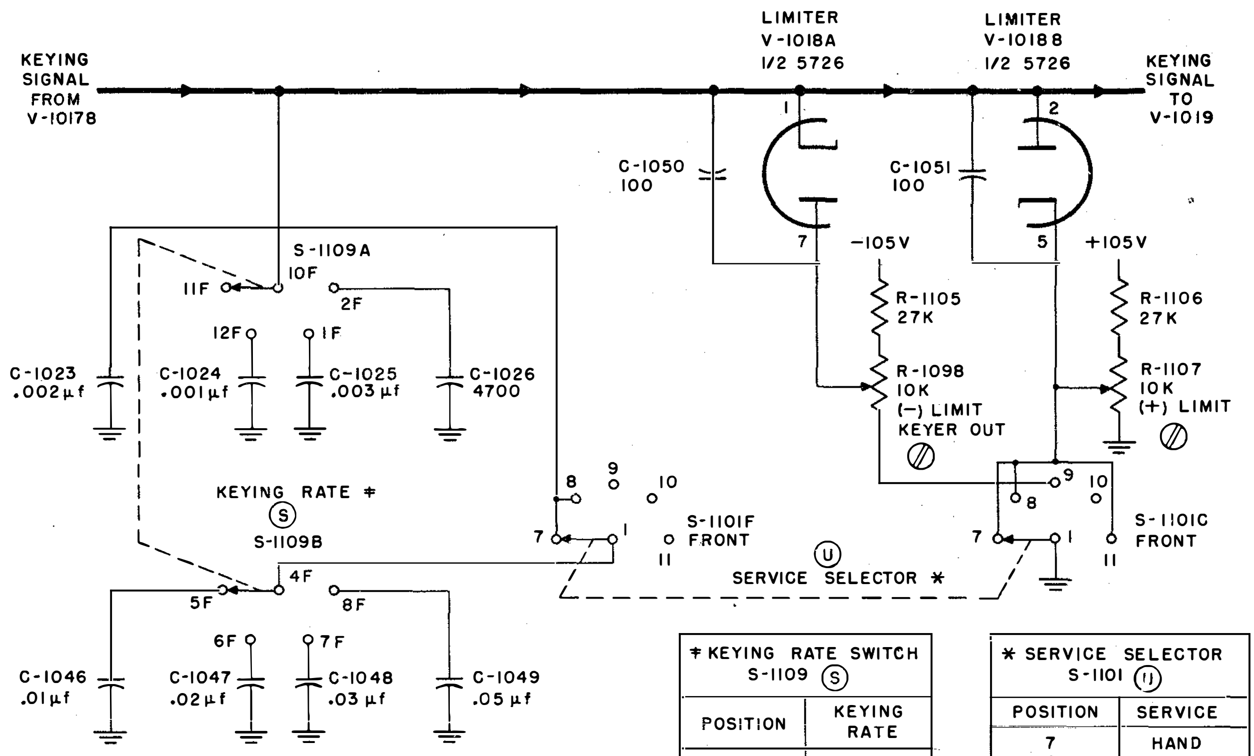


Figure 2–83. Dumping Cathode Follower, Simplified Schematic

TABLE 2–17. KEYING RATE SWITCH Ⓢ S–1109

SERVICE	KEYING RATE	CAPACITORS SELECTED	TOTAL CAPACITANCE
HAND or MACH	Teletype (23 dots/sec)	C–1023, C–1026, C–1049 in parallel	0.0567 µf
	Multiplex (60 dots/sec)	C–1023, C–1025, C–1048 in parallel	0.035 µf
	200 words per minute	C–1023, C–1024, C–1047 in parallel	0.023 µf
	400 words per minute	C–1023, C–1046 in parallel	0.012 µf
FSK or PHONE	Teletype (23 dots/sec)	C–1023, C–1026 in parallel	0.0067 µf
	Multiplex (60 dots/sec)	C–1023, C–1025 in parallel	0.005 µf
	200 words per minute	C–1023, C–1024 in parallel	0.003 µf
	400 words per minute	C–1023	0.002 µf

part of a voltage-divider network from regulated –105 volts through R–1105, R–1098 and contacts 9 and 1 of SERVICE SELECTOR switch Ⓤ, S–1101C front, to ground. R–1098 is adjusted for –10 volts at the tap. Therefore, any negative (space) keying signals in FSK operation are clipped at a maximum of 10 volts by the action of the limiting diode, V–1018A. In the other modes of operation the ground is removed from R–1098 by the action of the SERVICE SELECTOR switch Ⓤ, S–1101C front, and the plate of V–1018A is tied to –105 volts. As the maximum negative signal applied is 30 volts, no limiting action takes place and the negative signal applied to the keyer stage then is approximately 30 volts.



ǂ KEYING RATE SWITCH S-1109 (S)	
POSITION	KEYING RATE
5F, 11F	400 WPM
6F, 12F	200 WPM
7F, 1F	MLTPX
8F, 2F	TT

✱ SERVICE SELECTOR S-1101 (U)	
POSITION	SERVICE
7	HAND
8	MACH
9	FSK
10	FAX
11	PHONE

Figure 2–84. Limiter V—1018, Simplified Schematic

In hand-key, machine-key and phone operation, the cathode, pin 5, of limiter V–1018B is grounded through SERVICE SELECTOR switch (U) S–1101C front, through contacts 7 and 1 for HAND, 8 and 1 for MACH, and 11 and 1 for PHONE. In FSK operation, the cathode of V–1018B is connected to the tap of potentiometer R–1107, which is part of a voltage divider from regulated +105 volts, through R–1106, R–1107 to ground. R–1107, known as the (+) LIMIT control, is adjusted for +10 volts at the tap and the action of V–1018B clips positive (mark) keying signals at +10 volts. Therefore, positive (mark) signals in hand-key, machine-key and phone operation are clipped at zero, and they are clipped at +10 volts in FSK operation. Capacitors C–1050 and C–1051 are bypasses for the small amount of r-f energy that is picked up in the circuit wiring.

(7) KEYER V–1019.—The keyer, V–1019, is a cathode follower stage to provide a low impedance keying output supply (figure 2–85). The keying signals, as clipped by the limiters, are fed to the grids of the keyer, V–1019, which is a twin triode operating in parallel, through parasitic suppressors R–1099 and R–1100. The cathode load is made up of R–1103 and R–1102, which constitute a voltage divider with the output taken from the junction of the two. When the zero voltage mark keying signal is applied to the grid of the keyer, the cathode is at about +2 volts. However, the mark signal as delivered to the buffer of the RFA should not go above zero; hence the output is taken at the junction of R–1103 and R–1102 to reduce the mark voltage from +2 volts to zero.

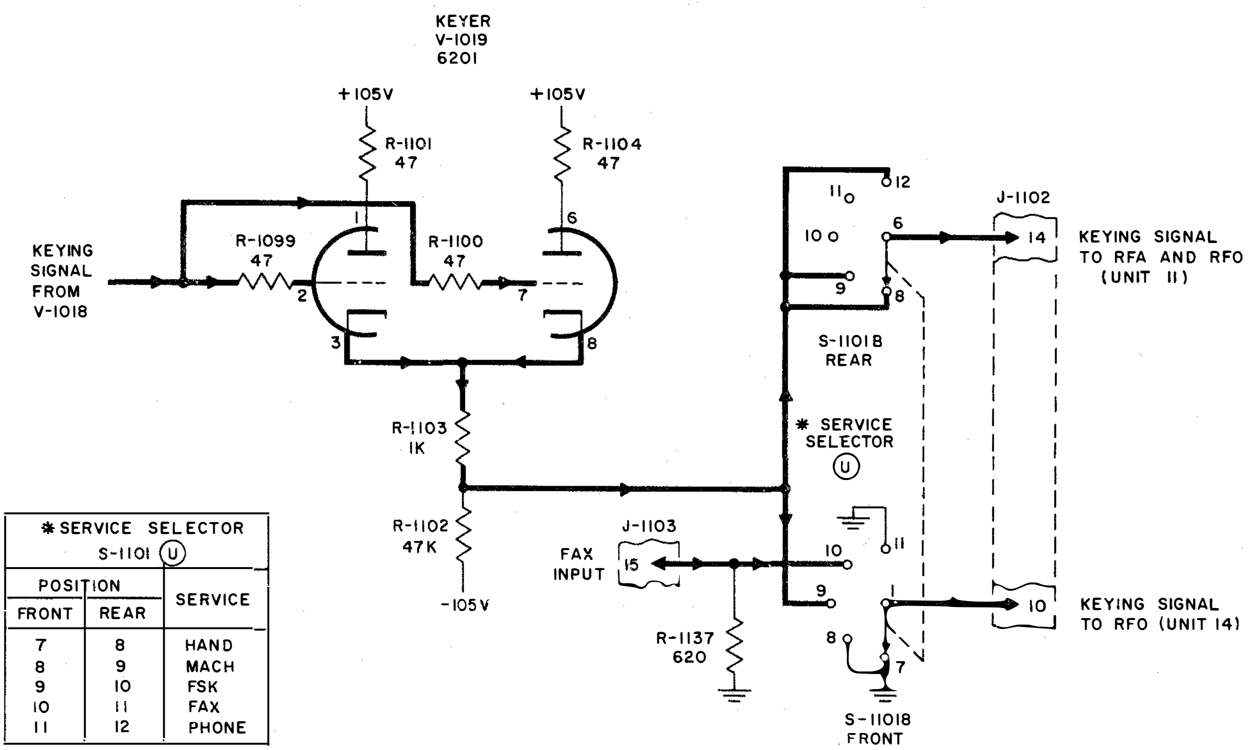
The output of zero volts for mark and —30 volts for space is the same in hand-key, machine-key, and phone operation and is used for the same purpose, namely, to cut off the buffer in the RFA and cut off the output stage of the RFO in the "key-up" (space) condition for the two keying modes or the press-to-talk "up" in the phone operation. Both the buffer in the RFA and the output of the RFO are keyed off to assure that the "key-up" radiation from the transmitter group is below the minimum allowable level of 400 micromicrowatts. In FSK operation, the output from the keyer, which is +10 volts for mark and —10 volts for space, is fed to the RFO to frequency-modulate the frequency-shift oscillator in the RFO.

SERVICE SELECTOR switch (U) S–1101B rear controls the keying input to the buffer in the RFA and the output stage of the RFO. In the HAND, MACH, and PHONE positions, the keying input is the output of the keyer as noted above. In HAND, the connection is through contacts 8 and 6 of S–1101B rear, in MACH through contacts 9 and 6, and in PHONE through 12 and 6. In FSK and FAX the keying input to the RFA and RFO is connected to the keying line as noted in paragraph 7*c*(1). As long as the transmitter is in the "operate" condition by having the keying line closed to ground, this ground is connected through contacts 10 and 6 or 11 and 6 of S–1101B rear to the RFA buffer and RFO output stage, keeping the transmitter "on the air" continuously. At the instant the transmitter is placed in "stand-by" by opening the keying line, there is —24 volts on the keying line, through contacts 5R and 6R of antenna transfer relay K–1306 before it releases. This —24 volts will instantaneously cut off the RFO output and RFA buffer, to prevent arcing on contacts of K–1306 as it transfers the antenna lead from the RFA output to the receiver input (see paragraph 10*e*(2)).

The input to the frequency-shift oscillator in the RFO is connected through SERVICE SELECTOR switch Ⓤ S–1101B front. In FSK this is the output of the keyer as described previously and is made through contacts 9 and 1 of S–1101B front. In FAX operation, the signal from the facsimile equipment is connected directly to the frequency-shift oscillator of the RFO through contacts 10 and 1 of S–1101B front. The other positions of this switch are grounded as the frequency-shift oscillator is not employed in hand-key, machine-key, or phone operations.

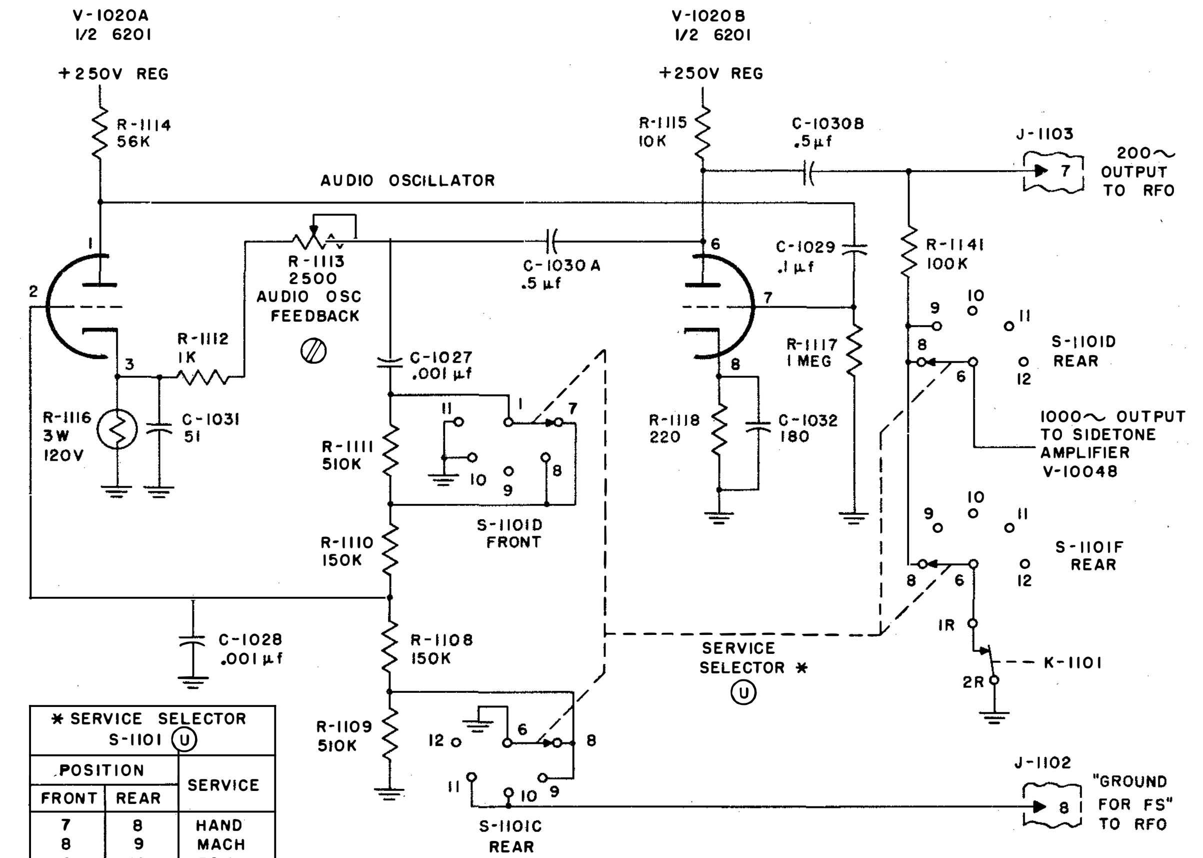
(8) AUDIO OSCILLATOR V–1020.—The audio oscillator, V–1020, figure 2–86, is a Wien-bridge oscillator with two outputs. In FSK operation, the output is a 200-cycle signal whose purpose is to phase-modulate the frequency-shift oscillator in the RFO, whenever it is necessary to prevent selective fading. Radio waves of slightly different frequencies occasionally are affected in different ways by atmospheric conditions. In the case of modulated transmission involving side-band frequencies, the carrier and the side-band components may not be propagated in the same relative amplitude at the antenna. This effect, known as selective fading, causes distortion in the signal. Phase-modulating the carrier creates a narrow band of carrier frequencies, some of which may be expected to overcome the adverse conditions causing the fading, thus insuring better signal reception. The 200-cycle frequency is sufficiently high with respect to the highest keying rates to insure sufficient sampling of the keying signals over the band of carriers established. The amplitude of the 200-cycle signal from the audio oscillator is sufficient to produce a one-radian phase shift in the carrier. This amount of shift can be controlled between zero and one radian by a control mounted on the front panel of the RFO (see below). In hand-key and machine-key operation, the audio oscillator produces a 1,000-cycle signal during the key down (mark) condition that is fed to the sidetone amplifier in the audio chain for monitoring purposes.

Two basic conditions must be fulfilled to sustain oscillation. A feedback signal must be developed that is large enough to overcome the losses in the grid circuit and be in phase with the signal on the grid. The selection circuit for the feedback is a Wien bridge. Signals appearing at the plate of V–1020A are coupled through C–1020 to the grid of V–1020B, which is an amplifier and phase inverter. The signals appearing at the plate of V–1020B, being shifted 180° in phase with respect



* SERVICE SELECTOR S-1101 Ⓤ		
POSITION		SERVICE
FRONT	REAR	
7	8	HAND
8	9	MACH
9	10	FSK
10	11	FAX
11	12	PHONE

Figure 2–85. Keyer V—1019, Simplified Schematic



* SERVICE SELECTOR S-1101 (U)		
POSITION		SERVICE
FRONT	REAR	
7	8	HAND
8	9	MACH
9	10	FSK
10	11	FAX
11	12	PHONE

Figure 2—86. Audio Oscillator V—1020, Simplified Schematic

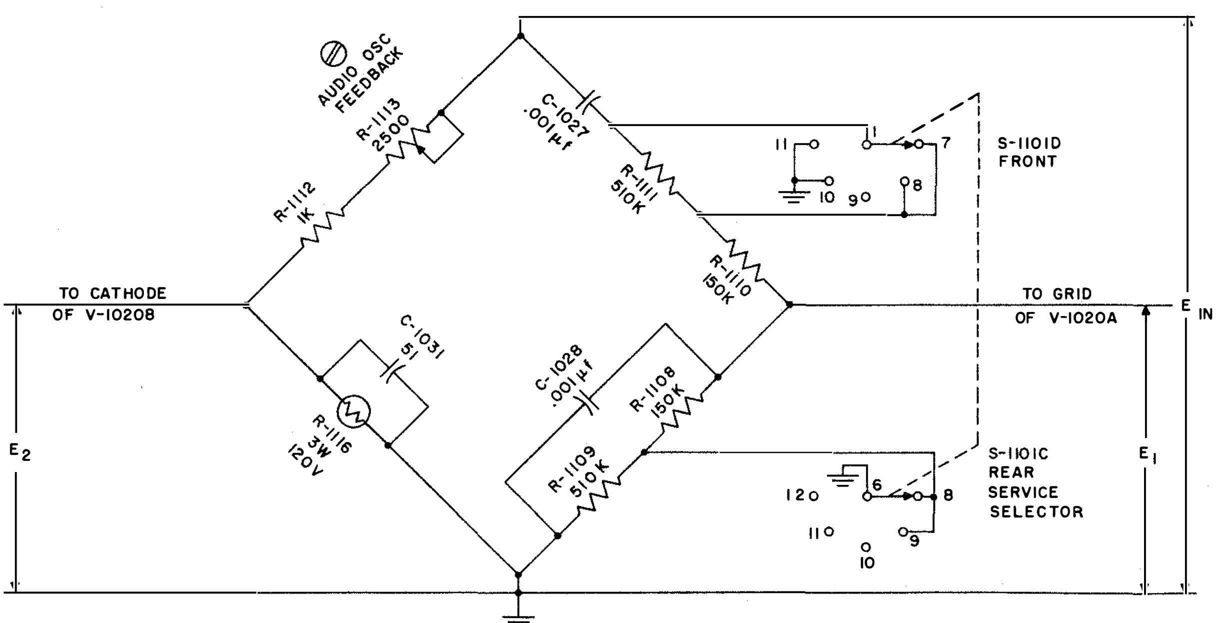


Figure 2—87. Wien Bridge Circuit, Simplified Schematic

to the grid, is now in phase with the signal on the grid of V–1020A. This signal is coupled to the bridge circuit through capacitor C–1030A.

Figure 2–87 shows the Wien bridge circuit. E_{IN}, the output of V–1020B, is the voltage applied across the bridge circuit. This voltage is developed across both the resistive half of the bridge (R–1113, R–1112, and R–1116) and the reactive half of the bridge. In FSK operation, the reactive half consists of C–1027, R–1111, R–1110, R–1108, R–1109, and C–1028. With the SERVICE SELECTOR switch Ⓤ, S–1101, in HAND or MACH position, R–1111 is shorted out through contacts 1 and 10 or 11 of S–1101D front, and R–1109 is grounded through contacts 6 and 8 or 9 of S–1101C rear, so that, in hand key or machine key, the reactive half of the bridge is composed of C–1027, R–1110, R–1108, and C–1028. A degenerative feedback voltage, E_2, is obtained across R–1116 in the resistive half of the bridge as R–1116 is the cathode resistor for V–1020A. This voltage is in phase with E_{IN}, which, in turn, is in phase with the signal on the grid of V–1020A. A regenerative feedback signal, E_1, obtained in the reactive half of the bridge, is applied to the grid of V–1020A at the junction of R–1110 and R–1108. At a frequency determined by the components of the reactive half of the bridge the regenerative voltage, E_1, will be in phase with the signal at the grid of V–1020A and concurrently will be at a maximum amplitude that is equal to or slightly larger than the degenerative voltage, E_2. This relative amplitude between E_1 and E_2 is controlled by the setting of AUDIO OSC. FEEDBACK control R–1113, which directly determines the amplitude of E_2. At any other frequency E_2 will be out of phase and at a smaller amplitude, so the degenerative voltage, E_1, which is independent of frequency, will suppress these frequencies. The resonant frequency of the bridge, when all the components in the reactive half are employed, is 200 cycles, which is the case for FSK operation. In hand-key and machine-key operation, with R–1111 and R–1107 removed by the above-described action of S–1101, the resonant frequency becomes 1,000 cycles. In FAX and phone operation, the regenerative feedback in the reactive half of the bridge is grounded through contacts 1 and 10 or 11 of S–1101D front, disabling the circuit.

In the cathode circuit of V–1020A, a 3-watt, 120-volt ballast lamp, R–1116, is used instead of a resistor to stabilize the amplitude of oscillation. If, for some reason, the amplitude tends to increase, the current through the lamp also tends to increase. This current increases the temperature of the lamp filament and its resistance becomes larger. This larger value of resistance in the bridge circuit previously described means that the degenerative feedback voltage is increased, thus reducing the gain of V–1020A and thereby holding the output voltage at a nearly constant amplitude. Keeping the amplitude of the voltage wave form small means that the oscillator tube, V–1020, operates in the linear portion of its characteristics, assuring that the output will be sinusoidal. C–1031 acts as an r-f bypass.

The output of the audio oscillator, V–1020, is taken from the plate of V–1020B and coupled through C–1030B. In FSK operation, the 200-cycle signal is fed to a voltage divider consisting of R–1119 and the F.S.K. PHASE MOD. control Ⓛ, R–2955, the latter being located in unit 14 of the RFO (see figure 2–11). R–2955 is a potentiometer with a built-in "on-off" switch, S–2997. This voltage divider action is such that the signal taken from the movable arm of R–2955 and fed to the frequency-shift oscillator (paragraph 2*f*(3)) can be adjusted to produce from zero to one radian in phase shift of the output of the frequency-shift oscillator, varying around the fundamental carrier frequency at a rate of 200 cycles per second. In hand-key or machine-key operation, the 1,000-cycle output is coupled through limiting resistor R–1141, contacts 6 and 8 or 9 of SERVICE SELECTOR switch Ⓤ S–1101D rear to the grid of the sidetone amplifier, V–1004B, in the audio chain. In hand-key operation, a parallel connection, through contacts 8 and 6 of S–1101F rear, is made to keying relay K–1101 contact 1R. In space, K–1101 is not energized and 1,000-cycle output is grounded through contacts 2R and 1R of K–1101. In mark, K–1101 energizes and this ground is removed, allowing the signal to be applied to V–1004B. The resultant output is a 1,000-cycle signal that follows the mark keying signals. The sidetone amplifier, V–1004B, amplifies this signal and presents it to the sidetone jack, J–1104, and the remote radiophone unit for monitoring purposes.

In addition to controlling the components of the Wien bridge circuit, S–1101C rear, when in FSK or FAX position, supplies a ground to the RFO known as the "ground for FS" line (see paragraph 2*g*(1)).

d. LOCAL-REM. SWITCH Ⓧ S–1106.—To enable the transmitter to be controlled either locally at the location of the transmitter group or from a remote position, a LOCAL-REM. switch Ⓧ, S–1106, is provided. This switch is a seven-pole, two-position, one-section rotary wafer switch, which is shown in simplified form in figure 2–88. The action of the various poles of S–1106 is covered in the discussion of the associated circuits that they control (see paragraphs 4*c*, 7*b*(1) and 7*c*(1)). For the purposes of uniting the functions required to switch from local to remote operation, table 2–18 is provided.

Four sets of contacts are employed to connect the a-c line to the master control relay, K–3001, in the LVPS to insure sufficiently low contact resistance for positive action of K–3001.

e. +250-VOLT REGULATED POWER SUPPLY.—A power supply is contained in the LLRM whose output is a regulated +250 volts, which is used in the critical keying and audio circuits of the LLRM and the RFO. This power supply consists of rectifier V–1009, regulator V–1010, regulator control V–1011, and voltage regulator V–1012.

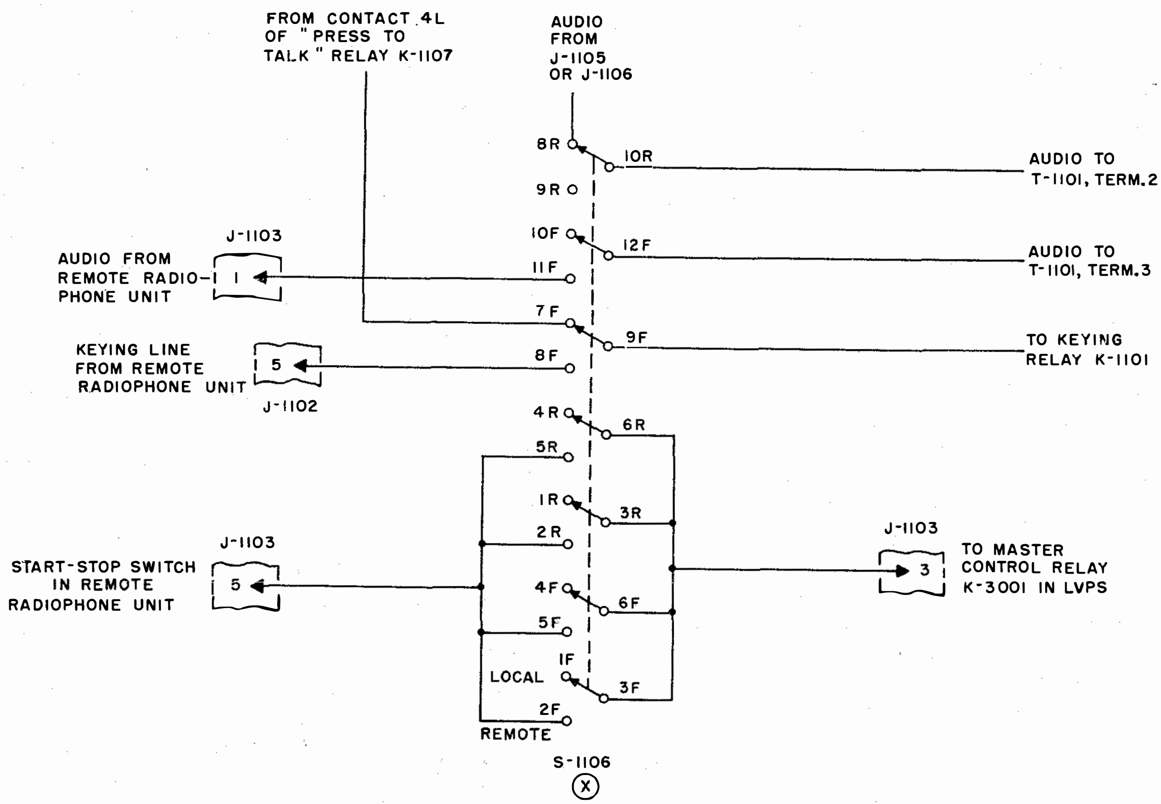


Figure 2—88. LOCAL-REM. Switch ⓧ S—1106, Simplified Schematic

TABLE 2—18. FUNCTIONS OF LOCAL-REM. SWITCH ⓧ S—1106

POSITION	CONTACTS	FUNCTION
REMOTE	2F, 5F, 2R, 5R and 3F, 6F, 3R, 6R	Connect "start-stop" switch in remote radiophone unit to master control relay K–3001 in LVPS.
REMOTE	8F and 9F	Connect keying line from remote radiophone unit to the keying relay K–1101.
REMOTE	11F and 12F	Connect audio from remote radiophone unit to audio transformer T–1003.
LOCAL	7F and 9F	Connect local press-to-talk line from HANDSET receptacle J–1106 or MIC. jack J–1105 to the keying relay K–1101.
LOCAL	8R and 10R	Connect audio from phone receptacle J–1106 or phone jack J–1105 to audio transformer T–1003.

(1) RECTIFIER V–1009.—Negative 110-volt, 60-cycle a-c power is applied to the +250-volt supply transformer T–1001 through fuse F–1001 (figure 2–89). This a-c power is supplied from the LVPS and is available after the MAIN POWER switch ⓡ, S–3004, ON button has been depressed (see paragraph 4*c*). Rectifier V–1009 is a conventional full-wave rectifier with plate voltage applied from terminals 3 and 5 of the secondary of T–1001. The supply has a ground return through the center-tap terminal 4 of T–1001. The output from V–1009 is filtered by L–1001 and C–1036. Resistors R–1055, R–1056, R–1057, and R–1058 are a bleeder network for C–1036.

(2) REGULATOR V–1010.—Regulator V–1010 is effectively a variable resistance in series with the power supply. When the output voltage of the power supply tends to rise above the +250 volts, apparent resistance of V–1010 increases, and when the output voltage tends to decrease below +250 volts, the resistance of V–1010 lowers. Thus the regulator opposes the changes in the output voltage owing to such causes as line voltage and current drain changes. The regulator control, V–1011, provides the controlling action of the apparent resistance of V–1010 as explained in the following paragraph. The regulator is a dual-triode (6AS7G) with the two sections operated in parallel to provide sufficient current capacity to meet the entire drain for the power supply. Resistors R–1059 and R–1060 are parasitic suppressors in the plate circuits of V–1010. Excessive cathode-to-filament potential on V–1010 is avoided by tying the center tap, terminal 4, of the secondary of filament transformer T–1002 serving V–1010 to the +250-volt output of the power supply. Similarly, the center tap of the secondary of T–1002, providing filament voltage to several other

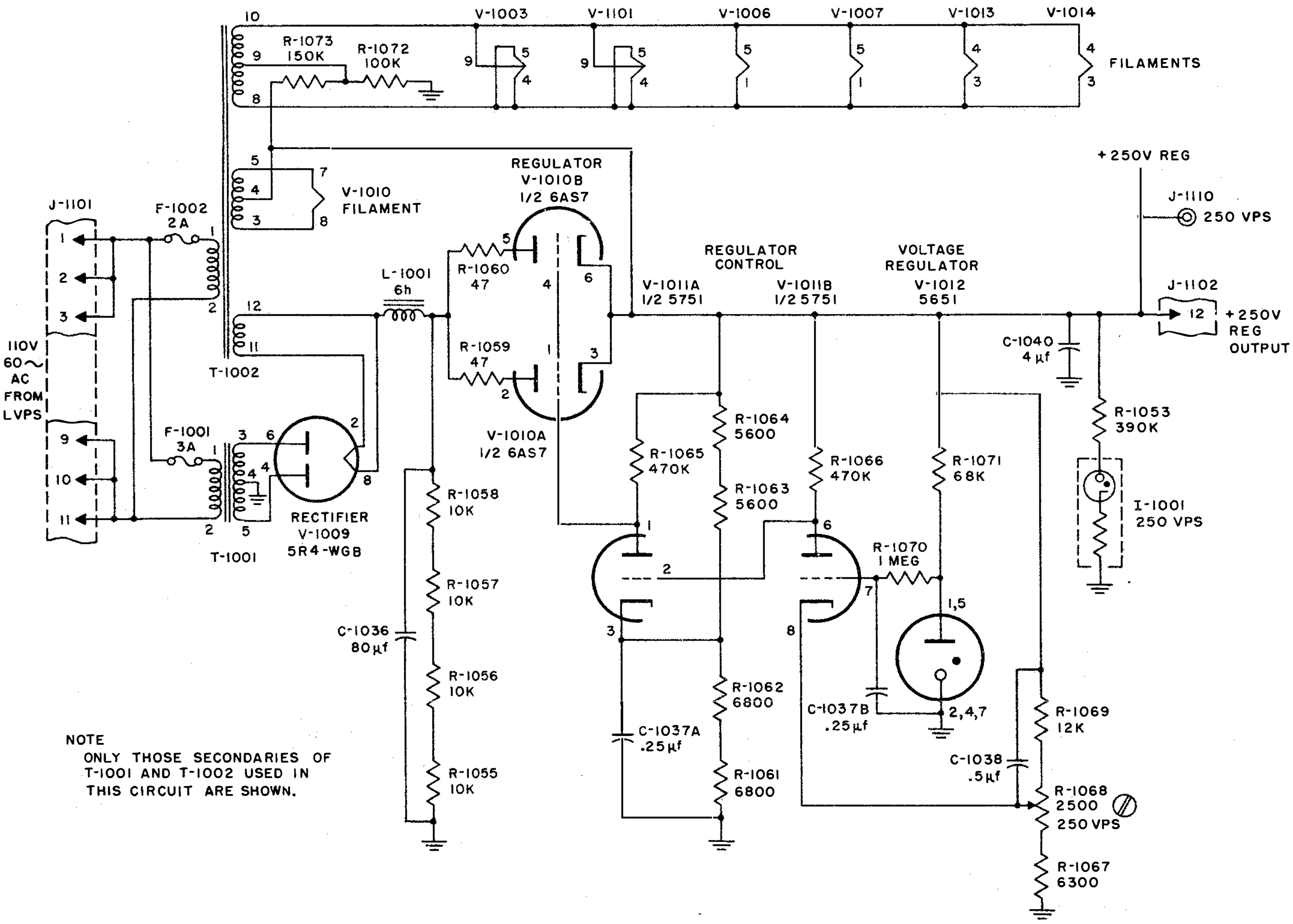


Figure 2—89. Rectifier V—1009, Regulator V—1010, Regulator Control V—1011 and Voltage Regulator V—1012, Simplified Schematic

tubes in the LLRM (V–1003, V–1006, V–1007, V–1011, V–1013, V–1014), is maintained at +100 volts, taken from the voltage divider comprised of R–1072 and R–1073 from +250 volts to ground.

(3) REGULATOR CONTROL V-1011 AND VOLTAGE REGULATOR V-1012.—When the power supply output tends to vary from +250 volts, regulator control V–1011 (figure 2-89) produces a signal that causes regulator V–1010 to oppose this change in voltage. The two triode sections of V–1011 are d-c amplifiers in cascade. The control grid of V–1011B, pin 7, is connected through R–1070 to a regulated +87 volts provided by the voltage divider, R–1071, and voltage regulator V–1012 from +250 volts to ground. The cathode of V–1011B is maintained at a positive potential by means of potentiometer R–1068, which is part of the voltage divider R–1069, R–1068 and R–1067 from +250 volts to ground. A change in power supply output voltage results in a change in the voltage divider and consequently a change in the cathode voltage of V–1011B. As the grid voltage of V–1011B is held constant by the action of V–1012, a change in cathode potential will cause a change in plate current and plate voltage of V–1011B. As the plate of V–1011B is directly connected to the grid of V–1011A, there will be the same change on the grid of V–1011A. The V–1011A cathode is tied to a positive potential by the voltage divider comprised of R–1064, R–1063, R–1062, and R–1061 from +250 volts to ground. Rapid changes of voltage appearing at the cathode of V–1011A are bypassed by C–1037A. Therefore, a change in grid potential of V–1011A causes a change in plate current and plate voltage and, therefore, the same change of grid voltage of both halves of the regulator V–1010 in such a direction that the output voltage of the power supply is restored to +250 volts.

For example, if the power supply output should tend to rise above +250 volts, the cathode potential of V–1011B rises, causing the plate current to fall, thus increasing the plate voltage of V–1011B. This increases grid voltage of V–1011A. The cathode of V–1011A does not follow the rapid change of voltage caused by the bypass capacitor, C–1037A. The increased grid voltage of V–1011A causes an increase in plate current and a decrease in plate voltage, and, consequently, a decrease in grid voltage of V–1010. As a result, the plate current of V–1010 is reduced, which can be considered as an increase in the apparent resistance of the tube, and the output voltage is reduced to the +250-volt value. If the output voltage tends to drop below +250 volts, a similar action takes place in reverse, decreasing the apparent resistance of V–1010 and restoring the output to +250 volts. The steady state apparent resistance of V–1010 determines the exact value of the output voltage of the supply. Potentiometer R–1068, known as the 250 V.P.S. control, can be adjusted to regulate the steady state value of the cathode potential of V–1011B, which sets the apparent resistance of V–1010 through the regulator control, V–1011, and, consequently, also regulates the exact output voltage. The ripple component, remaining after the filtering action, is bypassed by C–1038 directly to the cathode of V–1011B where the regulation described above takes place to further reduce the ripple content. C–1040 is a final filter capacitor. R–1053 is a dropping resistor for 250 V.P.S. indicator I–1001. J–1110 is a test point for measuring this supply.

f. –12-VOLT POWER SUPPLY. — The –12-volt power supply (figure 2–90) uses a metallic bridge rectifier, CR–1001, connected to give a negative voltage output. Rectifier CR–1001 receives 16.5 volts rms from terminals 15 and 16 of T–1002. The output is filtered by L–1005, C–1034, and C–1035 with R–1054 acting as a bleeder. The –12 volts is supplied to the DYNAMIC-CARBON switch (Y), S–1102 in the LLRM, for use as operating voltage for the carbon microphone. The output is also fed to the remote radiophone unit where it is the operating voltage for the carbon microphone and the CARRIER ON indicator and control relay in addition.

g. ATU BYPASS TRANSFER CIRCUIT.—The antenna tuning system is arranged to be bypassed during times when there is no transmitter carrier so that the antenna can be directly connected to a receiver that can be tuned to a different frequency from that of the transmitter. Indications of the presence of a carrier are taken from the keying line, with the exception that it is undesirable to have the bypass function attempt to follow the hand-keying signals. The function of the ATU bypass transfer circuit is to provide a signal that will cut the antenna tuning system in at the time of the first mark signal of a transmission and keep the antenna tuning system in until after the last mark of a transmission has been transmitted. The following describes the circuit design that accomplishes this.

For purposes of convenience of mounting location, the circuit components of the ATU bypass transfer circuit are mounted on the preamplifier subchassis (see figure 2–91). Relay K–1102, when energized, completes a signal path, through its contacts 3 and 4, to the antenna tuning system, which keeps the antenna tuning equipment in the line. Conversely, when K–1101 is not energized, this control circuit is opened and the antenna tuning system is bypassed. In a "key up" condition the keying line is at –24 volts, while in "key down" the keying line is at ground potential. The grid of the transfer control tube, pin 7 of V–1023B, and cathode of the limiter, pin 3 of V–1023A, are tied to –10 volts through resistors R–1130 and R–1134. The –10 volts is obtained from the voltage divider comprised of R–1121, R–1028, R–1133, and R–1132. The voltage divider is connected from the –105-volt source to ground, and the –10 volts is taken from the junction of R–1133 and R–1132.

Consider the condition of having the transmitter in the hand-key mode of operation with the key "up" just prior to the start of transmission. In "key up" the limiter, V–1023A, does not conduct, as its plate is at –24 volts while its cathode is at –10 volts. The –10 volts also appears at the grid of the transfer control tube, V–1023B, which is sufficient to cut the tube off. Therefore, K–1102, which is the plate load of V–1023B, is not energized, the transfer control circuit is opened, and the antenna tuning system is in the bypass condition. Also during this so-called steady state condition, the capacitor, C–1039, with one side connected to the plate of V–1023B and the other connected to the grid of V–1023B, is charged to 260 volts (from +250 volts to –10 volts).

Now, consider the first mark signal of a hand-key transmission. The keying line is now at zero potential with the result that the limiter, V–1023A, now conducts heavily, so that the grid of V–1023B is tied, effectively, to zero potential. This then causes V–1023B

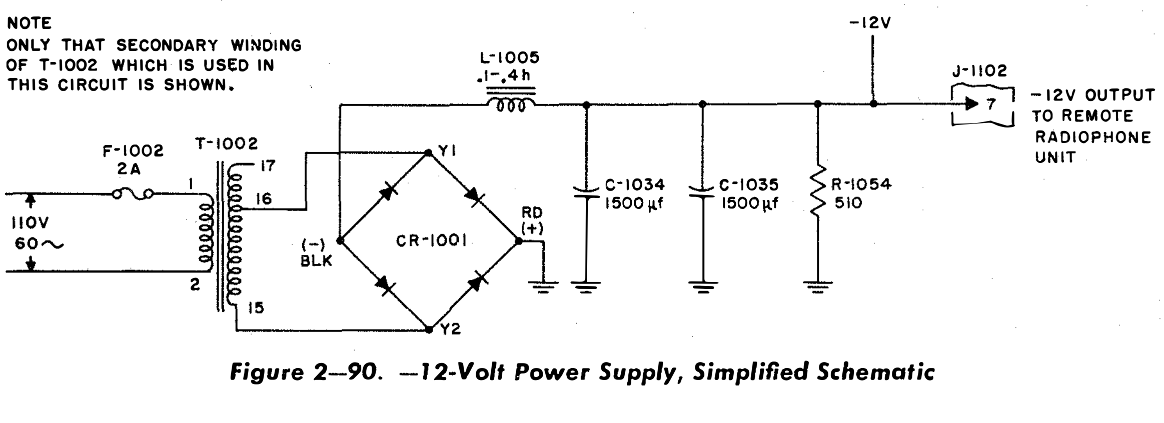


Figure 2–90. –12-Volt Power Supply, Simplified Schematic

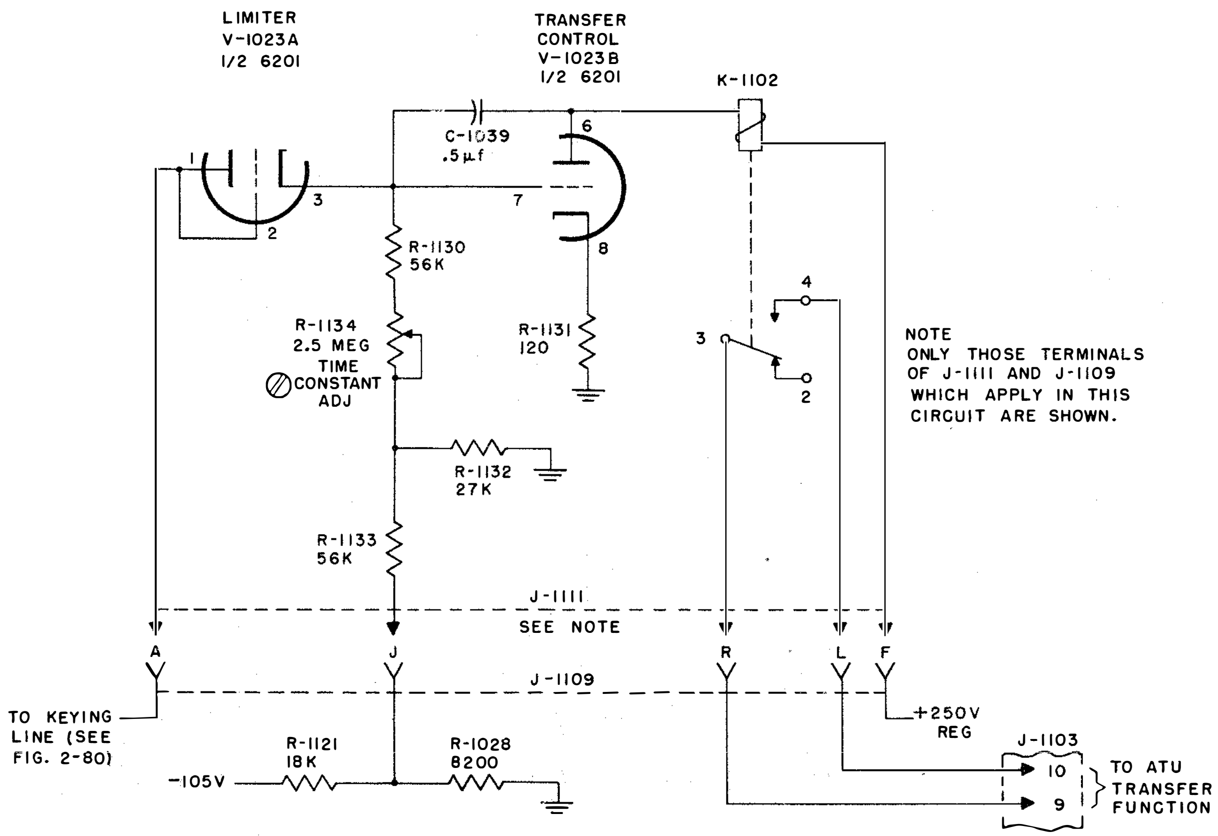


Figure 2–91. ATU Bypass Transfer Circuit, Simplified Schematic

to conduct heavily, and K–1102 operates, closing the transfer control circuit to the antenna tuning equipment, which, in turn, removes the bypass from the antenna tuning equipment. Owing to the conduction of V–1023A and B, capacitor C–1039 discharges to about 200 volts (+200 volts at plate of V–1023B and zero volts at the grid of V–1023B).

At the instant of the change from mark to space, the keying line returns to –24 volts and the limiter V–1023A stops conducting. Capacitor C–1039 starts to recharge, and the grid of V–1023B begins to return, exponentially, to –10 volts. As the grid of V–1023B starts to go negative, there is a corresponding reduction in plate current of V–1023B and increase of plate voltage. The plate relay, K–1102, will remain energized until the current through it reduces below 0.5 milliampere. The time constant of the charge of C–1039 and, consequently, the rate at which the grid of V–1023B returns to final space value of –10 volts are determined by the value of K–1102 winding resistance, C–1039, R–1130, R–1134 and the plate current characteristic of V–1023B. This time constant can be regulated by the variable resistor, R–1134, TIME CONST. ADJ., so that it takes anywhere from 0.5 second to 6 seconds after the completion of a mark signal before K–1102 de-energizes. The value that is set in this range depends on the operator and is set so that K–1102 remains up during periods between characters or words of a transmission.

In phone operation, the depressing of the press-to-talk button produces the same effect on the keying line as the depressing of a hand key and therefore the ATU bypass transfer circuit functions in the same manner as in hand key with the modification that the time constant, as determined by R–1134, be set at the minimum value to prevent the possible loss of the first part of an answering signal. In machine-key, FSK, and facsimile transmission, a permanent ground is supplied to the keying line, which means that K–1102 is permanently energized, and the antenna tuning system remains in at all times when these three modes of transmission are used.

8. RADIOPHONE UNIT.

The radiophone unit, usually located in a remote position, may be used in conjunction with, but is not part of, Radio Transmitting Sets AN/SRT–14, 15 or 16. This unit contains a start-stop switch for turning the transmitter on or off, jacks for connecting a handset, chestset, or hand key, a volume control for the earphones, and visual indicators for power and carrier.

9. RADIO MODULATOR MD—230/SRT (HIGH LEVEL RADIO MODULATOR, HLRM).

a. GENERAL.—During phone operation at the 500-watt level, an audio signal of 250 watts is required to amplitude-modulate the plate voltage of the RFA power amplifier. This is done by feeding the audio

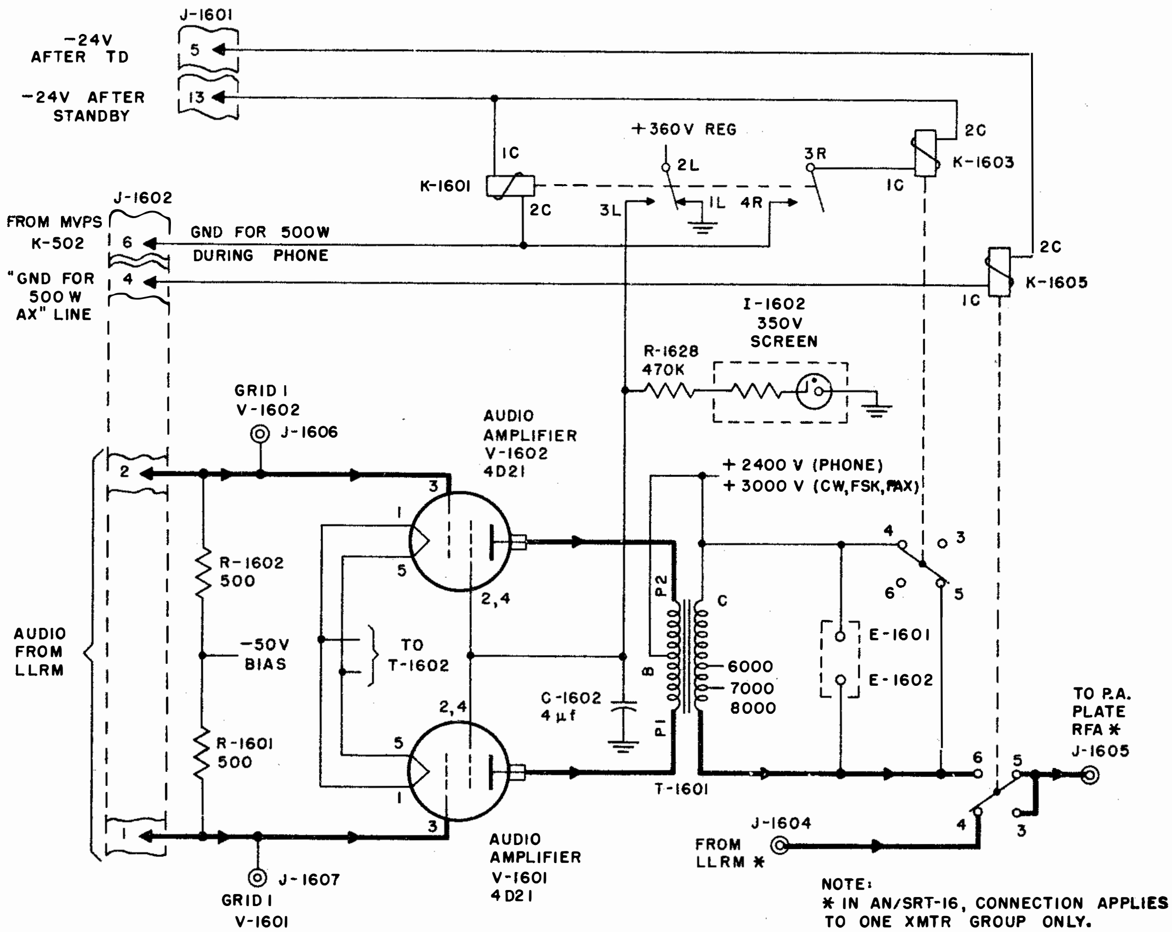


Figure 2–92. Audio Amplifiers V–1601 and V–1602, Simplified Schematic

signal from the LLRM, at a 6-watt level, to the HLRM and amplifying it to 250 watts. During hand-key, machine-key, FSK, and FAX operation, the plate voltage for the RFA power amplifier is routed directly through the HLRM. In the AN/SRT–16, the output of the HLRM is fed to the RFA in one transmitter group only, which signifies that only one transmitter group may operate at the 500-watt level. The AN/SRT–15 has only one transmitter group that employs the HLRM in 500-watt phone operation. As the AN/SRT–14 transmits only at the 100-watt level, no HLRM is employed.

b. AUDIO AMPLIFIERS V–1601 AND V–1602.—During 500-watt phone operation, the audio modulating signal from the LLRM, at the 6-watt level (see paragraph 7*b*(7)(*c*)), is fed to control grids of the push-pull amplifiers, V–1601 and V–1602 (figure 2–92) in the HLRM, equally but out of phase so that the push-pull action is amplified in the output modulation transformer, T–1601. Plate supply for the amplifier (+2,400 V during phone) is delivered to the center tap of the primary of T–1601. "Ground for 500 W during phone" is supplied from the MVPS (see paragraph 5*d*) to relay K–1601 and, if "—24 V after standby" is present, K–1601 energizes, supplying +360-volt screen supply through its contacts, 2L and 3L, to the screen grids of V–1601 and V–1602. Capacitor C–1602 is a bypass for the screen supply and resistor R–1628 is a dropping resistor for the +350 V SCREEN indicator, I–1602, which indicates that the HLRM screen supply is present. In phone operation, the "—24 V after standby" line is energized by the press-to-talk button of the phone which means that press to talk controls the applying of screen voltage to the HLRM. Whenever screen voltage is not applied to V–1601 and V–1602, these tubes cannot conduct, and there is no modulation signal output from the HLRM.

The output of the HLRM in 500-watt operation is used as the plate supply for the power amplifier in the RFA. In phone operation, the supply is +2,400 volts from the HVPS, which is first supplied to one side of the secondary of the output modulation transformer (terminal C of T–1601), so that the 250-watt audio modulating signal is imposed on the power amplifiers' plate supply. Protection against excessively high voltages across the secondary of T–1601 is provided by spark gaps E–1601 and E–1602. In other than phone operation, the HLRM output is +3,000 volts from the HVPS applied directly to the power amplifier plates, as modulation transformer secondary T–1601 is shorted. The shorting and unshorting of the secondary of T–1601

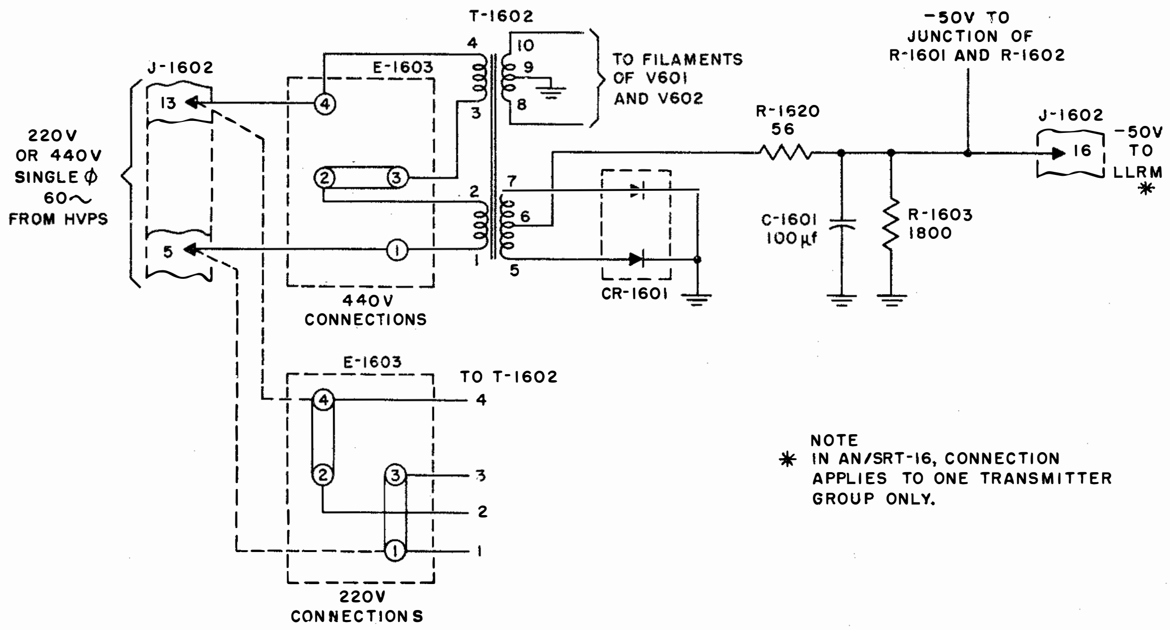


Figure 2–93. —50-Volt Bias Supply, Simplified Schematic

is controlled by relay K–1603. Shorting takes place through contacts 4 and 5 of K–1603 when K–1603 is not energized. As K–1603 is energized through contacts 3R and 4R of energized relay K–1601, it operates under the same conditions as K–1601, namely when the press-to-talk button is depressed in 500-watt phone operation. This removes the short and places the secondary of T–1601 in series with the high voltage supplied from the HVPS.

In the AN/SRT–15, the input to the plate of the power amplifier in the RFA comes from the output of the HLRM under control of the switching relay, K–1605. If the transmitter group is in 100-watt operation, the "ground for 500 W"AX line is open circuit, and K–1605 is not energized. This connects the output of the LLRM (see paragraph 7*b*(7)(*c*)), which enters through receptacle J–1604, through contacts 4 and 5 of K–1605 and receptacle J–1605 to the power amplifier plate. In 500-watt operation the "ground for 500 W" AX line is prepared, and K–1605 is energized after time delay. The output of the HLRM is now connected to the power amplifier plate through contacts 3 and 6 of energized K–1605 and receptacle J–1605. In the AN/SRT–16, the above applies to one transmitter group only. In the other transmitter group, the plate supply of the power amplifier is received from the LLRM directly. As the output of the HLRM is a permanent interconnection, the transmitter group to which it is fed, in the AN/SRT–16, will be the group that can be placed in 500-watt operation.

c. —50-VOLT BIAS SUPPLY.—To operate the audio amplifiers at the desired class-AB_2 operation, a —50-volt bias supply is required. This supply (figure 2–93) is obtained from terminals 5 and 7 of T–1602, using metallic rectifier CR–1601 connected as a negative full-wave rectifier, with the rectified voltage taken from the center-tap terminal 6 of T–1602 through the single section R-C filter comprised of R–1620 and C–1601. Resistor R–1603 is a bleeder for the filter capacitor. The —50 volts is applied to the center tap of the 6-watt secondary of the driver output transformer of the LLRM, which constitutes the signal input to the HLRM audio amplifier control grids. The —50 volts is also applied to the junction of the amplifier grid resistors, R–1601 and R–1602. These grid resistors act to limit grid current drawn in class AB_2 operation to reduce signal distortion. Transformer T–1602, through another secondary (terminals 8 and 10), also supplies filament voltages for V–1601 and V–1602. T–1602 has two primary windings that are either connected in series for 440-volt, single-phase, 60-cycle input or in parallel for 220-volt input by means of links on E–1603.

d. REGULATED +360-VOLT D-C SUPPLY.— A regulated +360-volt d-c supply (figure 2–94) is obtained for HLRM screen supply from the voltage-divider action of resistors R–1629, R–1630, and voltage regulator tubes V–1603, V–1604, V–1605, all in series from the +2,400-volt supply to ground whenever relay K–1601 is energized. During 500-watt phone operation, K–1601 is energized so that at the junction of resistor R–1630 and voltage regulator tube V–1603, through the contacts 2L and 3L of K–1601, a regulated +360 volts is obtained from the series action of V–1604 and V–1605, which are 105-volt regulators, and V–1603, which is a 150-volt regulator. Resistors R–1631, R–1632, R–1633 act as a voltage divider in parallel with the regulators when relay K–1601 is first operated, protecting the tubes until they fire and take control. When K–1601 is not energized, the junction of resistor R–1630 and regulator tube V–1603 is grounded through con-

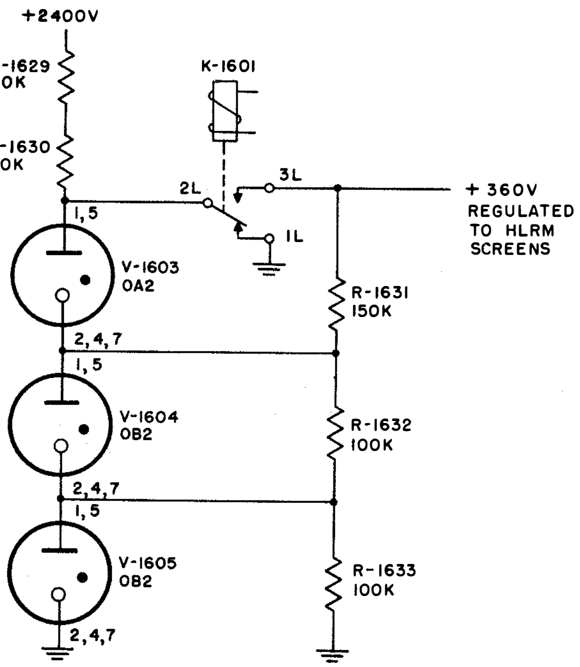


Figure 2–94. Regulated +360-Volt D-C Supply, Simplified Schematic

tacts 1L and 2L of K–1601, which effectively turns off the regulated +360-volt supply. Resistors R–1629, R–1630 now act as bleeder resistors for the +3,000-volt supply filter.

10. RADIO FREQUENCY AMPLIFIER AM–1008/SRT (RADIO FREQUENCY AMPLIFIER, RFA).

a. GENERAL.—The radio frequency amplifier (RFA) accepts from the RFO a signal at a frequency within the range of 0.3 to 26 mc. The RFA amplifies this signal from a level of approximately 0.1 watt (two volts rms) to a nominal level of either 100 watts or 500 watts. After harmonics have been attenuated by a suitable filter, the RFA output is transmitted by coaxial cable to the load adjusting unit. The RFA output may be either modulated by audio from the LLRM or HLRM, or keyed on and off by keying voltages from the LLRM. During FSK and facsimile operation the r-f signal from the RFO is frequency-modulated in the RFO.

Tuning of the RFA is accomplished manually by means of three controls: the BANDSWITCH Ⓒ, TUNE IPA control Ⓑ, and the TUNE PA control Ⓓ. To enable the RFA to tune through the entire range of 0.3 to 26 mc, the range of frequencies is grouped into six bands. The r-f output of the RFO is amplified by three stages: the buffer, intermediate power amplifier (IPA), and power amplifier (PA). The function of the BANDSWITCH Ⓒ is to connect a tank circuit to each of these amplifiers in accordance with the band that contains the frequency chosen for transmission.

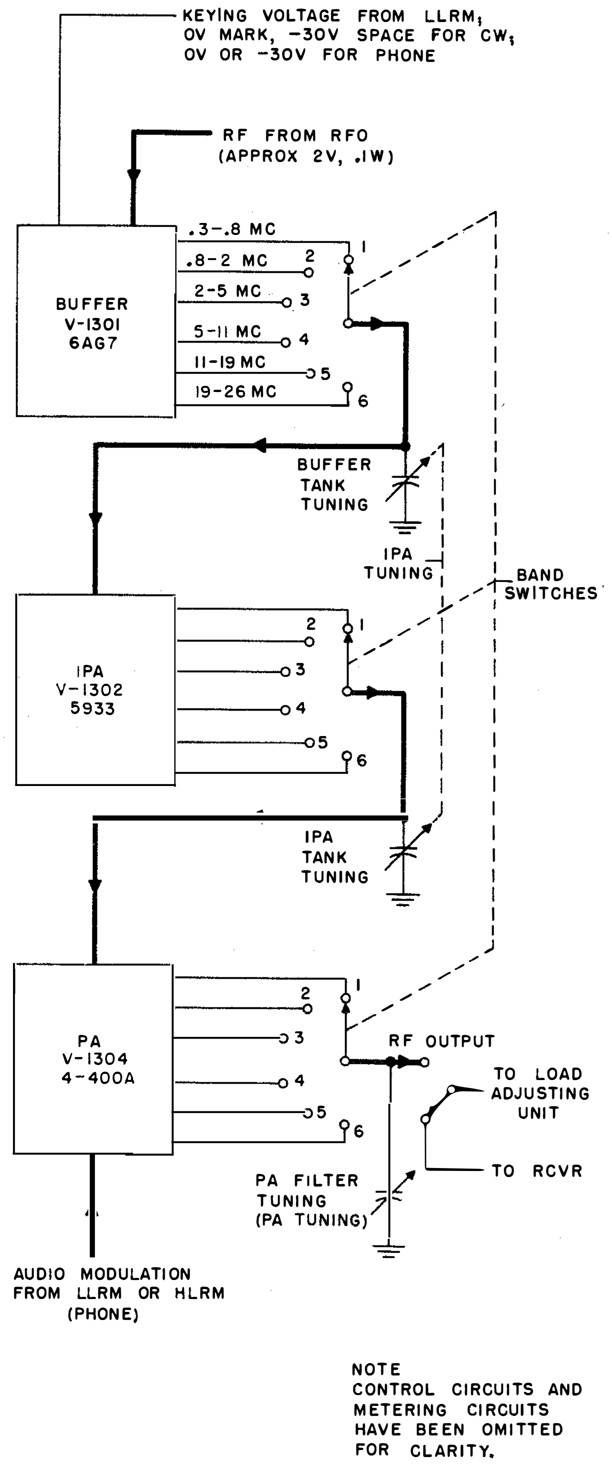


Figure 2–95. Radio Frequency Amplifier AM–1008/SRT (Radio Frequency Amplifier, RFA), Block Diagram

After the desired band is set by the bandswitch, the tuning of the buffer and IPA tank circuits is peaked by the TUNE IPA control Ⓑ. The tuning of the PA tank circuit is then peaked by the TUNE PA control Ⓓ. The buffer, in addition to amplifying the r-f signal, isolates the RFA from the RFO and turns the RFA off

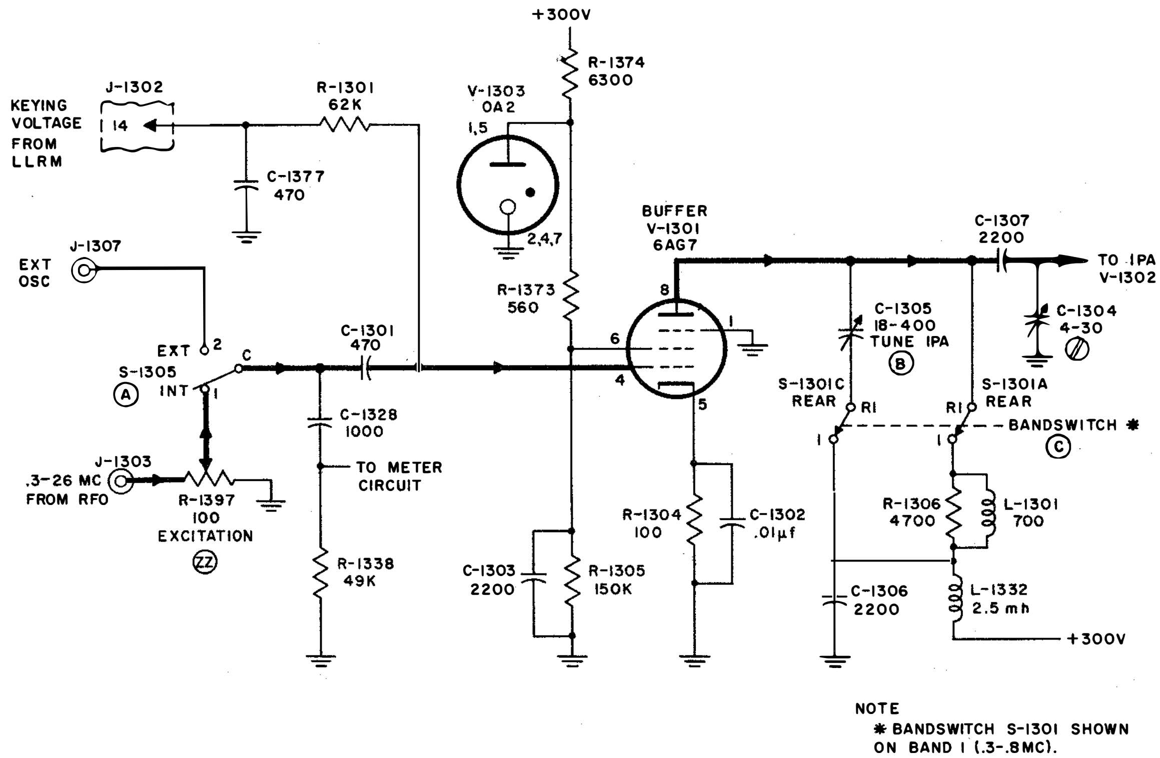


Figure 2–96. Buffer V—1301, Simplified Schematic

and on in accordance with the keying voltages from the LLRM. Figure 2–95 is a block diagram of the RFA with the metering and control circuits left out for clarity. Control circuits are shown in detail in figures 2–103 and 2–104 with the metering circuit shown in figure 2–108.

b. BUFFER V–1301.—Buffer V–1301 (figure 2–96) is a class A amplifier that amplifies the r-f output of the RFO and isolates the RFO from possible variations in buffer load impedance resulting from on-off keying of the buffer. During c-w and phone operations, the buffer and hence the carrier are keyed on and off by keying voltages from the LLRM. The buffer is keyed off during space in cw, and is keyed on during mark in cw or when the microphone press-to-talk button is depressed in phone operation. The buffer is always on in FSK and facsimile operations.

(1) BUFFER INPUT.—The output of the RFO is terminated by the EXCITATION control (ZZ) R–1397, which is a 100-ohm potentiometer to match the impedance of the coaxial cable carrying the r-f signal from the RFO to the RFA so that a uniform signal strength is presented to the RFA regardless of the length of this line. The amplitude of r-f signal coupled to the grid of the buffer, V–1301, through capacitor C–1301 and through the INT-OSC-EXT switch Ⓐ, S–1305, in the INT. position, is determined by the setting of the (ZZ) control, which should be such that the value is neither in excess of five volts rms nor is such that when all tuning is completed, the value of PA screen grid current does not exceed 70 ma (see paragraph 10*d*). An external signal may be fed to the RFA through receptacle J–1308 and coupled to the grid of the buffer through switch Ⓐ S–1305 in the EXT position. The r-f input is also coupled to the meter circuit through capacitor C–1328.

(2) BUFFER TANK CIRCUIT.—The buffer amplifies the r-f signal and tunes it in the plate tank circuit (figures 2–96 and 2–97). The components of the tank are determined by the bandswitch setting. The switches, S–1301A rear, S–1301A front, and S–1301C rear, select the buffer tank components. These switches are ganged together and are manually controlled by the BANDSWITCH control Ⓒ. Figures 2–96 and 2–97 show the setting for band 1. The frequency range of each band is given in paragraph 10*f*.

Bandswitch S–1301A rear selects the desired tuning inductor and, on bands 1 through 5, the required damping resistor. The damping resistor broadens the band response of the tank circuit required to maintain even excitation in phase-shift operation. Band 1 uses damping resistor R–1306 and inductor L–1301; band 2, R–1392 and L–1334; band 3, R–1310 and L–1305; band 4, R–1309 and L–1304; band 5, R–1308 and L–1303; band 6, L–1302. Bandswitch S–1301A front shorts out all unused inductors and damping resistors. Bandswitch S–1301C rear connects tuning capacitor C–1305 in parallel with the selected tuning inductor and, in bands 5 and 6, it selects band-spread capacitor C–1369 or C–1370, respectively. These capacitors spread the tuning of bands 5 and 6 over almost the full 180° rotation of tuning capacitor C–1305. After the desired tank

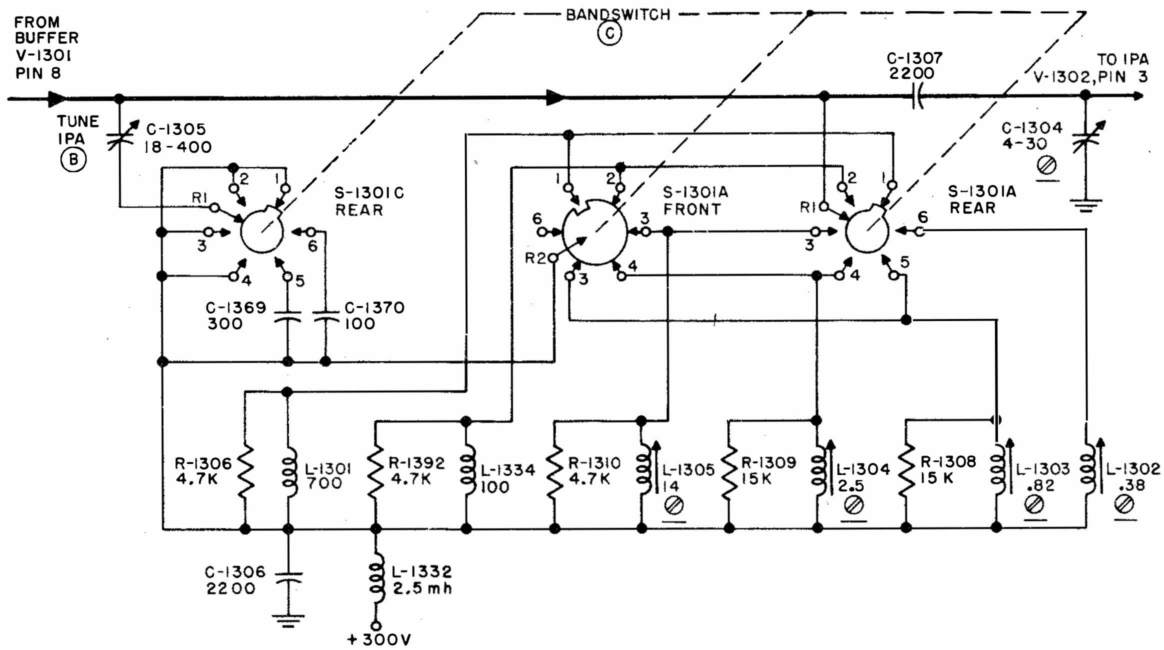


Figure 2—97. Buffer Tank Circuit, Simplified Schematic

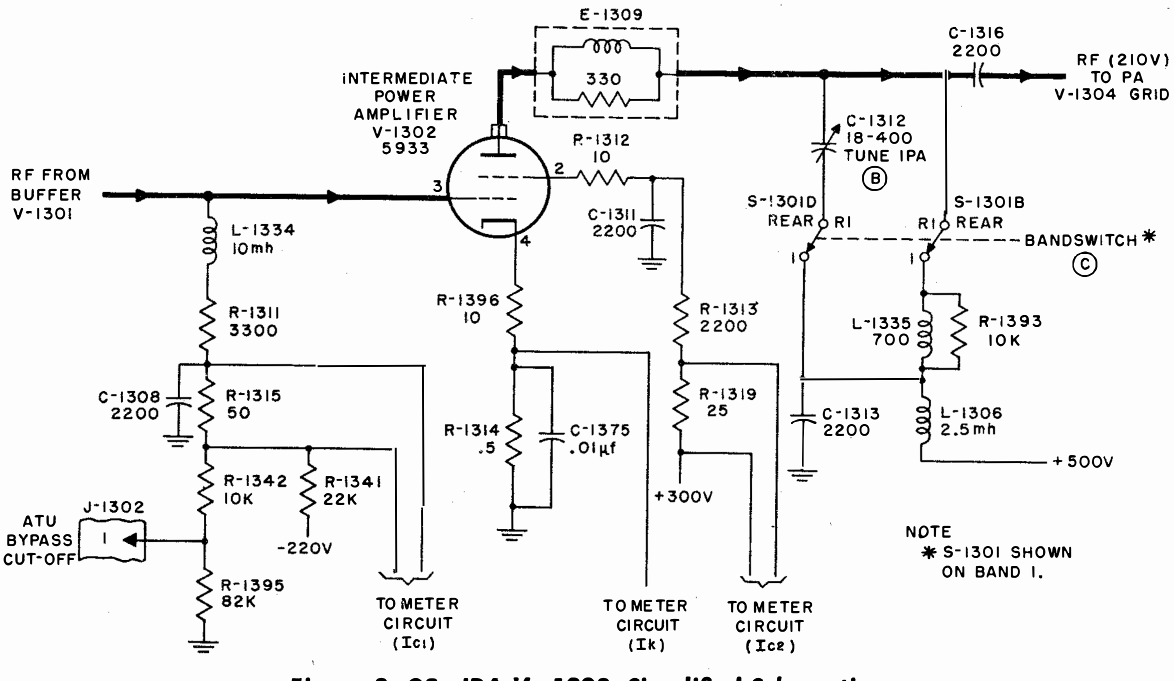


Figure 2—98. IPA V—1302, Simplified Schematic

circuit has been selected, the band circuit is tuned to maximum output by tuning capacitor C–1305, which is manually controlled by the TUNE IPA control Ⓑ. The tank circuit is decoupled from the 300-volt B+ supply by bypass capacitor C–1306 and filter choke L–1332. Capacitor C–1307 couples the output of the buffer stage to the grid of the IPA tube, V–1302. Trimmer capacitor C–1304 is connected on the IPA grid side of coupling capacitor C–1307 to reduce the d-c potential between its plates.

(3) BUFFER KEYING.—During FSK or FAX operation, the buffer control grid (figure 2–96) is maintained at a constant potential of zero volts and its screen grid at a constant potential of approximately +150 volts, thereby keeping the buffer amplifying and the carrier continuously on the air. The zero voltage on the control grid is directly applied from the LLRM, through isolating resistor R–1301, with capacitor C–1377 acting as an r-f bypass. The screen potential is supplied from the regulated +150 volts supplied by the action of the voltage regulator tube, V–1303, in series with resistor R–1403, forming a voltage divider across the +300-volt supply. Resistor R–1305 and capacitor C–1303 form an r-f filter to further stabilize the buffer screen supply, and resistor R–1402 acts as a suppressor. In c-w operation during mark and in phone operation when the press-to-talk button is depressed, the above conditions also prevail and the buffer amplifies. However, in c-w operation during space and in phone operation when the press-to-talk button is not depressed, −30 volts is received from the LLRM through isolating resistor R–1301 and is applied to the control grid of the buffer. This −30 volts is sufficient to drive the buffer well below cutoff so that any r-f signal from the RFO will not be amplified, which effectively cuts the carrier off the air. The origin of the zero and −30-volt keying voltage is explained in the keying circuit discussion in the LLRM (paragraph 7*c*(7)).

c. IPA V–1302.—The intermediate power amplifier (IPA) V–1302 (figure 2–98) amplifies the r-f signal from the buffer V–1301 to a level of approximately 210 volts rms. The r-f signal is further tuned in the IPA plate tank circuit.

(1) IPA INPUT.—During normal operation, the control grid of the IPA is power biased to approximately −65 volts by means of the voltage divider R–1341 and R–1342 connected between the −220-volt supply and a ground that is supplied from the antenna tuning unit. A grid leak circuit is comprised of r-f choke L–1344, R–1311, together with grid current meter shunting resistor R–1315. Thus, a combination of grid-leak bias and fixed bias is used. Capacitor C–1308 bypasses the meter and power bias circuit. The cathode is grounded through parasitic suppressor R–1396 and cathode current meter-shunting resistor R–1314, which is bypassed by C–1375. The screen is connected to the +300-volt supply through parasitic suppressor R–1312, filter resistor R–1313, and screen current meter-shunting resistor R–1319. E–1309, in the plate circuit, is a parasitic suppressor formed by a coil wound on a 330-ohm resistor. When switching takes place, to bypass the antenna tuning unit, the r-f line to the antenna is momentarily opened. At the same time the ground from the ATU supplied to the IPA grid bias voltage divider is removed and, momentarily, R–1395 is added to the voltage divider, raising the bias on the grid to −180 volts, cutting off the IPA and, consequently, the RFA output, to prevent any surge in the r-f output caused by the momentary loss of antenna load.

(2) IPA TANK CIRCUIT.—The IPA tank circuit (figures 2–98 and 2–99, shown for band 1) is similar to the tank circuit of buffer V–1301. Both are tuned by the TUNE IPA control Ⓑ, which is ganged to the IPA tuning capacitor, C–1312, as well as to the buffer tuning capacitor, C–1305. Choke L–1306 and capacitor C–1313 comprise a B+ decoupling network, for the +500-volt plate supply. BANDSWITCH control Ⓒ is ganged to IPA bandswitches S–1301D rear, S–1301B front, and S–1301B rear, as well as to the buffer bandswitches. The desired tuning inductor and associated damping resistor are selected by S–1301B rear. All other tuning inductors and damping resistors are shorted out by S–1301B front. On bands 5 and 6, bandswitch S–1301D rear selects a band-spread capacitor, C–1371 and C–1372, respectively, in series with tuning capacitor C–1312. The r-f output of the IPA, approximately 210 volts rms, is coupled by capacitor C–1316 to the control grid of the power amplifier (PA) V–1304.

d. PA V–1304. — Power amplifier V–1304 (figure 2–100) amplifies the r-f output of the IPA, V–1302, to a power level of 100 watts or 500 watts depending on the plate and screen voltages selected by means of the control circuits. The signal is again tuned in the PA plate circuit and is matched to the antenna line.

(1) PA INPUT.—In addition to higher plate and screen voltages required for 500-watt operation as compared to 100-watt operation, a higher grid bias is needed to keep "key-up" radiation below 400 micromicrowatts. The two grid biases are obtained from two taps on a voltage-divider network from the -200-volt supply. In 100-watt operation grid bias is obtained from a tap on potentiometer R–1345, which is part of a voltage-divider network from the −220-volt supply comprised of potentiometer R–1348, resistor R–1404, potentiometer R–1345, and resistor R–1405 to ground. From the tap on R–1345, bias is supplied through contacts 5R and 6R of relay K–1304, which is not energized in 100-watt operation, through grid current meter-shunting resistor R–1326, grid return resistor R–1344 and r-f choke L–1311 to the control grid of PA V–1304. In 500-watt operation, relay K–1304 is energized and grid bias is taken from a more negative point on the voltage divider, the tap on potentiometer R–1348, through contacts 10L and 9L of energized K–1304 to the grid circuit. Potentiometers R–1345 and R–1348 are normally adjusted for −110 volts and −155 volts respectively.

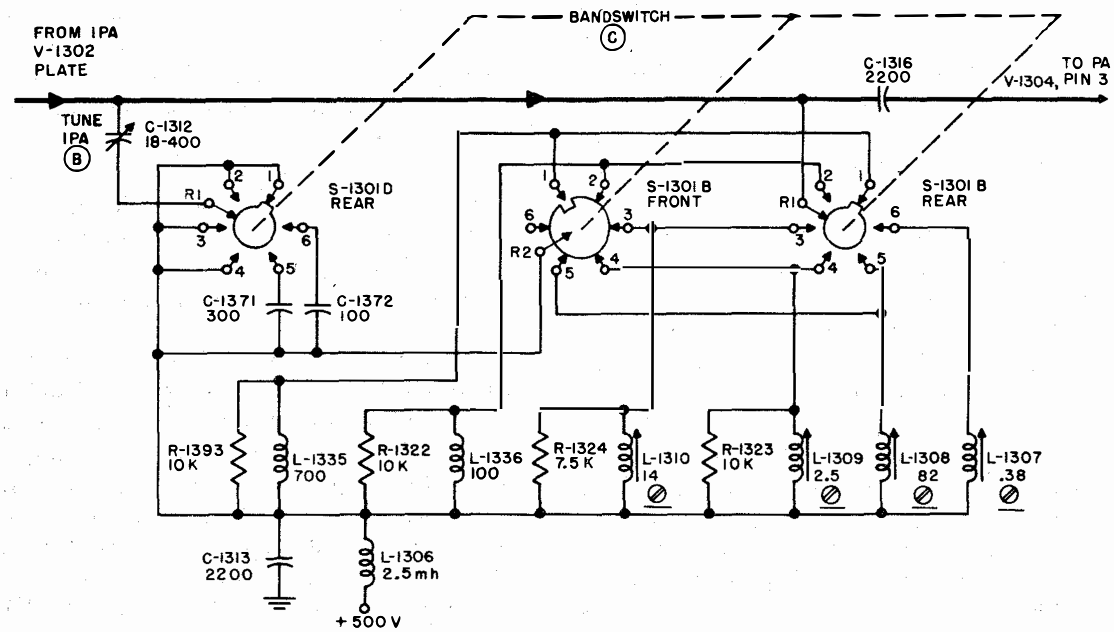


Figure 2–99. IPA Tank Circuit, Simplified Schematic

Filament power for the PA V–1304 is supplied from a secondary winding (terminals 5 and 7) of transformer T–1302. Center tap of this secondary (terminal 6) is grounded through cathode meter current shunting resistor R–1327. Capacitors C–1317 and C–1329 are feed-through bypasses for the cathode. Another secondary of T–1302 (terminals 3 and 4, not shown in figure 2–100) supplies filament power for the buffer, V–1301, and IPA V–1302.

(2) PA SCREEN CIRCUIT.—In 100-watt operation the +300-volt supply is the PA screen supply, while in 500-watt operation, the +500-volt supply is the screen supply. The switching is done by relay K–1304, which is energized in 500-watt operation but not in 100-watt operation. The +300-volt supply is connected as screen supply in 100-watt operation through contacts 5L and 6L of unenergized K–1304, thence through the overload coil of K–1303 and its shunting resistors R–1389 and R–1370, through the screen grid current meter-shunting resistor R–1330, then through screen modulation network L–1343 and R–1406, through the r-f filter network of R–1394, C–1322 and high frequency parasitic suppressing capacitor C–1367, to the screen grid of the PA V–1304. The +500-volt supply is applied to the screen grid circuit in 500-watt operation through contacts 8L and 7L of the now energized K–1304.

If screen grid current, which also flows through the overload coil of overload relay K–1303, is excessive, the slow operate overload relay K–1303 will operate. Operated K–1303 opens the "500 W disable" line (opened contacts 2R and 3R of K–1303). As the only effect of opening the "500 W disable" line is to restore the transmitter to the 100-watt level (see paragraph 10*e*(1)), screen overload protection is provided in 500-watt operation only. None is required in 100-watt level, as the screen dissipation is far below the maximum allowable level. Opening of the "500 W disable" line by K–1303 also removes ground from the PA SCREEN overload indicator I–1301, extinguishing it to denote overload. When the overload condition is cleared, the SCREEN OVERLOAD RESET push button Ⓚ, S–1304, may be depressed, which, in turn, energizes the reset coil of K–1303 from "–24 volts after time delay" to ground. The energized reset coil closes contacts 2R and 3R, restoring the "500 W disable" line. In 100 watt, resistors R–1389 and R–1370 shunt the overload coil. The allowable screen current in 500-watt operation is lower than in 100 watt; therefore, one of the shunting resistors, R–1389, is removed so that the overload coil will react to the lower screen grid current overload condition. R–1389 is disconnected by the open contacts 3L and 4L of K–1304, which is energized for 500 watts.

The rf is bypassed in the screen grid circuit, but a-f changes in screen grid current caused by the corresponding audio changes in the plate voltage, when in phone operation, are not bypassed. These audio changes in screen grid current are amplified by the modulation network of L–1343 and R–1377 so that 100 percent modulation can be obtained in the PA stage. This screen modulation is required for phone operation only and its presence when in cw is detrimental, owing to the transient effect on the screen supply by L–1343, caused by sudden changes in screen current at the instances of "key up" and "key down". Therefore, the action of relay K–1302 is such that the modulation network is shorted out in all modes of operation except phone, as K–1302 is energized from "–24 volts after time delay" to the "ground for phone" line, opening its contacts 1L and 2L and removing the short around L–1343 and R–1377.

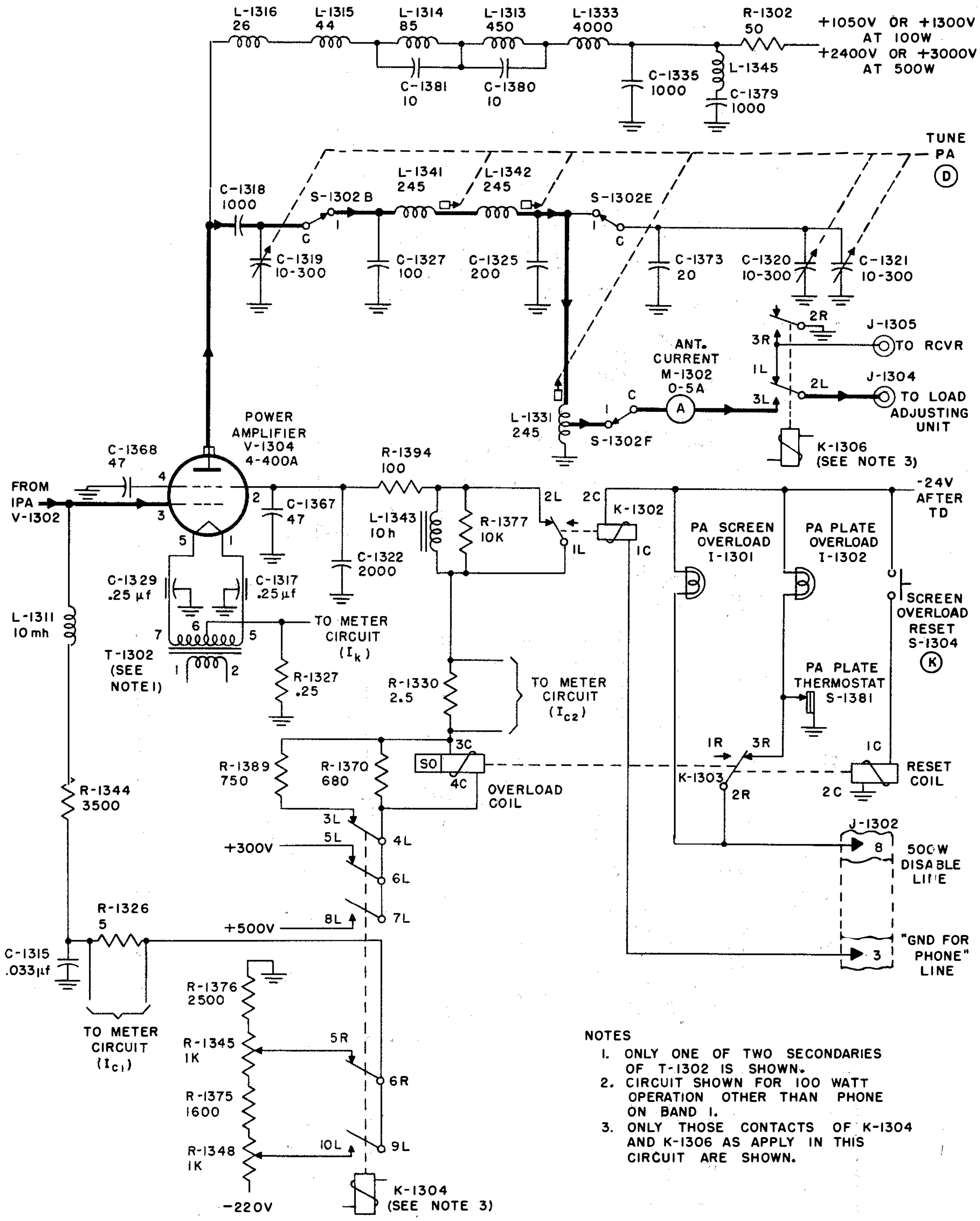


Figure 2–100. PA V–1304, Simplified Schematic

(3) PA PLATE CIRCUIT.—On bands 5 and 6, the PA plate (figures 2–100 and 2–101) is fed through choke L–1316 only; but on other bands, L–1316 is connected to the B+ source through one to four additional r-f chokes, depending on the band selected. Figures 2–100 and 2–101 show the power amplifier on band 1. In this case the PA plate is fed through chokes L–1333, L–1313, L–1314, L–1315, and L–1316. Capacitors C–1380 and C–1381 suppress any tendencies of the chokes to resonate under the influence of the audio modulation signal impressed on the plate supply during phone operation. During c-w transmission, the MVPS supplies plate voltage of +1,300 volts for 100-watt operation, and the HVPS supplies +3,000 volts for 500-watt operation. During phone transmission, the MVPS supplies +1,050 volts for 100-watt operation,

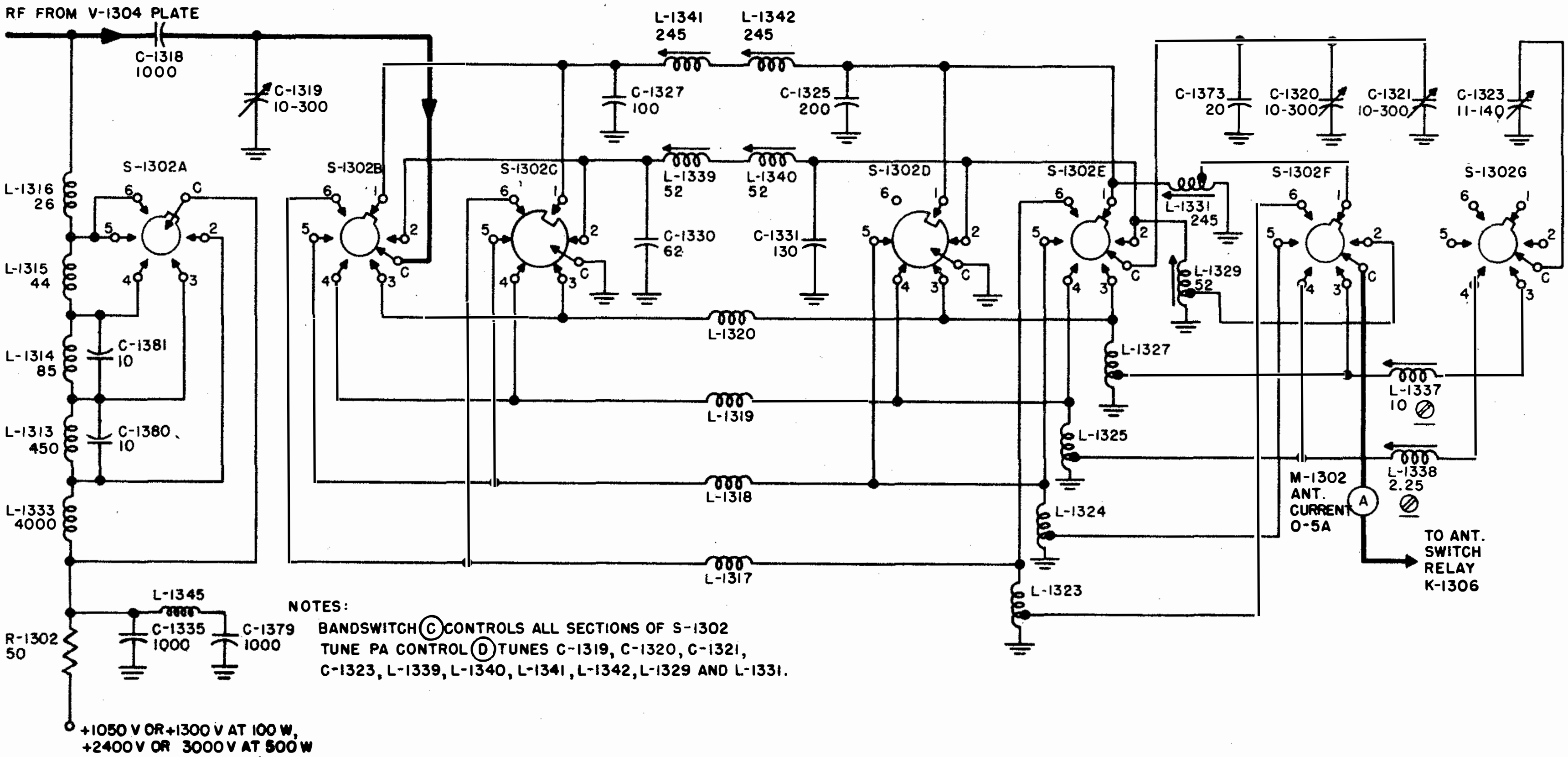


Figure 2—101. PA Harmonic Filter, Complete Schematic

and the HVPS supplies +2,400 volts for 500-watt operation. PA plate supply voltages are lower for phone transmission than for cw because the PA plate voltage is amplitude-modulated by the audio output of the LLRM or HLRM. If the PA plate voltage were not reduced during phone operation, it would exceed the PA peak voltage rating. R–1302, C–1335, and C–1379 decouple rf from the plate supply line, with L–1345 acting to suppress any tendencies to resonate.

The plate is coupled to the tank circuit (figures 2–100 and 2–101) in band 1 by d-c blocking capacitor C–1318. The PA output is obtained from a tap on the antenna matching coil (L–1331 for band 1) and is fed through the ANT CURRENT ammeter, M–1302, to contact 3L of the antenna switching relay, K–1306. When K–1306 is energized, the output of the PA is connected to the 50-ohm line to the load adjusting unit through contacts 3L and 2L of K–1306 and receptacle J–1304. When K–1306 is not energized, the antenna system is connected to the receiver through contacts 1L and 2L of K–1306 and receptacle J–1305.

If excessive PA plate dissipation takes place, the resultant increase in radiated energy will cause thermostat S–1381 to open the "500 W disable" line, producing the same results as noted in the screen overload discussion. Opening of S–1381 also removes ground from the PA PLATE overload indicator, I–1302, extinguishing it to denote overload.

(4) PA HARMONIC FILTER.—The output circuit of the power amplifier, V–1304, is essentially a harmonic filter (figures 2–101 and 2–102). The components of this filter are determined by the setting of the bandswitch, S–1302, which is ganged to the IPA buffer bandswitch, S–1301, both of which are set by the BANDSWITCH control Ⓒ. Bandswitch S–1302A selects the r-f chokes in the PA plate supply circuit. To keep the signal level constant for all frequencies, more inductance is required at the lower frequencies; therefore, on band 1, all the chokes, L–1333, L–1313, L–1314, L–1315, and L–1316, are connected in series in the PA plate circuit. On band 2, L–1333 is shorted. On band 3, L–1313 and L–1333 are shorted, etc., until, on bands 5 and 6, only L–1316 is in the circuit. Switch sections S–1302B and S–1302E select the required tuning inductors, while S–1302C and S–1302D short out the unused tuning inductors. Switch section S–1302E also selects the required antenna matching inductor and connects tuning capacitors C–1320 and C–1321 in parallel with it. Section S–1302F couples the output from the impedance matching network to the load adjusting unit. Section S–1302G adds additional impedances to the antenna matching inductor in bands 3 and 4 to form the correct matching network. The effect of the various selections of switch S–1302 is to produce a pi-section filter and an output impedance matching network. Figure 2–102 shows the make-up of the filter and matching network for each of the six bands. After the proper components of the filter have been selected, the filter is tuned to maximum output with the TUNE PA control Ⓓ. This control simultaneously tunes capacitors C–1319, C–1320, C–1321, C–1323 and inductors L–1329, L–1331, L–1339, L–1340, L–1341, L–1342.

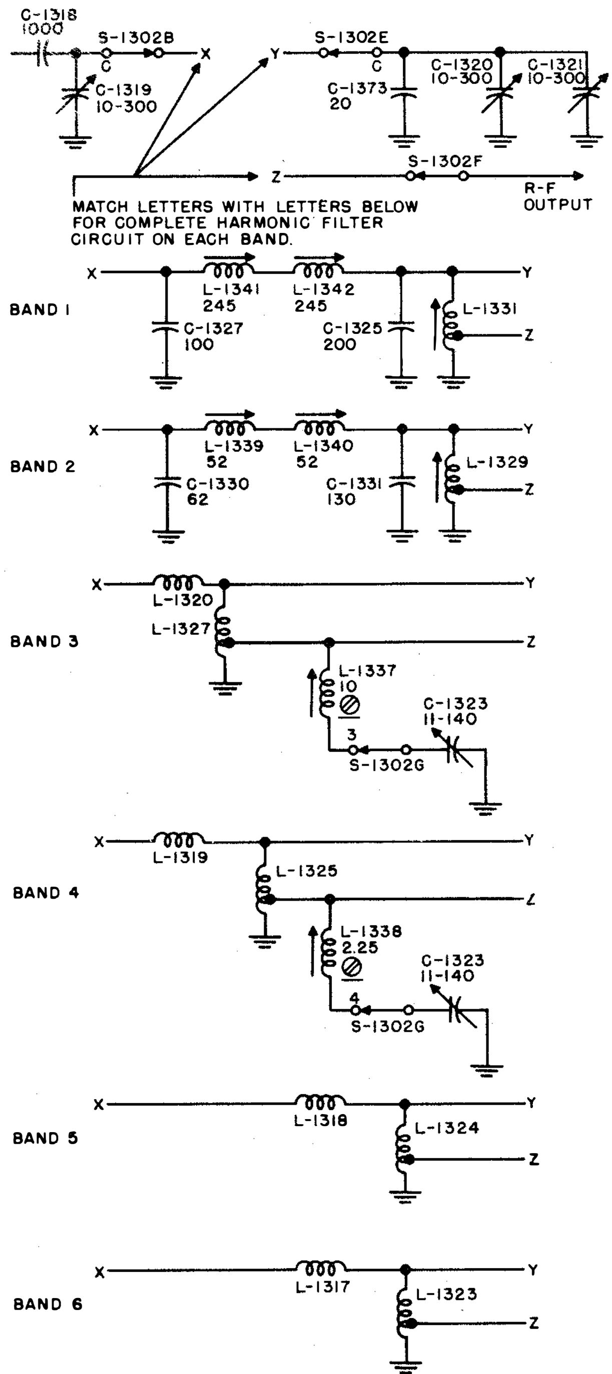


Figure 2–102. PA Harmonic Filter, Simplified Schematic

e. RFA CONTROL CIRCUITS.—In addition to the function of the BANDSWITCH Ⓓ, TUNE IPA Ⓑ, and TUNE PA Ⓓ controls, the master controlling function for differentiating between 100-watt and 500-watt operation and the antenna switching function are also included in the RFA.

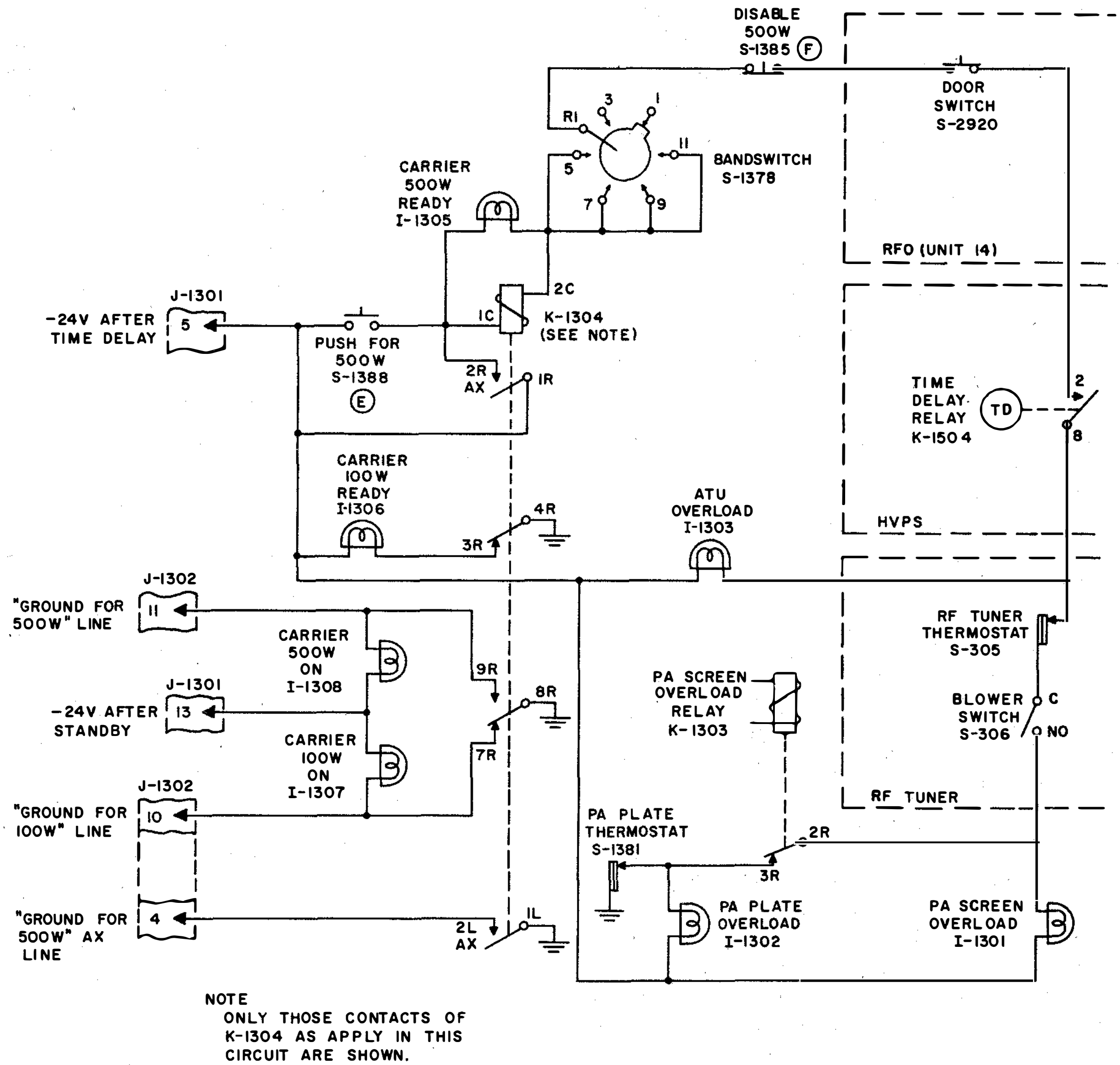


Figure 2—103. 500-Watt Operate Relay K—1304 and 500-Watt Disable Line, Simplified Schematic

(1) 500-WATT OPERATE RELAY K–1304 and "500 W DISABLE" LINE.—In addition to controlling the grid bias supply and screen grid supply of the PA for 500-watt or 100-watt operation (paragraphs 10*d*(1) and (2)), the 500-watt operate relay, K–1304 (figure 2–103), controls the "ground for 100 W" line and the "ground for 500 W" line, and "ground for 500 W" AX line.

The "ground for 500 W" line and "ground for 500 W" AX line establish the control circuits in the HVPS for turning on the high voltage supply (2,400 volts/ 3,000 volts); in the LLRM for connecting the output of the LLRM to the input of the HLRM; in the HLRM for switching the input to the PA plate from the LLRM output to the HLRM output; and for supplying screen voltage to the HLRM (in phone operation only). The "ground for 500 W" line and "ground for 500 W" AX line are established when K–1304 is energized, from ground, through contacts 8R and 9R and 1L and 2L, respectively, of K–1304. The AX line makes slightly ahead of the other so that faulty operation of the control circuits does not occur because of "sneak" paths.

The "ground for 100 W" line is established when K–1304 is not operated. This line establishes the control circuit in the MVPS for turning on the +1,050-volt/ +1,300-volt supply, which is required as PA plate supply in 100-watt operation.

It can be seen from the above discussion that if K–1304 is energized, the transmitter group will be in 500-watt operation, and, conversely, when K–1304 is not operated, the transmitter is in 100-watt operation. To place the transmitter in 500-watt operation, the PUSH FOR 500 W push button (E), S–1388, is depressed, which applies "—24 V after time delay" to the winding of K–1304. Ground for operating K–1304 is advanced through a series of controls and protective devices known as the "500 W disable" line. If any one of these controls or protective devices is not closed, ground cannot reach K–1304, and the transmitter can operate at the 100-watt level only. When K–1304 energizes, "—24 V after time delay" is connected to the winding of K–1304, through its holding contacts 1R and 2R, allowing S–1388 to be released. The following is a list of the components of the "500 W disable" line and their functions in the order in which they are connected in series from K–1304 to ground.

(*a*) IN THE RFA.

1. Bandswitch S–1378, which is ganged to BANDSWITCH control Ⓒ, so that the circuit is closed in all bands except 1 and 2.

2. DISABLE 500 W push button Ⓕ S–1385, which is normally closed; depressing S–1385 opens the circuit.

(*b*) IN THE RFO (UNIT 14).—Door interlock switch S–2920, which is closed when the door covering the frequency selector knob is closed. When this door is opened to change frequency, S–2920 opens the circuit.

(*c*) IN THE HVPS.—The time delay relay, K–1504, whose contacts 2 and 8 are open until the high-voltage time delay is over, when K–1504 energizes, closing the circuit through its now closed contacts 2 and 8. This allows the HVPS heaters to warm up before power is applied to the HVPS plate transformer.

(*d*) IN THE R-F TUNER.

1. Thermostat S–305, which is normally closed except when heat radiated from tuning coil is excessive, causing S–305 to open circuit.

2. Blower switch S–306, a centrifugal switch operated by the blower motor in the r-f tuner. The circuit is closed through S–306 only if the blower is operating.

(*e*) IN THE RFA.

1. PA screen overload relay K–1303, whose contacts 2R and 3R are normally closed. When K–1303 is energized, because of excessive PA screen grid current, contacts 2R and 3R are opened.

2. PA plate thermostat S–1381, which is normally closed except when energy radiated by excessive PA plate dissipation causes S–1381 to open circuit.

The three overload indicators (I–1301, I–1302, I–1303) are connected from "—24 V after time delay" to ground obtained from the "500 W disable" line, in such a manner that the energizing of any one of the overload protective devices will cause one or more of the indicators to extinguish. Figure 2–103 shows that, if the PA plate thermostat, which is the first in the series chain of overload protection devices, opens, there will be no ground anywhere on the "500 W disable" line, and all three indicators will extinguish. However, if the PA screen overload relay, K–1303, energizes, the PA PLATE overload indicator, I–1302, remains illuminated while the other two indicators are extinguished owing to the fact that I–1302 is connected before K–1303 in the series chain. This same reasoning can be followed for the indications when the r-f tuner protective devices open.

Four indicators controlled by the action of K–1304 indicate the power level of the transmitter and also indicate whether or not the transmitter is on the air.

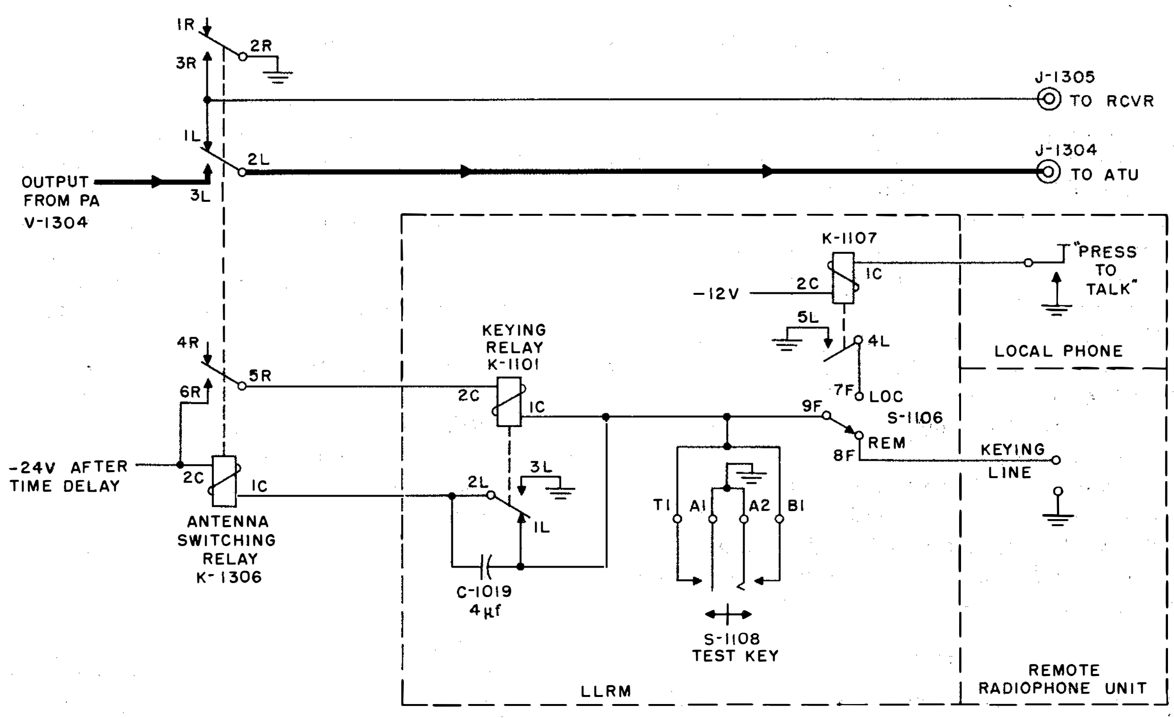


Figure 2—104. Antenna Switching Relay K—1306, Simplified Schematic

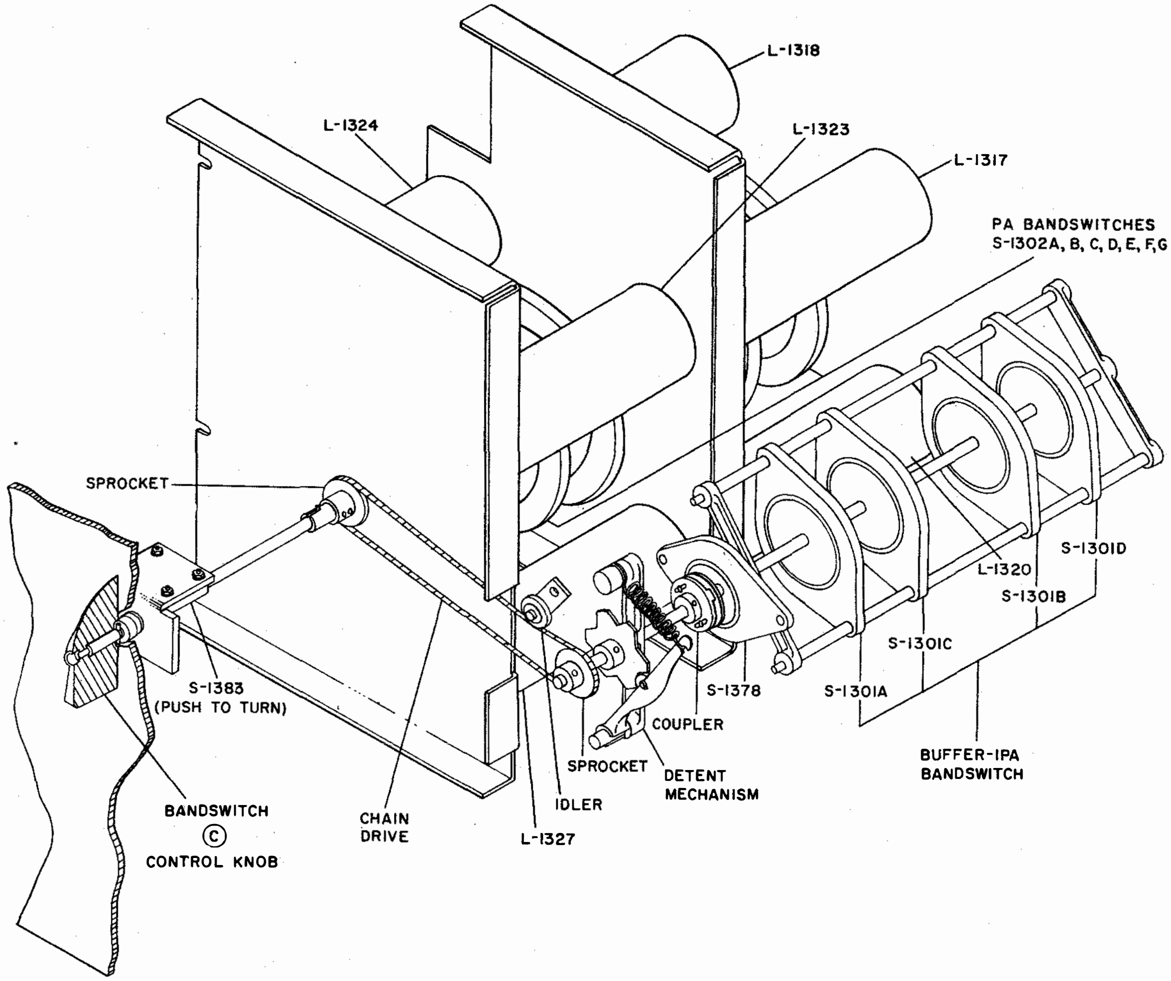


Figure 2—105. Bandswitch, Mechanical Linkages

In 100-watt operation, K–1304 is not energized and ground is connected to the CARRIER-100 W-READY indicator, I–1306, which lights from "–24 V after time delay." If the STANDBY-OPERATE switch ⓟⓟ, S–3005 in the LVPS (see paragraph *4d*), is in OPERATE, the "–24 volts after standby" supply will be on, which, in addition to turning on the power supplies which put the transmitter on the air, also will light the CARRIER-100 W-ON indicator, I–1307, through contacts 7R and 8R of K–1304 to ground. In 500-watt operation, the CARRIER-500 W-READY indicator, I–1305, will light from "–24 volts after time delay" through contacts 1R and 2R of energized K–1304 and to ground, as provided through the "500 W disable" line. If the transmitter is in OPERATE, as described above, the CARRIER-500 W-ON indicator will light from "–24 V after standby" and to ground, through contacts 9R and 8R of energized K–1304.

Note

The above discussion refers to the AN/SRT–15 and 16 only. The AN/SRT–14 operates at the 100-watt level only and does not include the HVPS. For uniformity, the 500-watt operate relay, K–1304, is included in the AN/SRT–14. However, K–1304 remains inoperative at all times owing to the fact that the "500 W disable" line is nonexistent because of the absence of the HVPS. Therefore, all the functions described above for 100-watt operation are pertinent to the AN/SRT–14.

(2) ANTENNA SWITCHING RELAY K–1306.—When the transmitter is on the air, the output of the RFA is coupled to the antenna system, but whenever there is no transmission, the antenna system is connected to the receiver. This switching is accomplished by the antenna switch relay, K–1306 (figure 2–104), which is energized only when there is transmission.

In remote hand-key operation, ground is forwarded from the remote radiophone unit, whenever the key is in the mark position, through contacts 1L and 2L of keying relay K–1101 in the LLRM, to K–1306, which then energizes to "–24 V after time delay". When the hand key is up (in space), there is no ground and

K–1306 is not operated. In paragraph 10*b*(3) it is shown that the transmitter is keyed on by mark and off by space in c-w operation, so the action of K–1306 follows the keying.

In machine c-w, FSK, and facsimile operation a permanent ground is placed on the keying line, which keeps K–1306 energized at all times.

In phone operation, local or remote, ground is placed on the keying line whenever the press-to-talk button is depressed. Therefore, K–1306 is energized only when the press to talk is depressed. Paragraph 10*b*(3) also shows that this is the only time the transmitter is on the air in phone operation.

Whenever K–1306 is energized as described above, the output from the PA is connected to the load adjusting unit through contacts 3L and 2L of K–1306 and receptacle J–1304, and the input to the receiver is grounded through contacts 2R and 3R and receptacle J–1305. When K–1306 is not energized, the antenna system is connected to the receiver through receptacle J–1304, contacts 2L and 1L of K–1306 and receptacle J–1305. Also, when K–1306 is energized, it advances "–24 V after time delay" through contacts 6R and 5R to keying relay K–1101 in the LLRM. A description of the function of K–1101 is found in the discussion of the LLRM.

f. BANDSWITCHING.—To cover the entire frequency range of 0.3 to 26 mc, six frequency bands are provided for the buffer, IPA, and PA amplifier stages. Each of the bands numbered 1 to 6 is identical for each of the stages and is selected by the manually operated BANDSWITCH control Ⓒ. Each band and its frequency range are listed in table 2–19 below.

TABLE 2—19. FREQUENCY BANDS

BAND	FREQUENCY RANGE (mc)
1	0.3 to 0.8
2	0.8 to 2
3	2 to 5
4	5 to 11
5	11 to 19
6	19 to 26

The BANDSWITCH control knob Ⓒ is a six-position rotary switch corresponding to each of the six bands (figure 2–105). A push-to-turn feature makes it necessary to push in on the knob before it can be rotated. This forward motion depresses the (PUSH TO TURN) switch, S–1383, whose function is discussed in the LVPS (paragraph 4*d*). The shaft of the BANDSWITCH control is coupled by a chain drive to a second shaft on which is mounted the bandswitch S–1378, and the buffer IPA bandswitch sections S–1301A, S–1301B, S–1301C, S–1301D. Another coupling links the BANDSWITCH control Ⓒ shaft to the PA bandswitch sections S–1302A, S–1302B, S–1302C, S–1302D, S–1302E, S–1302F, and S–1302G. Thus the BANDSWITCH control Ⓒ simultaneously positions the buffer, IPA, and PA bandswitches and switch S–1378 and actuates the (PUSH TO TURN) switch, S–1383. The setting of the BANDSWITCH control Ⓒ is denoted by the pointer on the knob.

g. BUFFER-IPA TUNING.—When bandswitching is completed, the buffer and IPA tank circuits must be tuned for maximum output. The shaft of the TUNE IPA control Ⓑ (figure 2–106) is coupled by chain drive to the dial mounted behind the IPA window. Another chain drive connects the control shaft to a gear box. In the gear box the rotary motion is reversed and a 2-to-1 reduction is introduced. The gear box, in turn, is coupled to the shafting on which is mounted the buffer tuning capacitor, C–1305, and the IPA tuning capacitor, C–1312. The TUNE IPA dial is calibrated from 0 to 100 to indicate whether the tuning capacitors are at the low end (maximum capacity) of the band, the high end (minimum capacity) or at some intermediate point. The dial is notched at the high and low limits of tuning so that the limit cam falls in the notch at the limits. The action of the cam falling in the notch causes the limit assembly to lock the shaft of the TUNE IPA control Ⓑ. Maximum tuning of the buffer and IPA is indicated by maximum PA grid drive as shown by a maximum reading on the PA CURRENT meter, M–1303 (figure 2–102), with the PA-METER SELECTOR Ⓗ in the I_{c1} position. In tuning, two peaks may be noted on M–1303. The tuning should be set to the maximum at the lowest TUNE PA dial reading to insure that the tuning is to the fundamental frequency and not a harmonic.

h. PA TUNING.—After buffer and IPA tuning are completed, the PA harmonic filter must similarly be tuned for maximum output. The shaft of the TUNE PA control Ⓓ (figure 2–107) is coupled by a chain drive to a right-angle drive which transfers the horizontal rotary drive to a vertical drive and then back to a horizontal drive where it couples, with a 10-to-1 reduction, to a shaft on which are mounted the gears and racks and pinions required for tuning the components of the PA harmonic filter. The cores of tuning inductors L–1339, L–1340, L–1341, L–1342, L–1329, L–1331 are mounted on a core-mounting plate assembly by means of adjusting locknuts, adjusted so the tuning inductors tune through the proper range for the frequency band selected. As the shaft is rotated, the mounting plate assembly is moved up or down by rack-and-pinion arrangement which is actuated by gears mounted on the shaft. This moves the cores in or out of the coils to tune the inductors. The adjustable plates of the special vacuum tuning capacitors C–1319, C–1320, and C–1321 are moved in and out of the cylindrical housing by means of a similar rack-and-pinion arrangement. A special spring is mounted eccentrically at the end of the rotary shaft to counterbalance the back pressure caused when the adjustable plates of the vacuum tuning capacitors are moved in. The rotor of tuning capacitor C–1323 is coupled by bevel gears to the shaft.

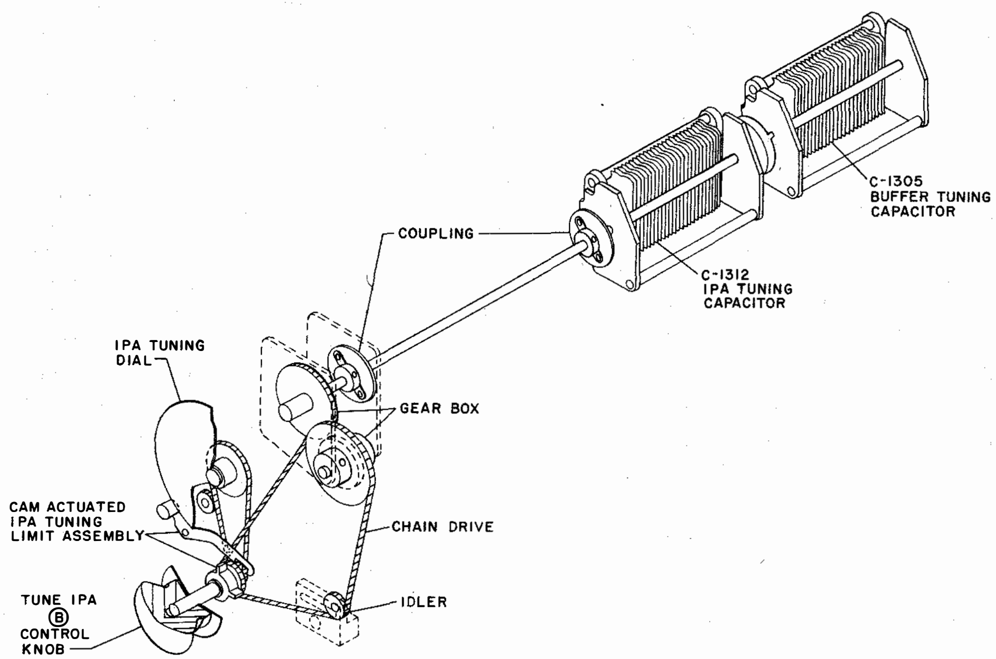


Figure 2—106. Buffer-IPA Tuning, Mechanical Linkages

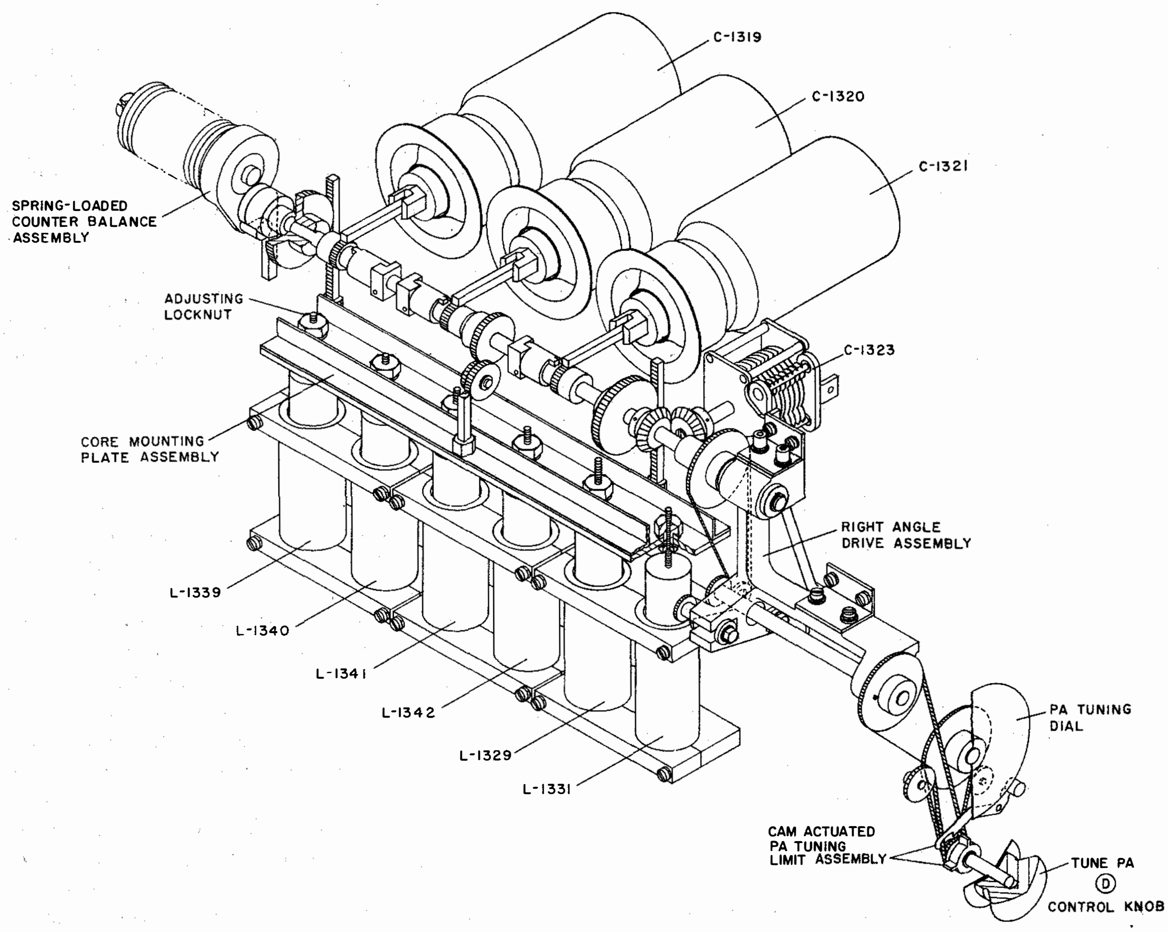


Figure 2—107. PA Tuning, Mechanical Linkages

WARNING

Tuning capacitors C–1319, C–1320, and C–1321 develop voltages which are dangerous to life. Exercise extreme caution when making adjustments near these capacitors.

The shaft of the TUNE PA control Ⓓ is coupled by a chain drive with a 5-to-1 reduction to the PA dial mounted behind the PA window. This is calibrated in a fashion similar to the IPA dial and has the same limiting arrangement as explained for the TUNE IPA. Maximum tuning of the PA harmonic filter is indicated by maximum reading on the PA CURRENT meter, M–1303, with the PA-METER SELECTOR Ⓗ in the $\bar{I}_{c2}$ position at the lowest setting of the TUNE PA dial.

i. METERING CIRCUITS.—Three meters are provided measuring the various operating voltages and currents in the RFA. These meters are microammeters designated VOLTMETER M–1301, IPA CURRENT M–1304, and PA CURRENT M–1303 (figure 2–108).

(1) VOLTMETER M–1301. — Various operating voltages employed in the RFA, as well as the peak value of the r-f input to the buffer, are selected by the VOLTMETER-METER SELECTOR switch Ⓙ, S–1384. As M–1301 is a microammeter the voltages are measured with the meter in series with meter-multiplying resistors located in the circuit to be tested. In the RF IN position, the r-f signal fed to the grid of the buffer, V–1301, is also fed to a network comprised of capacitors C–1328 and C–1309, resistor R–1338, and crystal diode CR–1301, which rectifies the signal and detects the approximate peak value, which is measured by M–1301. Capacitor C–1334 is an r-f bypass for M–1301. The positions of selector switch S–1384, the corresponding quantity measured, the full-scale deflection value of the quantity measured, and the meter-multiplying resistors used are given in table 2–20.

TABLE 2—20. VOLTMETER-METER SELECTOR SWITCH Ⓙ S–1384

POSITION	MEASURED QUANTITY	FULL-SCALE METER DEFLECTION	METER-MULTIPLYING RESISTOR USED
RF IN	R-f input at buffer grid	5 V	None
BIAS SUPPLY	−220-volt bias supply voltage	−500 V	R–1401
LOW VOLTAGE	+300-volt supply	+500 V	R–1318
MED. VOLTAGE	+500-volt supply	+1000 V	R–1317
PA SCREEN	PA screen grid voltage	+1000 V	R–1329
PA PLATE	PA plate voltage	+5000 V	R–1332 through R–1336, incl.

A receptacle, J–1309, used for checking of audio modulation (see Section 7, paragraph 6*a*(1)) is connected at the junction of meter-multiplying resistors R–1336 and R–1337.

(2) IPA CURRENT METER M–1304 AND PA CURRENT METER M–1303.—The IPA CURRENT meter, M–1304, and PA CURRENT meter, M–1303, are similar microammeters, used to measure operating currents independently in IPA (V–1303) and PA (V–1304), respectively. To measure these currents, the IPA-METER SELECTOR, switch Ⓖ, S–1386, and the PA-METER SELECTOR switch Ⓗ, S–1387, connect their respective meters across the shunting resistor that is located in the circuit to be measured. Capacitor C–1332 is an r-f bypass for M–1304, and capacitor C–1333 is an r-f bypass for M–1303. The positions of selector switches S–1386 and S–1387, the corresponding quantity measured, the full-scale deflection value of the quantity measured, and the shunting resistors used are given in tables 2–21 and 2–22.

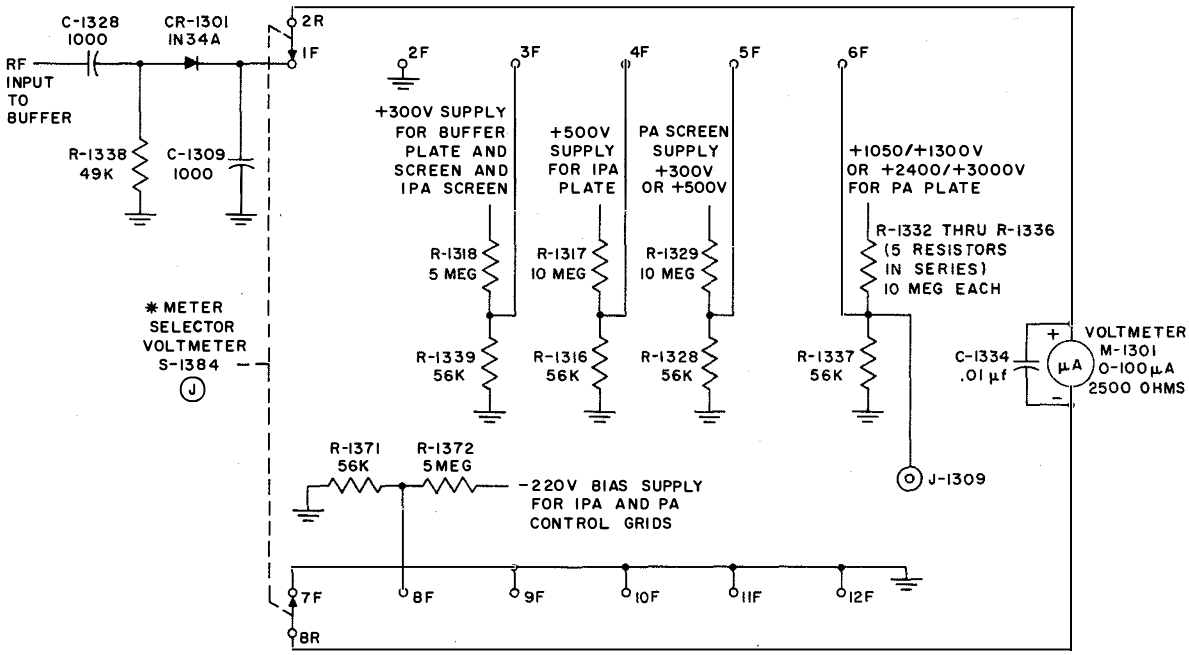
TABLE 2—21. IPA-METER SELECTOR SWITCH Ⓖ S–1386

POSITION	MEASURED QUANTITY	FULL-SCALE METER DEFLECTION	SHUNTING RESISTOR USED
I_{c1}	IPA control grid current	5 ma	R–1315
I_{c2}	IPA screen grid current	10 ma	R–1319
I_k	IPA cathode current	500 ma	R–1314

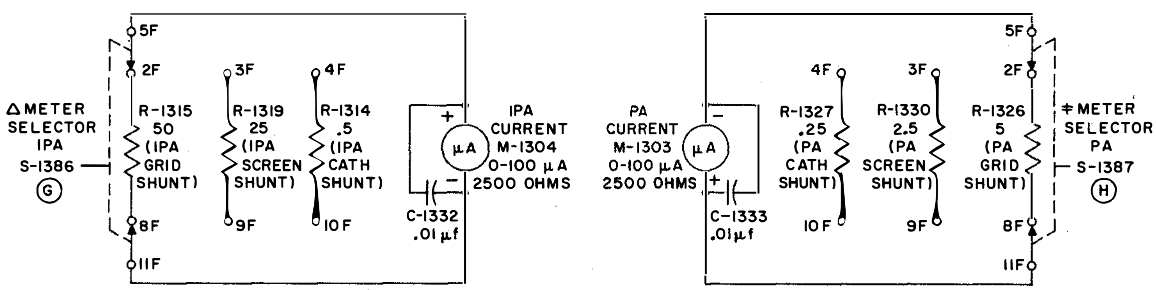
TABLE 2—22. PA-METER SELECTOR SWITCH Ⓗ S–1387

POSITION	MEASURED QUANTITY	FULL-SCALE METER DEFLECTION	SHUNTING RESISTOR USED
I_{c1}	PA control grid current	50 ma	R–1326
I_{c2}	PA screen grid current	100 ma	R–1330
I_k	PA cathode current	1000 ma	R–1327

j. R-F LINE FILTER Z–1301 AND BLOWER MOTOR B–1306.—Single-phase, 110-volt a-c, 60-cycle power is applied through terminals 1, 2, 3 and 9, 10, 11 of receptacle J–1301 to supply power for the RFA blower motor, B–1306, and the primary of the filament transformer, T–1302 (figure 2–109). The power is applied first through a capacity input L-C filter, Z–1301, for each side of the line. This prevents r-f voltages from the filament transformer being fed back into other units through the power line. The power is then fed through fuse F–1301 in one side of the line, to the blower motor, B–1306, and filament transformer primary terminals (terminals 1 and 2 of T–1302). Capacitor C–1310 is the phase-shifting capacitor needed to start and run B–1306.



* METER SELECTOR VOLTMETER S-1384 (J)	
POSITION	FUNCTION
1F, 7F	RF IN (+5V)
2F, 8F	BIAS SUPPLY (-500V)
3F, 9F	LOW VOLTAGE (+500V)
4F, 10F	MED VOLTAGE (+1000V)
5F, 11F	PA SCREEN (+1000V)
6F, 12F	PA PLATE (+5000V)



△ METER SELECTOR IPA S-1386 (G)	
POSITION	FUNCTION
2F, 8F	I_{c1} (5 MA)
3F, 9F	I_{c2} (10 MA)
4F, 10F	I_K (500 MA)

ǂ METER SELECTOR PA S-1387 (H)	
POSITION	FUNCTION
2F, 8F	I_{c1} (50 MA)
3F, 9F	I_{c2} (100 MA)
4F, 10F	I_K (1A)

Figure 2—108. Metering Circuits, Simplified Schematic

11. ELECTRICAL EQUIPMENT CABINET CY—1571/SRT (TRANSMITTER GROUP CABINET).

The transmitter group cabinet houses, from top to bottom, the RFA, LLRM, RFO, LVPS, and MVPS. On the cabinet is the retractable intercabling with the mating connectors for the five slide-in drawers and terminal boards for inputs and outputs to other assemblies of the transmitter. One cabinet is used in the AN/SRT–14 and AN/SRT–15; two are used in the AN/SRT–16. In a typical AN/SRT–14 and AN/SRT–15 installation, the transmitter group cabinet rests atop Mounting MT–1423/SRT; in the AN/SRT–16, the two cabinets (and mountings) are side by side.

The units in the transmitter group cabinet are removable drawers with mating connectors at their rear. These connectors engage corresponding connectors on the retractable cabinet intercabling, allowing the drawers to remain connected when pulled out. The input and out-

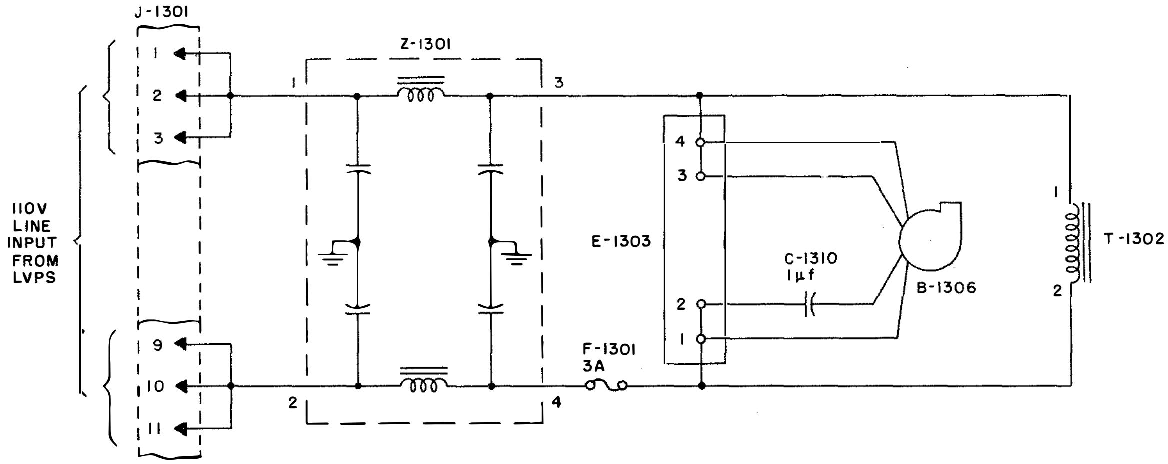


Figure 2—109. R-F Line Filter Z—1301 and Blower Motor B—1306, Simplified Schematic

put connections of these drawers (to units outside of the cabinet) are made at terminal boards E–601 through E–607, located at the bottom of the transmitter group cabinet. (However, the r-f output of the RFA requires special shielding and is fed to the load adjusting unit rather than a terminal board.)

Primary power to the transmitter bay is connected at terminal board E–602, terminals 15 and 16, and thence fed to r-f interference filters Z–601 and Z–602, which filter out any rf picked up in the power supplies, preventing r-f feedback into the primary power source. E–602 terminals 21 and 22 provide an input for uninterrupted 110 volts ac for the RFO oven heaters. This power is fed first through r-f interference filters Z–603 and Z–604. Exact location of Z–601 through Z–604 is shown on the transmitter group control circuit, figure 2–126.

12. ELECTRICAL EQUIPMENT CABINET CY—1572/SRT (HLRM CABINET).

The HLRM cabinet, which houses the high level radio modulator, is used only in the AN/SRT–15 and AN/SRT–16. It contains most of the terminal boards for the booster and has retractable cabling with mating connectors for the HLRM drawer, but no other electrical components. The HLRM cabinet and the HVPS cabinet, together with the units they house, constitute Radio Modulator-Power Supply OA–685/SRT, commonly called the "booster".

13. ELECTRICAL-EQUIPMENT CABINET CY—1573/SRT (HVPS CABINET).

The HVPS cabinet is physically similar to the HLRM cabinet and houses the high voltage power supply (used only in the AN/SRT–15 and AN/SRT–16). It contains retractable cabling with mating connectors for the HVPS drawer and terminal boards. A primary power input of 220- or 440-volt, 60-cycle, three-phase ac from the ship's supply is connected to the booster by means of E–1410 terminals 1, 2, and 3 located on the floor of the HVPS cabinet. Primary power is fed first through r-f interference filters Z–1401, Z–1402, and Z–1403, the exact location of these filters being shown on the booster control circuit, figure 2–127.

14. MOUNTING MT—1423/SRT (MOUNTING).

a. GENERAL.—The mounting contains two blowers and four heaters. The blowers supply air for cooling the various parts of the transmitter bay. In cold weather the heaters may be used to maintain the transmitter bay at a more favorable temperature during stand-by or nonoperating periods; after the transmitter bay has warmed up suffciently, the heaters may not be required. One mounting is used in the AN/SRT–14, and two are used in the AN/SRT–15 and AN/SRT–16. Operation of the blower motors and heaters is initiated by means of front panel controls on the LVPS.

b. BLOWERS.—The blowers are placed in operation by depressing the START push- button of MAIN POWER switch ⓇⓇ S–3004 on the LVPS front panel. The blowers continue to operate as long as the equipment is on. In the AN/SRT–16, the blowers in both mountings may be controlled from the LVPS in either the right or left transmitter group. The blowers draw air through three oil-impregnated filters in the front of the mounting. Air passes through the filters into an air chamber, from where it is led through two flexible ducts to the blower housings. The blower rotors force the air through two other flexible ducts into the side ducts of the transmitter group cabinet frames. Baffles are located in the transmitter group cabinet and on the drawer chassis to direct air flow through the equipment.

When the START push button of MAIN POWER switch ⓇⓇ is depressed, master control relay K–3001 and relay K–3004 are energized (see paragraph 4*c*), placing motors B–701 and B–702 (figure 2–110) across the 110-volt a-c line. In the AN/SRT–15 and AN/SRT–16, all the motors in both mountings are connected in parallel. (For terminal board connections, see the primary power distribution schematic, and the complete schematic of the mounting in Section 7.) Power is sup-

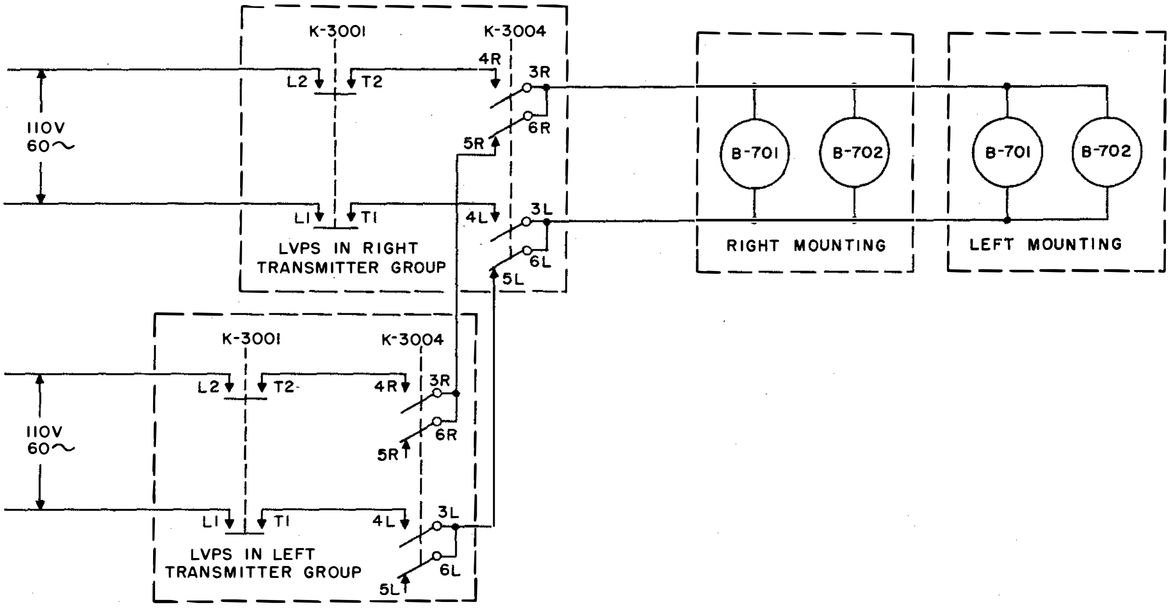
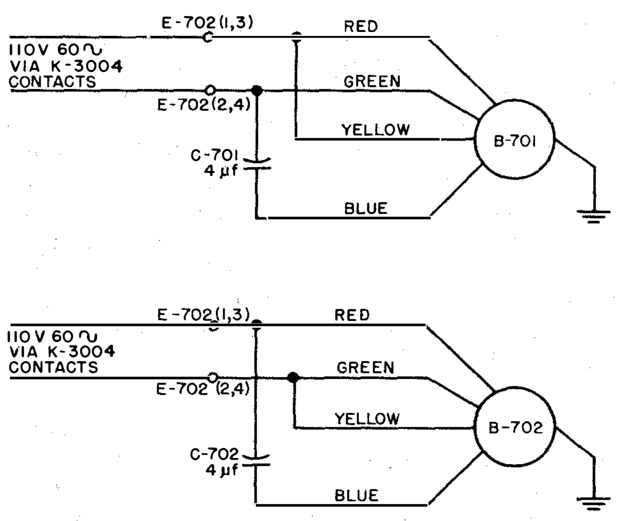


Figure 2—110. Blower Motors B—701 and B—702, Simplified Schematic

plied to the motors from either the right or left transmitter group through contacts of relay K–3004. These capacitor-start-and-run induction motors are designed for continuous duty and operation in ambient temperatures between −20°C. (−4°F.) and +65°C. (+149°F.). In each mounting, the two motors must run in opposite directions. Motor B–701 runs clockwise and B–702 runs counterclockwise. Although the motors are identical, in other respects, improper ventilation may result if the respective direction of rotation is not kept, because the impellers of B–701 and B–702 are of opposite pitch. The connections which determine the direction of rotation are shown in figure 2–111.



NOTE:
B-701 ROTATES CLOCKWISE, B-702 COUNTERCLOCKWISE (FACING MOTOR AT END OPPOSITE SHAFT EXTENSION).

Figure 2—111. Blower Motor Connections, Schematic

c. HEATERS.—Heating elements HR–701, HR–702, HR–703, and HR–704 (figure 2–112) are used when the temperature is below 16°C. (60°F.) to keep the oven circuits in the RFO at a temperature that permits them to function properly. When the cabinet ambient temperature is less than 16°C. (60°F.), the oven circuits are not capable of raising the temperature inside the oven to the specified 75°C. (167°F.). It may also be desirable to operate the heaters continuously when the equipment is shut down for long periods of time to prevent the condensation of moisture in the equipment. Power to the heating elements is controlled by CABINET HEATER switch (NN) S–3002 in the LVPS. When the temperature is between −1°C. (30°F.) and 16°C. (60°F.), heater and transmitter power should be turned on simultaneously, and the heaters should remain on 15 minutes. If the temperature is below −1°C. (30°F.), the heaters must be left on continuously (i.e., for the duration of transmitter operation).

The four 150-watt heaters are operated on 110 volts ac and are connected in parallel. In the AN/SRT–15, the heater circuits of both mountings are in parallel and receive power from the LVPS. In the AN/SRT–16 the heaters in the two mountings are individually energized from the CABINET HEATER switch (NN) in each of the transmitter groups. Therefore, to operate all heaters in the AN/SRT–16, both EMERGENCY SWITCH (MM) and the CABINET HEATER switch (NN) must be on in the LVPS of both transmitter groups. CABINET HEATER indicator light I–3003 in the LVPS of each transmitter group is illuminated individually as the respective heaters receive power.

15. TRANSMITTER COUPLER CU—402/SRT (LOAD ADJUSTING UNIT, LAU).

a. GENERAL.—The function of the load adjusting unit (LAU) is to improve the impedance match between the characteristic 50-ohm r-f output impedance of the radio frequency amplifier and the impedance presented by the antenna tuning equipment. The improved matching permits the final PA stage of the radio frequency amplifier to operate at optimum plate efficiency and improves the transfer of power to the antenna system. The LAU consists of the standing-wave ratio monitor circuit and the impedance transformer circuit.

b. STANDING-WAVE RATIO MONITOR CIRCUIT. — The function of the standing-wave ratio (SWR) monitor circuit is to detect and monitor the standing-wave ratio present in the r-f transmission line at the output of the radio frequency amplifier. The components of the SWR monitor circuit together form a unit designated Directional Coupler Z-3201 (figure 2-116).

The SWR monitor circuit is composed essentially of two bridge circuits combined with a voltage divider that is tapped to provide the required outputs. One bridge circuit provides a d-c voltage proportional to the reflected and the other bridge circuit provides a d-c voltage proportional to the incident wave in the r-f transmission line. Each bridge circuit utilizes a voltage proportional to the current in the r-f line and a voltage proportional to the voltage in the r-f line.

The r-f transmission line from the RFA is connected through J-3201 to the SWR monitor circuit and thence to the impedance transformer circuit. A voltage, e_{v2}, proportional to the r-f line voltage, is obtained directly from the line through the voltage divider, R-3201, and the d-c blocking capacitor, C-3201, to the crystal rectifier, CR-3202. A second voltage, e_{i2}, proportional to the current in the r-f line, is obtained from one-half of the secondary winding of current transformer T-3202. The center tap of the secondary winding of T-3202 is grounded, providing two voltages, one at each end, that are 180° apart with respect to each other. Resistors R-3201, R-3202, R-3203, and R-3204 are damping resistors. Voltage e_{i2}, since it is shifted 180° in phase by T-3201, is in phase with the voltage e_{v2} and both voltages add at the junction of CR-3202 and C-3201. Rectifier CR-3202 will conduct only when the voltage e_{v2} is of less value than e_{i2}. When rectifier CR-3202 conducts, a positive d-c potential will exist at the junction of CR-3202 and C-3201 because of the polarity of CR-3202. This resultant positive d-c voltage is proportional to the incident voltage on the transmission line.

A voltage, e_{v1}, proportional to the voltage on the r-f line is obtained directly from the line through voltage divider R-3201 and the d-c blocking capacitor, C-3204, and is applied to the crystal rectifier, CR-3201. Voltage e_{v1} is equal to and in phase with e_{v2}. A second voltage, e_{i1}, proportional to the r-f line current, is obtained from one-half of the secondary winding of T-3202. Voltage e_{i1} is 180° out of phase with voltage e_{i2}, obtained from the other half of T-3202 secondary. Voltage e_{i1} in this case is 180° out of phase with voltage e_{v1}. Rectifier CR-3201 will conduct only when the anode is positive with respect to the cathode. Since voltage e_{i1} is 180° out of phase with e_{v1}, these two voltages will subtract and produce a negative voltage at the junction of CR-3201 and C-3204 proportional to the reflected voltage in the r-f transmission line.

Between the junction of CR-3202 and C-3201, where a d-c potential proportional to the incident voltage is found, and the junction of CR-3201 and C-3204, where a d-c potential of opposite polarity, proportional to the reflected wave, is found, a voltage divider is connected. This voltage divider consists of resistors R-3206, R-3208, then through J-3203 pin B and interconnecting wiring to the control-indicator to pick up resistors R-410, R-415, R-414, R-412, then back to the LAU through J-3203 pin C to resistors R-3209 and R-3207. At some point on this divider there is a voltage equal to the ratio of the reflected voltage to the incident voltage, which bears a simple relationship to the standing-wave

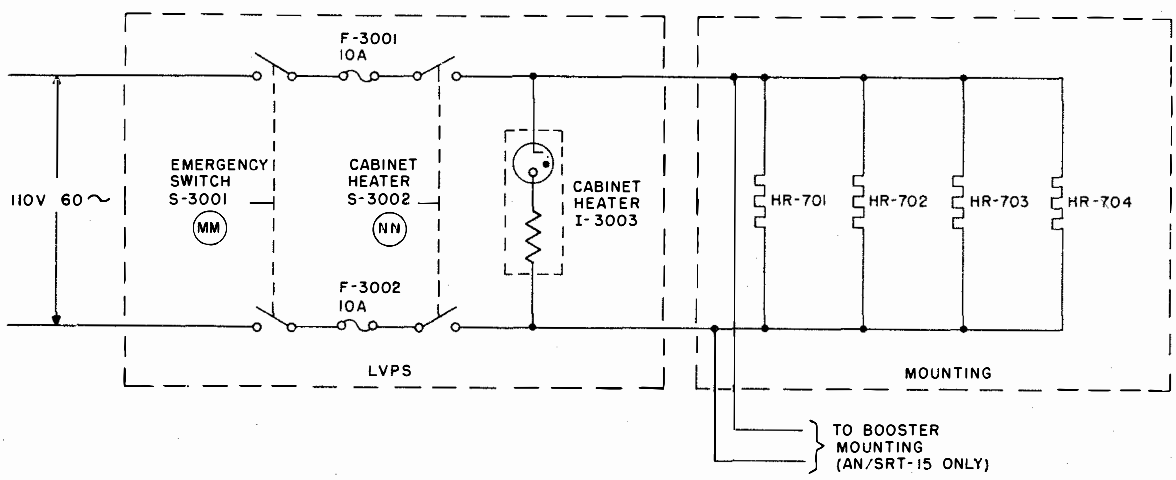


Figure 2—112. Heaters HR—701 Through HR—704, Simplified Schematic

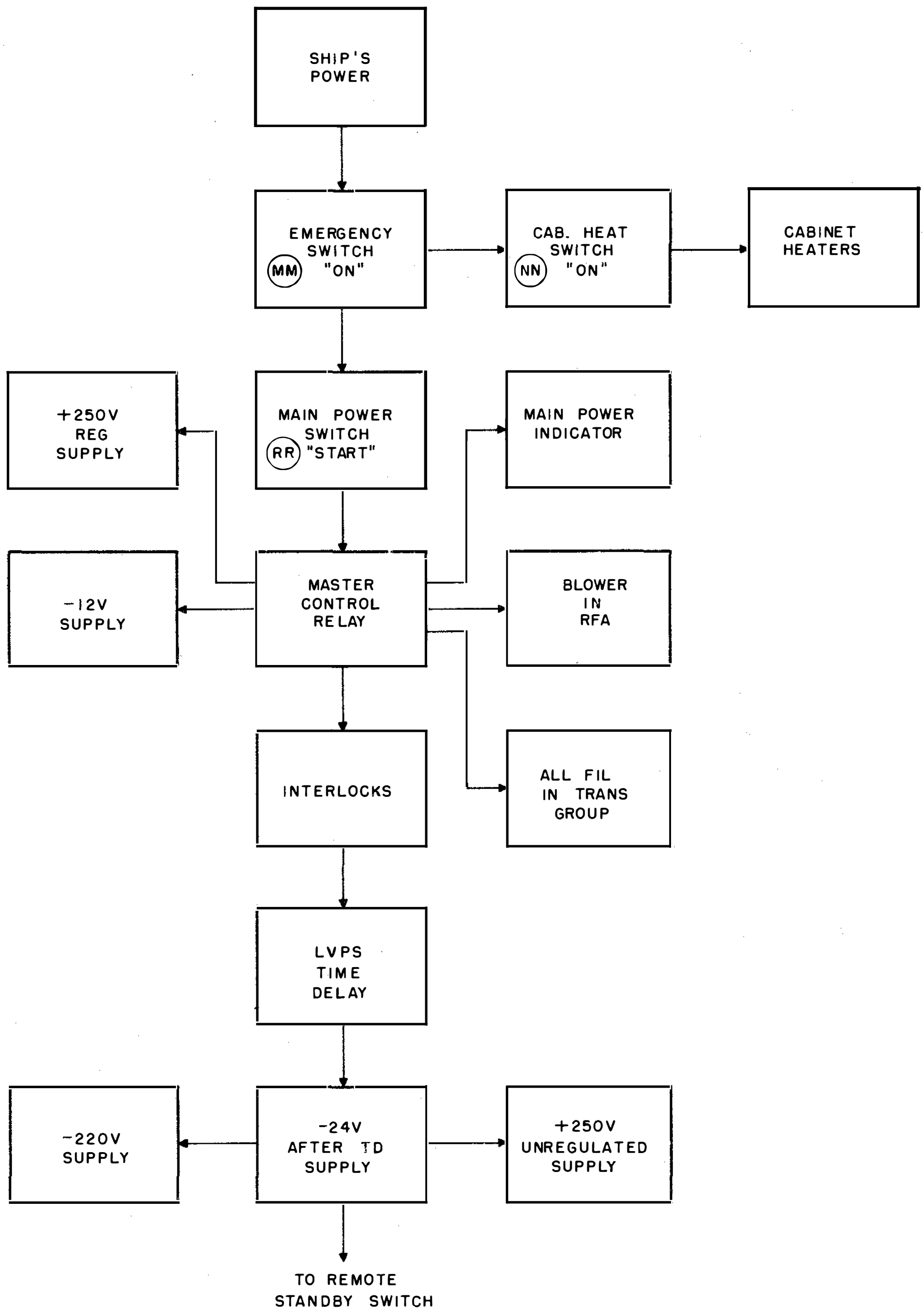
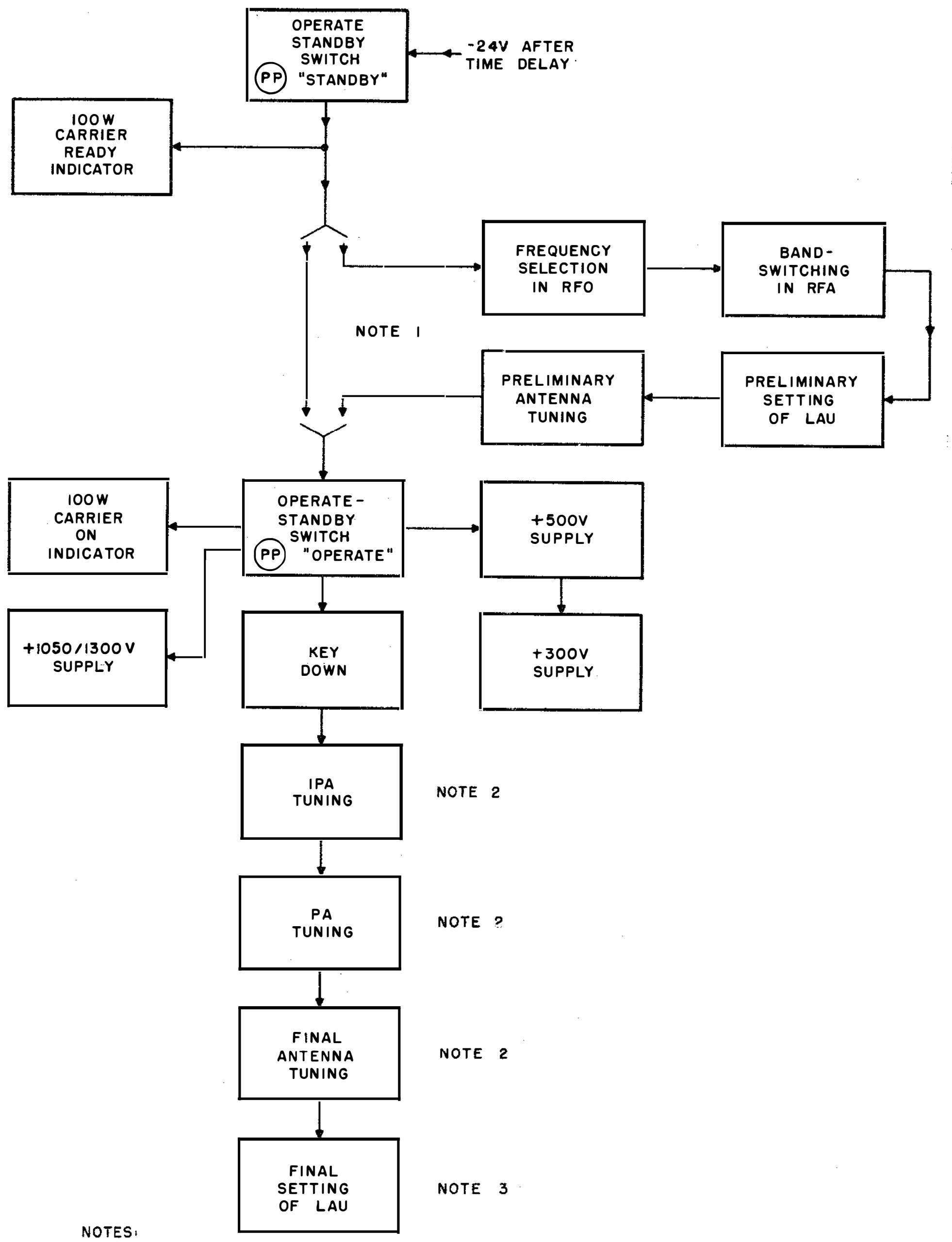


Figure 2—113. Control Circuits Operation Through —24 Volts After Time Delay, Simplified Functional Block Diagram

ratio (SWR). For any value of SWR, there will be a balanced (zero) condition at some point on the divider. The value of R–3201 is such that if there were no reflected current (SWR of 1:1), the d-c voltage at the junction of CR–3201 and C–3204 would be zero, and some positive d-c voltage would exist at the junction of CR–3202 and C–3201. With reflection on the line, d-c voltage at the junction of CR–3201 and C–3204 is negative and the d-c voltage at the junction of CR–3202 and C–3201 is positive. The zero point lies somewhere on the voltage-divider network. The voltage divider is tapped in the control-indicator unit at points that represent the location of the zero d-c voltage at standing-wave ratios of 8:1, 4:1, and 2:1. Paragraph 2*q*(6) covers the location of these taps and how the information is transformed to a meter indication of SWR.



NOTES:

1. FREQUENCY SELECTION, BANDSWITCHING, PRELIMINARY SETTING OF LAU, AND PRELIMINARY ANTENNA TUNING APPLY ONLY WHEN A DIFFERENT FREQUENCY IS DESIRED FROM PREVIOUS TRANSMISSION.
2. IPA, PA AND FINAL ANTENNA TUNING NOT REQUIRED WHEN SAME CONDITIONS EXIST AS LAST PREVIOUS TRANSMISSION.
3. FINAL SETTING OF LAU REQUIRED ONLY IF SWR IS GREATER THAN TWO TO ONE.

Figure 2—114. Control Circuits Operation from —24 Volts After Time Delay for 100-Watt Operation, Simplified Functional Block Diagram

c. IMPEDANCE TRANSFORMER CIRCUIT.—To improve the impedance match between the characteristic 50-ohm output impedance of the r-f output from the radio frequency amplifier (RFA) and the impedance presented to RFA by the antenna and the antenna tuning equipment, an autotransformer, T–3201 (figure 2–117), is introduced into the r-f transmission line. The r-f energy from the output of the RFA, after passing through the SWR monitor circuit, is connected to one of the taps of T–3201 through the contacts of INPUT TAP (W) switch S–3201. The output of the transformer, selected from one of the taps by the position of the OUTPUT TAP switch (WW), S–3202, is connected through r-f ammeter M–3201 to J–3202, which is the output to the antenna coupler. With controls (W) and (WW) both set at position 4, the full winding of the impedance transformer is shunted across the line. This is the normal setting of these controls. If, after all tuning procedures have been completed, the measured SWR is higher than 2:1, controls (VV) and (WW) are set for the optimum impedance match as indicated by the tuning indications of the PA stage of the radio frequency amplifier (see Section 4, paragraph *6a*) .

16. TRANSMITTER BAY CONTROL CIRCUITS.

a. GENERAL.—The control circuits located in the transmitter bay have been discussed separately under the descriptions of the various major units to which the individual control functions apply. The following will be a condensed discussion to unite all of the control functions. Included as control functions are the control of power circuits, manual setting up of a frequency in the RFO, manual tuning of the RFA, selection of the output power level, and placing the carrier on the air. Overload and other protection devices are employed to prevent damage to the equipment when operating at the 500-watt level. Various indicator lights show the operating condition of the transmitter bay.

b. SEQUENCE OF OPERATION.—Figures 2–113, 2–114, and 2–115 are simplified functional diagrams showing, in sequence, the operation of the control circuits. Figure 2–113 shows the operation through "—24 V after time delay", which is the same for either 100-watt or 500-watt operation. Figure 2–114 continues the sequence operation for 100-watt operation; figure 2–115 shows the sequence for 500-watt operation.

Note

As the AN/SRT–14 does not operate at the 500-watt level, the sequence of operation for 500-watt output level applies to the AN/SRT–15 and 16 only.

(1) The main power input (top block of figure 2–113) is 110-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).

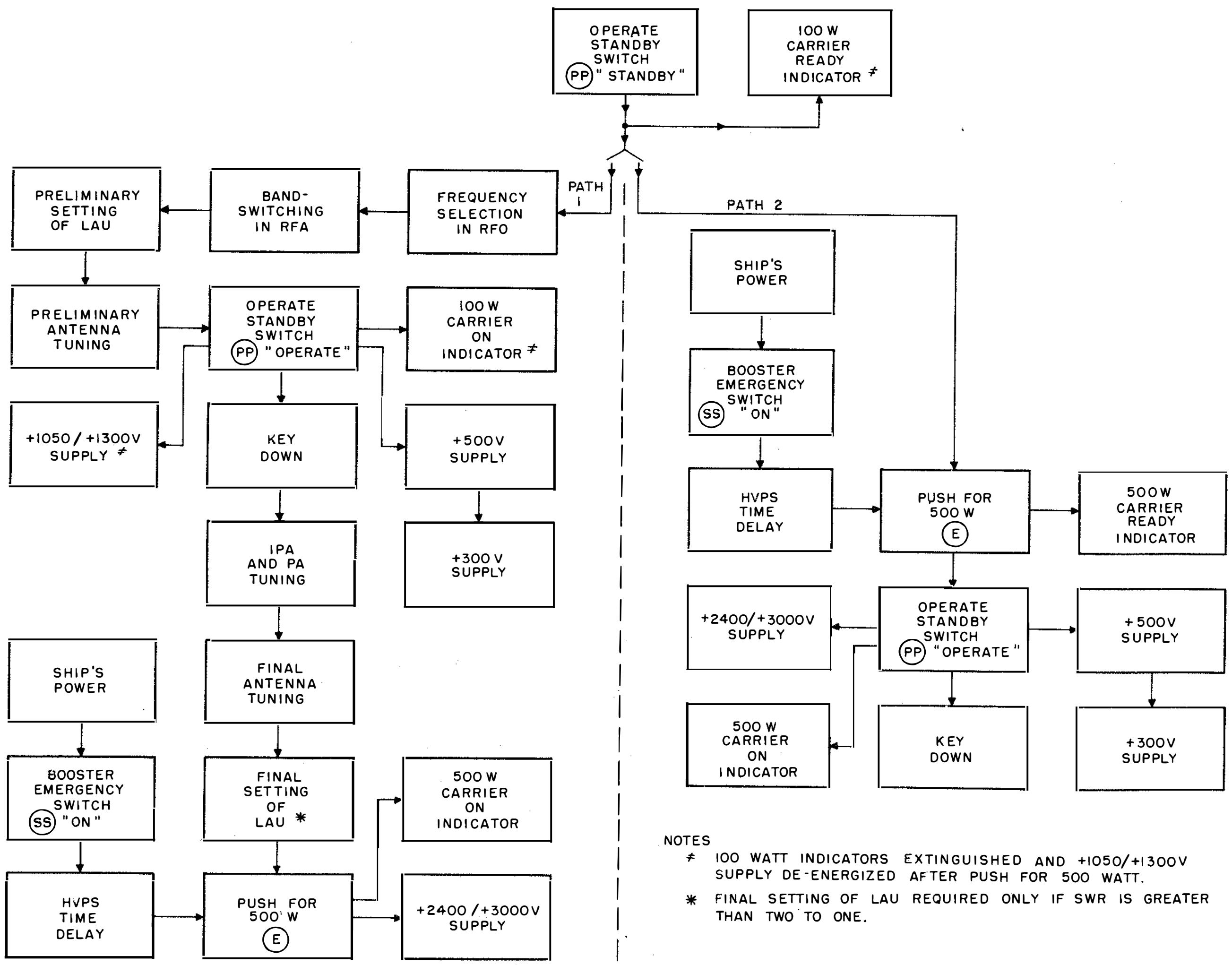


Figure 2—115. Control Circuits Operation, from —24 Volts After Time Delay for 500-Watt Operation, Simplified Functional Block Diagram

(2) When the start button of switch Ⓡⓡ is depressed, the master control relay is energized, which distributes a-c power for the following purposes: to distribute a-c power through the transmitter 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 V after time delay" supply is energized, which is a control voltage. With "−24 V after time delay" the −220 V and the +250 V unregulated supplies in the LVPS are energized.

Note

The following sequence applies only with the SERVICE SELECTOR Ⓤ on the LLRM set at the HAND position.

(3) At this point for 100-watt operation (figure 2–114), with the STANDBY-OPERATE switch Ⓟⓟ in STANDBY, the CARRIER-100W-READY indicator will be energized. If a different frequency is desired from the last previous transmission, the manual settings of the new frequency by the control knobs on the RFO are made at this point in sequence, followed by the corresponding manual bandswitching in the RFA, the initial setting of the two switches on the load adjusting unit, and then initial antenna tuning by the manual controls on the control-indicator. Placing the STANDBY-OPERATE switch Ⓟⓟ in OPERATE energizes +500-volt and +1,050/+1,300-volt supplies in the MVPS and energizes the CARRIER-100W-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 a 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.

(4) For 500-watt operation (figure 2–115) after LVPS time delay, and with the STANDBY-OPERATE switch Ⓟⓟ in STANDBY, frequency selection, if required, takes place as described in the previous paragraph. The sequence now takes one of two paths, depending on whether or not tuning is required. If tuning is required, this 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 explained above. After tuning is complete, the BOOSTER EMERGENCY SWITCH Ⓢⓢ, which controls power input to the booster, is turned on. This supplies either 220-volt 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 W button Ⓔ is depressed, energizing the +2,400/+3,000-volt supply and the CARRIER-500W-ON indicator. Concurrently, the 100 W indicator and the +1,050/+1,300-volt supply are de-energized. If no tuning is required (path 2), the booster emergency switch Ⓢⓢ is placed in the ON position. When switch Ⓢⓢ is closed, the booster receives either 220-volt 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 W button Ⓔ is depressed, energizing the CARRIER-500-W-READY indicator. Placing the STANDBY-OPERATE switch Ⓟⓟ in OPERATE energizes the +2,400/+3,000-volt supply in the HVPS, the +500-volt supply in the MVPS, the CARRIER-500-W-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.

(5) The operation of the control circuits in the AN/SRT–14 can be, as described above, for 100 watts only; however, in the AN/SRT–15, operation can be either as described for 100 watts or 500 watts, depending on the power level selected. The AN/SRT–16 has two transmitter groups: one group operates at the 100-watt level only, the other at either 100 watts or 500 watts. Both transmitter groups of the AN/SRT–16 may operate simultaneously. The choice of which transmitter group in the AN/SRT–16 operates at both power levels is made at the time of installation, when the "booster" output is connected to one of the transmitter groups.

Note

In the discussion that follows, reference will be made to other portions of Section 2 where the circuits being analyzed are covered more completely. Figures 2–126 and 2–127 are simplified schematics of the AN/SRT transmitter bay control circuits, excluding those in the left transmitter group. Switches, relays, and relay contacts that are used in the signal circuits of the transmitter are not shown in figures 2–126 and 2–127. Wire numbers are given to aid in following the discussion. The portion of figure 2–126 concerning the control-indicator control circuits is discussed with the r-f tuner and antenna coupler control circuits (paragraph 17*d*).

c. SUMMARY OF CONTROL CIRCUIT OPERATION.—The LVPS and HVPS receive all the power from the ship's supply. The LVPS receives 110-volt a-c, 60-cycle, single-phase power. The HVPS receives either 220- or 440-volt, three-phase, a-c power from the ship's supply. All other units in the transmitter bay receive a-c power from the LVPS or the HVPS (with the exception of the RFO oven circuits).

(1) POWER CONTROL.—The power input to the transmitter bay is controlled by EMERGENCY SWITCH Ⓜⓜ, BOOSTER EMERGENCY SWITCH Ⓢⓢ, and MAIN POWER switch Ⓡⓡ. The CABINET HEATER switch Ⓝⓝ controls power to the cabinet heaters in the mounting.

(*a*) The transmitter group cabinet receives the input power (110 volts ac) to the LVPS through E-602 terminals 15 and 16 (figure 2-126). The input power is fed first through interference filters Z-601 and Z-602 to E-602 terminals 17 and 18. Wires 215 and 216 deliver the 110 volts ac through J-611 to the LVPS via mating connector J-3003 pins 4 through 8 and 12 through 16. Five pins are used on P-3001 for each side of the incoming line to insure adequate current-carrying capacity. This power is fed to EMERGENCY SWITCH Ⓜ︎Ⓜ︎ S-3001, which controls power to the transmitter group. With switch Ⓜ︎Ⓜ︎ closed, power is delivered to the cabinet heaters in the right and left mountings through CABINET HEATER switch ⓃⓃ S-3003, and its presence is shown by CABINET HEATER indicator light I-3003.

(*b*) Power is also delivered through fuses F-3007, F-3008 and F-3005, F-3006 to the start-stop circuit and to the INTERLOCK BATTLE SHORT indicator, I-3007, under control of the INTERLOCK BATTLE SHORT switch, S-3007.

(*c*) The start-stop circuit controls power to the transmitter group and protects personnel. Depressing the START button on MAIN POWER switch ⓇⓇ S-3004 energizes master control relay K-3001 and MAIN POWER INDICATOR light I-3001. When K-3001 is energized, power is applied to the LVPS rectifiers, the RFA filaments and blower, the RFO filaments, the LLRM filaments, the +250-volt regulated supply and the -12-volt supply in the LLRM, and the MVPS filaments. (For a complete discussion of power distribution, see paragraph 4*c*.)

(*d*) The booster (HVPS and HLRM) receives input power (figure 2-127) (220 or 440 volts, three phase, 60 cps) through E-1410 terminals 1, 2, and 3. The input power is fed first through interference filters Z-1401, Z-1402, and Z-1403 to E-1403 terminals 21, 22, and 23. Wires 414, 415, and 416 connect the power to the HVPS through J-1401 and J-1501 pins 1 through 4, 9 through 12, and J-1402 and J-1502 pins 1, 2, 9, 10. This power is then fed to the BOOSTER EMERGENCY SWITCH ⓈⓈ, S-1501, which controls a-c power to the booster. With switch ⓈⓈ closed, power is fed to the contacts of relay K-1502, through fuses F-1501, F-1502, and F-1503, and one phase is fed through fuses F-1504 and F-1505 to the HLRM and HVPS filaments and to the HVPS time delay. The TIME DELAY indicator light indicates that the HVPS time delay has run out. With the STANDBY-OPERATE switch ⓅⓅ in OPERATE, the transmitter in 500-watt operation and the HVPS time delay run out, K-1502 energizes and, through its contacts, connects three-phase power to the +2,400/+3,000-volt rectifier. Indicator lights H.V. PRIMARY ϕ1 (I-1503), H.V. PRIMARY ϕ2 (I-1502, and H.V. PRIMARY ϕ3 (I-1501) indicate that power is being applied to the +2,400/+3,000-volt rectifier.

(2) POWER SUPPLIES.—Power supplies providing the various working voltages required are located in the LVPS, HVPS, LLRM, and, for the AN/SRT-15 or 16 only, in the HVPS.

The LVPS (figure 2-126) contains five power supplies: "−24 V after time delay" supply, "−24 V after standby" supply, the −220-volt supply, the +250-volt unregulated supply, and the +300-volt supply.

(*a*) As soon as the master control relay is operated, a −24 volts, from a metallic rectifier, is fed, through the interlock system, to the time delay relay K-3003. After approximately 30 seconds, K-3003 is operated and a "−24 V after time delay" source becomes available. This is first carried to the (PUSH TO TURN) switch, S-1383, associated with bandswitch in the RFA, by way of J-3001 and J-609 pin 12, through wire 229 to J-601 and J-1301 pin 12. The "−24 V after time delay" is then distributed to the control circuits of the other major units in the following manner: by wire 102 from J-1301 and J-601 pin 5 (in the RFA) to J-603 and J-1101 pin 5 (in the LLRM); then by wire 115 from J-603 pin 5 to J-606 and J-2916 pin 5 (in the RFO); then by wire 126 from J-606 pin 5 to J-609 and J-3001 pin 5 (in the LVPS); then by wire 132 from J-609 pin 5 to J-612 and J-501 pin 5 (in the MVPS); then by wire 161 from J-612 pin 5 to E-607 terminal 87; then by interconnecting cabling to E-1406 terminal 4 (of the HLRM cabinet) (figure 2-127) through wire 304 to J-1403 and J-1601 pin 5 (in the HLRM); and, finally, by interconnecting cabling, from E-1406 terminal 4 to E-1401 terminal 4 (of the HVPS cabinet), through wire 404 to J-1401 and J-1501 pin 5 (in the HVPS). In the LVPS (figure 2-126) the TIME DELAY indicator, I-3002, is illuminated when the "−24 V after time delay" supply becomes energized. The "−24 V after time delay" is delivered to the STANDBY-OPERATE switch ⓅⓅ, S-3005. When S-3005 is closed, the stand-by relay operates, provided there is a ground on the keying line in the LLRM and, through its closed contacts, provides a supply known as the "−24 V after standby" supply. This supply is fed to the control circuits in the RFA by wire 228 from J-3001 and J-609 pin 13 to J-601 and J-1301 pin 13. The "−24 V after standby" is also fed to other control circuits in the following manner: by wire 135 from J-609 pin 13 to J-612 and J-501 pin 13 (in the MVPS); then by wire 166 from J-612 pin 13 to E-607 terminal 94; then by interconnecting cable to E-1406 terminal 5 (of the HLRM cabinet) (figure 2-127), through wire 305 to J-1403 and J-1601 pin 13 (in the HLRM); and, finally, by interconnecting cabling from E-1406 terminal 5 to E-1401 terminal 5 (in the HVPS cabinet), through wire 405 to J-1401 and J-1501 pin 13 (in the HVPS).

(*b*) When the "−24 V after time delay" supply becomes energized, relay K-3004 operates (figure 2-126). In addition to applying power to the blowers in the mounts, operated K-3004 energizes the -220-volt, +250-volt unregulated and the +300-volt supplies in the LVPS. The output of the −220-volt supply illuminates the −220 V indicator, I-3006, and is delivered to the LLRM from J-3001 and J-609 pin 14, over wire 197 to J-603 and J-1101 pin 14; then it is delivered

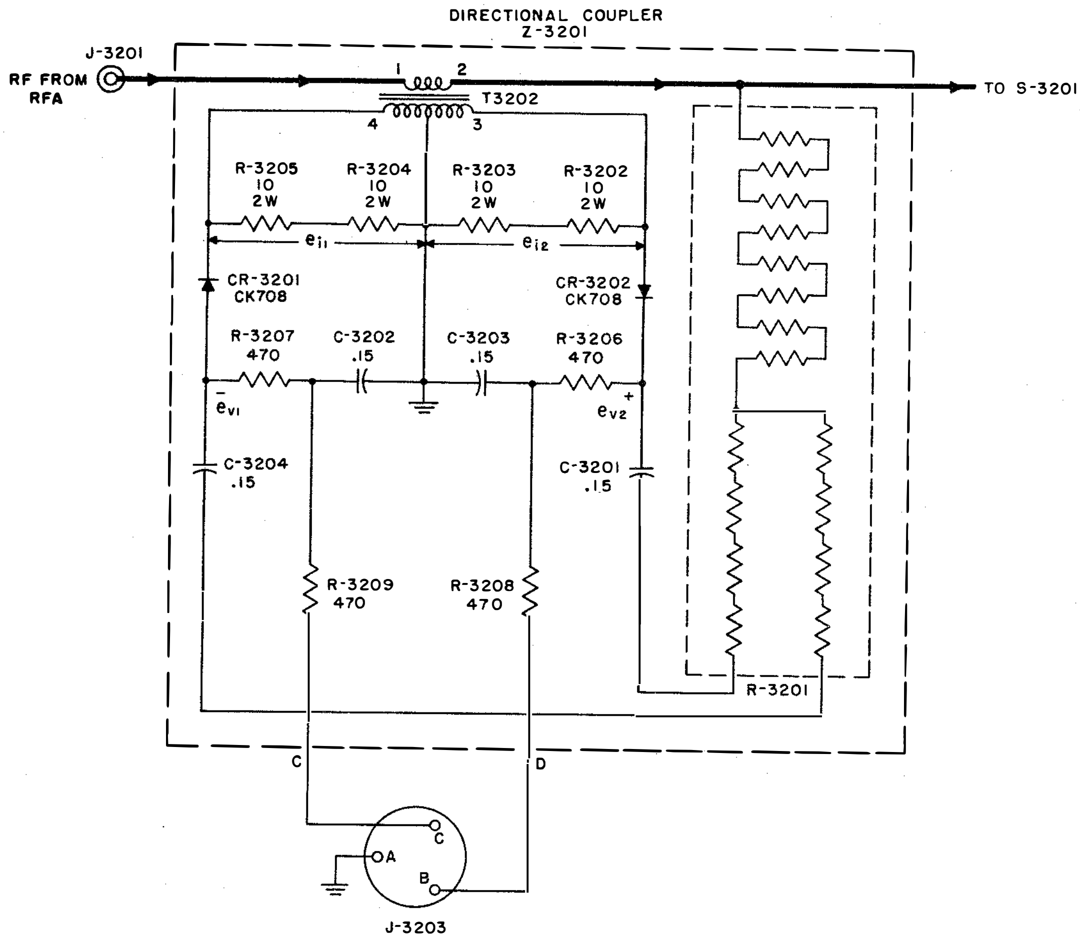


Figure 2—116. Standing-Wave Ratio Monitor Circuit, Simplified Schematic

to the RFA from J–603 pin 14 over wire 106 to J–601 and J–1301 pin 14. The output of the +250-volt unregulated supply illuminates the +250 V indicator, I–3004, and is fed to the RFO from J–3002 and J–610 pin 7 over wire 129 to J–607 and J–2917 pin 7. The output of the +300-volt supply is delivered first to the MVPS from J–3002 and J–601 pin 16, over wire 137 to J–613 and J–502 pin 16. In the MVPS the +300 volts is fed to the contacts of relay K–504. K–504 is energized when the +500-volt supply in the MVPS is energized. With K–504 operated, +300 volts is returned through the contacts 5R and 6R of K–504 to the LVPS by way of J–502 and J–613 pin 8, over wire 136 to J–610 and J–3002 pin 8. In the LVPS, the +300-volt supply is now filtered and the output illuminates the +300 V indicator, I–3005, and is delivered to the LLRM from J–3001 and J–609 pin 6, over wire 196 to J–603 and J–1101 pin 6; then it is fed to the RFA from J–603 pin 6 over wire 103 to J–601 and J–1301 pin 6.

(*c*) The MVPS contains two power supplies: the +500-volt supply and the +1,050/+1,300-volt supply. The +500-volt supply is turned on when relay K–501 is energized. K–501 operates after the LVPS time delay has run out and with the STANDBY-OPERATE switch Ⓟ in the OPERATE position in either 100-watt or 500-watt operation. As soon as power is applied, through the contacts 2L, 3L and 2R, 3R of K–501, to the plate transformer of the +500-volt supply, the 500 V PRI indicator, I–501, is illuminated. The output of the +500-volt supply illuminates the 500 V OUTPUT indicator, I–503, and is fed first to the LLRM from J–502 and J–613 pin 15, over wire 195 to J–604 and J–1102 pin 15; then it is delivered to the RFA from J–604 pin 15 over wire 113 to J–602 and J–1302 pin 15. The output of the +500-volt supply also energizes relay K–504, which switches on the +300-volt supply as described in the previous paragraph.

(*d*) The +1,050/+1,300-volt supply is energized when relay K–503 operates. K–503 operates in 100-watt operation only after the LVPS time delay has run out and with the STANDBY-OPERATE switch Ⓟ in the OPERATE position. As soon as power is applied, through the contacts 3L, 4L and 2R, 3R of K–503, to the plate transformer of the +1,050/+1,300-volt supply, the 1300 V PRI indicator, I–502, is illuminated, and when there is an output, the 1300 V OUTPUT indicator, I–504, is illuminated. In all modes of operation except phone, relay K–502 is not energized, and the output of the supply is +1,300 volts. In phone operation, K-502 is energized, decreasing the secondary-to-primary turns ratio of the plate transformer, thus reducing the output of the supply to +1,050 volts. The output is delivered to the LLRM from J-503 and P-608 over wire 225 to P-605 and J-1107. In the LLRM this voltage is fed to T-1004. In phone operation K-1106 is energized, removing the short from T-1004, and the +1,050-volt supply is modulated. In operations other than phone, K-1106 is not energized and T-1004 is shorted out, having no effect on the +1,300-volt supply. The supply, either +1,050 volts modulated or +1,300 volts unmodulated, is now fed through J-1108 and J-606 over wire 231 to E-608 terminal 1. In an AN/SRT-15 or 16, where there is a booster, the +1,050/+1,300-volt supply is fed to the HLRM through interconnecting cabling from E-608 terminal 1 to E-1408 terminal 3 (in the HLRM cabinet) (figure 2-127) over wire 318 to P-1403 and J-1604. The supply is switched in the HLRM, as explained in paragraph 9(*b*), and then fed to the RFA. In an AN/SRT-14, which has no booster, the +1,050/+1,300-volt supply is fed directly to the RFA by a jumper from terminal 1 to terminal 2 of E-608, over wire 232 to P-604 and J-1306.

(*e*) The LLRM contains two power supplies, a +250-volt regulated and a −12-volt supply (figure 2-126), which are used in other major units in addition to the LLRM. As soon as the master control relay in the LVPS is energized by depressing the START button on the MAIN POWER switch ⓇⓇ, both the +250-volt regulated and −12-volt supplies are energized. The output of the +250-volt regulated supply illuminates the 250 V.P.S. indicator, I-1001. This supply is used for a plate supply in the LLRM and also is supplied to the RFO through J-1102 and J-604 pin 12, over wire 121 to J-607 and J-2917 pin 12. The −12-volt supply provides power for operating the carbon microphone and press-to-talk relay K-1107 in the LLRM and is supplied to the control circuits of the remote radiophone unit through J-1102 and J-604 pin 7, over wire 209 to E-601 terminal 7, and interconnecting cabling to the remote radiophone unit.

(*f*) The HVPS, which is a component of the AN/SRT-15 and 16 only, contains the +2,400/+3,000-volt supply used in the RFA as PA plate supply in 500-watt operation (figure 2-127). The output is +2,400 volts for phone operation, +3,000 volts in other modes of operation. The supply is fed to the HLRM from J-1503 and P-1401, over wire 417 to E-1404 terminal 1 (in the HVPS cabinet); then over interconnecting cabling to E-1408 terminal 2 (in the HLRM cabinet), over wire 317 to P-1402 and J-1603. In the HLRM, the supply is filtered and delivered to T-1601. In phone operation, relay K-1603 is energized, removing the short from T-1601, and the +2,400-volt supply is modulated. In other modes of operation, K-1603 is not energized, and T-1601 is shorted out, having no effect on the +3,000-volt supply. The supply, whether +2,400 volts modulated or +3,000 volts unmodulated, is fed through J-1605 and P-1404, over wire 316 to E-1408 terminal 1, through interconnecting cabling to E-608 terminal 2 (in the transmitter group cabinet) (figure 2-126) over wire 232 to P-604 and J-1306 in the RFA.

(3) FREQUENCY SELECTION.—At this point of the operation, it is assumed that all power has been turned on, the time delays have run out, and the STANDBY-OPERATE switch ⓅⓅ is in the STANDBY position. If a frequency of different value from that of the last previous transmission is desired, the selection of the new value is now made in the RFO. Frequency selection in the AN/SRT-14, 15 and 16 is accomplished by the manual setting of nine frequency selection knobs located behind a door on the RFO front panel. To change frequency, the door must first be opened; this opens door switch S-2920, whose function is to reduce the carrier level to 100 watts if someone should attempt to change frequency with a 500-watt carrier on. Paragraph 10*e*(1) describes this action in more detail. After the door is opened, the nine knobs are set according to the instructions appearing on the front panel; then the door is closed, completing the frequency selection.

(4) BANDSWITCHING.—Bandswitching in the AN/SRT-14, 15 and 16 also is a manual function and is accomplished by the appropriate setting of the BANDSWITCH Ⓒ in the RFA according to the frequency selected for transmission.

(5) LOAD ADJUSTING UNIT TUNING.—With the transmitter in stand-by the INPUT TAP Ⓥ and OUTPUT TAP ⓌⓌ are both set at 4. After all other tuning is completed and SWR as recorded on the SWR BALANCE meter on the control indicator is still greater than 2:1, Ⓥ and ⓌⓌ controls must be changed to improve the standing-wave ratio.

(6) IPA AND PA TUNING.—As in the case of frequency selection, IPA and PA tuning are required only if a new frequency is selected, or if there is some other reason that the transmitter is not in the same condition as that of the previous transmission. At this point, the RFA must be energized and a signal sent to it from the RFO. This is accomplished by placing the STANDBY-OPERATE switch ⓅⓅ in OPERATE and, with the SERVICE SELECTOR Ⓤ in the HAND position, depressing the TEST KEY, Ⓣ. The IPA and buffer tank circuits are tuned first by manually tuning the TUNE IPA control Ⓑ to obtain maximum PA grid drive as measured on the PA CURRENT meter, M-1303, with PA METER SELECTOR Ⓗ in the Ic_1 position. After IPA tuning is complete, the tank circuit of the PA is tuned by manually controlling the TUNE PA control Ⓓ to maintain maximum PA screen grid current as measured on the PA current meter, M-1303, with PA METER SELECTOR Ⓗ in the Ic_2 position.

(7) ANTENNA TUNING.—Preliminary antenna tuning takes place at the same time as frequency selection and bandswitching, that is, with the transmitter in stand-by. Final antenna tuning is accomplished after IPA

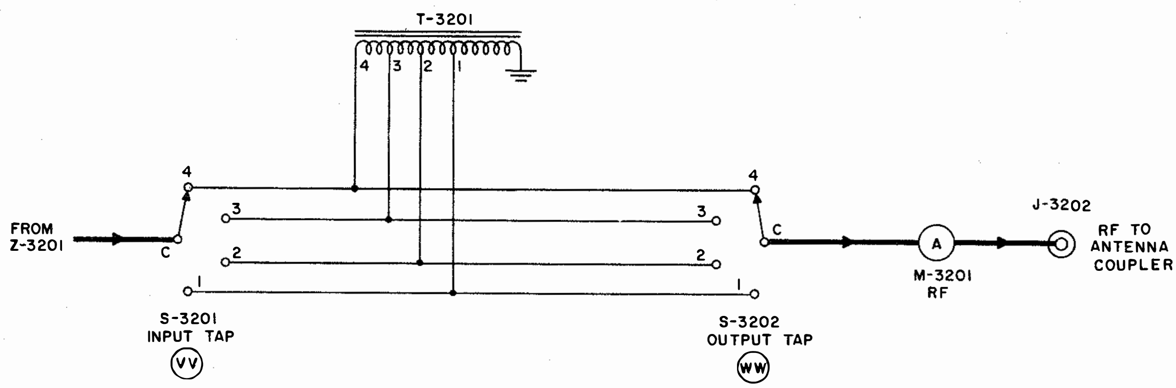


Figure 2—117. Impedance Transformer Circuit, Simplified Schematic

and PA tuning with a carrier energized. A complete discussion of the control circuits involved in antenna tuning is covered in paragraph 17*d*.

(8) CARRIER ON.—With all power on, all time delays run out and all tuning functions complete, the equipment is prepared for transmission. Five services are available and chosen by the SERVICE SELECTOR Ⓤ, located on the LLRM front panel. These services are: hand key, machine key, frequency-shift key, facsimile, and phone. Any of the above services can be operated at either the 100-watt level or 500-watt level. The transmitter group is in 100-watt operation as long as the 500-watt operate relay K–1304 is not energized and, conversely, is in 500-watt operation when K–1304 is operated.

(*a*) HAND-KEY OPERATION. — When the SERVICE SELECTOR Ⓤ is in the HAND position, the carrier can be placed on the air by the TEST KEY Ⓣ or by depressing an external key connected to a remote radiophone unit. Depressing the key operates the keying relay, K–1101, which, in turn, activates the keying circuit of the LLRM to key on the transmitter. "Key down" also energizes the ATU bypass transfer circuit and the antenna switching relay, K–1306, in the RFA, whose functions are described in paragraphs 7*g* and 10*e*(2), respectively.

(*b*) MACHINE-KEY OPERATION.—When the SERVICE SELECTOR Ⓤ is in the MACH position, keying signals from teletype or other machine equipment are received to trigger the keying circuit of LLRM to key the transmitter. Concurrently, the keying line must be permanently closed in machine-key operation to keep the keying relay, K–1101, and the antenna switching relay, K–1306, permanently energized so that the "–24 V after standby" line remains energized and the antenna remains connected to the RFA output during machine-key transmissions. This also provides a permanent signal for the ATU bypass transfer circuit.

(*c*) FREQUENCY-SHIFT KEY OPERATION.—When the SERVICE SELECTOR Ⓤ is in the FSK position, the carrier remains on the air. Keying signals are received from machine-key equipment that triggers the keying circuit of the LLRM. In this case, the keying output is used to frequency-modulate the carrier instead of keying the carrier on and off. As for the MACH position described above, a permanent signal must be applied to the keying line for FSK operation.

(*d*) FACSIMILE OPERATION.—With switch Ⓤ in the FAX position, a permanent signal must be applied to the keying line, as in the MACH and FSK positions, to keep the carrier on the air. There is no keying function in this operation and the signal from the facsimile equipment is fed to the RFO to frequency-modulate the carrier.

(*e*) PHONE OPERATION.—In the PHONE position of switch Ⓤ a special line of ground potential is established known as the "ground for phone" line. The presence of this ground energizes K–1106 in the LLRM, which removes the short from T–1004, and allows the plate supply of the PA to be audio-modulated. This line also energizes K–502 in the MVPS, which reduces the turns ratio of T–502, reducing the output of the +1,300-volt supply to +1,050 volts. This supply is the PA plate supply in 100-watt operation only. Through contacts of energized K–502, a source of ground potential, present in 500 watts only, is supplied to energize K–1601 in the HLRM, which turns on the screen supply for the HLRM. K–1601, in turn, energizes K–1603, which removes the short from T–1601, permitting the PA plate supply to be audio-modulated. Also in 500-watt operation, "ground for phone" energizes K–1501 in the HVPS, which reduces the turns ratio of T–1502, thus reducing the output of the +3,000-volt supply to +2,400 volts. Placing switch Ⓤ in the PHONE position also connects the keying line to the phone output so that the press-to-talk button operates the keying relay in the same manner as the hand key does when switch Ⓤ is in the HAND position. Therefore, press to talk keys the transmitter carrier on and off, controls the antenna switching function, and controls the output of the ATU bypass transfer circuit.

(*f*) 100-WATT OPERATION.—When all the operations for energizing the transmitter are followed, as described previously, and transmitter is keyed-on, transmission will be at the 100-watt level unless K–1304 in the RFA is energized. With K–1304 not operated, a ground supply known as the "ground for 100 W" line is established. This line energizes the +500-volt and +1,050/+1,300-volt supplies by energizing relay K-503 and K-501 in the MVPS. This line also supplies a ground to illuminate the CARRIER-100 W-READY and CARRIER-100 W-ON indicators. The screen supply to the PA is also controlled by K-1304, and with K-1304 not operated in 100 watts, +300 volts is applied to the PA screen.

(*g*) 500-WATT OPERATION.—To change the transmitter from the 100-watt level to 500 watts, the plate and screen supplies of the PA are increased and, in phone, the power of the audio modulating signal is increased. To accomplish this, K-1304 is energized by depressing the PUSH FOR 500 W button Ⓔ on the RFA. With K-1304 energized, the "ground for 100 W" line is opened, and in its place two other sources of ground potential known as the "ground for 500 W" and "ground for 500 W" AX lines are established. The latter is established slightly ahead of the former as K-1304 energizes, to prevent a false operation of the control circuits due to "sneak paths". As the "ground for 100 W" line is no longer present, the +1,050/+1,300-volt supply is no longer energized, and, in its place, the +2,400/+3,000-volt supply is energized by the operation of K-1502 through the "ground for 500 W" line (assuming the BOOSTER EMERGENCY SWITCH ⓈⓈ has been previously turned ON and that the HVPS time delay has run out). As described in phone operation, the "ground for 500 W" line also energizes K-1603 in the HLRM. The "ground for 500 W" AX line energizes K-1104 in the LLRM, which connects the 6-watt output winding of modulation transformer T-1004 to the input of the HLRM to permit amplification of the modulation signal for 500 watts. This ground supply also operates K-1605 in the HLRM, which switches the PA plate supply from the output of the LLRM to the output of the HLRM for 500 watts. Energized K-1304 also changes the PA screen supply from +300 volts to +500 volts and illuminates the CARRIER-500 W-READY and CARRIER-500 W-ON indicators. The ground return for operating K-1304 passes through several auxiliary protective devices, any one of which, if activated, will open this ground return, de-energizing K-1304 and thus returning the transmitter to the 100-watt level. These protective devices are: bandswitch S-1378 in the RFA; DISABLE 500 W switch Ⓕ S-1385 in the RFA; door interlock switch S-2920 in the RFO unit 14; time delay relay K-1504 in the HVPS; thermostat S-305 and blower switch S-306 in the r-f tuner; PA screen overload relay K-1303 and PA plate overload thermostat S-1381 in the RFA. The detailed functioning of these devices is described completely in paragraph 10*e*(1).

17. ANTENNA TUNING EQUIPMENT.

a. GENERAL.—The customary antennas used in the frequency range in which the AN/SRT-14, 15 and 16 operate (0.3 to 26 mc) are grounded vertical antennas. For any given frequency the impedance presented to the transmission line can be expressed in terms of R + jX. The r-f output from the radio frequency amplifier works into a characteristic impedance of 50 ohms. Whenever the antenna presents an impedance other than 50 ohms, energy that is being reflected back on the transmission line reduces the energy being radiated and causes high-voltage nodes along the line. The standing-wave ratio measurement is an indication of the mismatch. The ideal matching of the antenna load to the RFA output (SWR 1:1) would be to have the reactive component of the antenna impedance reduced to zero and have the resistive component equal to 50 ohms. However, acceptable tuning of the antenna load by the antenna tuning equipment is achieved if the standing-wave ratio is reduced to at least 4:1 for any frequency in the range.

The antenna characteristic is such that it is resonant (zero reactance) for any given frequency if its length is some multiple of quarter-wavelengths. However, at even multiples of quarter-wavelengths the resistive component is high, while at odd multiples of quarter-wavelengths, the resistance is low or medium. The reactive component of the load of an antenna whose length is between an odd multiple and an even multiple of quarter-wavelengths is positive (inductive). An antenna whose length is between some even multiple of quarter-wavelength and the next odd multiple presents a negative (capacitive) reactance. These antenna characteristics are demonstrated by figure 2-118 which shows the impedance characteristics of a standard Navy 35-foot whip antenna.

It can now be seen that the function of the antenna tuning equipment is to make the antenna length together with the tuning component appear as some odd multiple of quarter-wavelength for any frequency within the 0.3- to 26-mc tuning range. Radio Frequency Tuner TN-229/SRT contains the main tuning component, an adjustable length of transmission line. The Antenna Coupler CU-372/SRT contains loading components to extend the range of the r-f tuner. The manual controls for the tuning adjustments are located in the Control-Indicator C-1352/SRT, which is a part of Transmitter Group OA-684/SRT and is covered in paragraph 2*q*.

b. RADIO FREQUENCY TUNER TN-229/SRT (R-F TUNER).—Radio Frequency Tuner TN-229/SRT (r-f tuner) contains the main tuning coil with an adjustable sliding short, which is the primary tuning element, and an impedance transformer, together with a switch to cut the transformer in or out, depending on the tuning requirement. The r-f tuner also contains a blower, B-302, for cooling purposes, the operation of which is covered in paragraph 2*q*(1). A blower switch, S-308, and a thermostat, S-305, are included as protective devices for operation at the 500-watt level (see paragraph 10*e*(1)).

(1) MAIN TUNING COIL.—R-f output to the antenna coupler loading components is connected to the main tuning coil, L-302 (figure 2-119), through the

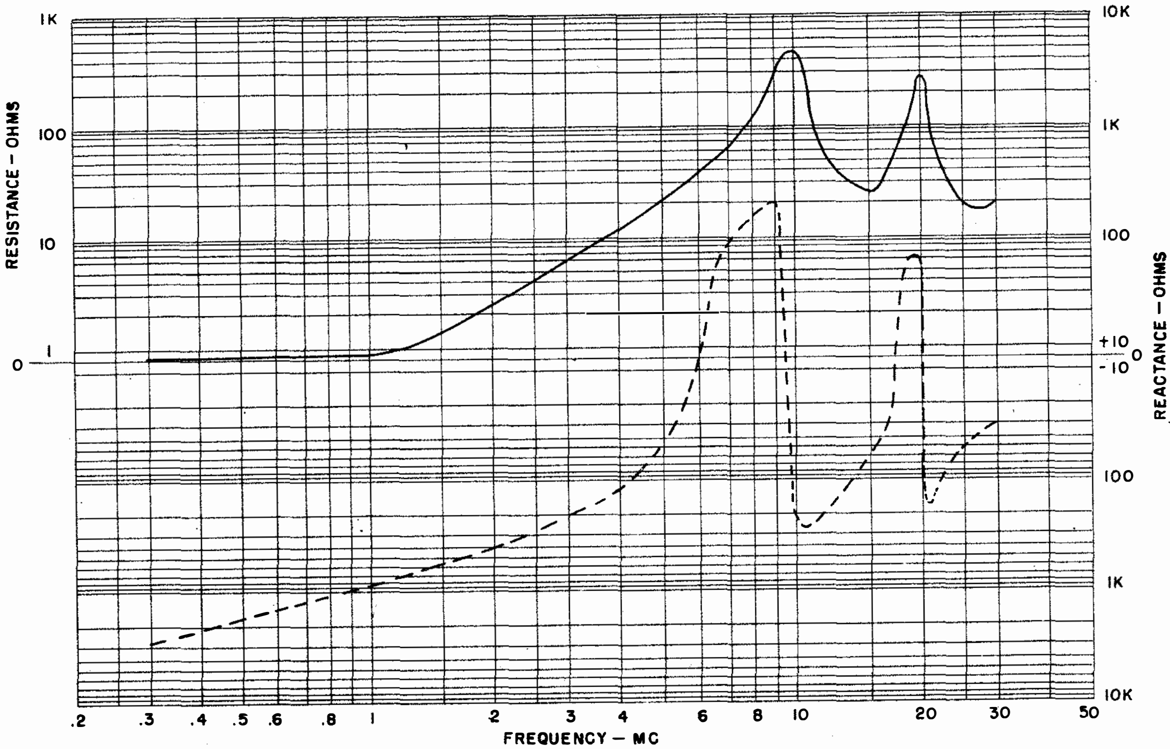


Figure 2–118. Impedance Characteristics, Typical 35-Foot Whip Antenna

bypass switch in the antenna coupler (see paragraph 17*c*(1)). L–302 is a section of helical center conductor transmission line whose length is made adjustable by means of a sliding short. The sliding short is adjusted so that the effective length of the main coil, together with the effective antenna length, is an odd multiple of quarter-wavelength for the frequency, which is the point of resonance (zero reactance). Highest efficiency usually corresponds to the lowest odd multiple, which means employing the shortest length of nonradiating variable line in the circuit. Drive motor B–301 positions the sliding short along the main coil. The manual control for regulating the position is contained in the control-indicator and is discussed in paragraph 2*q*(1). The transmission line is coupled to the main coil by a single loop coupling coil, L–301, which is mounted on the shorting ring.

(2) IMPEDANCE TRANSFORMER.—The length and configuration of the single loop coupling coil, L–301, has been designed for optimum coupling above 1 mc. The characteristic of the 35-foot whip antenna (figure 2–118) shows that the resistive component of the antenna impedance is so low at a frequency of 1 mc or lower that a step-up transformer will be required after the antenna is resonated to bring the SWR to within the allowable limit.

Rf from the load adjusting unit, via the antenna coupler (see paragraph 17*c*(1)), is connected first to transformer switch S–308 (figure 2–120), which will either connect a 9:1 impedance transformer, Z–301, in the transmission line through its contacts 1, 2 and 3, 4 or, in its other setting, will bypass the action of Z–301, through contacts 2, 4, at the same time shorting out the impedance transformer. Magnerotor actuator B–303 positions transformer switch S–308 under control of the positioning cam and the manual control in the control-indicator, as described in paragraph 2*q*(4). The output from contact 4 of S–305 is fed to the coupling coil, L–301.

(3) R-F TUNER MECHANICAL DRIVE.—To position the shorting ring on the main tuning coil, the drive motor, B–301 (figure 2–121), is energized. Its output of rotary motion is transmitted through a coupling to an extending shaft having fixed to it a helical gear, O–323. A mating helical gear, O–308, permits the right-angle transfer to a shaft to the magnetic clutch, O–301. Rotary motion is further transmitted through the friction plates of the clutch, O–301, to an output shaft that has worm O–304 fixed to it. The mating worm gear transfers rotary motion to the main drive shaft with a 100-to-1 reduction ratio. Driving gears O–340 and O–341, on either end of the main drive shaft, transfer the rotary motion, through idler gears O–338 and O–339, to the parallel racks, O–321 and O–322. Rotary motion has now been changed to the required rectilinear motion for the positioning of the shorting ring that is mounted on the end of the racks. Also mounted on the main drive shaft is a worm, O–342, that is mated to a worm gear, O–344. This worm gear, in turn, drives the shaft of position potentiometer R–301 whose function is described in paragraph 2*q*(5).

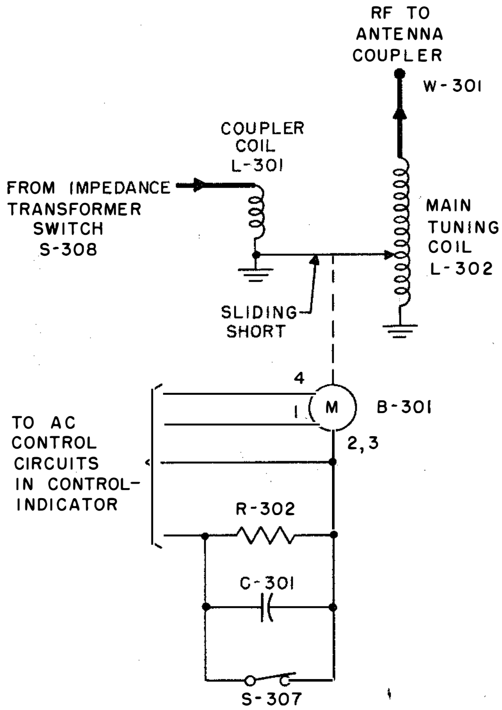


Figure 2—119. Main Tuning Coil L—302, Simplified Schematic

Operational requirements demand accurate control of the positioning of the shorting ring. To achieve this, the magnetic clutch, O–301 (figure 2–122), is inserted in the drive to limit the inertia effects. Under normal driving conditions, rotary action is transferred from the clutch input shaft to the clutch output shaft by virtue of having the driven clutch plate in contact with the driving clutch plate under pressure from spring O–302. At the time positioning of the shorting ring is to be stopped, the drive motor is de-energizing and, concurrently, the brake coil, L–303, in the clutch is energized. The magnetic field of the brake coil attracts the driven clutch plate against the stationary housing of the brake coil. The magnetic field opposes the spring action. This causes braking of the output shaft at the same time as it disengages from the driving clutch plate and the input shaft. In this manner the low-velocity members are quickly stopped, leaving the high-velocity members to coast without affecting the positioning of the shorting ring. The braking time of the clutch is a function of the air gap existing between the back surface of the driven clutch plate and the front surface of the brake coil housing. This gap is adjusted by having the lower housing screwed into the upper housing to give the required gap. Locking screw holes are so placed in the lower and upper housings to permit adjustments in increments of 0.002 inch.

c. ANTENNA COUPLER CU-372/SRT (ANTENNA COUPLER).—Antenna Coupler CU-372/SRT (antenna coupler) contains a switch that enables complete bypassing of the antenna tuning equipment in the transmission line under certain operating situations, a set of loading reactive components to extend the range of tuning accomplished by the main tuning coil in the r-f tuner, together with a switch to select the desired component and set of grounding cams used to prevent surges in the transmitter during periods of switching. Also incorporated in the antenna coupler is a junction box that contains a set of connectors from which are used all the cross-connecting of control leads between the r-f tuner and the antenna coupler and between each of these units and the transmitter group. The usage of these cross-connections is described in paragraph 17*d* on antenna tuning equipment control circuits.

(1) ANTENNA BYPASS SWITCH S–3512.—At certain frequencies, the actual antenna impedance is such that no tuning is required to meet the SWR reading of 2:1 required at the r-f output of the radio frequency amplifier. Also, it is sometimes desired to have the antenna and transmission line connected directly to a receiver (see paragraph 7*g*). To meet these conditions, antenna bypass switch S–3512 (figure 2–123) is introduced into the r-f transmission line.

When it is desired to have the tuning elements in the line, S–3512 is in the "tuner-in" position. The r-f line from the load adjusting unit enters the antenna coupler through connector J–3506, through contacts 4 and 3 of S–3512, and then out through connector J–3505 to the r-f tuner input. The output of the r-f tuner is permanently interconnected to the loading switch, S–3511 (see paragraph 17*c*(2)). The output from S–3511 is connected to contact 2 of bypass switch S–3512. In the "tuner in" position, the r-f transmission line is complete through contacts 2 and 1 of S–3512, through length of RG–19/U first extrusion cable W–3501 to external standoff E–3523, from whence it is interconnected to the antenna lead-in.

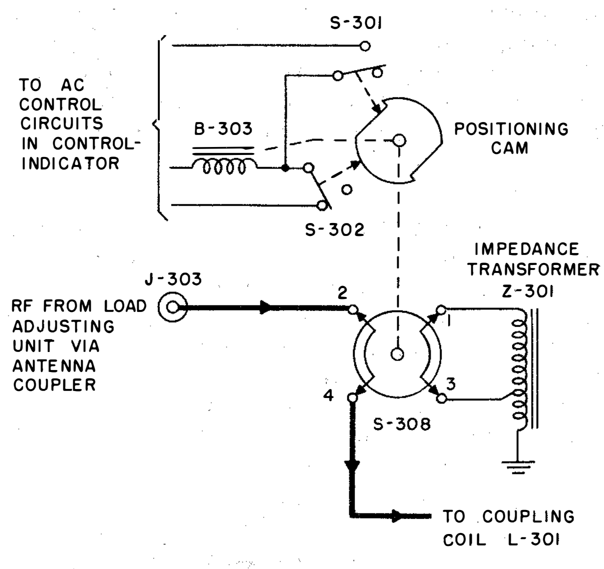


Figure 2—120. Impedance Transformer Z—301, Simplified Schematic

With the antenna bypass switch, S–3512, placed in the "bypass" position, the r-f output from the load adjusting unit is connected directly to the antenna, through J–3506, contacts 4 and 1 of S–3512, W–3501, and E–3523.

Magnetic actuator B–3502 positions S–3512 in either the "tuner-in" or "bypass" under control of the positioning cam and the manual control in the control-indicator, as described in paragraph 2*q*(2).

(2) LOADING SWITCH S–3511.—At the low frequencies, a series inductor must be added to the transmission line to increase the effective length of the line, since the total length of the main tuning coil is insufficient to achieve resonance. At frequencies where the effective antenna length is an even multiple of wavelengths (antiresonance) and the resistive impedance is high, a capacitor can be added in series with the line where in the "direct" position a poorer match would be obtained, since the antenna impedance is approaching the characteristic impedance of the variable line. At frequencies where the effective electrical length of the antenna is slightly longer than a quarter-wavelength, a length of tuning coil equal to a little less than a half-wavelength would have to be added to resonate. Here a series capacitor may be added to shift the reactive component of the effective antenna impedance from inductive to capacitive, permitting tuning near the top of the main tuning coil for increased efficiency. In the case of longer "L"-type antennas, the frequency at which first resonance occurs is lower. This requires a greater length of main coil to provide the balance of the extra half-wavelength and may result in no reliable tuning point for a small range of frequencies without the use of capacitance. In some cases the series plus shunt capacitor or the shunt capacitor alone may be used effectively.

If one of the loading components is required to tune for the reasons noted above, the required component is switched into the transmission line through the two-section loading switch, S–3511 (figure 2–124). If no loading component is required, the r-f transmission line is switched through the two sections of S–3511. The output of the r-f tuner is interconnected to contact 1 of S–3511A and contact 1 of S–3511B through the RG–19/U first extrusion cable, W–3502. If no loading component is required, S–3511 is in the "direct" position and the output of the tuner is connected from S–3511A contact 1, through the connecting link between sections A and B, through S–3511B contact 2, and then to contact 2 of the antenna bypass switch, S–3512, and then to the antenna (see paragraph 17*c*(1)). If the series capacitor, C–3501, is desired in the line, S–3511 is placed in the "A" position. The output of the r-f tuner is now connected through S–3511B contacts 1 and 5 to one side of C–3501; the other side of C–3501 is connected to S–3511B contact 3, and through the connecting link between sections B and A to contact 2 of S–3511A, and then to S–3512 contact 2. S–3511 has six positions, one

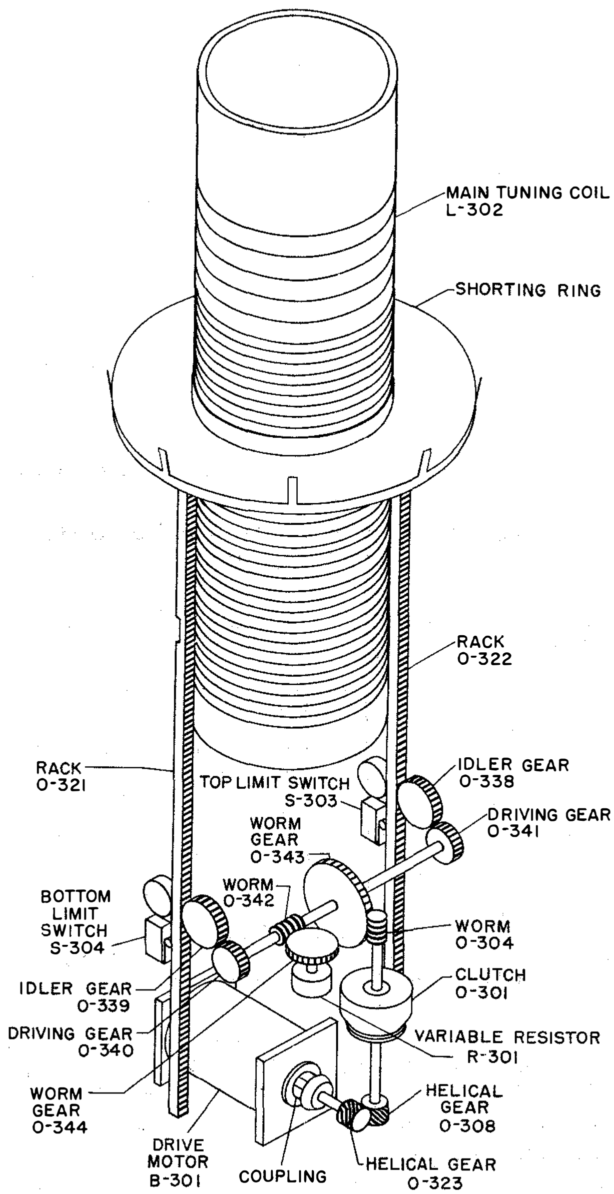


Figure 2—121. R-F Tuner Mechanical Drive

for direct connection and five for different combinations of loading components. Positioning S–3511 to the desired position is accomplished by magnerotor actuator B–3501 under control of the two positioning cams as covered by paragraph 2*q*(3). Table 2–23 shows the tuning component employed for each position of the loading switch, S–3511.

(3) GROUNDING CAMS.—As described in paragraph 17*c*(1), the bypass switch, S–3512, is inserted in the transmission line. At the times S–3512 is switching from "tuner-in" to "bypass" or vice versa, the transmission line is momentarily opened, removing the antenna load. At these times the output of the radio frequency amplifier must be cut off to prevent surges in the output caused by the momentary removal of antenna load.

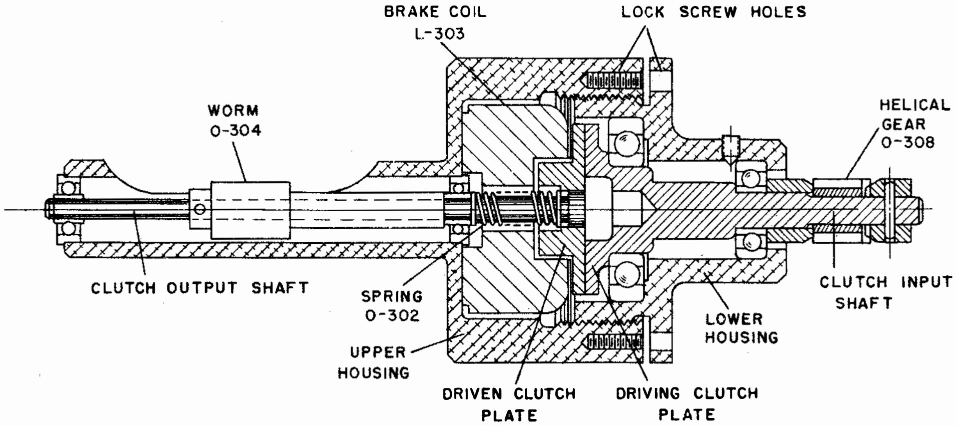


Figure 2—122. Magnetic Clutch O—301, Cross Section

TABLE 2—23. FUNCTION OF LOADING SWITCH S—3511

POSITION OF S—3511*	LOADING COMPONENT USED
DIRECT	None
A	C—3501 in series
B	C—3501 in series, C—3502, C—3503 shunted across line
C	L—3502 in series
D	L—3501 in series
E	C—3502, C—3503, shunted across line

* Positions of S—3511 correspond to same positions of ANTENNA COUPLER LOADING (AD) switch S—404 on control-indicator.

Fixed to the shaft of the bypass switch, S—3512, are grounding cams A and B (figure 2—125) which, together with the microswitches S—3507 and S—3510, remove a ground during the instances switching takes place. This ground signal is interconnected to the IPA stage in the radio frequency amplifier (RFA). The absence of the ground will cause the IPA to be cut off, which will cut off the output of the transmitter (see paragraph 10*c*(1)).

Grounding cam A is of such a configuration that it will cause contacts C and NO of its associated microswitch, S—3507, to be closed only when the bypass switch, S—3512, is completely homed in either the "bypass" or "tuner-in" positions. Grounding cam B is formed so that it will close the C and NO contacts of its associated microswitch, S—3510, to be closed only when bypass switch S—3512 is in the "tuner-in" position. With the "tuner in" condition, ground is forwarded through contacts C and NO of S—3510 and through C and NO of S—3507 and interconnected to the IPA stage in the RFA, making it possible to transmit carrier. During the switching from "tuner-in" to "bypass", contacts C and NO of S—3507 are opened, removing the ground to the RFA to cut off the carrier. When the bypass switch reaches the "bypass" position, contacts C and NO of S—3507 again close, but contacts C and NO of S—3510 are now opened because of the action of cam B. If the transmitter is to be operated with the tuning equipment bypassed, an auxiliary ground will be forwarded through contacts of relay K—401 in the control-indicator (see paragraph 2*q*(2)), through contacts C and NO of S—3507, to the RFA to energize the carrier. However, if it is desired to operate with the automatic bypassing of the tuning equipment between periods of transmission, as explained in paragraphs 7*g* and 2*q*(2), the ground from K—401 in the control-indicator will not be present. At the end of a transmission, the bypass switch, S—3512, is automatically driven to the bypass position by the action of the ATU bypass transfer circuit in the low level radio modulator and the ANTENNA TRANSFER switch (AE), S—402, in the control-indicator in the REMOTE position. While in bypass, in this mode of operation, the IPA stage in the RFA is cut off, as there will be no ground caused by contacts C and NO of S—3510 being open and no auxiliary ground from K—401. At the beginning of the next transmission, the ATU bypass transfer circuit signals the return of the bypass switch S—3512 to the "tuner-in" position. The carrier cannot go on until the bypass switch has reached the tuner-in position, as the ground required to remove the cutoff potential from the IPA stage is not forwarded until both grounding cams A and B have returned to the "tuner-in" position, closing the C and NO contacts of both S—3507 and S—3510. This prevents a premature surge of r-f energy before the proper antenna load is replaced on the transmitter output.

d. ANTENNA TUNING EQUIPMENT CONTROL CIRCUIT SUMMARY.—The control of the tuning functions accomplished in the antenna coupler and r-f tuner is from the control-indicator, which is a component of Transmitter Group OA—684/SRT. These functions have been described in detail in paragraphs 2*q* and 17*c*(1), (2), and (3) and are now being summarized to show continuity of connections. Figure 2—128 is a simplified schematic of the control circuitry in the antenna coupler and r-f tuner and must be used in conjunction with the control-indicator control circuits shown on figure 2–126. With the exception of the control of —24 volts dc in two instances, and one ground control, antenna tuning equipment control circuits are concerned with the control of 110-volt, 60-cycle, single-phase, a-c power used to operate the two magnerotor actuators in the antenna coupler and one magnerotor actuator, together with the drive and blower motors, in the r-f tuner. In addition to the control functions in the following summary, the r-f tuner contains a thermostatic switch, S–305, and a blower switch, S–306, employed in the 500-watt operate circuit of the transmitter, as described in paragraph 10*e*(1) and 16*c*(8) (*g*).

(1) ANTENNA TRANSFER CONTROL.—Placing the ANTENNA TRANSFER switch (AE), S–402, in the control-indicator in the TUNER IN position (figure 2–126) connects "—24 V after time delay" through contacts 3 and 2 of S–402 and then connects it to the antenna coupler through P–402 and J–2919 pin 12, through J–2916 and J–606 pin 4, over wire 145 to E–605 terminal 66, then by interconnecting cable to the antenna coupler junction box (figure 2–128), through P–3301 and J–3502 pin M, through P–3501 and J–3507 pin P, into the antenna coupler to terminal 4 on TB–3501, to winding of K–3501. The winding of K–3501 is completed to ground through terminal 1 of TB–3501, through J–3507 and P–3501 pin F, to J–3502 and P–3301 pin N, over the interconnecting cabling to the ground potential found at E–606 terminal 74, which will energize K–3501. Energized K–3501 connects one side of a 110-volt a-c line, which is taken from the uninterrupted oven heater supply in the transmitter, through contacts 1 and 3 of K–3501, through NO and C contacts of S–3509 to one side of magnerotor actuator B–3502 winding. The other side of the a-c line is connected directly to the other side of the winding of B–3502, which energizes B–3502. This circuit is maintained until B–3502 drives the positioning cam to the point where the actuator of S–3509 falls into the notch, which opens the NO and C controls of S–3509, de-energizing B–3502, stopping at the point corresponding to the "tuner-in" position of the antenna transfer switch.

Placing the ANTENNA TRANSFER switch (AE), S–402, in the BYPASS position, which is the "center-off" position, disrupts the —24 volts dc from the line to K–3501 which de-energizes K–3501. The a-c supply to B–3502 is now connected through contacts 1 and 4 of de-energized K–3501, through the NO and C contacts of S–3508. B–3502 operates again until the actuator of S–3508 falls into the notch of the position cam which corresponds to the "bypass" position of the antenna transfer switch.

With the ANTENNA TRANSFER switch (AE), S–402, placed in the REMOTE position, the line to K–3501 is connected through contacts 2 and 1 of S–402 (figure 2–126), through P–402 and J–2919 pin 14, through J–2916 and J–606 pin 12, over wire 144 to E–605 terminal 65, over wire 240 to E–603 terminal 40, over wire 238 through J–605 and J–1103 pin 10, through

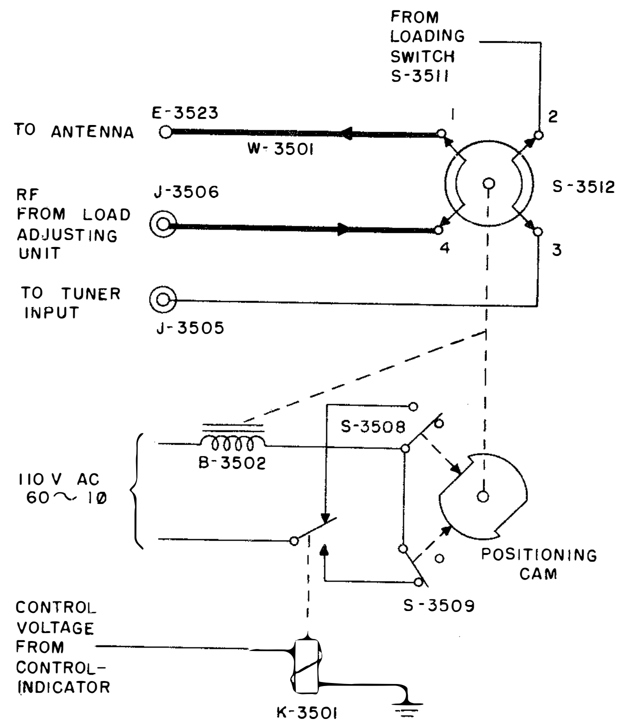


Figure 2–123. Antenna Bypass Switch S–3512, Simplified Schematic

J–1109 and J–1111 pin 4, to the ATU bypass transfer circuit. When K–1102 is energized, "—24 V after standby" is placed on the line through contacts 4 and 3 of K–1102, which will position the antenna transfer switch in the "tuner-in" position. When K–1102 is not operated, the "—24 V after standby" is removed from the line, and the antenna transfer switch is driven to the "bypass" position.

(2) ANTENNA LOADING CONTROL. — The 110-volt, 60-cycle, single-phase, a-c line, which is energized in the transmitter after the START button of the MAIN POWER switch (RR), S–3004 in the low voltage power supply, has been depressed, is connected from E–605 terminals 63 and 64 through the interconnecting cabling to the antenna coupler junction box (figure 2–128) through P–3301 and J–3502 pins V and U. One side of the line, from J–3502 pin V, is connected to J–3501 pin V and then through P–3501 and J–3507 pin K to one side of the antenna loading magnerotor actuator, B–3501. The other side of the line, from J–3502 pin U, is connected to J–3501 pin U and then through J–3504 and P–3302 pin G, back over the interconnecting cabling to E–606 terminal 82 (figure 2–126) over wire 158, through J–607 and J–2917 pin 15, through J–2920 and P–401 pin 16 to the arm (contact 11) of ANTENNA COUPLER LOADING switch (AD) S–404. S–404 can be set to one of six positions (DIRECT, A, B, C, D or E). For the DIRECT position, the a-c line is connected through contacts 11 and 13 of S–404, through P–402 and J–2919 pin 1, through J–2918 and J–608 pin 6, over wire 192 to E–604 terminal 55,

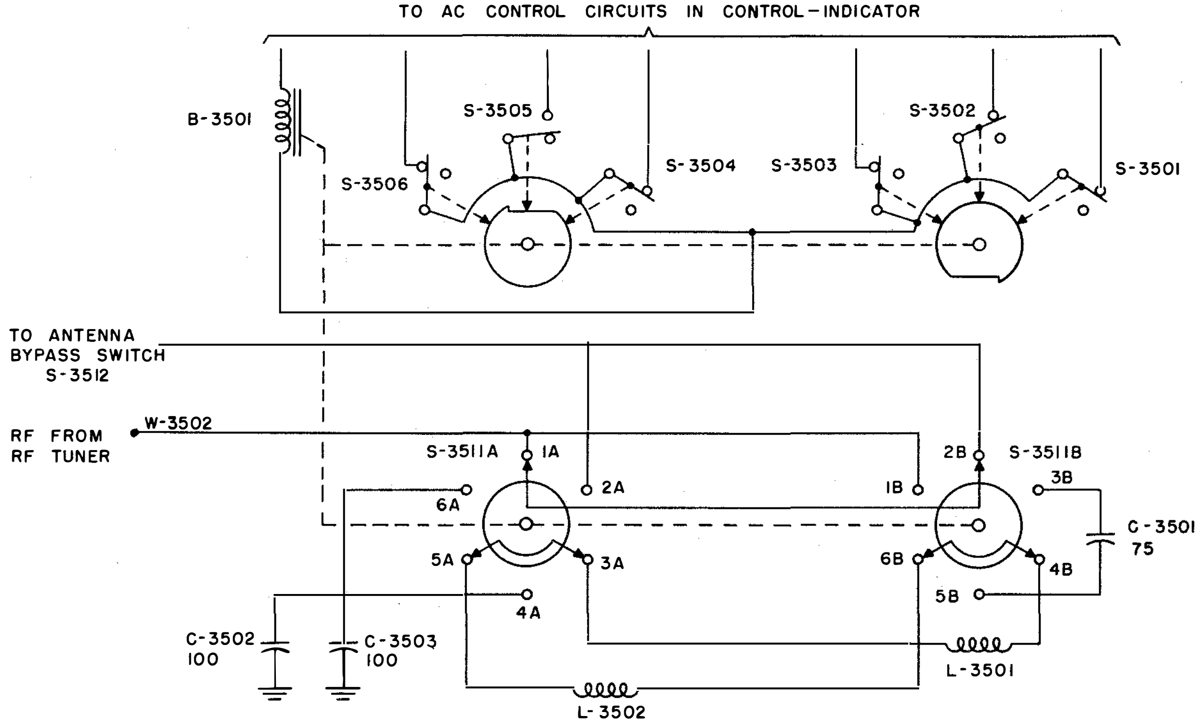


Figure 2—124. Loading Switch S—3511, Simplified Schematic

through the interconnecting cabling to the antenna coupler junction box (figure 2–128), through P–3302 and J–3504 pin A, through P–3501 and J–3507 pin G, through contacts NO and C of S–3505, to the other side of actuator B–3501. This energizes B–3501 and it drives the positioning cam and loading switch until the actuator of S–3505 falls in the notch of the cam, opening contacts NO and C of S–3505, which opens the circuit to B–3501, stopping the loading switch at the "direct" position. Similar paths for actuating B–3501 can be followed when the ANTENNA COUPLER LOADING (AD) switch, S–404, is in the other five positions.

(3) GROUNDING CAM CONTROL. — When the antenna transfer switch in the antenna coupler is in the "tuner-in" position, the same ground used to operate K–3501 is connected from TB–3501 terminal 1 to TB–3501 terminal 3, through contacts C and NO of S–3510 to terminal 5 of TB–3501, through J–3507 and P–3501 pin E, through J–3502 and P–3301 pin C, over interconnecting cabling to E–606 terminal 71, back through the interconnecting cabling, through P–3301 and J–3502 pin A, through P–3501 and J–3507 pin C to terminal 7 of TB–3501, through contacts NO and C of S–3507 to TB–3501 terminal 6, through J–3507 and P–3501 pin D, through J–3502 and P–3301 pin B, over interconnecting cabling to E–603 terminal 41 (figure 2–126) and then over wire 236, through J–602 and J–1302 pin 1 to the junction of R–1342 and R–1395 in the radio frequency amplifier. This is the ground required to permit the IPA stage to amplify. During switching of the antenna transfer switch, grounding cam A (figure 2–128) opens the contacts NO and C of S–3507, breaking this ground. When the switch is in the "bypass" position, grounding cam B also breaks this ground by opening contacts NO and C of S–3510. When the ANTENNA TRANSFER (AE) switch, S–402 in the control-indicator unit (figure 2–126), is in either the REMOTE or TUNER IN position, a ground to relay K–401 is completed through either contacts 5 and 4 or contacts 5 and 6 of S–402. As the other side of K–401 is connected to "—24 V after time delay", K–401 operates, opening its contacts 1 and 4. When S–402 is in the BYPASS position, ground is removed from K–401, and it ceases to operate, closing its contacts 1 and 4. In this condition, ground is connected through contacts 1 and 4 of K–401, through P–401 and J–2920 pin 3, through J–2917 and J–607 pin 6, over wire 150 to E–606 terminal 71. This ground now connects through S–3507 in the antenna coupler back to the junction of R–1342 and R–1395 in the radio frequency amplifier through the same connections previously described.

(4) TRANSFORMER CONTROL.—The 110-volt, a-c line available at J–3501 pins V and U of the antenna coupler junction box is also used for the control of the impedance transformer switch in the r-f tuner. One side of the line, from J–3501 and P–3304 pin V, is connected through the interconnecting cabling through P–3306 and S–301 pin V of the r-f tuner, through terminal 12 of TB–301 and terminal 4 of TB–303, to one side of the impedance transformer switch magnerotor actuator, B–303. The other side of the a-c line from J–3501 pin U is connected through J–3504 and P–3302

pin 4, over the interconnecting cabling to the transmitter group, through E-604 terminal 49 (figure 2-126), over wire 186, through J-608 and J-2918 pin 13, through J-2920 and P-401 pin 14, to the arm (contact 11) of TRANSFORMER switch Ⓐⓖ S-403. S-403 has two active positions (DIRECT and 1). For the DIRECT position, the a-c line is connected through contacts 11 and 13 of S-403, through P-401 and J-2920 pin 10, through J-2918 and J-608 pin 10, over wire 189 to E-604 terminal 52, through the interconnecting cabling to the antenna coupler junction box (figure 2-128), through P-3302 and J-3504 pin M, through J-3503 and P-3303 pin M, over the interconnecting cabling to P-3305 and J-302 pin M in the r-f tuner, through terminal 11 on TB-301 and terminal 3 of TB-303, through contacts NO and C of S-301, to the other side of actuator B-303. This energizes B-303, and it drives the positioning cam and the impedance transformer switch until the actuator of S-301 falls into the notch of the cam, opening contacts NO and C of S-301, which opens the circuit to B-303, stopping the impedance transformer switch at the "direct" position. A similar path for actuating B-303 can be followed when the TRANSFORMER switch Ⓐⓖ, S-403, is in the other position (1).

(5) DRIVE MOTOR CONTROL.—The 110-volt, single-phase, 60-cycle a-c filament supply found in the radio frequency oscillator is connected to P-401 pins 7 and 15 on the control-indicator (figure 2-126). This ultimately is the same a-c supply as found in the antenna coupler junction box at J-3501 pins V and U, with the side of the line found at J-3501 pin V corresponding to the side of the line found at P-401 pin 7. The side of the a-c line at P-401 pin 7 also is fed through fuse F-2917, located in the radio frequency oscillator. This line is connected through the normally closed contacts 3 and 1 of the SLOW switch Ⓐⓗ, S-407, through P-401 and J-2920 pin 2, through J-2918 and J-608 pin 2, over wire 181 to E-604 terminal 44, over the interconnecting cabling, to the antenna coupler junction box (figure 2-128), through P-3301 and J-3502 pin W, through P-3501 and P-3304 pin W, over the interconnecting cabling to the r-f tuner, through P-3306 and J-301 pin W, through terminal 11 of TB-302 to winding terminals 2 and 3 of drive motor B-301. The other side of the a-c line from P-401 pin 15 in the control-indicator (figure 2-126) is connected to contact 1 of the UP Ⓐⓕ switch S-406 and to contact 4 of the DOWN Ⓐⓖ switch S-405. Depressing the UP push button Ⓐⓕ will connect the a-c line through contacts 1 and 2 of S-406, through P-401 and J-2920 pin 5, through J-2918 and J-608 pin 4, over wire 183 to E-604 terminal 46, over the interconnecting cabling to the antenna coupler junction box (figure 2-128), through P-3301 and J-3502 pin X, through P-3501 and J-3304 pin X, over the interconnecting cabling of the r-f tuner, through P-3306 and J-301 pin X, through terminal 10 of TB-302 to winding terminal 1 of drive motor B-301. This same side of the a-c line through contacts 1 and 2 of closed UP switch Ⓐⓕ S-406 (figure 2-126) is also connected through phase-shifting capacitor C-402, through P-401 and J-2920 pin 4, through J-2918 and J-608 pin 3, over wire 182 to E-604 terminal 45, over the interconnecting cabling to the antenna coupler junction box (figure 2-128), through P-3301 and J-3502 pin Y, through J-3501 and P-3304 pin Y, over the interconnecting cabling to the r-f tuner, through P-3306 and J-301 pin Y, through terminal 9 of TB-302 to winding terminal 4 of B-301. These connections will energize B-301 so that it drives the shorting ring up along the main tuning coil. If the DOWN push button Ⓐⓖ is depressed instead of the UP push button Ⓐⓕ, similar paths to winding terminals 3 and 4 of B-301 can be traced through contacts 4 and 5 of S-405.

If the SLOW switch Ⓐⓗ, S-407, is depressed, the side of the a-c line, which is usually connected through contacts 3 and 1 of S-407 to winding terminals 1 and 2 of E-301, as previously described, is opened. Ac is now supplied by alternate connections to B-301. The side of the a-c line found at the J-3501 pin V is the same as that previously connected through the SLOW switch Ⓐⓗ, S-407. This line is connected through P-3304 and the interconnecting cabling to the r-f tuner, through P-3306 and J-301 pin V to terminal 12 of TB-302. From this point there are two branches; one branch connects the line from terminal 12 of TB-302 through terminal 4 of TB-303, through the closed contacts of centrifugal switch S-307 to the winding terminals 1 and 2 of B-301. The other branch from TB-302 terminal connects to the parallel combination of C-301 and R-302, which, in turn, are connected through terminal 11 of TB-301 to winding terminals 1 and 2 of B-301. With the SLOW push button Ⓐⓗ depressed, together with either the UP Ⓐⓕ or the DOWN Ⓐⓖ push button, B-301 will be energized through connections described, until rotational speed sufficient to open the contacts of the centrifugal switch, S-307, is reached, at which point the R-302, C-301 network is added in series with the winding, preventing B-301 from attaining a speed higher than that set by the action of S-307.

(6) MAGNETIC CLUTCH CONTROL.—The "−24 volts after time delay" is connected through the normally closed contacts 6 and 4 of the UP switch Ⓐⓕ, S-406 (figure 2-126), through the normally closed contacts 3 and 1 of the DOWN switch Ⓐⓖ, S-405, through dropping resistor R-402, through P-401 and J-2920 pin 8, through J-2917 and J-607 pin 13, over wire 185 to E-604 terminal 48, through the interconnecting cabling to the antenna coupler junction box (figure 2-128), through P-3301 and J-3502 pin O, through J-3501 and P-3304 pin O, through the interconnecting cabling to the r-f tuner, through P-3306 and J-301 pin O, through terminal 7 to TB-302 to one side of the winding of magnetic clutch coil L-303. The other side of the coil is connected to ground through terminal 8 of TB-302, through J-301 and P-3306 pin N, over the interconnecting cabling to the antenna coupler junction box, through P-3304 and J-3501 pin N through J-3502 and P-3301 pin N, over the interconnecting cabling to the transmit-

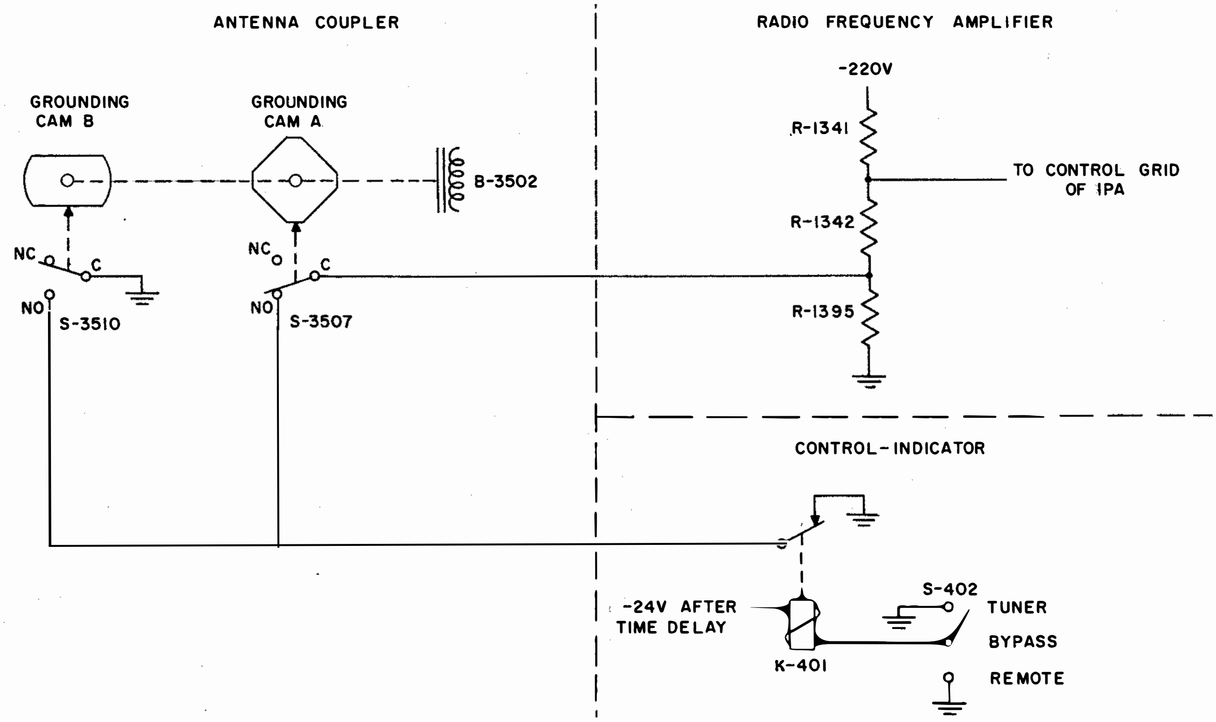


Figure 2—125. Grounding Cam Circuit, Simplified Schematic

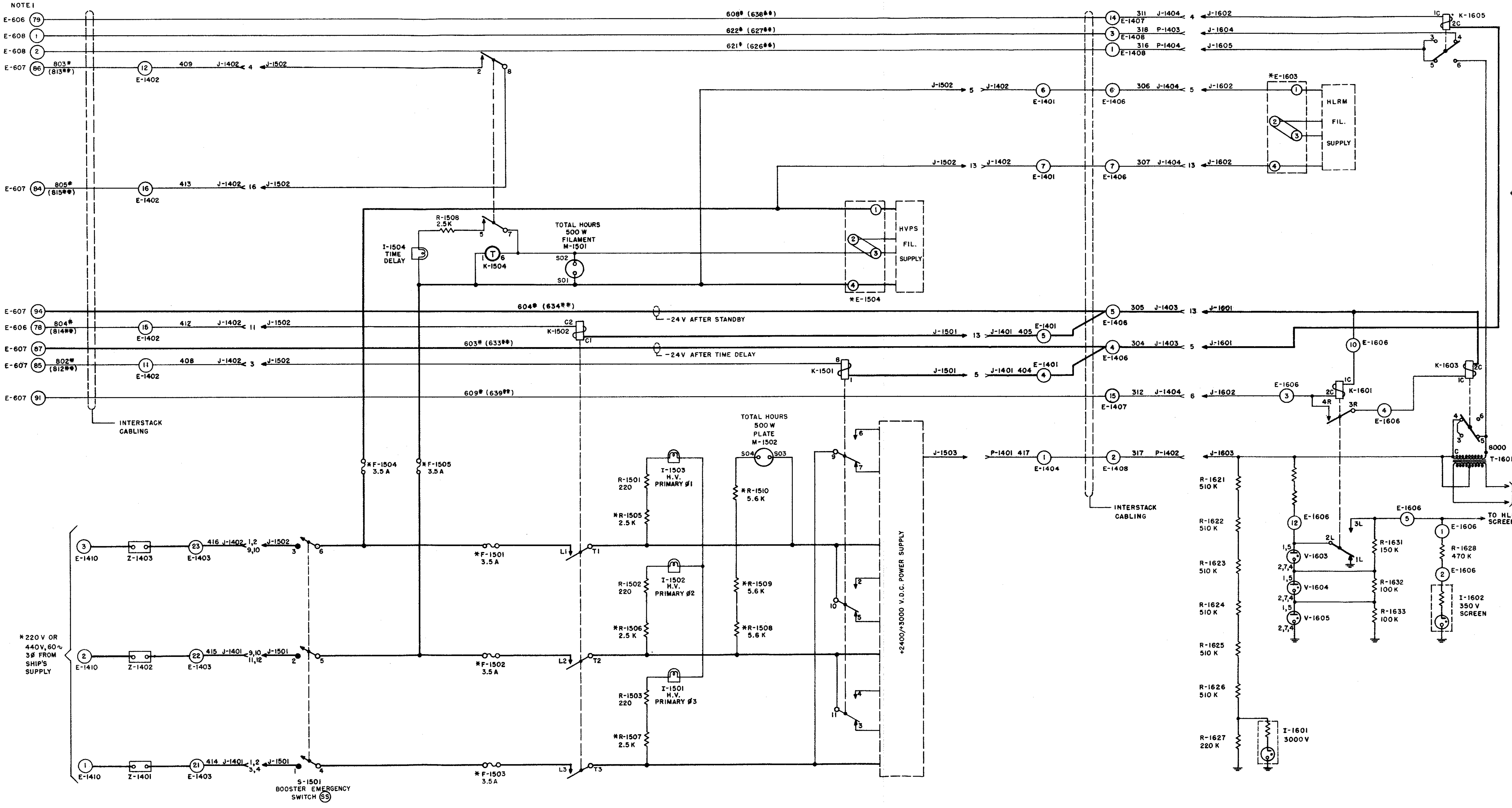
ter group, to the ground potential found at terminal 74 of E-606. This energizes L-303, which mechanically disconnects the drive shaft of drive motor B-301 from the load (shorting ring). If the UP push button Ⓐ on the control-indicator (figure 2-126) is depressed, the one side of the magnetic clutch coil, L-303, is disconnected from the "—24 volts after time delay" and instead is connected through contacts 4 and 5 of S-406, through P-401 and J-2920 pin 6, through J-3918 and J-608 pin 5, over wire 184 to E-604 terminal 47, over the interconnecting cabling to the antenna coupler junction box (figure 2-128), through P-3301 and J-3502 pin D, through J-3501 and P-3304 pin D, over interconnecting cabling to the r-f tuner, through P-3306 and J-3501 pin D, through terminal 2 of TB-301 to the NO contact of top limit switch S-303. If the top limit of travel of the shorting ring has not been reached, the circuit is open at this point, and the magnetic clutch coil is not energized, which means that the clutch is mechanically energized, allowing the drive motor, B-301, to drive the shorting ring. When the top limit of travel is reached, contacts NO and C of S-303 close, and the circuit to the clutch coil continues through the contacts, through contacts NO and C of the bottom limit switch S-304, through terminal 1 of TB-302, through J-301 and P-3306 pin S, through the interconnecting cabling to the antenna coupler junction box, through P-3303 and J-3501 pin S, through J-3502 and P-3301 pin S, and through the interconnecting cabling to a "—24 volts after time delay" found at terminal 87 of E-609. Therefore, at the time the top limit is reached, L-303 will be re-energized to disconnect the load from the drive to prevent jamming. Control of energizing coil L-303 through the action of the bottom limit switch S-304 when the DOWN push button Ⓐ is depressed can be followed in a similar manner.

(7) BLOWER MOTOR CONTROL.—The 110-volt a-c line found at J-3501 pins V and U in the antenna coupler junction box, which is energized when the START push button on the transmitter group is depressed, is used to energize the r-f tuner blower motor, B-302. One side of the line is connected through J-3501 and P-3304 pin V, through the interconnecting cabling to the r-f tuner, through P-3306 and J-301 pin V, through terminal 12 of TB-301, to winding terminals 1 and 2 of B-302. The other side of the line is connected through J-3501 and P-3304 pin U, through the interconnecting cabling to the r-f tuner, through P-3306 and J-301 pin U, through terminal 13 of TB-301 to winding terminal 2 of B-302. The side of the a-c line found at P-401 pin 15 on the control-indicator (figure 2-126) is the same side of the line as that at J-3501 pin U. This is connected through phase-shifting capacitor C-401, through P-401 and J-2920 pin 1, through J-2918 and J-608 pin 1, over wire 180 to E-604 terminal 43, through the interconnecting cabling, to the antenna coupler junction box (figure 2-128), through P-3301 and J-3502 pin T, through J-3501 and P-3304 pin T, through the interconnecting cabling to the r-f tuner, through P-3306 and J-301 pin T, through terminal 14 of TB-301 to winding terminal 4 of B-302. This completes the energizing circuit for the blower motor, B-302, as soon as the START push button on the transmitter group is depressed.

NOTES:

1. IN AN/SRT-16, THE HEATERS IN THE TWO MOUNTINGS ARE INDIVIDUALLY ENERGIZED FROM THE CABINET HEATER SWITCH (NN) IN EACH TRANSMITTER GROUP. IN AN/SRT-15 THE HEATERS IN THE TWO MOUNTINGS ARE IN PARALLEL.
2. RESISTANCE VALUES EXPRESSED IN OHMS UNLESS OTHERWISE INDICATED.
3. SEE ANTENNA COUPLER AND RADIO FREQUENCY TUNER CONTROL CIRCUITS FOR INTERCONNECTING DATA BETWEEN TRANSMITTER GROUP AND ANTENNA COUPLER.
4. COLOR CODE-- R-RED, Y-YELLOW, GR-GREEN, BU-BLUE.
5. ⊂⊃ DENOTES INTERCONNECTING CABLING, FOR DETAILS SEE INTERCONNECTING CABLING DIAGRAMS IN SECTION 3 OF INSTRUCTION BOOK.
6. OTHER CONNECTIONS IN 500W STACK ARE THE SAME AS 100W STACK.
7. IN AN/SRT-14, JUMPERS ARE PLACED BETWEEN E606(76) AND E606(77) AND BETWEEN E608(1) AND E608(2).

Figure 2—126. Transmitter Group and Mounting Control Circuits, Simplified Schematic



NOTES

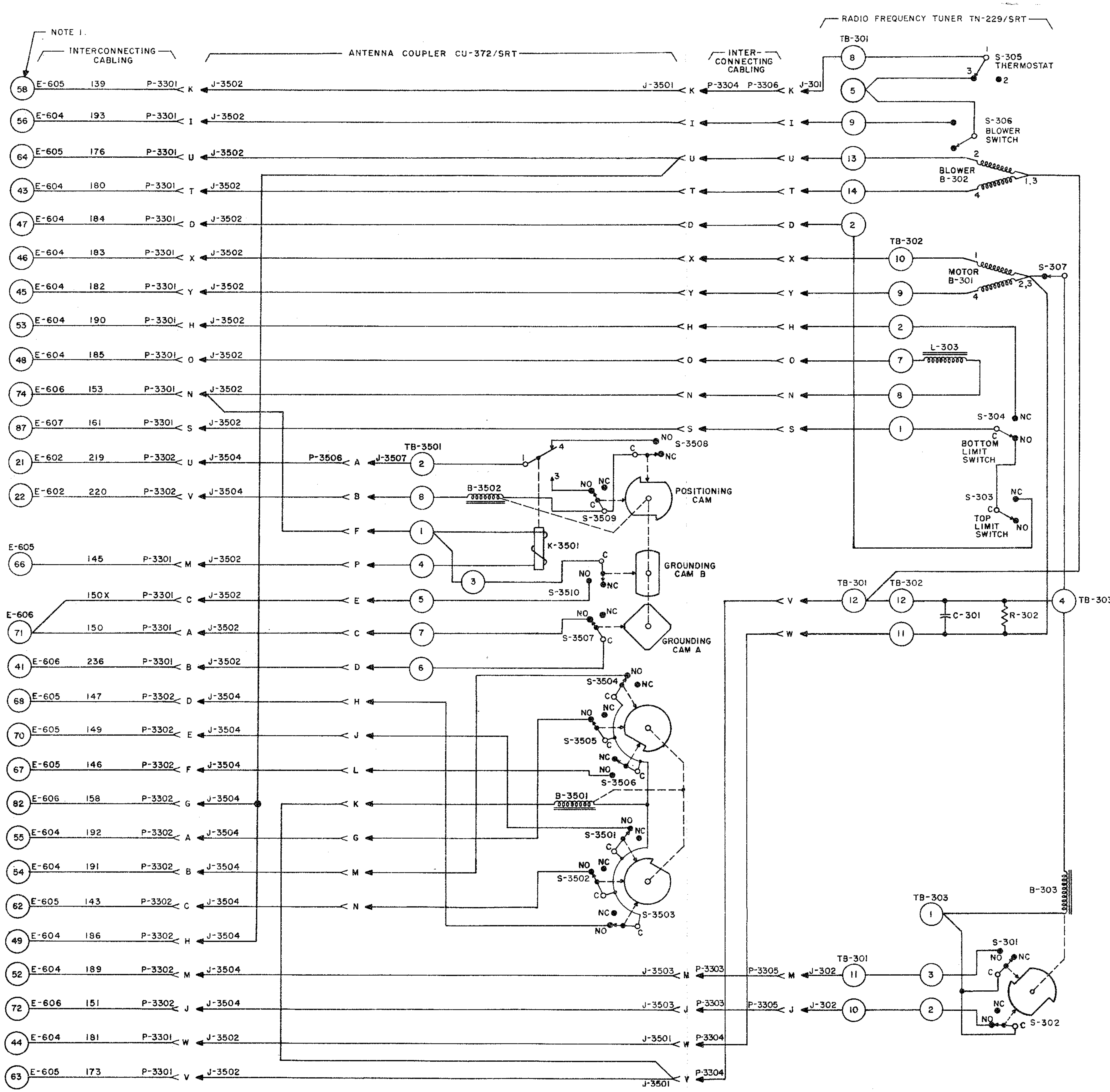
1. TERMINALS AT LEFT EDGE OF SHEET ARE DUPLICATE OF THOSE AT RIGHT EDGE OF TRANSMITTER GROUP AND MOUNTING CONTROL CIRCUITS SIMPLIFIED SCHEMATIC (FIGURE 2-126), KEY UP TO TRACE BETWEEN SHEETS.

* CONNECTIONS ARE SHOWN FOR 440 VOLT 3 PHASE INPUT. FOR 220 VOLT 3 PHASE INPUT.
  - A FUSE F-1506 THROUGH F-1510 (6.25A EACH) ARE SUBSTITUTED FOR F-1501 THROUGH F-1505 RESPECTIVELY.
  - B RESISTORS R-1505 THROUGH R-1510 ARE SHORTED OUT BY MEANS OF LINKS.
  - C ON E-1504 AND E-1603, LINKS ARE USED BETWEEN TERMINALS 1 AND 3 AND BETWEEN 2 AND 4.

\# DESIGNATE WIRE NUMBERS IN INTERSTACK CABLES "C", "F" AND "G" USED IN AN/SRT-15.

\#\# DESIGNATE WIRE NUMBERS IN INTERSTACK CABLES "H", "R" AND "S" USED IN AN/SRT-16.

Figure 2–127. Booster Control Circuits, Simplified Schematic



NOTES:—

1. TERMINALS AT LEFT EDGE OF SHEET ARE DUPLICATE OF THOSE FOUND ON THE TRANSMITTER GROUP AND MOUNTING CONTROL CIRCUITS SIMPLIFIED SCHEMATIC (FIGURE 2-126). TO TRACE ANY CIRCUIT MATCH TERMINAL NUMBERS ON EACH DRAWING.

Figure 2—128. Antenna Coupler and R-F Tuner Control Circuits, Simplified Schematic

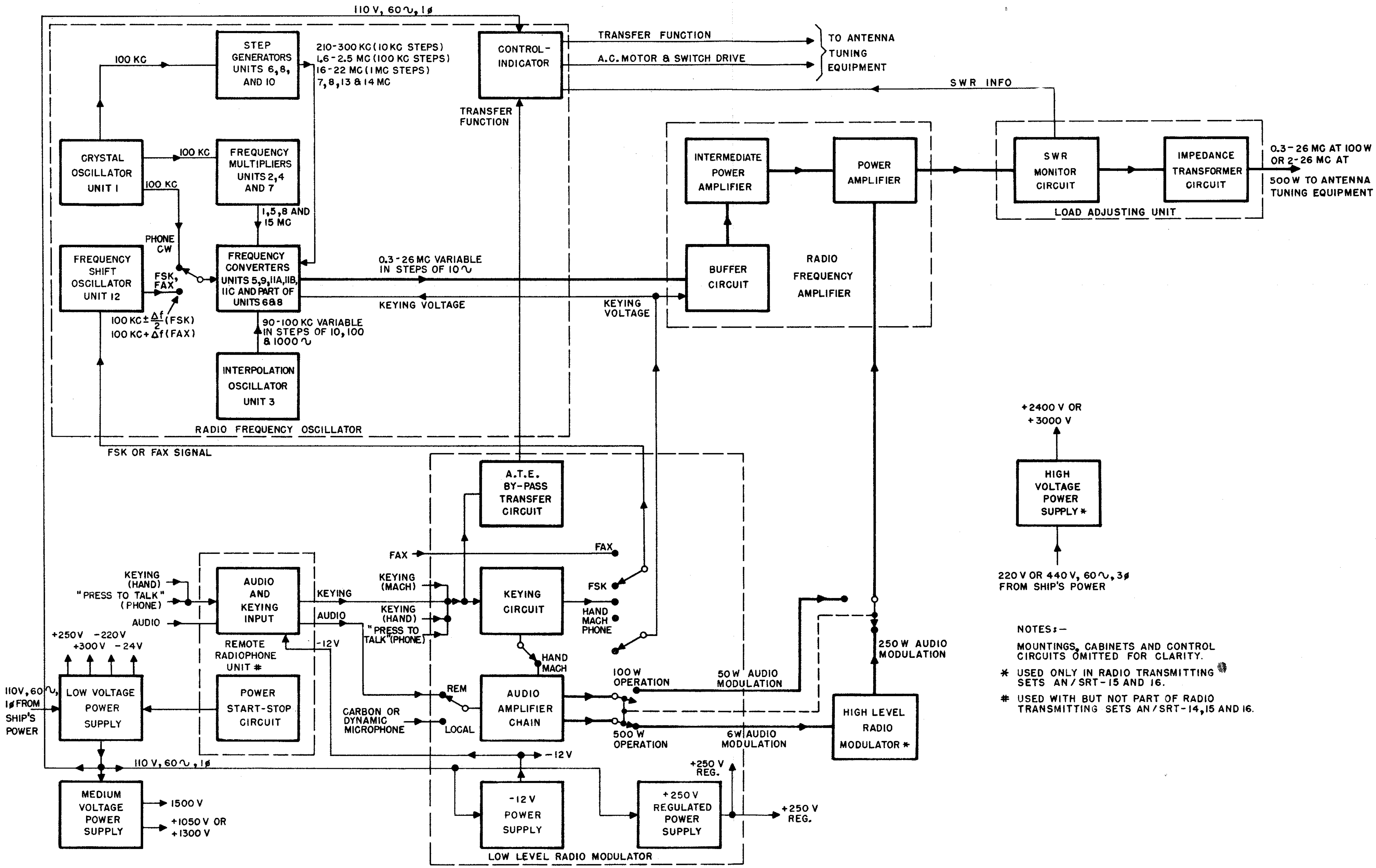


Figure 2–129. Transmitter Bay, Radio Transmitting Set AN/SRT–15, Simplified Block Diagram

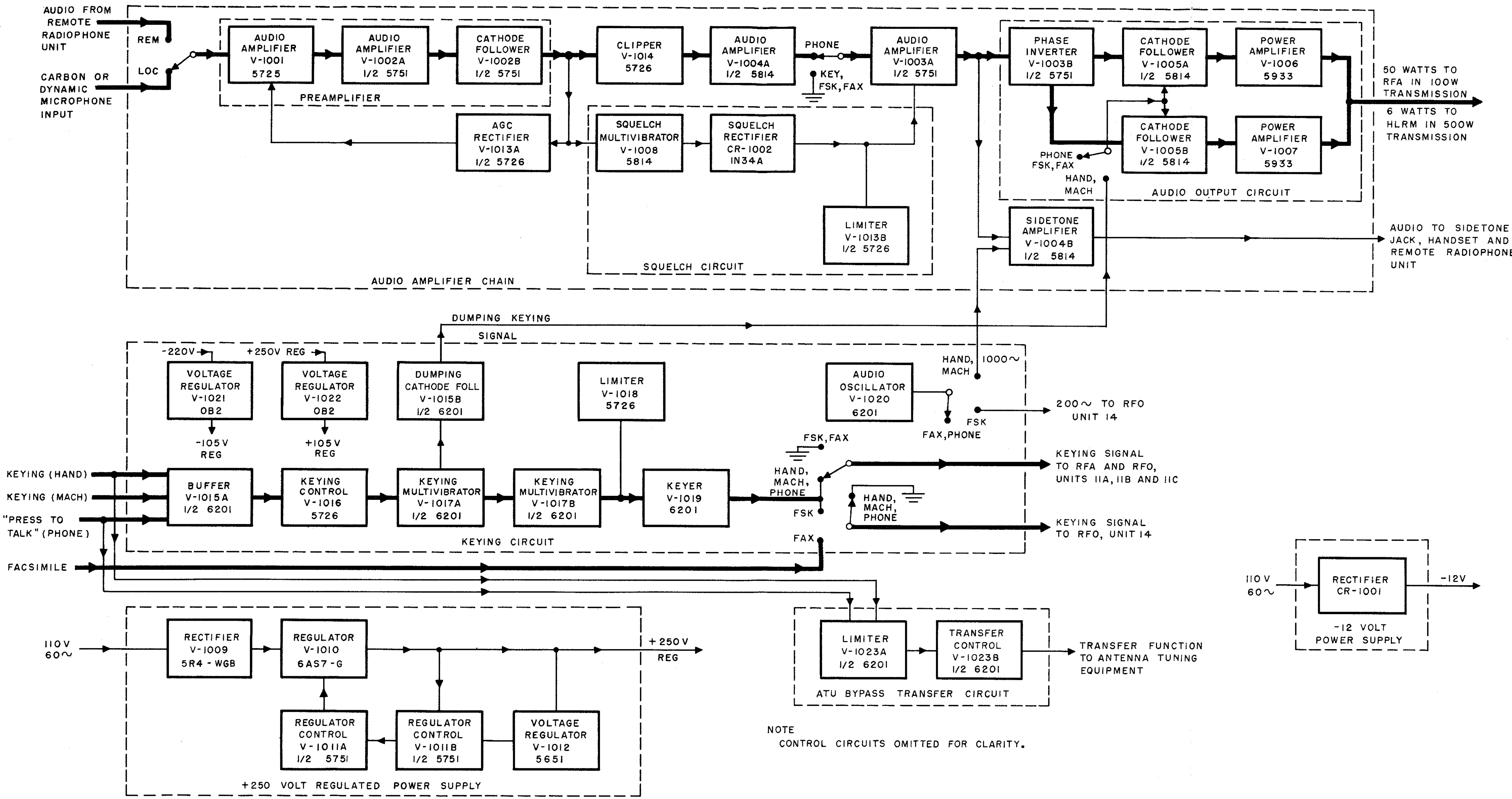


Figure 2—130. Radio Modulator MD—229/SRT (Low Level Radio Modulator, LLRM) Functional Block Diagram

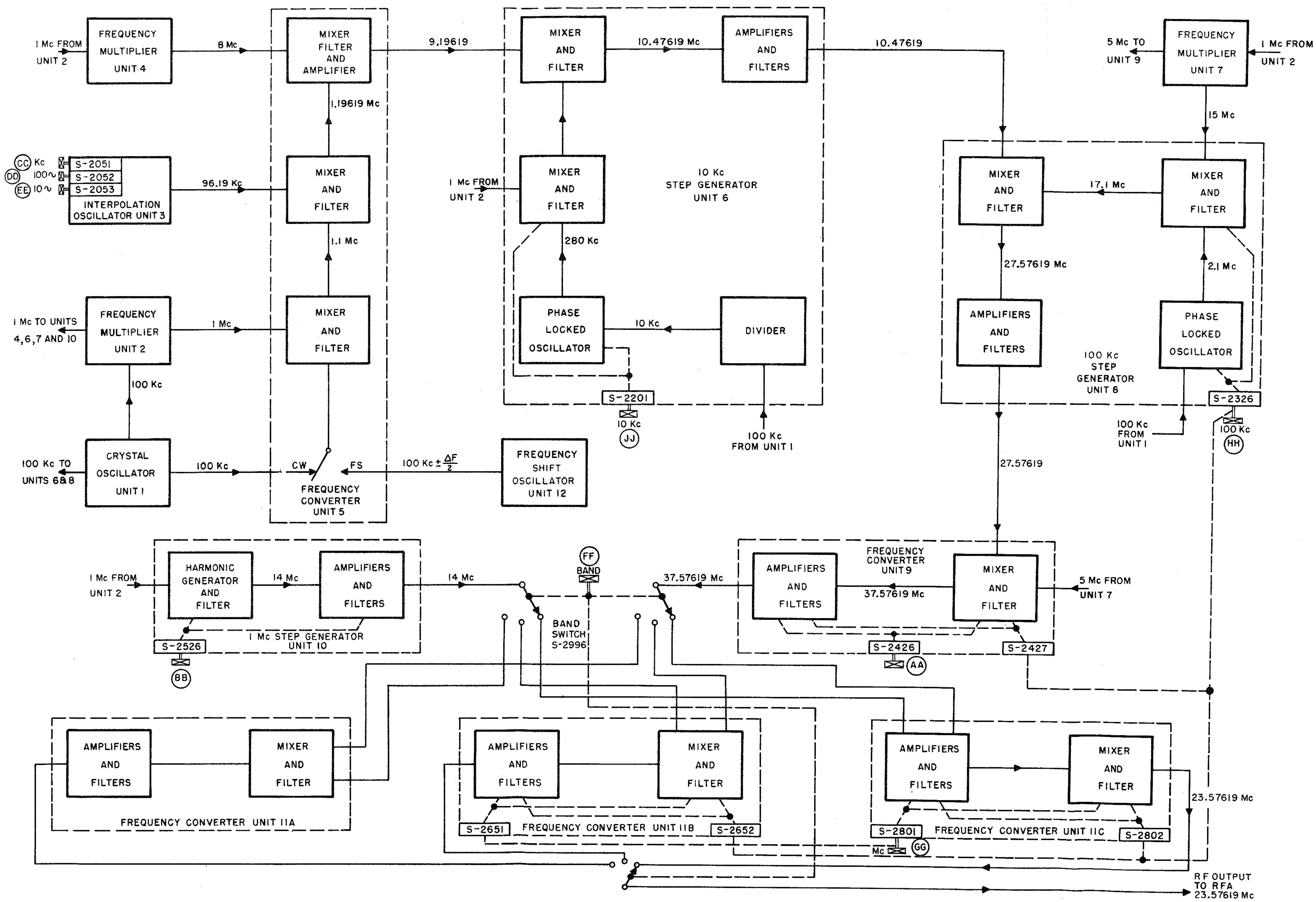


Figure 2—131. RFO Producing 23.57619 Mc, Functional Block Diagram

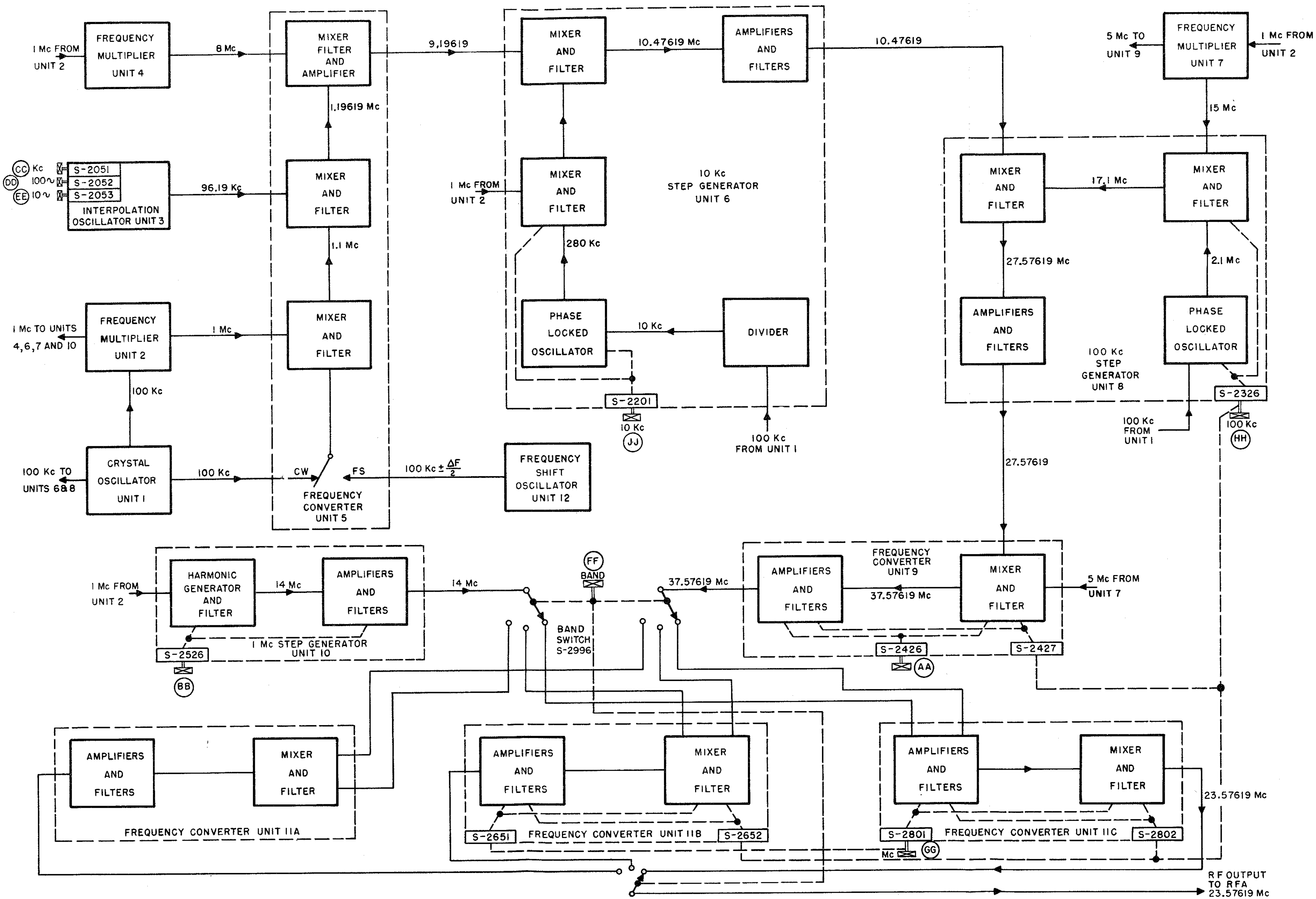


Figure 2—131. RFO Producing 23.57619 Mc, Functional Block Diagram