former-coupled stages V901 and V903, the input audio and output audio amplifiers, respectively, both of which are operated Class A push-pull. The advantages of using transformers T901, T902, and T903 are ease in matching balanced input and output lines, in driving the push-pull amplifiers, and in obtaining a pass band (100 to 5000 cps) for voice frequencies with optimum gain. An audio-level meter (M902) can be switched to measure the audio level at the output of V901 or the audio level at the output of transformer T903. The amplified signal taken from T903 is applied to the Modulator Assembly through a 600-ohm, balanced line.

A bridge-type compressor circuit reduces the gain of the amplifier whenever the audio level exceeds a preset value. This circuit includes compressor rectifier V904, compressor tube V902, interstage transformer T902, and an audio bridge. Whenever the audio signal from V903 exceeds the preset value of cut-off bias applied to V904, V904 conducts, and the resulting rectified voltage is applied to the input of V902. Tube V902 then conducts and brings the audio bridge more nearly into balance, so that the audio-signal voltage appearing across the primary winding of T902 is reduced, thereby lowering the over-all gain of the amplifier as long as a signal exceeding the preset value is maintained.

Telephone dial S903 of the Transmitter Control and the dial on Telephone Set TA-267/U are connected in parallel, so that either component can apply ground pulses to the Dial Control Assembly, which in turn selects the required transmitter function. The number of pulses transmitted corresponds to the number dialed. By dialing certain positions, an established group of pulses will actuate the Dial Control Assembly to set the transmitter to a different frequency channel or type of emission, or to turn off its plate or filament circuits. The new frequency channel to which the transmitter has been set will be indicated on CHANNEL meter M901, since a voltage proportional to the channel selected is fed to this meter from the Autotune system through the center tap of T903.

The voltage for all the circuits of the Transmitter Control is supplied by power rectifier V906. Voltage for the operation of a microphone, for push-to-talk relay K901, and for keying is obtained from taps on bleeder resistors connected across the output of V906. During phone operation, pressing the push-to-talk switch on the microphone or Telephone Set TA-267/U, energizes K901, which in turn applies 50 volts, dc, through its contacts to energize a similar relay in the Modulator Assembly so that plate voltage can be applied to the transmitter. During c-w operation, a telegraph key is shunted across the normally open contacts of K901, so that depressing the key applies the same 50 volts, dc, to the keyer assembly, which then turns on the r-f carrier for on-off type keying.

d. TELEPHONE SET TA-267/U.—Except for certain modifications the Telephone Set is similar in function to any ordinary commercial telephone. The circuits of the Telephone Set are connected in parallel with those in the Transmitter Control so that the operator can use the set to dial a new channel, turn filament or plate power on or off, or the type of emission, as well as to modulate or key the transmitter. The handset contains a standard mouth and earpiece so that the operator can modulate the transmitter after the switch on the hand grip is pressed. The mouthpiece, which is a carbon-type microphone, is connected to the audio-preamplifier circuits in the Transmitter Control, and the handset switch, when actuated, energizes the push-to-talk control circuits in the Transmitter Control and Modulator Assembly when the transmitter is set for PHONE operation. For two-way operation with another transmitting location, the earpiece can be connected to the receiver. For c-w operation, a telegraph key can be connected to a receptacle in the base of the Telephone Set to permit on-off keying of the transmitter.

e. R-F OSCILLATOR O-243/FRT-24.—A simplified block diagram of R-F Oscillator O-243/FRT-24 is shown in figure 2-4. The R-F Oscillator is a very stable automatic-frequency-controlled oscillator which covers a frequency range of 2 to 4.2 mc. It employs a master oscillator and amplifiers in conjunction with automatic-frequency-control circuits and a servo motor which maintain the output frequency from the master oscillator constant at any selected value within its range. The circuits that provide power to drive the transmitter are master oscillator V3131, first multiplier V3111, and final amplifier V3113. (These circuits are marked with an orange arrow on the chassis.) The remainder of the circuits, with the exception of the 450-kc mixer-amplifier (V3104), comprise the frequency-control circuits. The 450-kc mixer-amplifier (V3104) and the 100-kc amplifier (V3102B) are both provided with external jacks, so that the output of either may be fed to any external equipment requiring a frequency source of this type.

The stability of R-F Oscillator O-243/FRT-24 can be controlled by a 100-kc standard signal, either external or internal. The internal signal, when used, is generated by the 100-kc crystal oscillator (V3101). This 100-kc standard signal is subdivided by a frequency-divider circuit (V3103) to 25 kc and is then mixed, in harmonic mixer V3105 with the 100-kc signal from V3102B, to produce a signal range of 9.125 to 20.125 mc, which in turn is amplified by V3106.

The 9.125 to 20.125-mc signal from V3106 is mixed, in the first mixer (V3107), with the fifth harmonic (10—21 mc) produced by multipliers V3111 and V3112 from the generated frequency (1—1.5 mc) supplied by V3131, to produce an intermediate frequency (if.) in the range of 875—900 kc. This i-f signal is amplified by V3108 and combined in the second mixer (V3109) with a 75 to 100-kc signal, which is obtained by subdividing the 300 to 400-kc output of interpolation oscillator V3126 by means of dividers V3114 and V3115, to produce an 800-kc i-f signal in the output of V3109.

The 800-kc i-f signal is amplified by V3110 and is then subdivided to 100 kc by regenerative dividers V3124 and V3125. V3124 also provides bias to the first and second mixers and amplifiers, so that the amplitude of the 800-kc input from V3110 is maintained at a constant level at all times. Any error in the frequency of master oscillator V3131 will appear as a deviation from the 100-kc signal, which is used as one of the inputs to an error-correcting servo system. This input signal is combined, in a pair of diode mixers (V3122 and V3123), with a signal from the 100-kc standard (V3102B) to produce an output which, although in the audible range, still retains the original frequency-error deviation. In one of the diode mixers, the 100-kc standard input signal is shifted 90 electrical degrees, in order to provide a two-phase output. This two-phase output is fed to a pair of d-c amplifiers (V3120 and V3121), and thence to a pair of power amplifiers consisting of V3116, V3117, and V3118, V3119, respectively. The resultant two-phase output from the power amplifiers is fed to a-f-c motor V3101, which rotates a capacitor in the master-oscillator circuit, in the proper direction to correct the master-oscillator frequency. As soon as the master oscillator is set to the correct frequency, the 100-kc signal from V3124 matches the 100-kc signal from V3102B, and the motor ceases to rotate. The capacitor-centering relay (K3101) applies 115 volts, ac, to the a-f-c motor when the SET UP-OPERATE switch is thrown to SET UP. This sets the

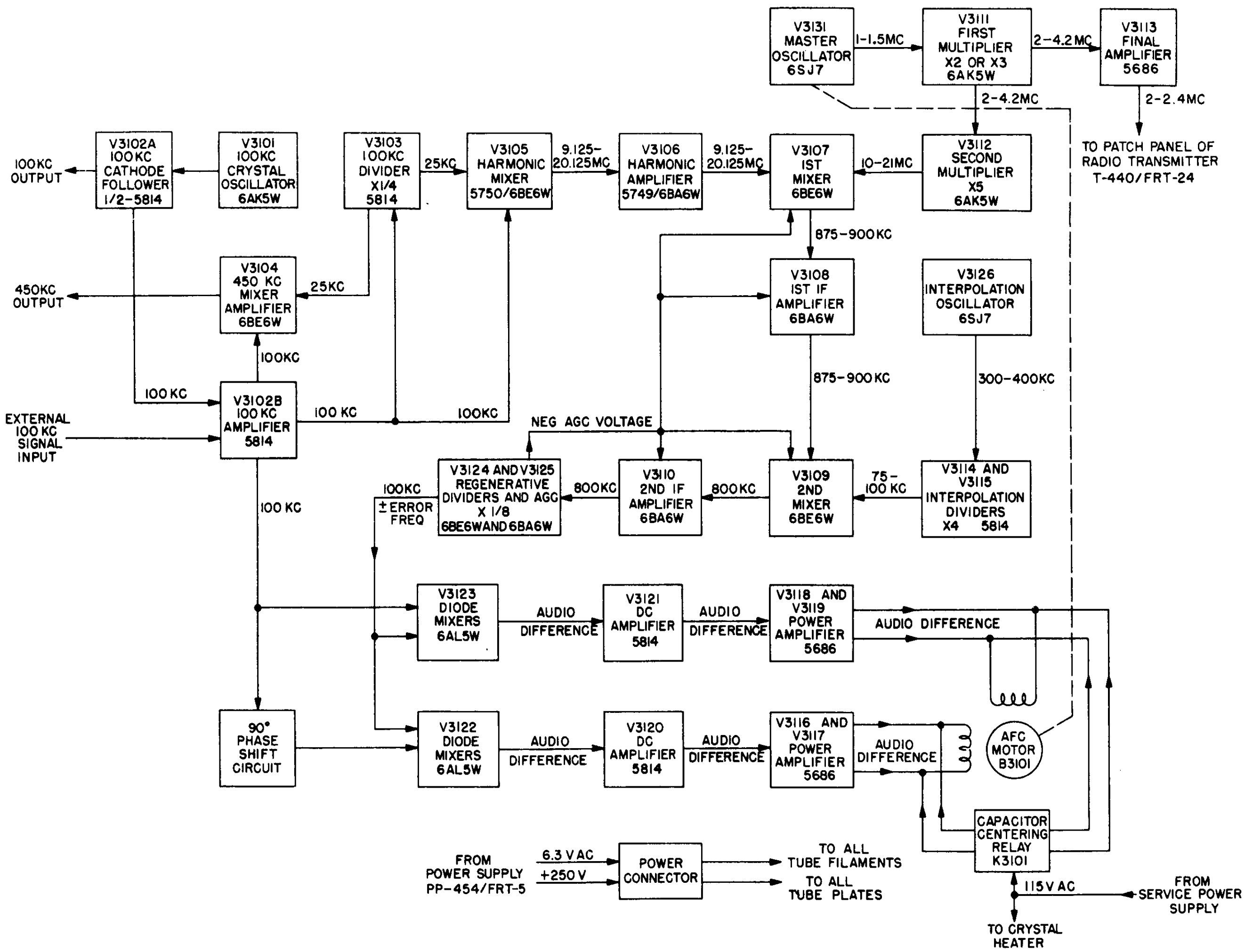


Figure 2-4. R-F Oscillator O-243/FRT-24, Block Diagram

capacitor in the master-oscillator circuit to the center of its range to permit adjustment of the R-F Oscillator controls.

f. POWER SUPPLY PP-454/FRT-5. — This Power Supply contains two similar power-supply sections, each capable of providing outputs of +250 volts unregulated, +150 volts regulated, and 6.3 volts, ac. One section of the component is used to supply +250 volts and 6.3 volts, ac, to the plate and filament circuits, respectively, of R-F Oscillator O-243/FRT-24. The section that supplies the d-c voltage is produced by two rectifier tubes (V1001 and V1002). The filament output is taken from a winding on rectifier transformer T1001. The +150 volts, which is regulated by a cold-cathode type regulator (V1005), is not required for the operation of the R-F Oscillator. The other section of the Power Supply, employing two rectifier tubes (V1003 and V1004) and voltage regulator V1006, can be used to supply plate and filament power to an external FSK oscillator when the FSK function (after certain circuit modifications are made) of the transmitter is to be enabled. The d-c output voltage from either supply can be measured by means of voltmeter M1001 and switch S1003. The input power of 230 volts, ac, from the Service Power Supply in Radio Transmitter T-440/FRT-24 is supplied to the primary windings of rectifier transformers T1001 and T1002 of the dual-section power supply. Operation from a 115-volt, a-c source is possible when switch S1002 is thrown to the 115V position.

2. CIRCUIT ANALYSIS

a. RADIO TRANSMITTER T-440/FRT-24.—Radio Transmitter T-440/FRT-24 consists of an R-F Assembly, Modulator Assembly, Dial Control Assembly, Power Control Assembly, three separate Power Supplies, Power Change Assembly, and Patch Panel Assembly, which are mounted in and interconnected within a cabinet. Each is discussed in the following paragraphs.

(1) R-F ASSEMBLY.—The R-F Assembly, shown in figure 1-3, is divided into a crystal oscillator and buffer, two multiplier stages, a driver and power-amplifier stage, a bias supply, an exciter voltage regulator, a keyer assembly, and an Autotune electromechanical system. Each is discussed in paragraphs (*a*) through (*h*), below.

(*a*) CRYSTAL OSCILLATOR AND BUFFER (*see figure 2-5*).—The crystal-oscillator stage, using a JAN 5654 pentode (V101), is essentially an electron-coupled, Colpitts-type circuit employing a highly selective crystal in place of a conventional tuned circuit for generating the transmitter frequency. The oscillator can be set to nine different channels within the frequency range of 1.0 mc to 8 mc by selecting crystals Y101 through Y109 with the 10-position channel switch (S101D). Each crystal has a trimmer capacitor (C171 through C179), which permits slight adjustment of the resonant frequency of the crystal to a more accurate setting. The oscillator portion of the tube consists of the cathode, control grid, and screen grid, the latter

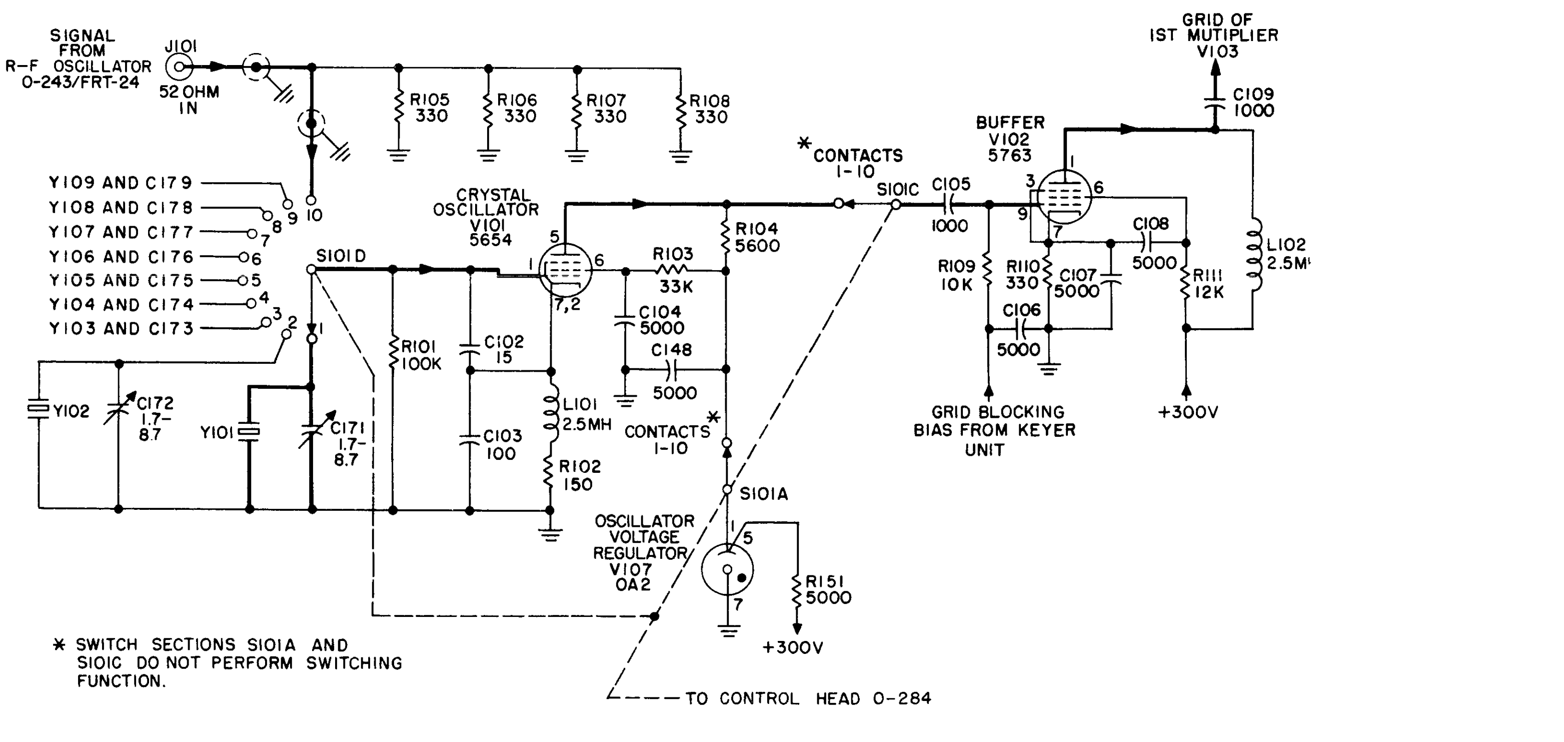
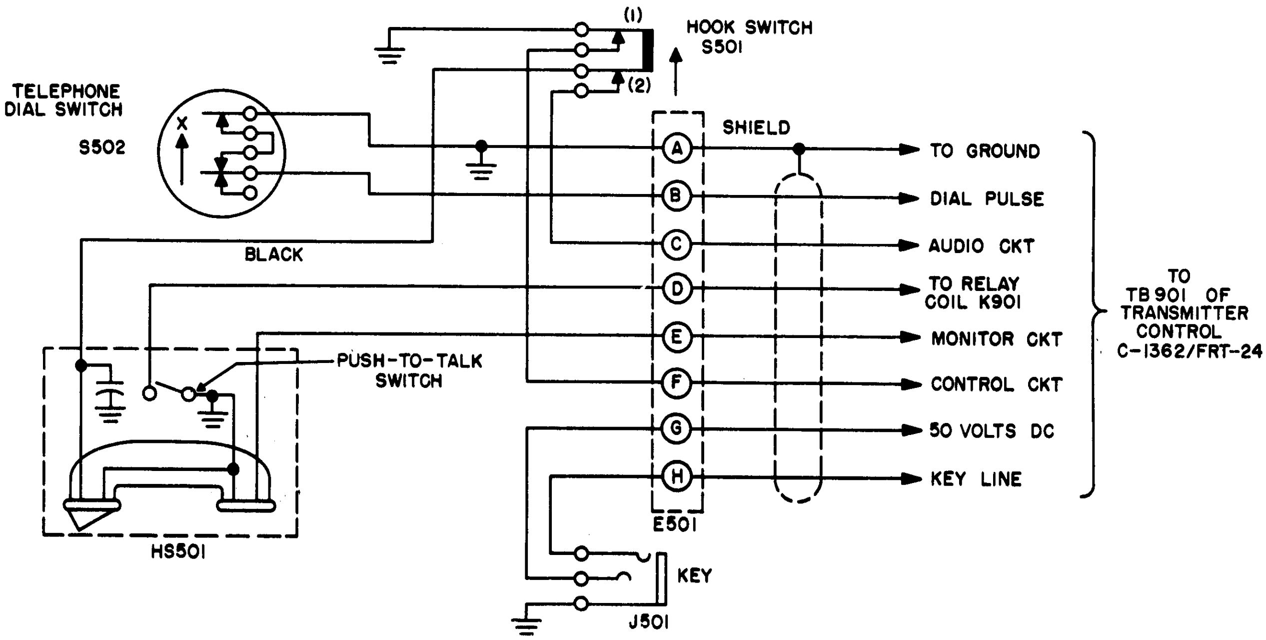


Figure 2-5. Crystal Oscillator and Buff r, Simplified Sch matic



NOTE:
SYMBOL DESIGNATIONS FOR THE TELEPHONE SET SHOULD NOT BE CONFUSED WITH SIMILAR DESIGNATIONS GIVEN FOR THE POWER CONTROL ASSEMBLY.

Figure 2-35. Telephone Set TA-267/U, Simplified Schematic

d. TELEPHONE SET TA-267/U (*see figure 2-35*).—Except for certain modifications, the Telephone Set (shown in figure 1-17) is similar in function to any ordinary commercial telephone. (Symbol designations for the Telephone Set should not be confused with similar designations given for the Power Control Assembly.) The base of the unit contains dial switch S502, which is connected in parallel with S903 and TB902 of Transmitter Control C-1362/FRT-24 by means of terminal board E501 and a seven-conductor shielded cable so that the function of this switch in channel, emission, and power selection is identical with that of the dial switch of the latter unit. The base also contains a KEY receptacle (J501) to provide a means of introducing a telegraph key, if the operator wishes to employ the transmitter for c-w operation. When handset HS501 is picked up from the base, microphone voltage is applied to the carbon-button type mouthpiece through closed contacts (2) of hook or enabling switch S501 (provided that an open-circuit or dummy plug has been inserted in MICROPHONE jack J901 so as to apply 4.5 volts, dc, to terminal E501, and to complete the input circuit through capacitor C901 to input transformer T901, as shown in figure 2-31). The capacitor across the microphone prevents carbon-granule packing due to loud noises or physical impact. The push-to-talk switch of HS501, when actuated, will energize relay K901 in the Transmitter Control and relay K603 in the Modulator Assembly so that the transmitter will provide phone operation, as explained in paragraph 2.*a.*(2) of this section. The permanent-magnet type earpiece of HS501 can be wired to the output circuit of a communications receiver for reception of signals from another transmitting location, or it may be used in any other way to meet the particular requirements of an individual installation. Contacts (1) of S501 can also be used for operating an external control circuit to meet the individual requirements of an installation. These contacts apply a ground whenever switch S501 is actuated by picking up HS501.

e. R-F OSCILLATOR O-243/FRT-24.—R-F Oscillator O-243/FRT-24, shown in figure 1-13, provides an extremely stable and accurate input signal within the frequency range of 2 to 4.2 mc. The over-all schematic diagram of the R-F Oscillator, as shown in figure 7-65, contains a master oscillator (V3131) feeding a multiplier (V3111) that acts as a doubler or tripler; the final amplifier (V3113) applies the signal at sufficient power level to drive the radio transmitter. These three stages are the basic components of the unit; the remainder of the circuits with the exception of the 450-kc mixer-amplifier (V3104) comprise the frequency control circuits, which serve to drive an a-f-c motor, B3101 (part of a servo system) whenever the frequency of master oscillator V3131 deviates in either direction. V3104 and V3102B provide a 450-kc output and a 100-kc output respectively to coaxial connectors J3104 and J3106 (located on the rear of the chassis), for use with any external equipment requiring frequency sources of this type. Whenever the tenth channel is selected, locally at the transmitter by CHANNEL SELECTOR switch S243 or remotely by a telephone dial of the remote station, a signal that has been previously set up in the R-F Oscillator is applied through the Patch Panel Assembly to the 52 OHM R-F INPUT receptacle (J101) of Radio Transmitter T-440/FRT-24. On this channel, crystal oscillator V101 of the transmitter will not be self-excited but will operate as an untuned r-f amplifier, as explained in paragraph 2.*a.*(1) (*a*) of this section.

(1) MASTER OSCILLATOR (*see figure 2-36*).—The oscillator assembly is a precision device which supplies an output signal of very stable frequency under conditions of extreme temperature and humidity changes. The circuit used is an electron-coupled type employing a 6SJ7 tube (V3131), and covering a frequency range of 1000 to 1500 kc. The output frequency of the oscillator is determined by the position of the tuning slug within grid inductor L3103, and the capacitance setting of C3170, which is across the grid inductor. The tuning-slug position is determined by the setting of MASTER OSCILLATOR dial A-1. The setting of C3170 is determined by the frequency control circuit, which operates the a-f-c motor that is mechanically linked to capacitor C3170.

(2) FIRST MULTIPLIER V3111 (*see figure 2-37*).—The first multiplier stage (V3111) employs a JAN 5654/6AK5W miniature pentode using cathode bias, and operating as either a frequency doubler or frequency tripler. The plate circuit of V3111 consists of a tuned circuit which is composed of slug-tuned inductor L3109, trimmer capacitor C3144, and one section of variable ganged capacitor C3120D. Capacitor C3166 is employed to block d-c plate voltage from the tuning gang, but its value is made sufficiently large so that tuning is not affected. The plate tank circuit may be tuned to twice the input frequency to produce an output frequency of 2 to 3 mc, or it may be tuned to three times the input frequency to produce an output frequency of 3 to 4.2 mc. Tuning is accomplished by OUTPUT TUNING dial C-1 (C3120D). The output of V3111 is capacitively coupled through C3171 to the second multiplier grid, and through C3167 to the final-amplifier grid.

(3) FINAL AMPLIFIER (*see figure 2-37*).—The final-amplifier stage (V3113) utilizes a

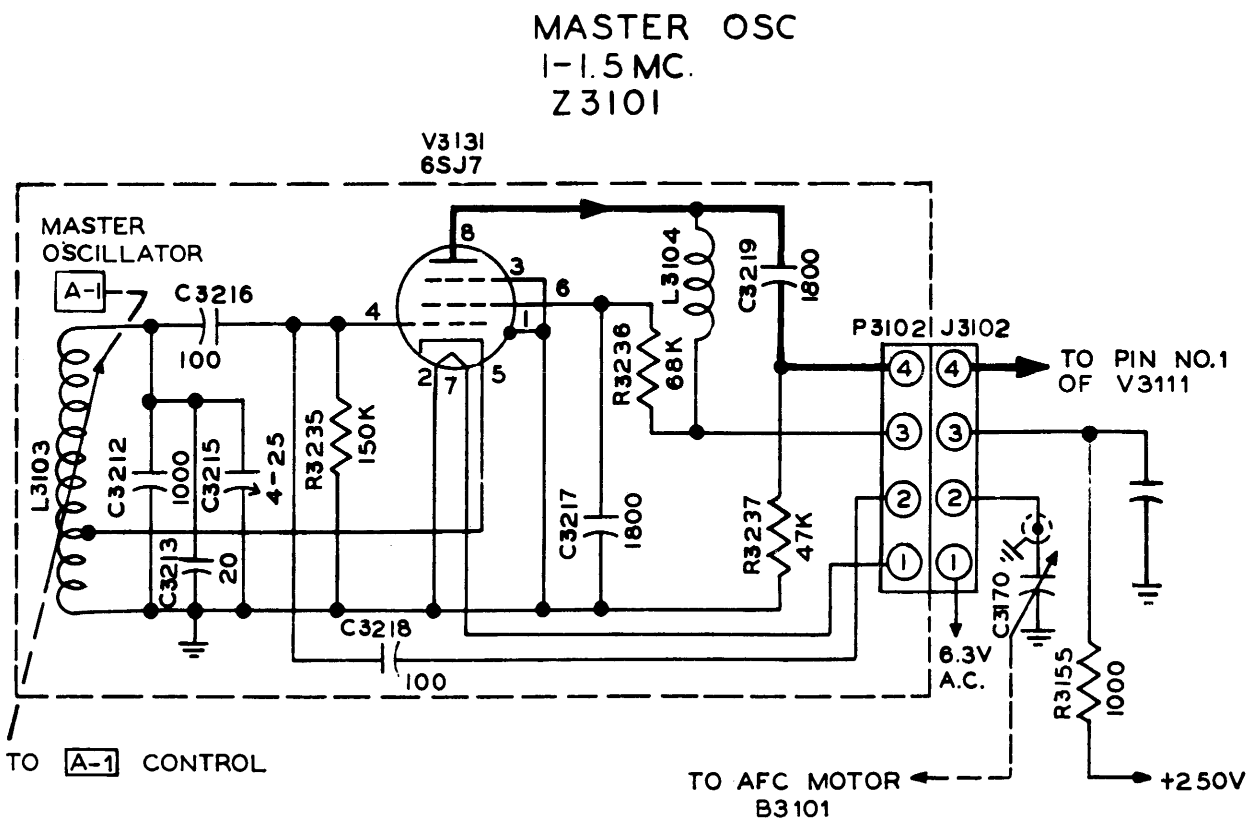


Figure 2-36. Master Oscillat r, Simplified Schematic

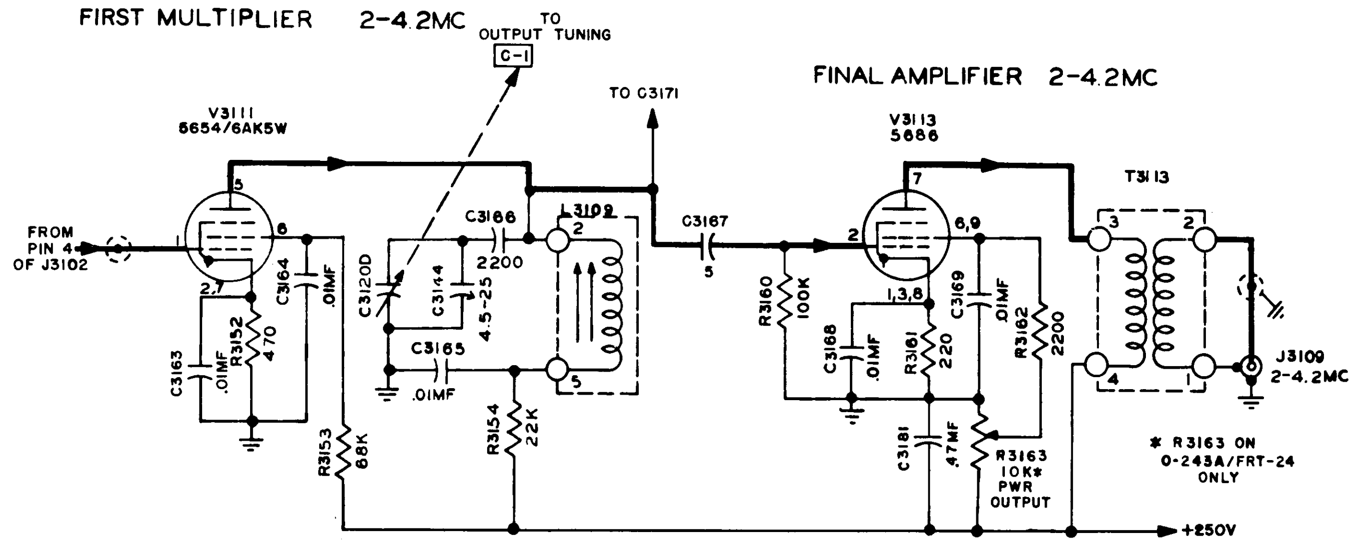


Figure 2-37. First Multiplier and Final Amplifier, Simplified Schematic

JAN 5686 pentode and operates as a straight Class-A amplifier using cathode bias. Input voltage is fed from the plate circuit of V3111 through capacitor C3167 to the control grid of V3113. The plate circuit of V3113 contains an untuned transformer, T3113, the output winding of which is coupled to the transmitter through a coaxial cable. O-243A/FRT-24 has PWR output potentiometer R3163 in the final amplifier V3113 screen grid circuit which is set for maximum output voltage for use in Radio Transmitting Set AN/FRT-24. In O-243/FRT-24 the screen dropping resistor R3162 connects directly to the +250 v supply.

Note

THE FREQUENCY CONTROL CIRCUITS CONSIST OF A 100-KC CRYSTAL OSCILLATOR, 100-KC AMPLIFIER, 100-KC DIVIDER, HARMONIC AMPLIFIERS, FIRST INTERMEDIATE-FREQUENCY AMPLIFIER (875—900 KC), SECOND INTERMEDIATE-FREQUENCY AMPLIFIER (800 KC), INTERPOLATION OSCILLATOR, BUFFER, INTERPOLATION DIVIDERS, REGENERATIVE DIVIDERS, DIODE MIXERS, D-C AMPLIFIERS, AND POWER AMPLIFIERS.

(4) 100-KC CRYSTAL OSCILLATOR (*see figure 2-38*).—The 100-kc crystal oscillator employs a JAN 5654/6AK5W miniature pentode (V3101), in an electron-coupled, Pierce-type of oscillator circuit. In this circuit, the screen grid of V3101 is used for the oscillator plate. Feedback takes place through a division of voltage between the screen-to-cathode capacitance and the grid-to-cathode capacitance of the tube, and the crystal acts as a resonant circuit. By means of the small variable capacitor, C3101, the circuit may be adjusted to oscillate at precisely 100 kc. The output is taken from the plate circuit of V3101 through capacitor C3104. The 100-kc crystal. Y3101, is contained in a temperature-controlled oven. When 115 volts, ac, is applied to the crystal oven, pilot light I-3101, designated as "CRYSTAL OVEN—HEAT ON", lights, indicating that the heater resistors are energized to raise the temperature of the oven. The temperature is thermostatically controlled between 59°C to 61°C (138.2°F to 141.8°F). When the temperature within the oven becomes stabilized, the heating cycle should be "heat on" for about 4 to 5 minutes and "heat off" for about 8 to 10 minutes with the room temperature constant. The required stability is reached within one hour after a-c power is applied. Capacitor C3114 is connected across the thermostat contacts to prevent arcing.

(5) 100-KC AMPLIFIER (*see figure 2-38*). — The 100-kc amplifier (V3102) uses a JAN 5814 miniature dual-triode tube. The input signal is taken from the plate circuit of the crystal oscillator and is applied through C3104 to the grid of section A of V3102, which is connected as a cathode follower. The output of the cathode follower is brought out to a coaxial connector on the rear of the chassis (J3105), so that a signal can be supplied to any external equipment that requires a 100-kc source. Section B of V3102 is operated as a Class-A amplifier with cathode bias, and its grid circuit is connected to a coaxial connector, (J3106), also located on the rear of the chassis. If an external 100-kc standard is used, its output may be fed into J3106. If use of the self-contained 100-kc standard is desired, a coaxial jumper is used to connect J3105 to J3106. The output from V3102B is fed through C3112 to the 450-kc amplifier stage, and through C3109 to the crystal-divider circuit.

(6) 100-KC DIVIDER (*see figure 2-38*).— the resistors cause the grid of tube B to be driven iature dual-triode tube, (V3103) in a synchronized, plate-coupled multivibrator circuit. The purpose of the circuit is to divide the input frequency (100 kc) by 4, in order to supply an output frequency of 25 kc. To understand the operation more thoroughly, consider V3103 as a free-running 25-kc multivibrator. When power is first applied, the full B-plus voltage will be applied to both plates of V3103, and capacitors C3110 and C3111 are charged almost to the B-plus value. As the tube begins to conduct, there will be a slight unbalance of plate currents between both sections of the tube, and one side will conduct slightly more than the other. For purposes of explanation, assume that tube A (V3103A) begins conducting more rapidly than tube B (V3103B). For this condition, the plate voltage of tube A will decrease more rapidly than the plate voltage of tube B, and capacitor C3111 will begin to discharge. The discharge path for C3111 is through R3115, R3113, and R3111, through the power supply, and back to the other side of the capacitor via R3116. The polarities of the resulting voltage drops across the resistors cause the grid of tube B to be driven in a negative direction toward cutoff. This causes the plate voltage on tube B to increase, as the plate current tapers off. As the charge on C3110 tends to follow this increase, a corresponding increase of voltage, in the positive direction, is transferred to the grid of tube A, causing its plate voltage to continue decreasing. The action is cumulative, and as a result, the grid of tube B is driven beyond cutoff for a period until the discharge of C3111 is nearly completed. During the time that tube B is cut off, tube A conducts strongly. The amount of time required for C3111 to discharge is determined by the time constant of the grid-circuit network associated with tube B.

When capacitor C3111 has discharged sufficiently, tube B comes out of cutoff and starts to conduct. Simultaneously, the plate voltage on tube B starts to decrease, causing capacitor C3110 to begin discharging. As a result, the whole cycle of events reverses, and tube A is then cut off while tube B is left conducting strongly. This condition marks the completion of one cycle of operation, after which the sequence of events is repeated indefinitely.

In order that this type of frequency divider may be synchronized, its free-running frequency is made slightly less than a submultiple of the synchronizing frequency (in this case, slightly lower than 25 kc). The 100-kc synchronizing signal is applied through capacitor C3109 and appears across the common grid resistor, R3111. Every other positive half-cycle of this signal causes each grid of the divider to be brought out of cutoff alternately, an instant sooner than it would be if the circuit were free running. To see this action more clearly, refer to figure 2-39. At the top of the figure is shown the 100-kc synchronizing waveform; directly beneath it is the waveform that would appear at the grid of tube A if the divider were free running. The third waveform from the top illustrates the combination of the two, the solid line representing the waveform at the grid of tube A when synchronized (locked in). The remaining two waveforms at the bottom illustrate the grid voltage of tube B for both free-running and synchronized conditions. It will be observed that tube A is brought out of cutoff, by the 100-kc voltage, at instants T_2 and T_4, while tube B is brought out of cutoff at instants T_1 and T_3. In this

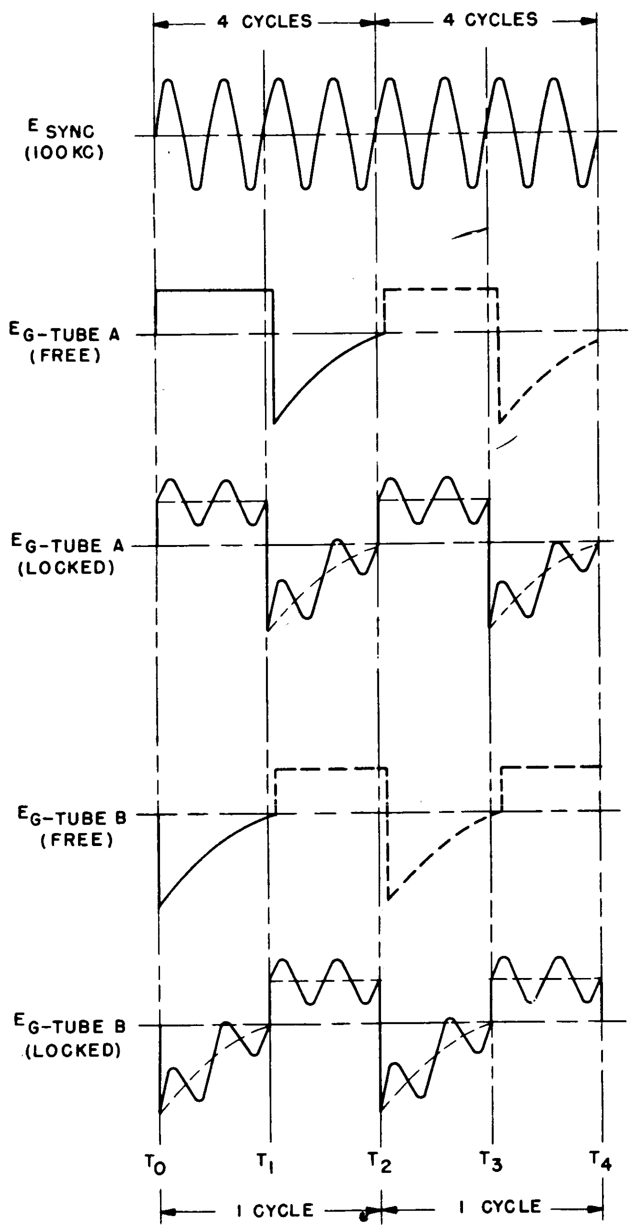


Figure 2-39. 100-KC Fr qu ncy Divid r Wav forms

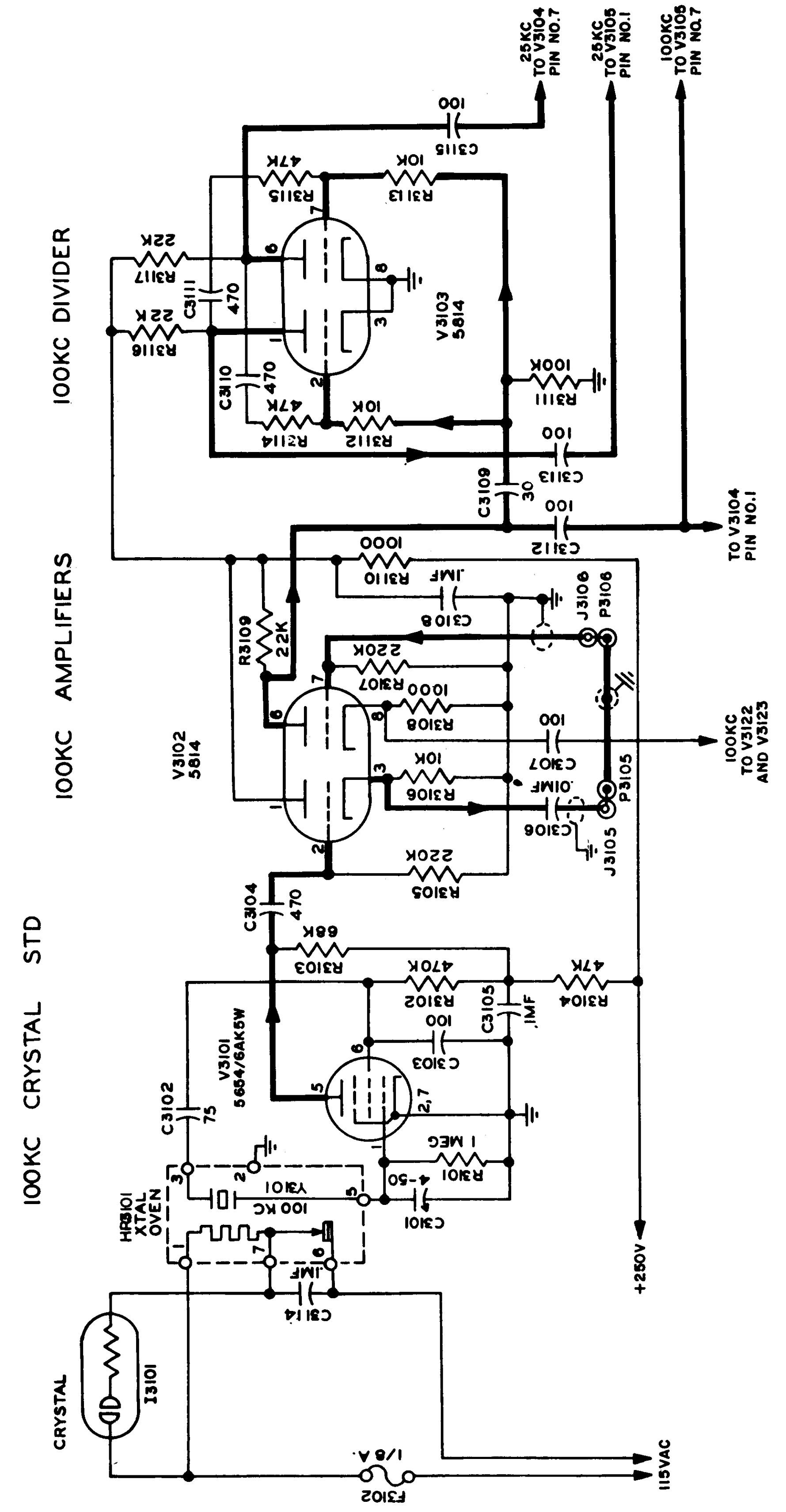


Figure 2-38. 100-KC Crystal Oscillat r, Amplifiers and Divider, Simplifi d Sch matic

manner the divider is synchronized twice per cycle of output by every other cycle of input, giving a frequency division of 4 to 1.

(7) HARMONIC AMPLIFIERS (*see figure 2-40*).

(*a*) HARMONIC MIXER V3105. — The harmonic mixer employs a JAN 5750/6BE6W miniature pentagrid converter tube (V3105). This stage combines a 25-kc signal taken from the crystal divider with a 100-kc signal taken from the 100-kc amplifier. The 25-kc signal is fed to grid number 1 of V3105 through capacitor C3113, and the 100-kc signal is fed to grid number 3 of V3105 through capacitor C3112. The two signals are mixed to produce a multitude of frequencies spaced 25 kc apart, starting with 25 kc and extending upward in frequency. The plate circuit of V3105 contains a parallel-resonant combination composed of slug-tuned inductor L3107, capacitor C3120B (part of the main tuning gang), and trimmer capacitor C3141. The circuit is tuned through the range of 9.125—20.125 mc by means of C3120B, which is controlled by OUTPUT TUNING dial C-1. Capacitor C3123 is inserted in the plate tank circuit to allow the rotor of C3120B to be grounded; in addition, it serves, in conjunction with R3126, to decouple the stage. The capacitance of C3123 is sufficiently large so that its effect on the tuned circuit is negligible. The signal appearing in the plate circuit of V3105 is applied to the grid of harmonic amplifier V3106 through capacitor C3124.

(*b*) HARMONIC AMPLIFIER V3106. — The harmonic amplifier employs a JAN 5749/6BA6W miniature pentode (V3106), operated as a Class-A amplifier with cathode bias. The parallel resonant combination used in the plate circuit of this stage is identical to that used in the preceding stage; it is tuned through the range of 9.125—20.125 mc by C3120A, which is controlled by OUTPUT TUNING dial C-1.

Note

THE OUTPUT SIGNAL FROM SECOND-HARMONIC AMPLIFIER V3106 IS FED TO THE INPUT OF THE FIRST I-F STRIP. SINCE THE FIRST STAGE OF THIS STRIP IS OPERATED AS A MIXER, ANOTHER SIGNAL, TAKEN FROM SECOND MULTIPLIER V3112, IS REQUIRED FOR ITS OPERATION.

(8) SECOND MULTIPLIER V3112 (*see figure 2-40*).—Multiplier stage V3112 employs a JAN 5654/6AK5W miniature pentode operating as a Class-C stage to multiply the input frequency five times. Bias for Class-C operation is obtained by a combination of cathode and grid-leak bias. Cathode bias is developed across R3157 and C3172, while grid-leak bias is developed across R3156 and C3239. The plate tank circuit is composed of slug-tuned inductor L3110, one section of main tuning gang C3120C, and trimmer capacitor C3145, and is tuned to the fifth harmonic (10—21 mc) of the input frequency. The setting of variable capacitor C3120C is controlled by OUTPUT TUNING dial C-1. The output is taken from the plate circuit and fed to the input of the first i-f strip.

(9) FIRST IF. (875—900 KC) (*see figure 2-40*).

(*a*) MIXER V3107. — The mixer stage (V3107) makes use of a JAN 5750/6BE6W miniature pentagrid converter tube, which is operated with agc and cathode bias. The signal from the harmonic amplifiers, which is somewhere in the range 9.125—20.125 mc depending upon the tuning, is applied to grid number 3 of mixer V3107, through capacitor C3129; grid number 3 is returned through resistor R3132 to the a-g-c system. The signal from the second multiplier, which is somewhere in the range 10—21 mc depending upon the tuning, is applied to grid number 1 of mixer V3107, through capacitor C3176. The two signals are mixed and would normally produce, in the output, several frequencies spaced 25 kc apart; however, the response in the plate circuit of the mixer is limited to a pass band of 875—900 kc by means of a double-tuned i-f transformer, T3106. Therefore, only one of these frequencies will predominate in the plate circuit of the mixer (the frequency that falls within the 875—900-kc pass band).

(*b*) I-F AMPLIFIER.—The first i-f amplifier (V3108) utilizes a JAN 5749/6BA6W miniature pentode. The input signal for this stage is supplied by the secondary winding of i-f transformer T3106. Negative grid bias taken from the a-g-c system through R3136, is also supplied through the secondary winding of T3106. The plate circuit of V3108 contains a double-tuned i-f transformer, T3107, which is identical to that used in the plate circuit of the preceding mixer stage.

Note

THE OUTPUT SIGNAL FROM THE FIRST I-F STRIP IS FED, BY MEANS OF THE SECONDARY WINDING OF T3107, TO THE INPUT OF THE SECOND I-F STRIP. SINCE THE FIRST STAGE OF THIS STRIP IS OPERATED AS A MIXER, ANOTHER SIGNAL, TAKEN FROM THE INTERPOLATION CIRCUITS, IS REQUIRED FOR ITS OPERATION.

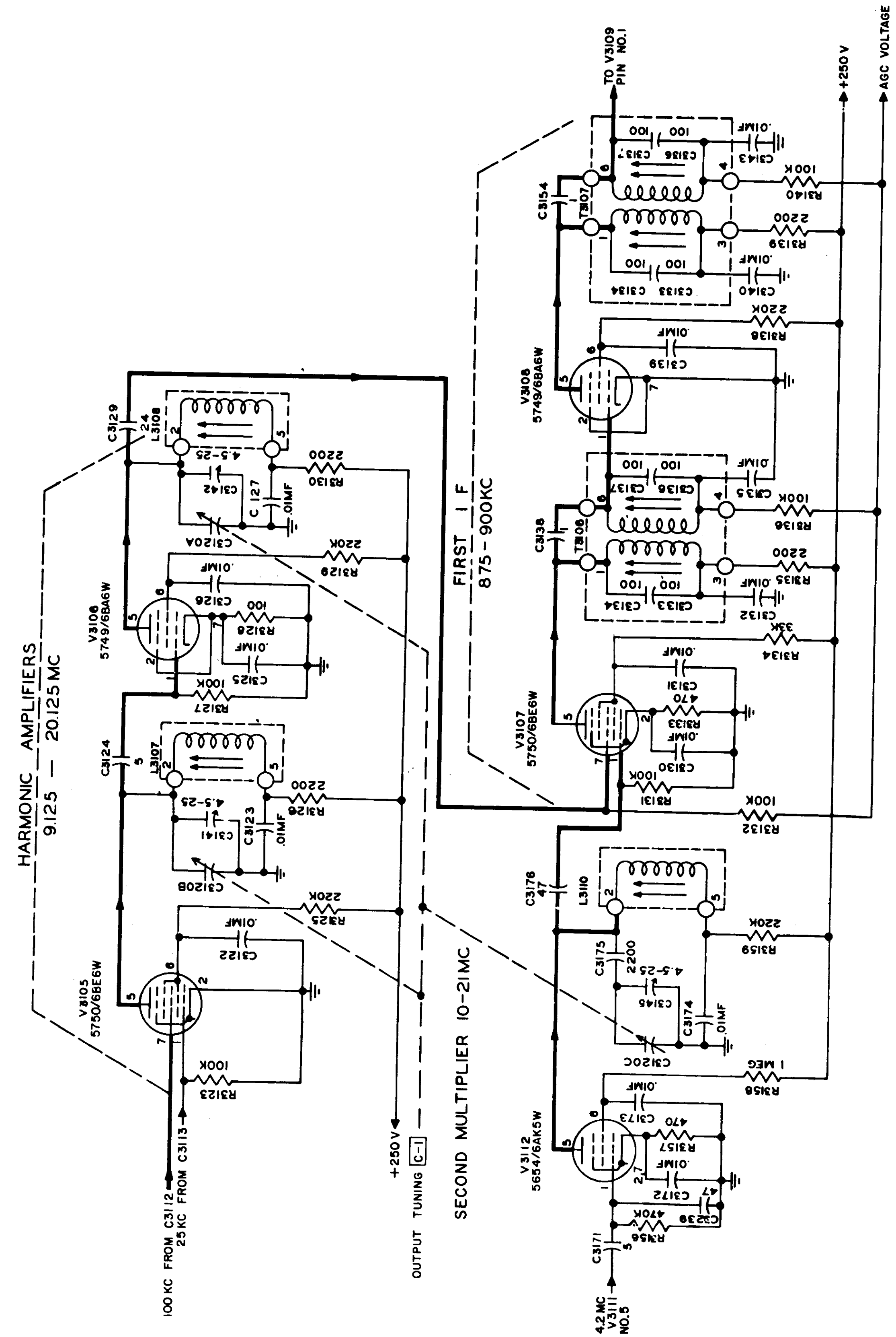


Figure 2-40. First I-F Strip, Simplified Schematic

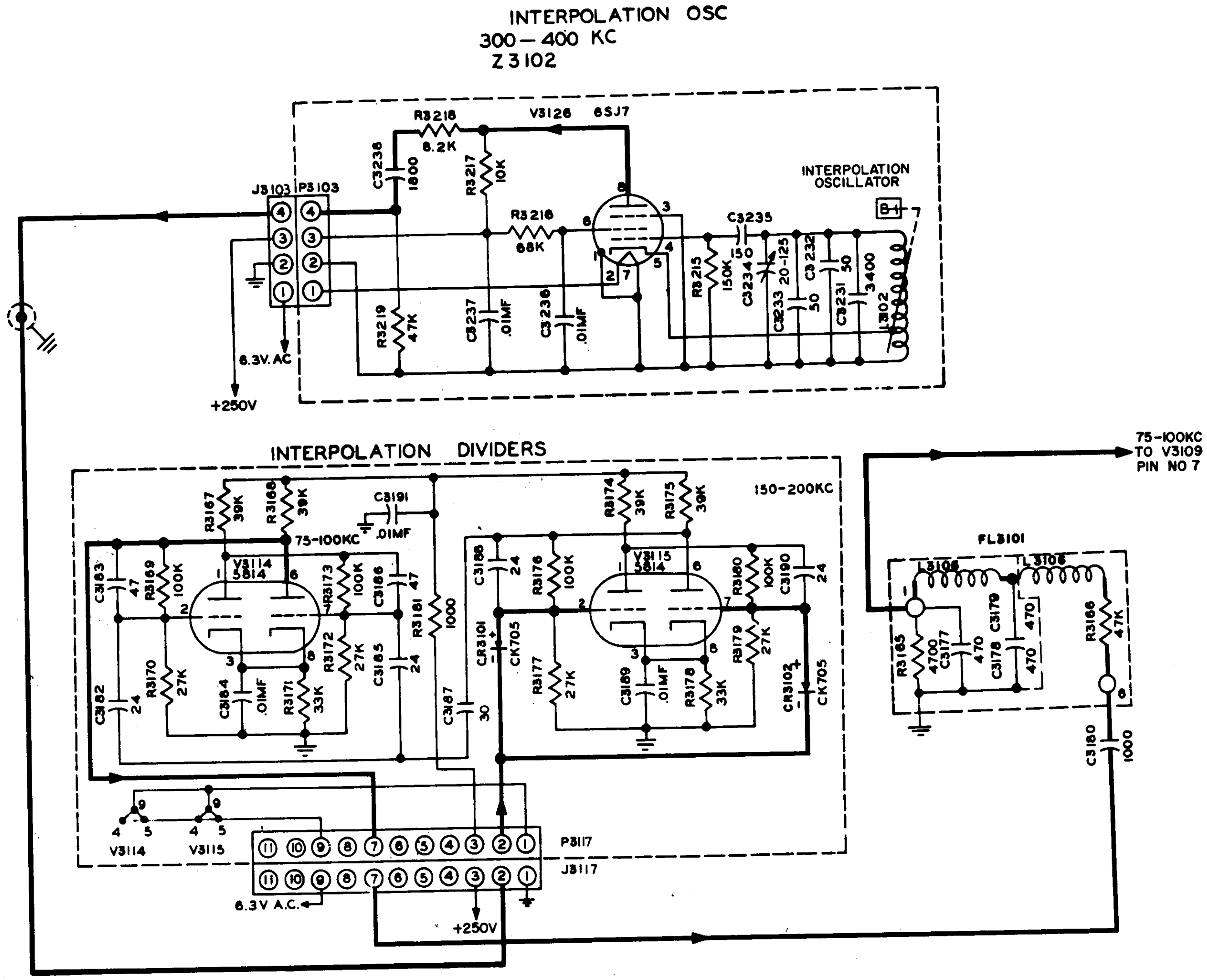


Figure 2-41. Interpolation Oscillator and Dividers, Simplified Schematic

(10) INTERPOLATION CIRCUITS (*see figure 2-41*).

(*a*) INTERPOLATION OSCILLATOR.—The interpolation-oscillator assembly is a precision device which supplies an output signal with a very stable frequency under conditions of extreme temperature and humidity changes. The circuit used is an electron-coupled type employing a 6SJ7 tube (V3126) and covering a frequency range of 300—400 kc. The output frequency of the oscillator is determined by the position of the tuning slug within grid inductor L3102, which in turn is determined by the setting of INTERPOLATION OSCILLATOR dial B-1.

(*b*) INTERPOLATION DIVIDERS (*see figure 2-41*).—The interpolation dividers (V3114 and V3115) each make use of a JAN 5814 miniature dual-triode tube in a triggered flip-flop multivibrator circuit. This type of circuit exhibits two stable states in which either section of the tube is left conducting while the other section is cut off, reversing only when a trigger is applied. Each divider stage functions to divide its input frequency by 2, giving a total frequency division through the interpolation divider circuits of 4 to 1 (dividing 300—400 kc down to 75—100 kc). To understand the operation more thoroughly, consider only the second-divider stage, V3114. When no excitation voltage is applied to the grids of this stage, one section of the tube (to be called A) conducts heavily and at the same time the other section of the tube (to be called B) is cut off. When a negative-going pulse is applied to the grids through capacitors C3182 and C3185, there will be no immediate effect on section B of the tube, but section A will be cut off. As a consequence, the plate voltage on section A will increase, and this increase will be transferred to the grid of the other section, through R3173 and

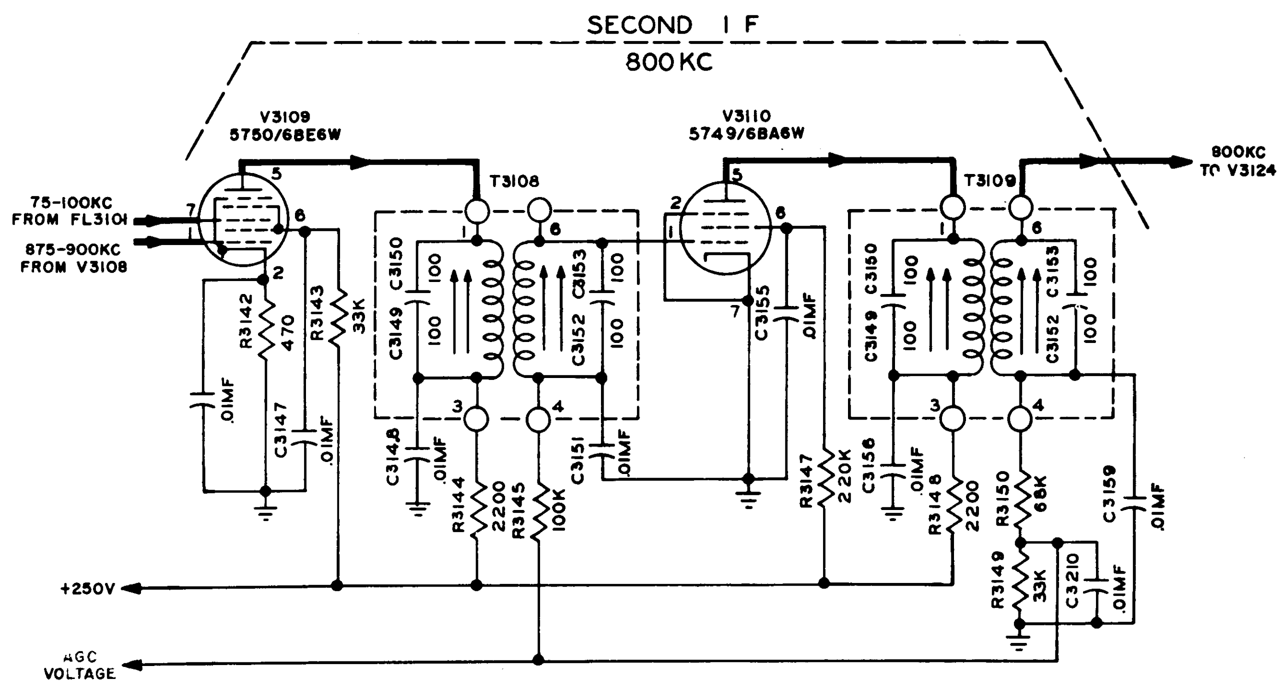
C3186, causing section B to be brought out of cutoff. Thus one-half cycle of output from the divider is produced, and nothing further happens until the next negative-going pulse is applied to the grids. When this occurs, section B of the tube is cut off by the trigger; the resulting sharp increase in plate voltage is transferred to the grid of section A through R3169 and C3183, bringing section A out of cutoff and completing one cycle of output from the divider.

Actually, the second divider is triggered by the negative half-cycle of the square-wave output from the first divider; the high negative bias used in the second divider makes the positive half-cycles of the triggering voltage ineffective.

The first-divider stage (V3115) operates in a similar manner to the second stage just described, the principal difference being that the triggering voltage is introduced into the circuit through a pair of crystal rectifiers, CR3101 and CR3102. The reason for this difference in design is twofold, both tending to make the divider operation more stable. First, it tends to make the triggering action more positive—a very desirable feature when the circuit is triggered from a sine-wave source; second, it reduces the loading effects of the interpolation oscillator upon the divider. It can be seen from the circuit arrangement that crystal rectifier CR3101 and CR3102 can conduct only on the negative portions of the triggering signal. (The grids of V3115, and therefore the anodes of CR3101 and CR3102, are prevented, by the flow of grid current, from going more than slightly positive at any time.) The triggering action in the first divider therefore is as follows: Assume that, initially, section A of V3115 is conducting and section B is cut off. The next negative half-cycle of the sine-wave triggering voltage will have no effect on section B because the anode of CR3102 is biased negatively. However, since the anode of CR3101 is positive with respect to the negative half-cycle of trigger voltage, CR3101 will conduct and cause section A of V3115 to be cut off, and this action in turn will cause section B to begin its period of conduction. On the next negative half-cycle of trigger voltage, CR3102 will conduct and cut off section B, which in turn will cause section A to begin its period of conduction. Thus, one cycle of output from the first divider is produced by two cycles of the triggering voltage.

(11) SECOND IF. (800 kc) (*see figure 2-42*).

(*a*) MIXER V-3109.—The mixer stage, V3109, makes use of a JAN 5750/6BE6W miniature pentagrid converter tube, which is operated with a-g-c and cathode bias. The signal from the first i-f strip, which is somewhere in the range 876—900 kc depending upon the tuning, is applied to grid number 1 of mixer V3109; the grid is returned through resistor R3140 to the a-g-c system. The signal from the interpolation divider, which is somewhere in the range 75—100 kc depending upon the tuning of the interpolation oscillator, is applied to grid number 3 of the mixer through a



Figur 2-42. Sec nd I-F Strip, Simplified Schematic

low-pass filter network (FL3101). This filter circuit passes all frequencies from zero up to 100 kc, and attenuates all frequencies above 100 kc (the upper harmonics of the 75—100-kc output signal from the interpolation divider). The two signals are mixed, and only the intermediate frequency is accepted by the plate circuit of V3109, which is tuned by means of double-tuned i-f transformer T3108. This transformer is tuned to pass only a narrow band of frequencies centered about 800 kc, and couples the output of the mixer to the input of the second i-f amplifier.

(*b*) I-F AMPLIFIER.—The second i-f amplifier (V3110) utilizes a JAN 5749/6BA6W miniature pentode. The input signal for this stage is supplied by the secondary winding of i-f transformer T3108. Negative grid bias, taken from the a-g-c system through R3145, is also supplied through the secondary winding of T3108. The plate circuit of V3110 contains a double-tuned i-f transformer (T3109), which is identical to that used in the plate circuit of the mixer stage.

(12) REGENERATIVE DIVIDERS AND AGC (*see figure 2-43*).—JAN 5750/6BE6W miniature pentagrid converter tube (V3124) is used in conjunction with a JAN 5749/6BA6W miniature pentode (V3125) in a regenerative divider circuit wherein the 800-kc output signal from the second i-f strip is effectively divided by 8. Essentially the circuit is composed of a mixer stage (V3124) and a frequency-multiplier stage (V3125). Both employ cathode bias and are coupled together in a manner that allows regeneration to take place over a small band of frequencies determined by resonance characteristics of the two tuned circuits contained in Z3104. Both tuned circuits, while located in a common container, are isolated from each other by means of shielding. The tuned circuit composed of L3113, C3227, and C3228 is resonant at 700 kc, while the tuned circuit composed of the primary winding of T3105 and capacitors C3225 and C3226 is resonant at 100 kc. When power is first applied, transient oscillations will be set up by shock excitation of the two resonant circuits. A portion of the 700-kc signal developed in the plate tank of frequency-multiplier stage V3125 is applied through capacitor C3221 to grid number 3 of mixer stage V3124. At the same time the 800-kc i-f signal from the secondary winding of the last second i-f transformer (T3109) is applied through resistor R3204 to grid number 1 of the mixer. The two signals are mixed, and the difference frequency (100 kc) is developed across tuned transformer T3105 in the plate circuit of the mixer stage. A portion of this 100-kc signal is fed to the grid of the frequency-multiplier stage through capacitor C3220, and is multiplied by 7 (producing 700 kc) in the plate tank circuit of that stage. As a point of general interest, the circuit is self-starting, that is, after regeneration has started in the above man-

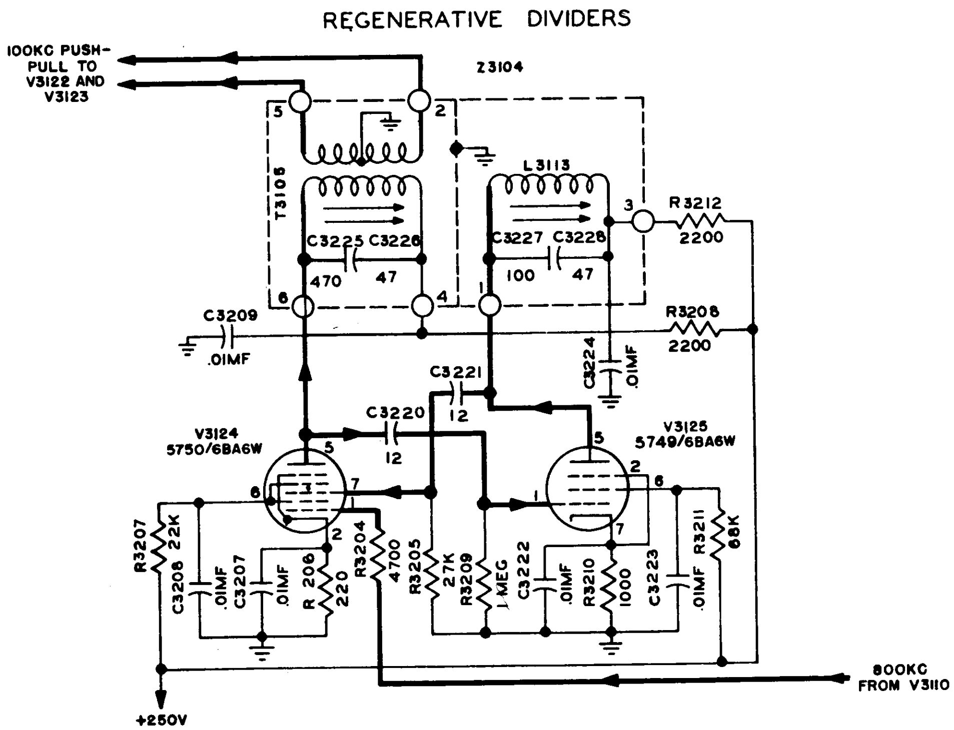


Figure 2-43. Regenerative Dividers, Simplified Schematic

ner, the process is continuous as long as the 800-kc signal is present at the input of the divider; if the 800-kc signal fails, regeneration can no longer be sustained, and the circuit ceases to operate and will not resume operation until the 800-kc signal is restored. A 100-kc push-pull output, balanced to ground, is taken from the divider by means of the secondary winding of transformer T3105.

A-G-C voltage is developed at grid number 1 of mixer stage V3124. The extreme positive excursions of the input signal (800 kc) to this grid overcome the cathode bias on V3124 and cause grid current to flow during these intervals. The grid-current flow through R3204, the secondary winding of i-f transformer T3109, R3150, and R3149 to ground, develops a voltage across a-g-c filter capacitors C3159 and C3210 which is negative with respect to ground. The negative voltage appearing across capacitor C3210 is used as bias for all stages in both the first i-f and second i-f strips, and is directly proportional to the amplitude of the 800-kc signal at grid number 1 of mixer V3124. Since an increase in signal amplitude at this point will cause increased negative bias on the i-f stages, the gain of these stages will be reduced, and the amplitude of the 800-kc input signal to the regenerative divider will be held essentially constant at all times.

(13) A-F-C MOTOR CONTROL CIRCUIT (*see figure 2-44*).—The a-f-c motor control circuit is made up of two identical channels, one of which is operated 90 electrical degrees out of phase with the other, and each containing a balanced diode mixer, a push-pull d-c amplifier, and a push-pull power amplifier. For greater clarity in the following discussion, one complete channel will be described, followed by a description of the method of obtaining quadrature operation in the other channel.

(*a*) DIODE MIXER. — The diode mixer stage (V3123), employing a JAN 5726/6AL5W miniature duo-diode tube, combines the output signal from the regenerative divider (100 kc ± error frequency) with a signal derived from the 100-kc standard, to produce an output signal whose frequency is the difference between the two combined signals. The circuit operation is as follows: The balanced output of the regenerative-divider circuit, taken from the secondary winding of transformer T3105, is fed push-pull through capacitors C3205 and C3206 to the cathodes of diode mixer V3123. The 100-kc standard signal, taken from the cathode circuit of the 100-kc amplifier (V3102B) through capacitor C3107, is applied to both plates of the diode mixer, and also appears across the parallel combination of L3111 and C3198, which is common to both diode sections and tuned somewhat below 100 kc. Mixing of the two applied signals takes place, and the mixer products appear across load resistors R3202 and R3203. The junction of the two load resistors and the resonant circuit is effectively held at a-c ground potential by means of bypass capacitor C3197, allowing a balanced push-pull output to be taken from the cathodes of mixer V3123. All mixer products except the audio difference frequency, are attenuated by the low-pass balanced filter network consisting of R3198, C3194, R3199, and C3195. This filter network terminates at the grids of d-c amplifier V3121.

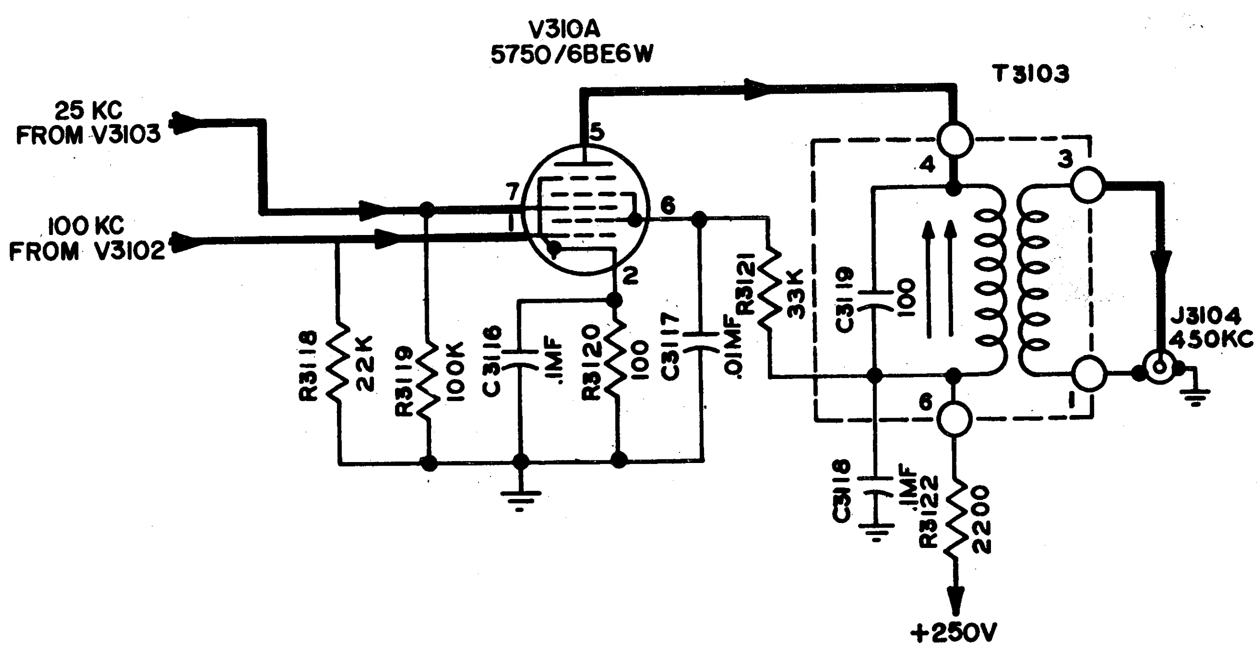
(*b*) D-C AMPLIFIER.—A JAN 5814 miniature dual-triode tube (V3121) is connected as a balanced, push-pull, direct-coupled voltage amplifier. Cathode bias is employed, and the stage functions to amplify the filtered push-pull output from diode mixer V3123. One plate of this amplifier is connected directly to the grid of power amplifier V3119; the other plate is connected to the grid of power amplifier V3118 (connected in push-pull with V3119) through SET UP-OPERATE switch S3103, when the switch is in the OPERATE position. When the switch is in the SET UP position, the signal path from one plate of d-c amplifier V3121 is broken. PHONE jack J3110 is connected through capacitor C3200 to the d-c amplifier plate side of switch S3103. This jack is mounted on the front panel so that the audio difference frequency may be monitored.

(*c*) POWER AMPLIFIER.—The power-amplifier stage makes use of two JAN 5686 miniature pentodes (V3118 and V3119), connected as a push-pull, direct-coupled power amplifier. The grids of V3118 and V3119 are connected to the plates of the preceding d-c voltage amplifier, V3121. Cathode bias for the power amplifier is developed across the common cathode resistor, R3183. B-plus voltage is applied, through a pair of normally closed contacts on capacitor-centering relay K3101, to the screen grids, and thence to the plates of the power amplifier through windings comprising one phase of the two-phase a-f-c motor, B3101.

Voltage for the other phase of the a-f-c motor is supplied from a second channel which, with the exception that there is no switch or phone connection in the plate circuit of the d-c amplifier, is identical to the channel just described but the output voltage is displaced 90 electrical degrees. The phase displacement is accomplished by means of the two tuned circuits contained in Z3103, in conjunction with capacitor C3202. The resonant circuit consisting of L3111 and C3198 is tuned somewhat below 100 kc, while the resonant circuit consisting of L3112 and C3199 is tuned somewhat above 100 kc. As a result, the former combination appears inductive to the 100-kc standard signal, while the latter appears capacitive. Since capacitor C3202 is effectively in series with tuned circuit L3112 and C3199, it causes this branch to appear even more capacitive. The tuning of the two branches, one below 100 kc and the other above, determines the exact amount of phase shift. Therefore, the two branches are adjusted apart in frequency by an amount that causes the 100-kc standard signal to be shifted exactly 90 degrees in phase between the plates of V3123 and the plates of V3122. For a 70-percent decrease, on one side of the response curve, of the maximum amplitude obtained at resonance, the detuned signal will be given a 45-degree phase shift in one direction; for a corresponding decrease on the other side of the response curve, the signal will be given a 45-degree phase shift in the opposite direction — making a total of 90 degrees. Since the phase-shifted 100-kc standard signal is a constituent of the mixer products, the audio difference frequency in both channels are therefore in quadrature with respect to each other.

(14) 450-KC MIXER-AMPLIFIER (*see figure 2-45*).—The 450-kc mixer-amplifier employs a JAN 5750/6BE6W miniature pentagrid converter tube (V3104), and is operated as a mixer-multiplier stage, using cathode bias. A 100-kc signal, taken from the plate circuit of the 100-kc amplifier (V3102B), is fed through capacitor C3112 to grid number 1 of V3104. At the same time a 25-kc signal, taken from the plate circuit of the crystal-divider stage (V3103), is fed through capacitor C3115 to grid number 3 of V3104. The plate circuit of the 450-kc amplifier is tuned to the sixth harmonic (450 kc) of the difference frequency (75 kc) by means of slug-tuned transformer T3103. The secondary winding of T3103 is brought out to a coaxial connector (J3104), on the rear of the chassis which permits supplying the signal to any external equipment that requires a 450-kc source.

(15) SET UP-OPERATE SWITCH (S3103) (*see figure 2-46*).—Placing the SET UP-OPERATE switch (S3103) in the SET UP position energizes capacitor-centering relay K3101. The operation of this relay removes B-plus voltage from the screen grids and plates of power amplifiers V3116, V3117, V3118, and V3119, and applies 115 volts, ac, to a-f-c motor B3101. The necessary phase shift between the voltages applied to the motor windings is provided by capacitors C3201A and C3201B, which are connected in series with one phase of the motor. The applied 115 volts, ac, causes the motor to rotate until S3104, a cam-operated switch, opens the a-c line to the motor. The cam is an integral part of a-f-c capacitor C3170, and is positioned in a manner that causes the switch (S3104) to open when C3170 is centered. Centering of the a-f-c capacitor is an important consideration in setting up the desired frequency. The AFC ON light (I-3104)



Figur 2-45. 450-KC Amplifi r, Simplified Sch matic

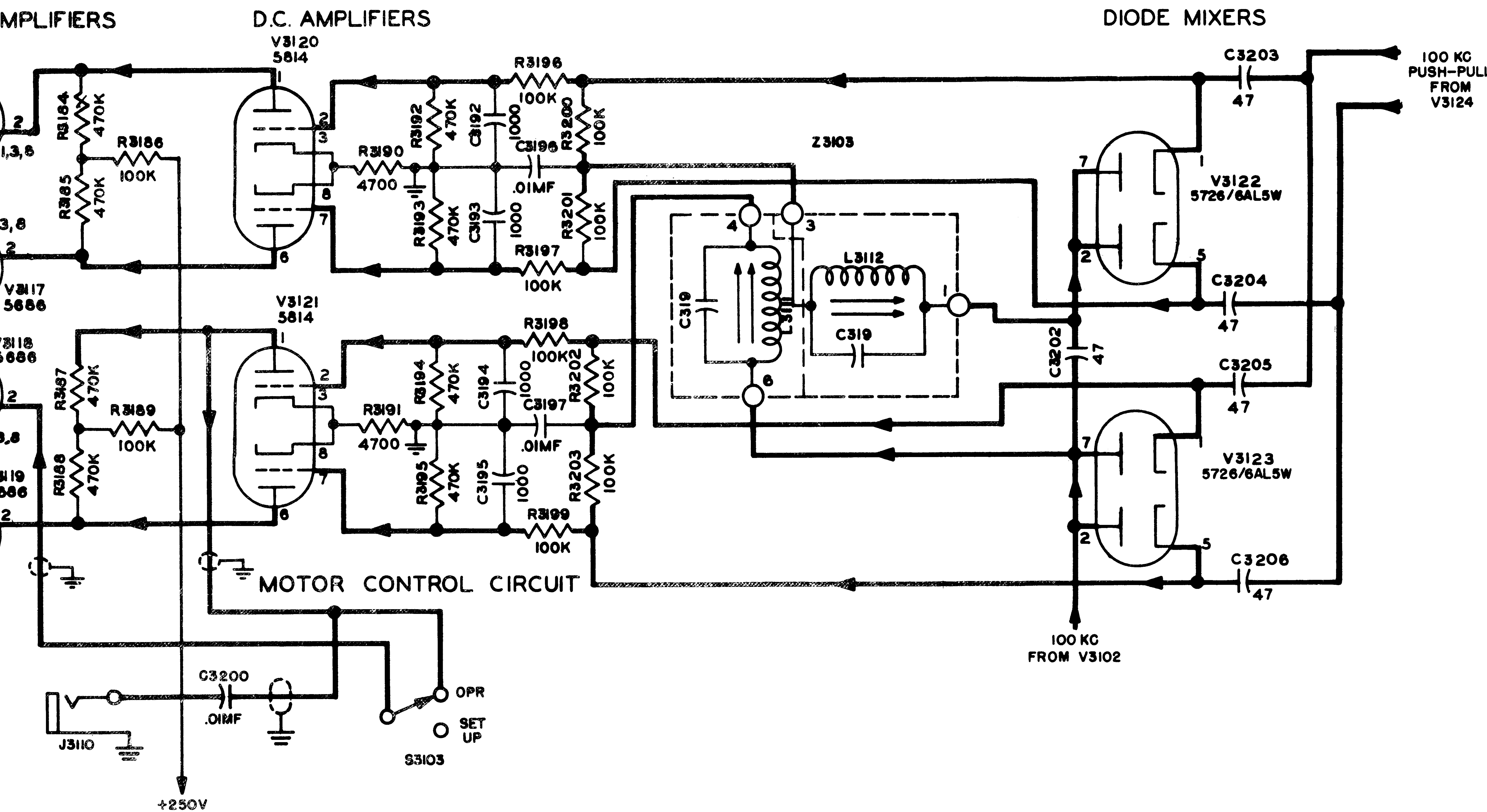


Figure 2-44. A-F-C Motor Control Circuit, Simplified Schematic

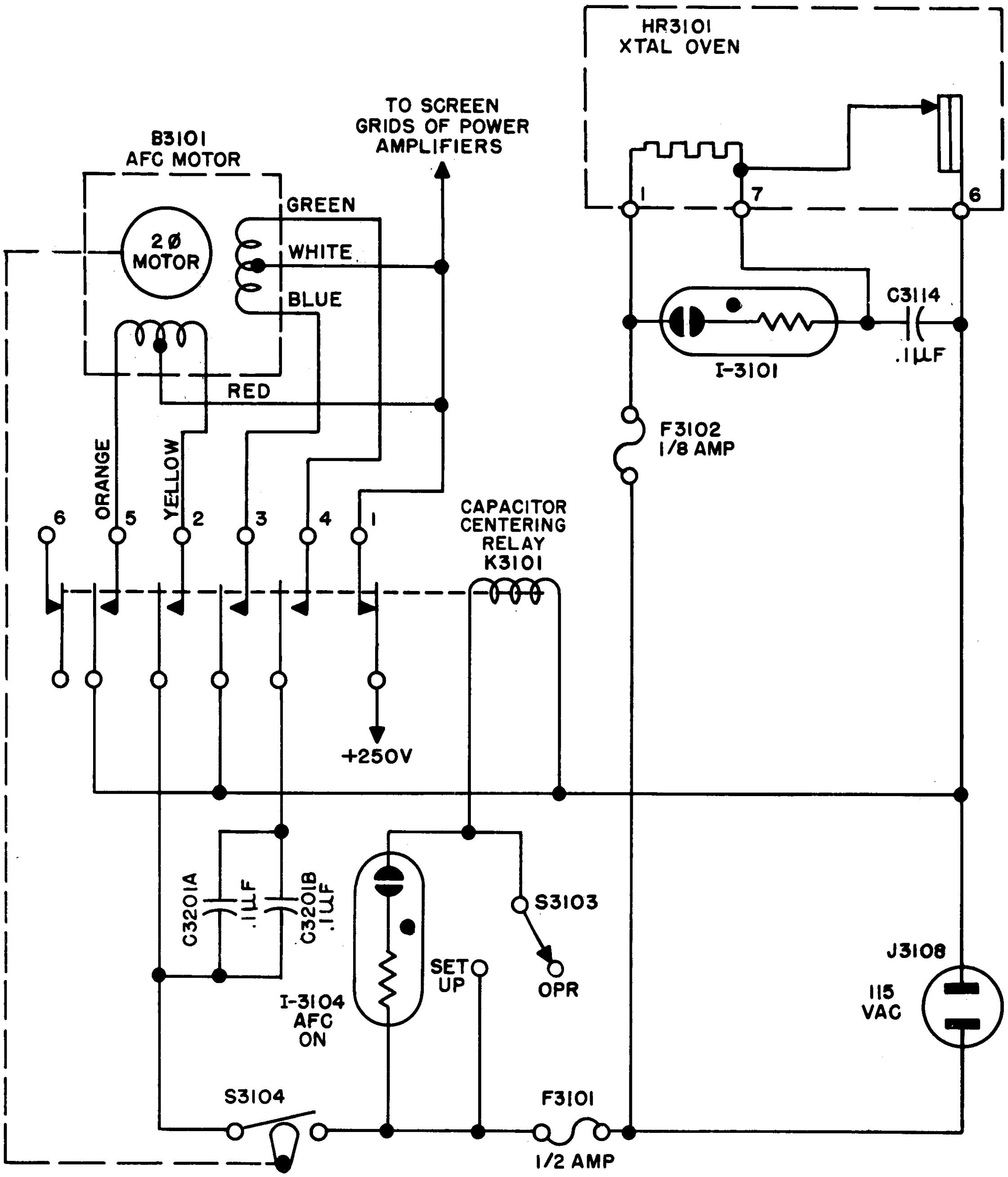


Figure 2-46. R-F Oscillator Control Circuit and A-C Distribution, Simplified Schematic

glows when the SET UP-OPERATE switch (S3103) is placed in the OPERATE position, indicating that the afc is in operation.

(16) TYPICAL FREQUENCIES DURING OPERATION. — Figures 2-47 and 2-48 are included to tie together, graphically, the foregoing discussion of the individual circuits. Both figures were prepared using the same output frequency (in this case, 3, 127.362 kc), but figure 2-48 assumes that the master oscillator is set up with some error.

Figure 2-47 assumes that the master oscillator is set up exactly on the desired frequency. The arrows indicating the direction of signal flow, and the numbers indicating the frequencies involved should be quite clear; however, a short explanation may be required in the case of the harmonic amplifier and the first mixer. As explained previously, a complete spectrum of frequencies, spaced 25 kc apart, is generated in the harmonic-amplifier circuit. For simplicity, however, only the frequency used in this example and

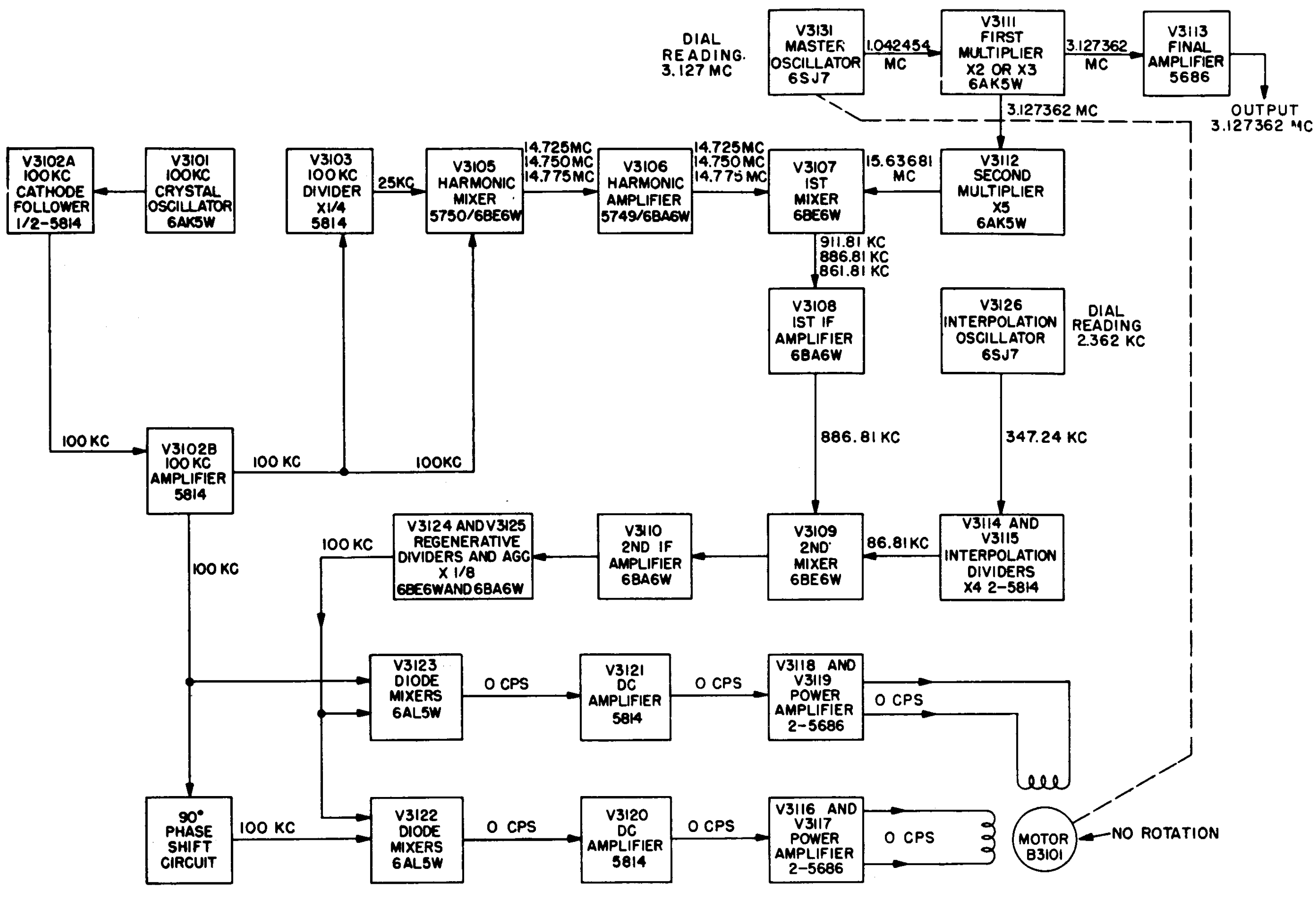


Figure 2-47. Typical Frequencies during Operation with No Error in Master Oscillator Setting, Block Diagam

the one on either side of it are shown. Likewise, only three frequencies are shown leaving the 1st mixer; the two outer frequencies, 911.81 kc and 861.81 kc, have suffered some attenuation in the plate circuit of the mixer. The first i-f amplifier, having a pass band of 875—900 kc, further attenuates the two side frequencies so that only the one frequency, 886.81 kc, appears in the output of the first if.

Some difficulty may be encountered with the apparent difference in the INTERPOLATION OSCILLATOR dial reading and the actual frequency of the oscillator. The dial is calibrated from 0—5 kc while the actual oscillator tuning range is from 300—400 kc. Therefore, with a reading of 0 on the dial, the oscillator is actually working at 300 kc, while with a dial reading of 5 kc, the oscillator frequency is 400 kc. The interpolation-oscillator frequency (in kc) for a given dial reading (in kc) may be found from the relation: $\text{Osc freq} — 300\text{ kc} + \frac{\text{Dial reading}}{.05}$. The dial reading (in kc) for a given interpolation-oscillator frequency (in kc), may be found from the relation: Dial reading $= .05$ (Osc freq—300 kc). In the case shown in figure 2-47, the dial reading is 2.362 kc; therefore, the oscillator frequency is found to be: $\text{Osc freq} = 300\text{ kc} + \frac{2.362}{.05} = 347.24\text{ kc}$.

Another point which may raise questions is the case where the output frequency of the master oscillator is such as to cause the first i-f amplifier to receive frequencies of 875 kc and 900 kc at the same time. Since both of these frequencies lie within the pass band of the first i-f strip, they will appear at the second mixer with little or no attenuation. However, in a case of this sort, the output from the interpolation oscillator, and hence from the interpolation dividers, would be such that the output frequencies of the second mixer would be 800 kc and 825 kc, and since the second if. will pass only a narrow band of frequencies centered about 800 kc, the 825-kc signal would be greatly attenuated in the second i-f amplifier.

Figure 2-48 shows the frequencies which would result if the same output frequency (3, 127.362

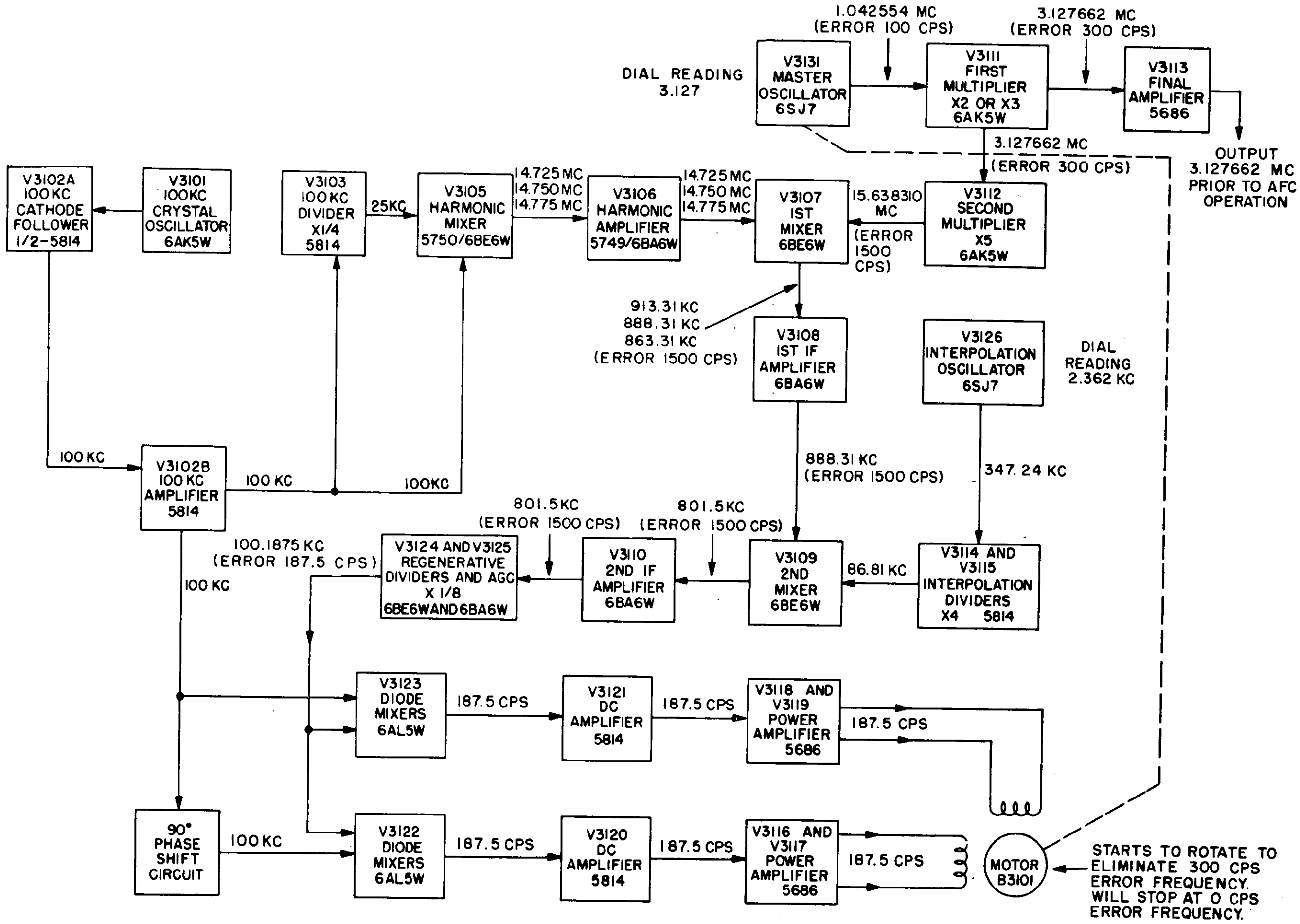


Figure 2-48. Typical Frequencies during Operation with 100-Cycle Error in Master Oscillator Setting, Block Diagram

kc) were desired but with the master-oscillator setting being in error by, say, 100 cycles. It is evident that an output frequency will be obtained from the power amplifiers (V3116, V3117, V3118, and V3119) which will cause the a-f-c motor to rotate and start correcting the master-oscillator frequency. As the master-oscillator frequency error becomes smaller, the output from the power amplifiers also decreases in frequency, until the master-oscillator frequency is corrected. When the output frequency error from the power amplifiers has decreased to 0 cps, the a-f-c motor will cease to rotate.

f. POWER SUPPLY PP-454/FRT-5. — One section of Power Supply PP-454/FRT-5, shown in figure 2-49, provides the filament and plate potentials necessary for the operation of R-F Oscillator O-243/FRT-24. Refer to the over-all schematic diagram in figure 7-66. A voltage of 230 volts, ac, is applied from the Service Power Supply to both sections of the primary winding of power transformer T1001, which are connected in parallel through switch S1002A located on the rear of the chassis. Switch S1002A permits operation from either a 115-volt or a 230-volt, a-c source; in the 115-volt position, the two primary

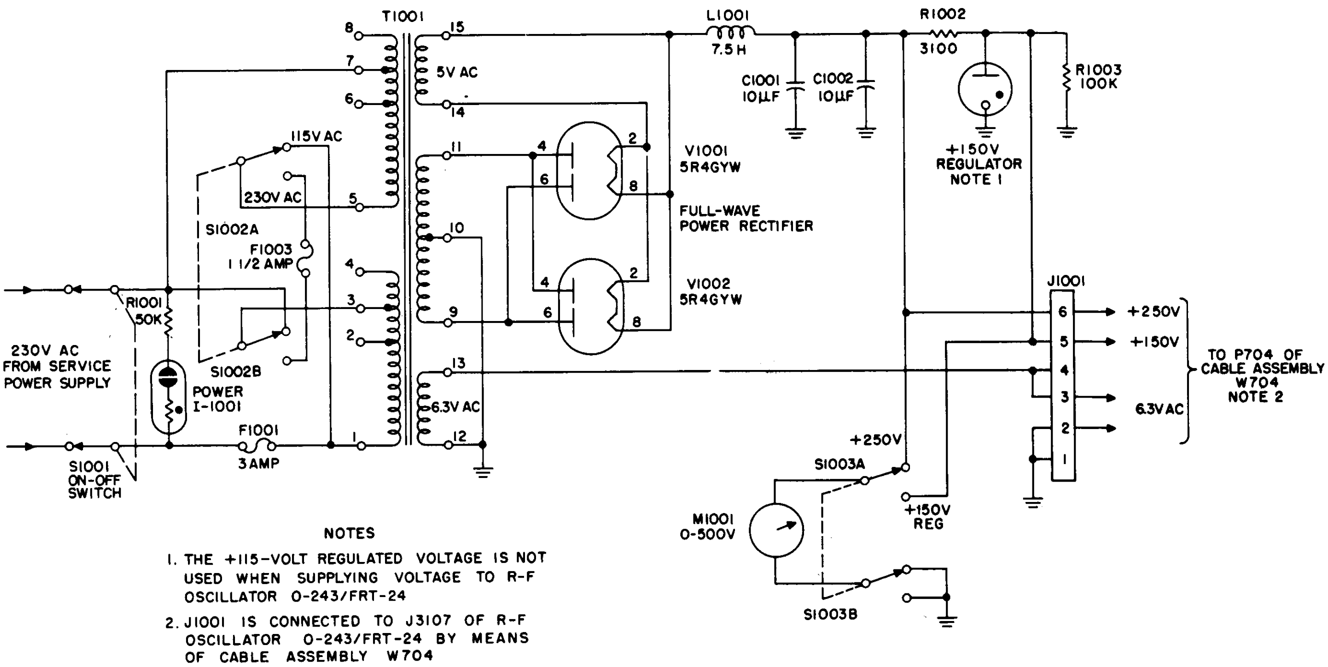


Figure 2-49. Operative Section of Power Supply PP-454/FRT-5, Simplified Schematic

windings are connected in parallel. To prevent damage to these windings, caution must be exercised not to connect a 230-volt source when the switch is in the 115-volt position. A voltage of 6.3 volts, ac, taken from a filament winding on T1001, is supplied to terminals 3 and 4 of output receptacle J1001. Terminals 1 and 2 of this receptacle act as a common ground return for both filament and plate power. A full-wave rectifier circuit employing two 5R4GYW tubes (V1001 and V1002) is used in conjunction with a choke-input filter (L1001 together with C1001 and C1002 in parallel) to supply +250 volts, dc, to terminal 6 of J1001. A d-c voltmeter (M1001) and a selector switch (S1003) are provided on the front panel to allow the d-c output voltage from this section of the Power Supply to be monitored by placing S1003 in the correct position. The POWER on light (I-1001) glows when the power ON-OFF switch A (S1001) is in the ON position.

TABLE 7-2. TUBE OPERATING VOLTAGES—Continued

REFERENCE SYMBOL	TUBE TYPE	FUNCTION	PIN NUMBER									
			1	2	3	4	5	6	7	8	9	CAP
POWER SUPPLY PP-454/FRT-5												
V1001	5R4GYW	High-voltage rectifier		5		355 ac		355 ac		5		
V1002	5R4GYW	High-voltage rectifier		5		355 ac		355 ac		5		
V1003	6X4W	Bias rectifier	−465		6.3	6.3		−465	363 ac			
V1004	5R4GYW	High-voltage rectifier		5		363 ac		363 ac		5		
V1005	OA2	+150-volt regulator		160								
V1006	OA2	+150-volt regulator		160								
R-F OSCILLATOR O-243/FRT-24												
V3101	5654/ 6AK5W	100-kc crystal oscillator	−5	0	6.3 ac	6.3 ac	155	55	0			
V3102	5814	100-kc amplifier	163	1	6.3 ac	6.3 ac	6.3 ac	155	1	6.3 ac		
V3103	5814	25-kc divider	163	−10	0	6.3 ac	6.3 ac	155	−10.5	0	0	
V3104	5750/ 6BE6W	450-kc amplifier	−18.3	0.8	6.3 ac	0	246	51	−7.7			
V3105	5750/ 6BE6W	9.125 to 20.125-mc first harmonic amplifier	−24	0	6.3 ac	0	265	17	−17.5			
V3106	5749/ 6BA6W	9.125 to 20.125-mc second harmonic amplifier	0	0.2	6.3 ac	0	260	42	0.2			
V3107	5750/ 6BE6W	875 to 900-kc first mixer	0	2.7	6.3 ac	0	265	82	−1.5			
V3108	5749/ 6BA6W	875 to 900-kc second mixer	−2.0	0	6.3 ac	0	255	60	0			

TABLE 7-2. TUBE OPERATING VOLTAGES—C ntinued

REFERENCE SYMBOL	TUBE TYPE	FUNCTION	PIN NUMBER									
			1	2	3	4	5	6	7	8	9	CAP
R-F OSCILLATOR O-243/FRT-24—Continued												
V3109	5750/ 6BE6W	800-kc first mixer	−1.85	2.0	0	6.3 ac	260	118	0			
V3110	5749/ 6BA6W	800-kc second amplifier	−1.8	0	6.3 ac	0	260	67	0			
V3111	5654/ 6AK5W	2 to 4.2-mc multiplier	−17.5	3.7	6.3 ac	0	157	105	3.7			
V3112	5654/ 6AK5W	10 to 21-mc multiplier	−11	54	6.3 ac	0	90	48	0.54			
V3113	5686	75 to 100-kc interpolation divider	6.0	−71	6.0	6.3 ac	0	256	265	6.0	256	
V3114	5814	75 to 100-kc interpolation divider	175	32	45	6.3 ac	6.3 ac	174	34	45	0	
V3115	5814	150 to 200-kc interpolation divider	170	28	45	6.3 ac	6.3 ac	165	27	45	0	
V3116	5686	Motor power amplifier	71	50	71	6.3 ac	0	260	250	71	260	
V3117	5687	Motor power amplifier	71	50	71	6.3 ac	0	265	250	71	265	
V3118	5686	Motor power amplifier	71	50	71	6.3 ac	0	265	250	71	265	
V3119	5686	Motor power amplifier	71	50	71	6.3 ac	0	265	250	71	265	
V3120	5814	D-C amplifier	50	0	3.0	6.3 ac	6.3 ac	50	0	3.0	0	
V3121	5814	D-C amplifier	50	0	3.0	6.3 ac	6.3 ac	50	0	3.0	0	
V3122	5726/ 6AL6W	Diode mixer	0	−3.8	0	6.3 ac	0	0	−3.8			

TABLE 7-2. TUBE OPERATING VOLTAGES—Continued

REFERENCE SYMBOL	TUBE TYPE	FUNCTION	PIN NUMBER									
			1	2	3	4	5	6	7	8	9	CAP
R-F OSCILLATOR O-243/FRT-24—Continued												
V3123	5726/ 6AL5W	Diode mixer	0	−3.5	0	6.3 ac	0	0	−3.5			
V3124	5749/ 6BE6W	Regenerative divider	−6.0	1.8	6.3	0	265	114	−2.6			
V3125	5749/ 6BA6W	Regenerative divider	−40	6.8	0	6.3 ac	252	135	6.8			
V3126	6SJ7Y	300 to 400-kc interpolation oscillator		6.3 ac	0	−3	0	140	0	250		
V3131	6SJ7Y	1 to 1.5-mc master oscillator		0	0	−7	0	155	6.3 ac	250		

5. REMOVAL AND REPLACEMENT

a. GENERAL.—The removal of the majority of the units, assemblies, and components in this equipment requires no special treatment. The following paragraphs explain the removal and replacement procedures.

b. MAJOR UNITS.—Power Supply PP-454/FRT-5 and R-F Oscillator O-243/FRT-24 are the two major units located in Radio Transmitter T-440/FRT-24. These units are mounted on roller slides. The removal and replacement procedure of each is identical and is given below.

(1) REMOVAL. — To remove either unit, proceed as follows:

(*a*) Remove vertical style strips from relay rack.

(*b*) Slide out unit until it makes contact with the stops.

(*c*) Disconnect all associated cabling.

(*d*) Raise front of unit and slide out all the way, being careful not to drop it.

(*e*) Set unit out of the way.

(2) REPLACEMENT. — To replace either unit, proceed in the reverse order of its removal.

c. ASSEMBLIES.—All assemblies, except the R-F Assembly which is mounted on roller slides, are bolted to the transmitter cabinet frame. To remove the R-F Assembly, proceed with paragraph 5.*b.*(1)(*b*) through (*c*). To replace the R-F Assembly, proceed with paragraph 5.*b.*(2). The following assemblies are mounted on the transmitter cabinet frame:

(1) Rectifier chassis.
(2) Filter chassis.
(3) Low-Voltage Power Supply chassis.
(4) Power Control Assembly chassis.
(5) Blower Assembly chassis.
(6) Plate Transformer.
(7) Modulation Transformer and Filter chassis.
(8) Power Change Assembly chassis.
(9) Patch Panel Assembly chassis.
(10) Service Power Supply chassis.

To remove any of these assemblies, remove the bolts securing it to the cabinet frame and disconnect the associated cabling. To replace any of these assemblies, bolt it to the cabinet frame and reconnect the associated cabling. (Refer to Section 3.)

d. AUTOTUNE.—To remove and replace the components of the Autotune, proceed as follows:

(1) AUTOTUNE PANEL.—Proceed as follows:

(*a*) REMOVAL.—Remove the Autotune panel as follows:

1. Rotate all Autotune control knobs fully counterclockwise. Note position of channel indicator dial.

2. Remove Autotune locking screws, Autotune knobs, and all other knobs on control panel of R-F Assembly.

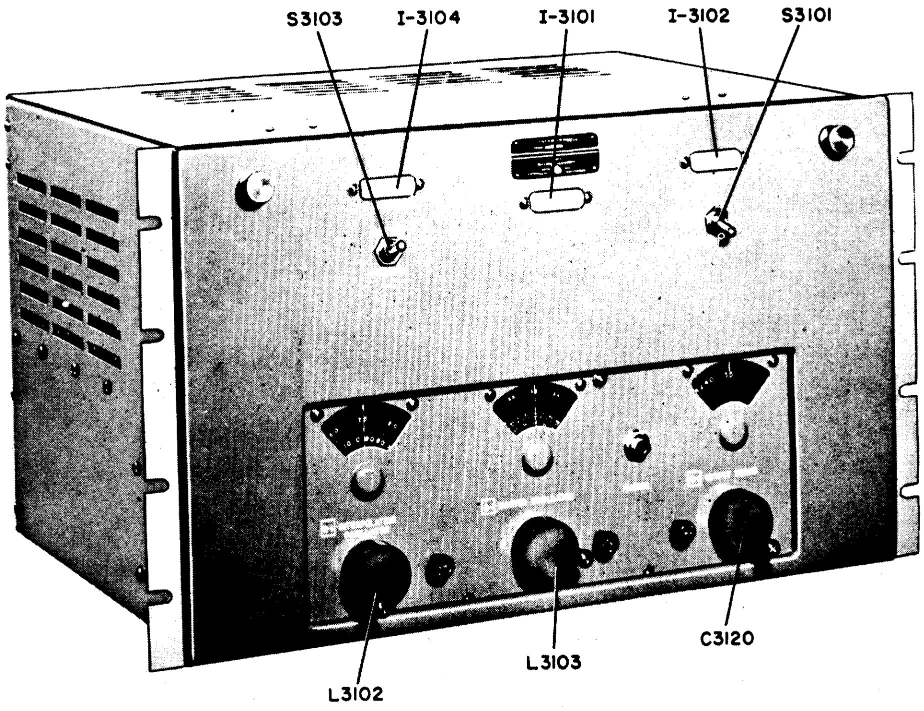
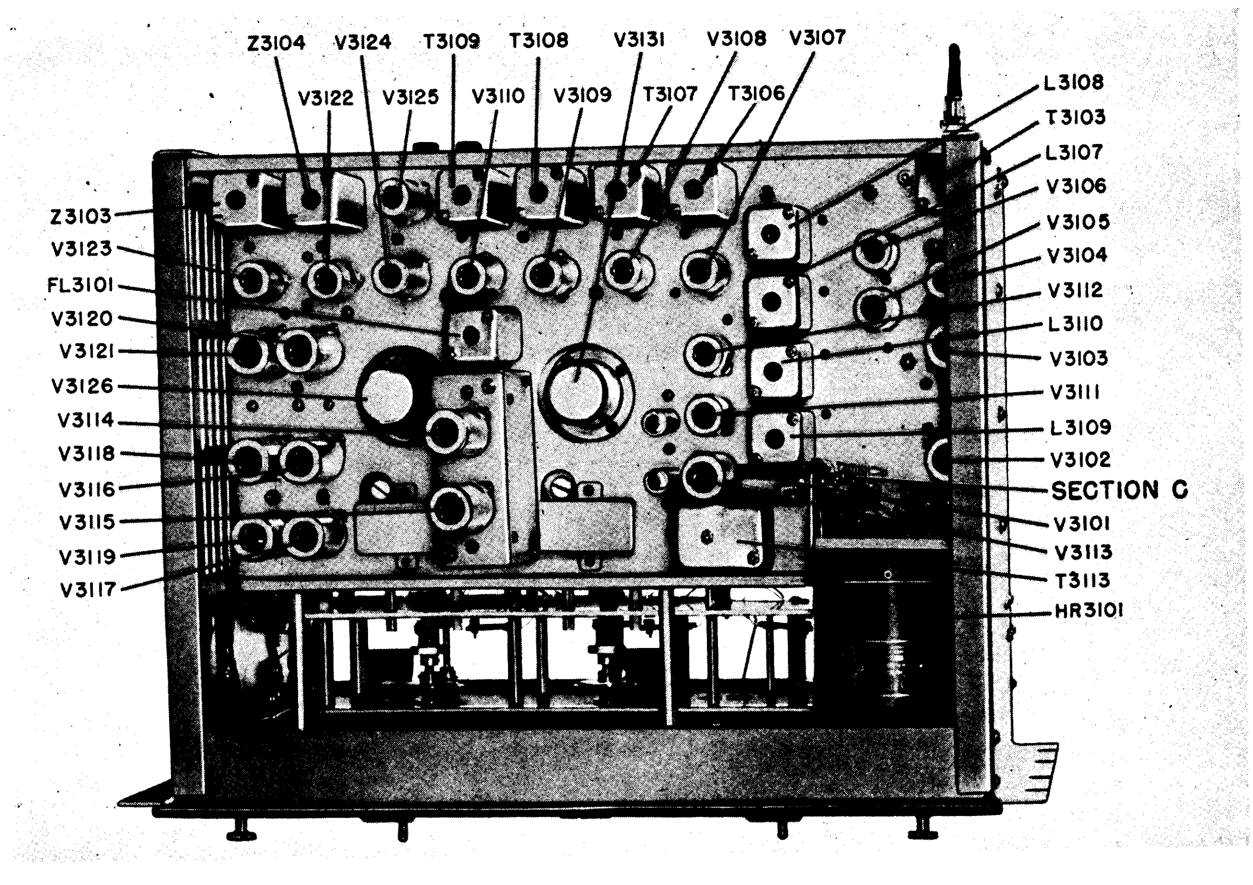


Figure 7-44. R-F Oscillator O-243/FRT-24, Front Oblique View, Location of Parts



Figur 7-45. R-F Oscillator O-243/FRT-24, Case Rem v d, T p Vi w, L cati n f Parts

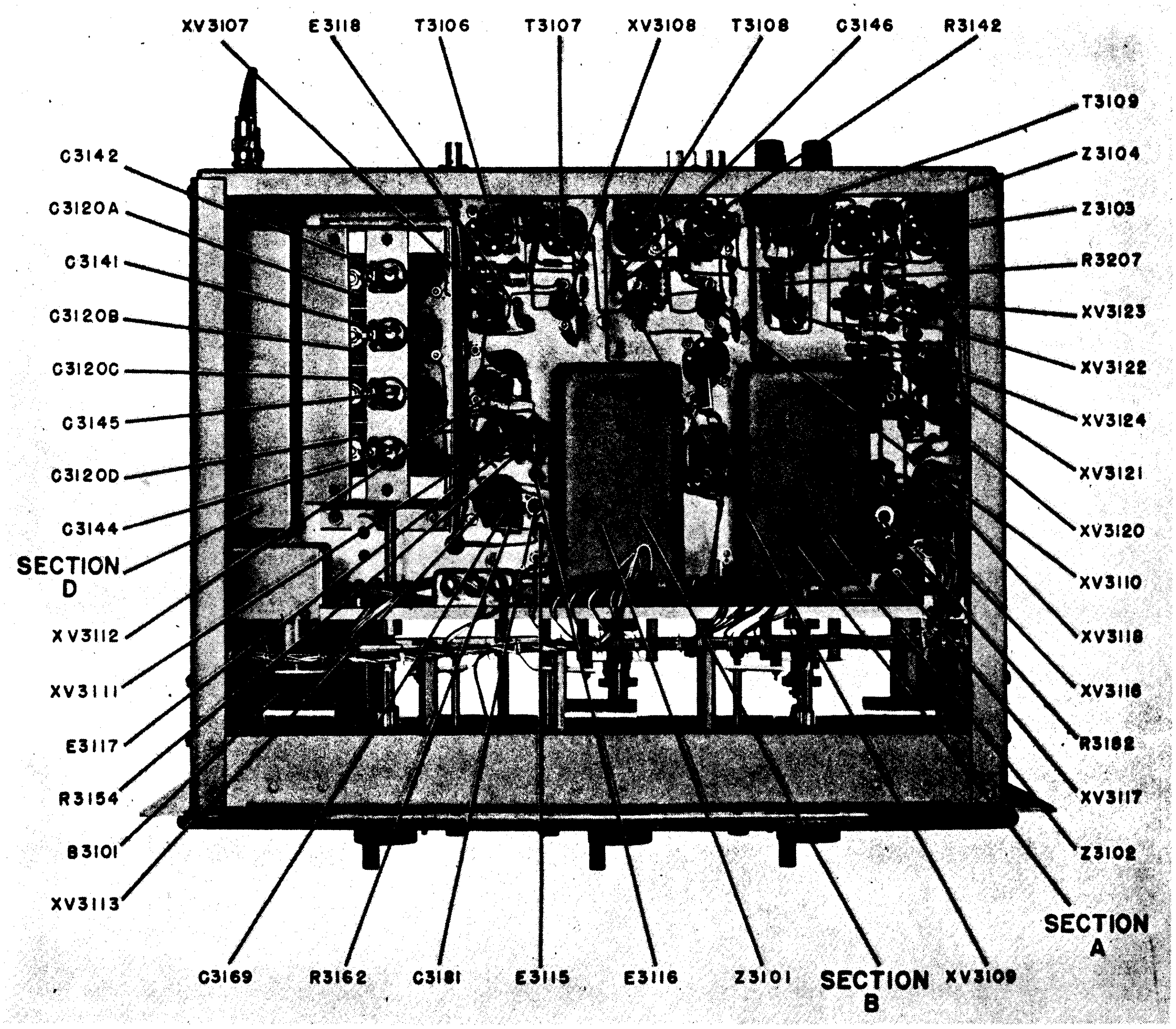


Figure 7-46. R-F Oscillator O-243/FRT-24, Case Removed, Bottom View, Location of Parts

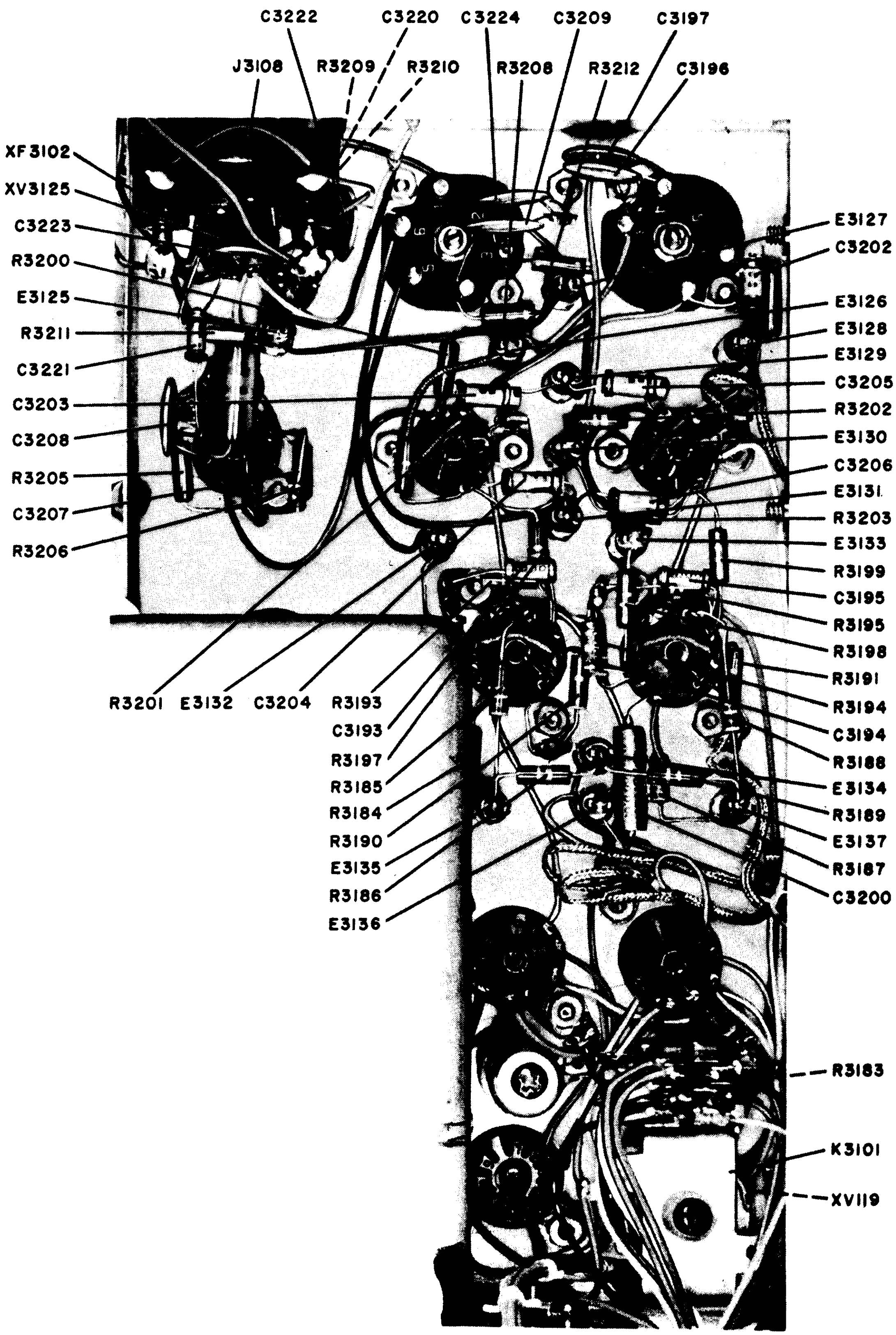


Figure 7-47. R-F scillat r O-243/FRT-24, Section A, Locati n f Parts

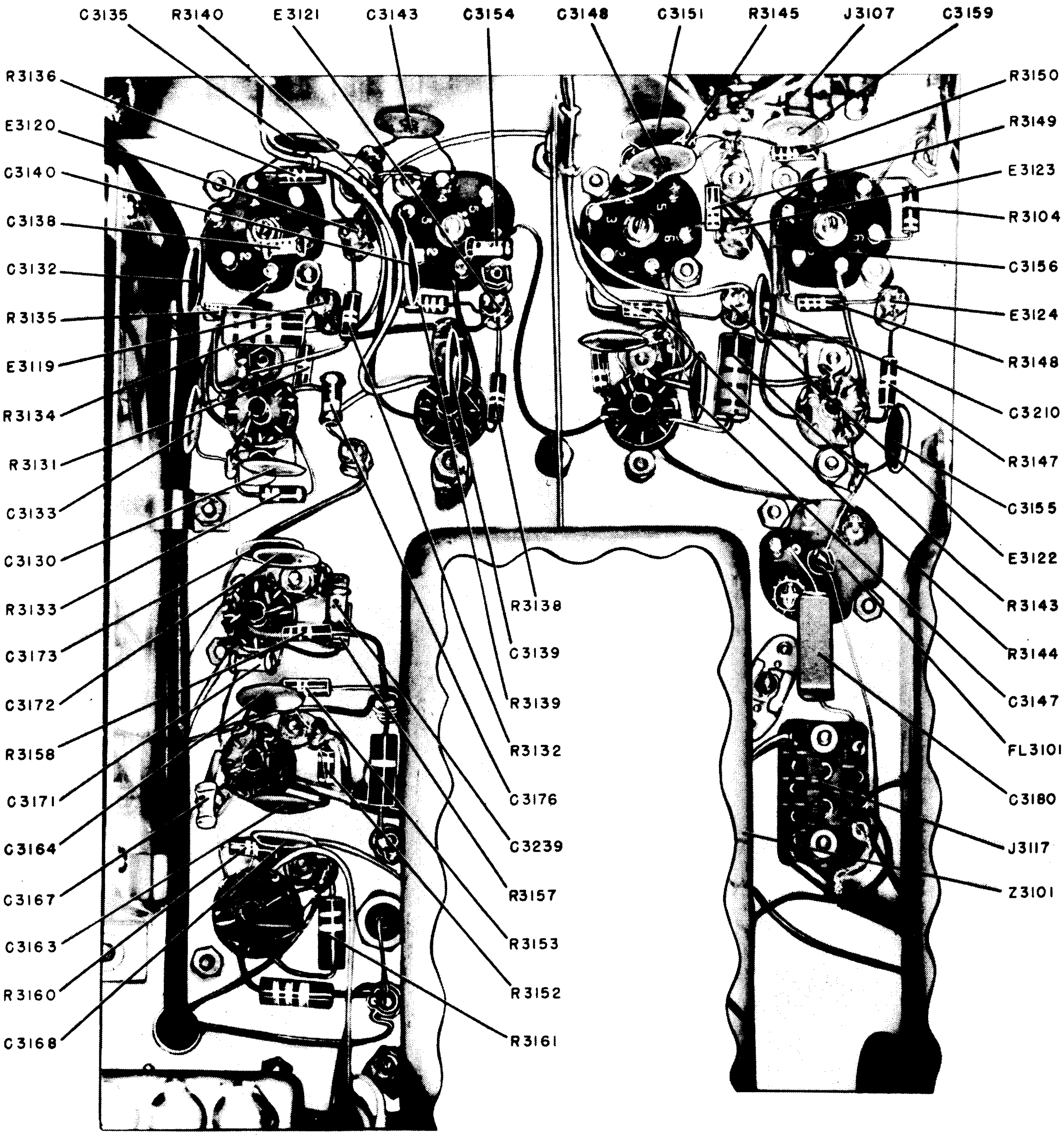


Figure 7-48. R-F Oscillator O-243/FRT-24, Section B, Location of Parts

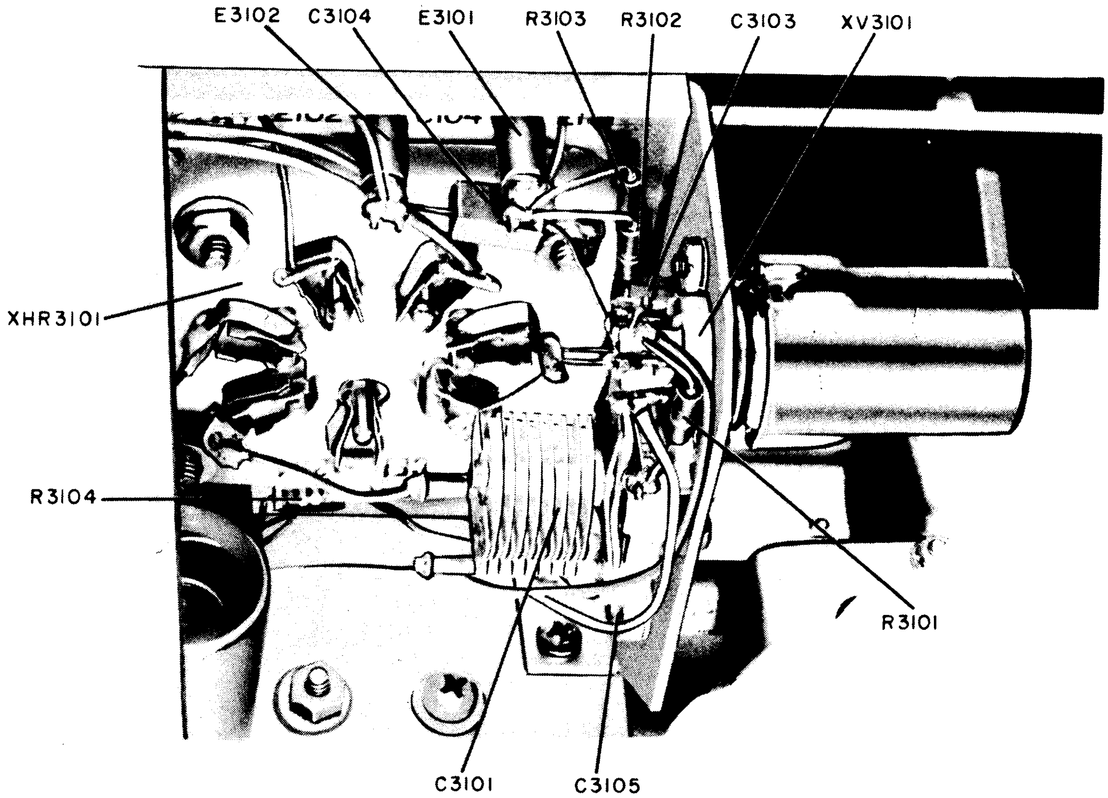


Figure 7-49. R-F Oscillator O-243/FRT-24, Section C, Location of Parts

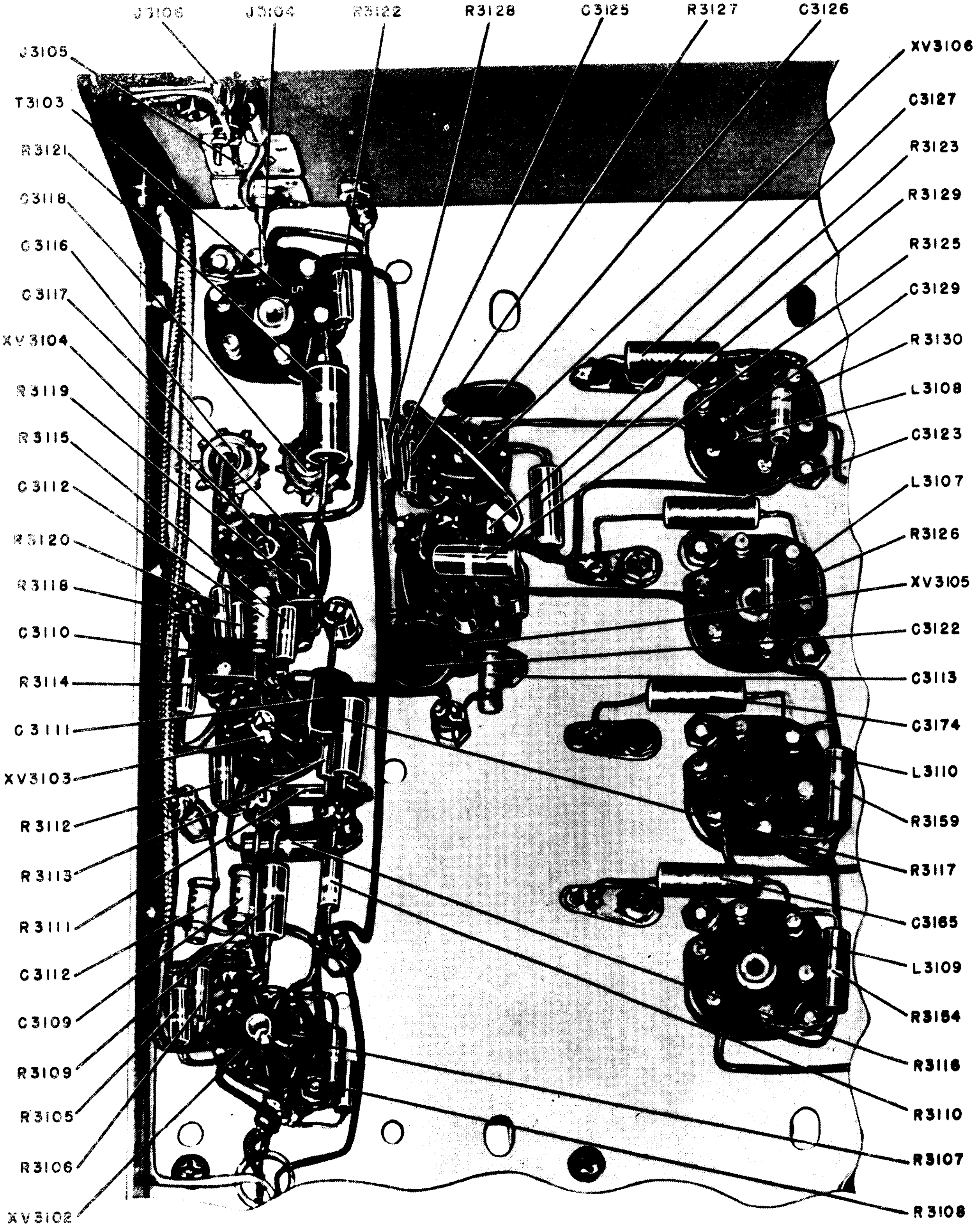


Figure 7-50. R-F Oscillator O-243/FRT-24, Section D, Location of Parts

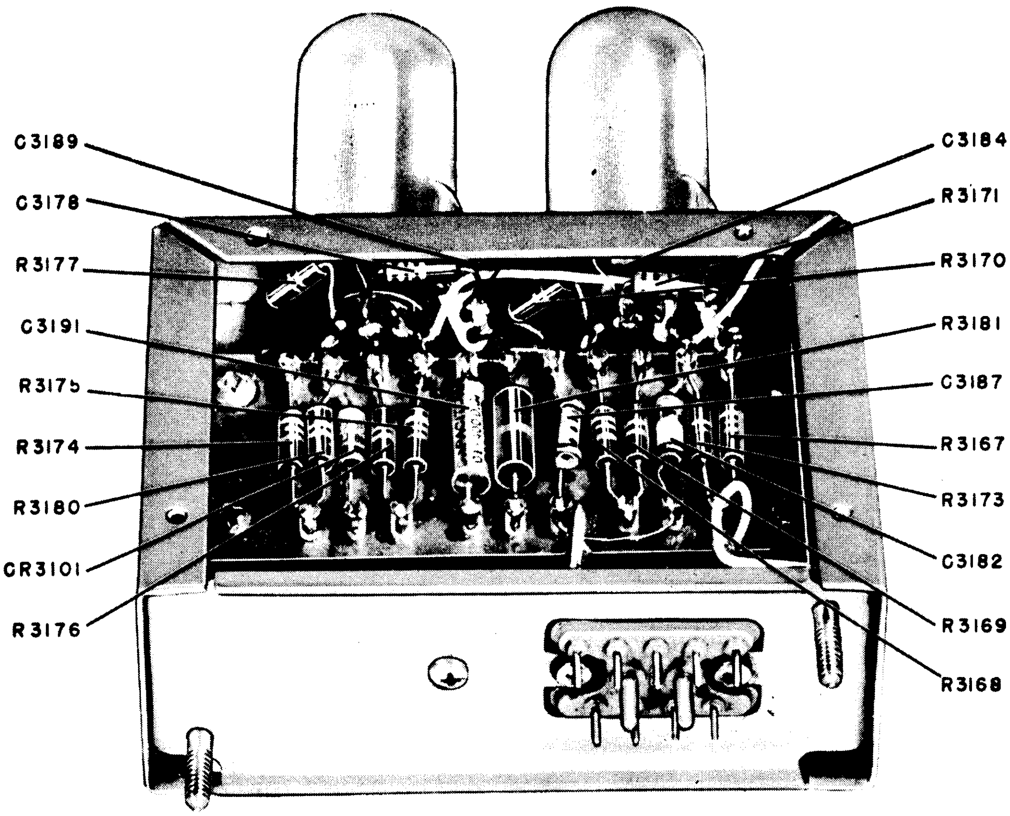


Figure 7-51. R-F Oscillator O-243/FRT-24, Interpolation Divider, Left-Side View, Location of Parts

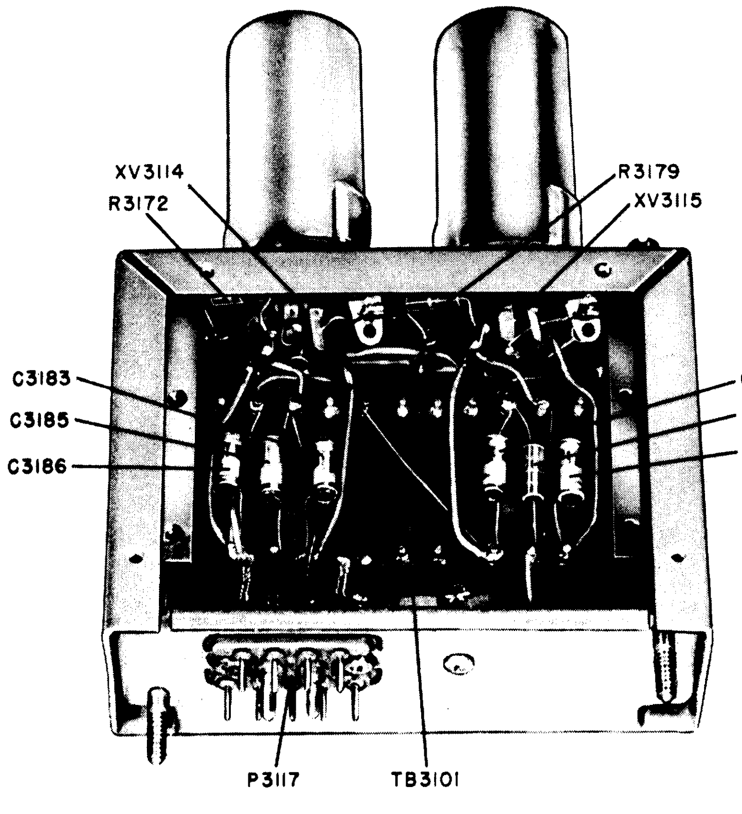


Figure 7-52. R-F Oscillat r O-243/FRT-24, Interp lati n Divider, Right-Side View, Locati n of Parts

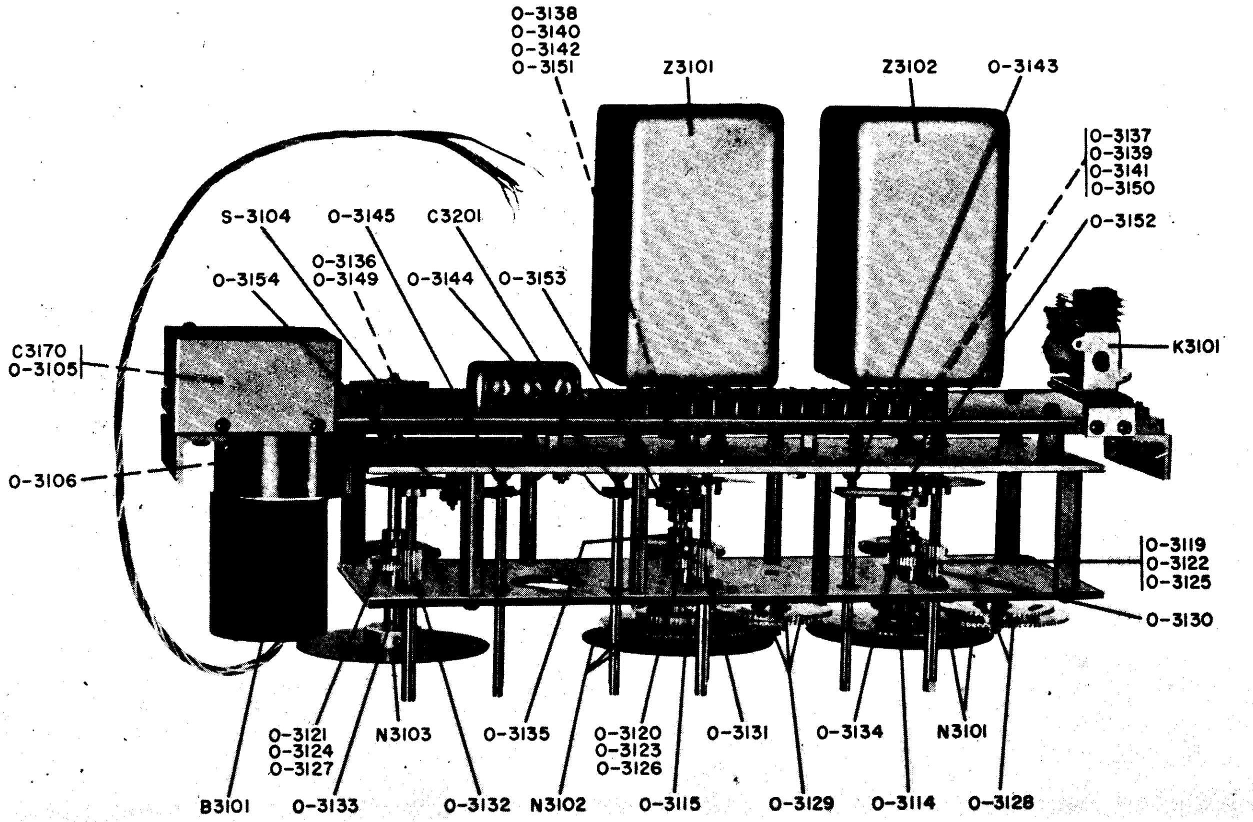
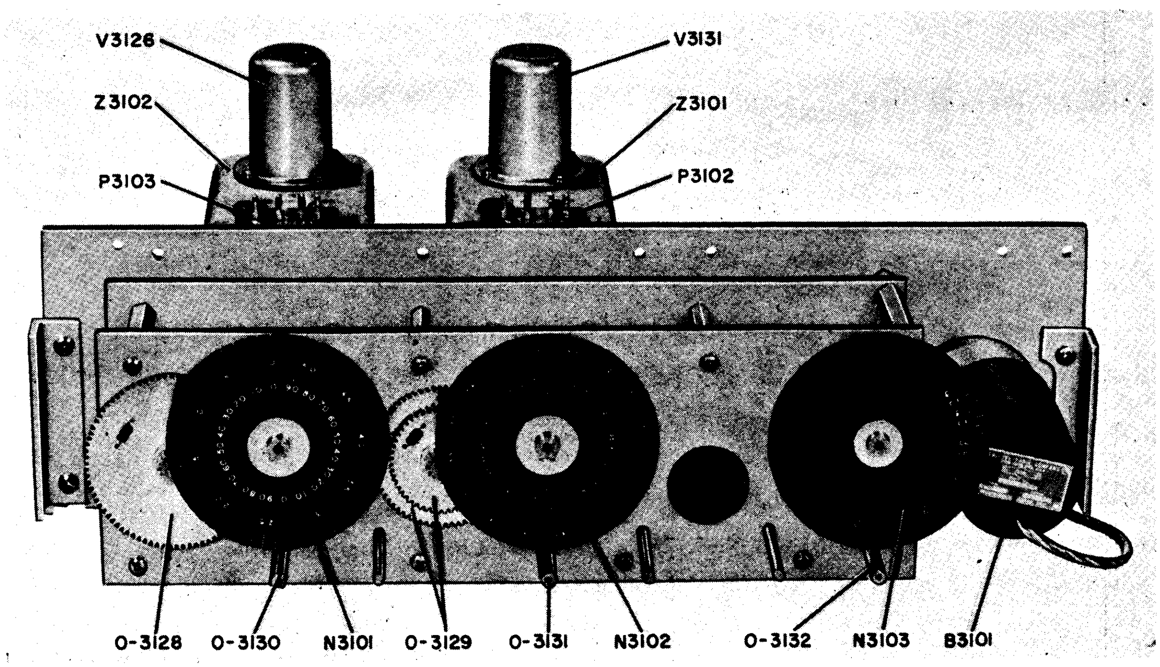


Figure 7-53. R-F Oscillator O-243/FRT-24, Top View of Dial Gears, Location of Parts



Figur 7-54. R-F Oscillat r O-243/FRT-24, Front Vi w f Dial G ars, L cation f Parts

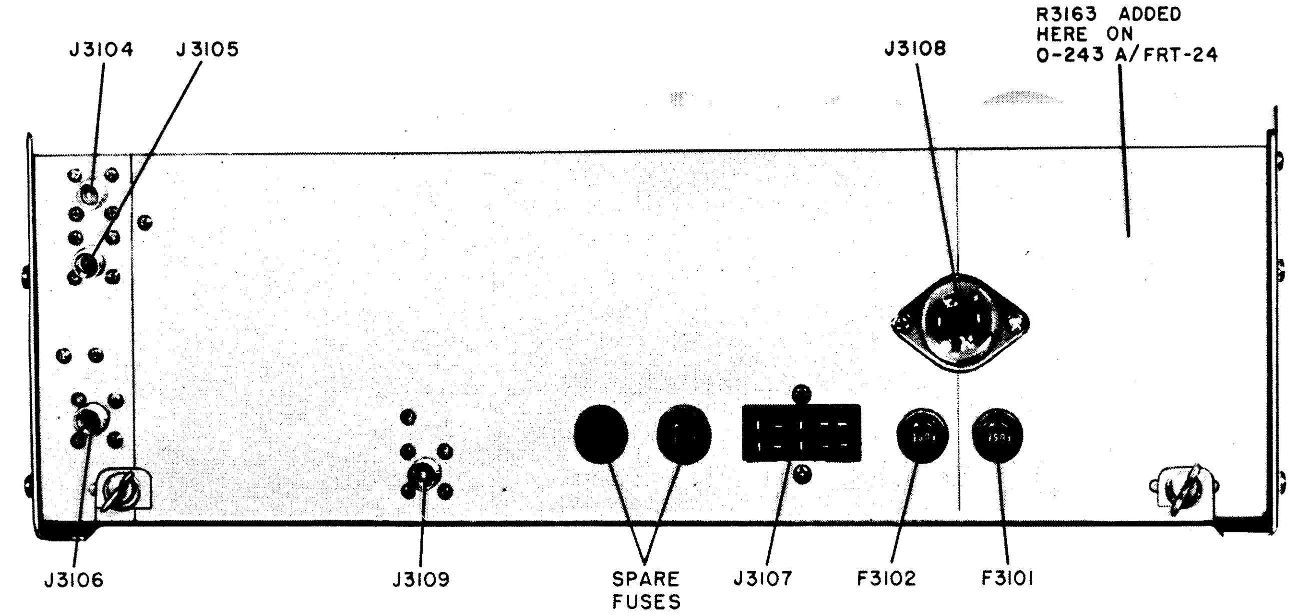


Figure 7-55. R-F Oscillator, O-243/FRT-24, Rear View, Location of Parts

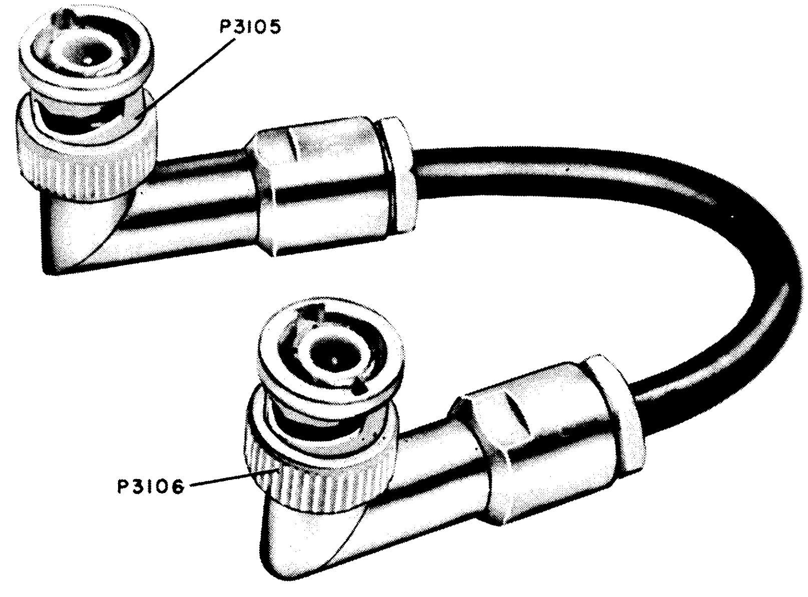


Figure 7-56. R-F Oscillator O-243/FRT-24, Coaxial Jumper Cable

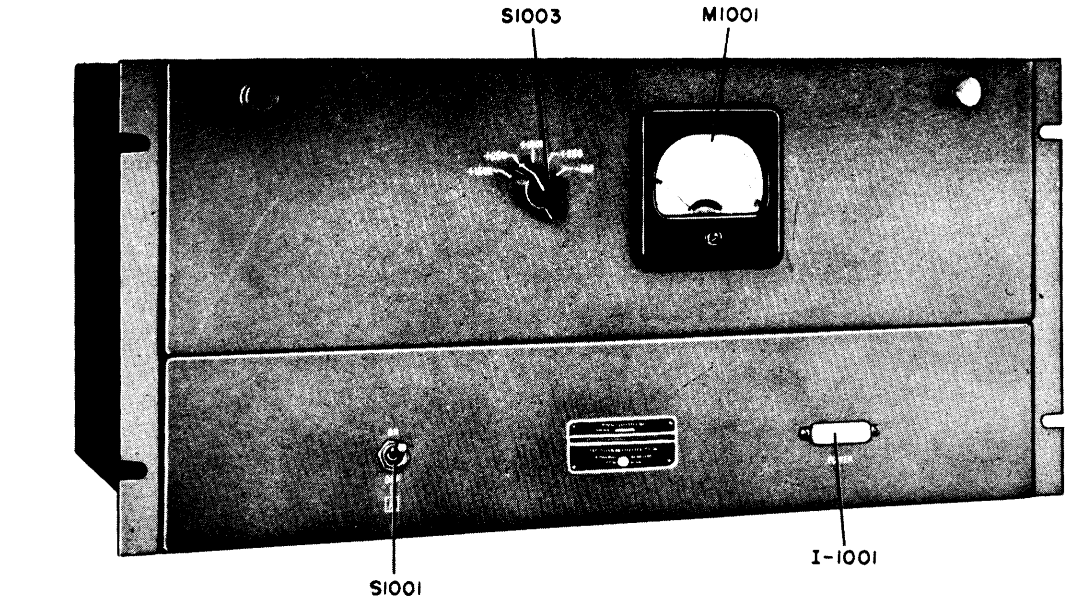


Figure 7-57. Power Supply PP-454/FRT-5, Front Oblique View, Location of Parts

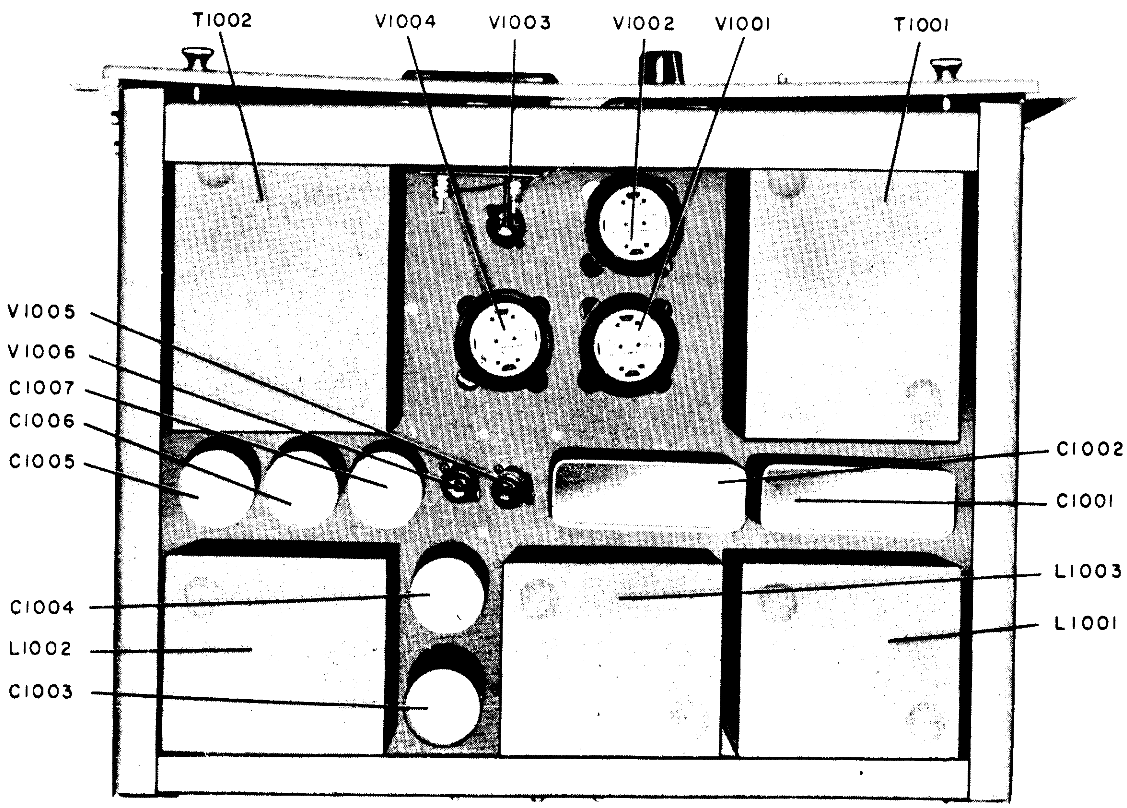


Figure 7-58. P wer Supply PP-454/FRT-5, Cas R moved, Top Vi w, L cati n of Parts

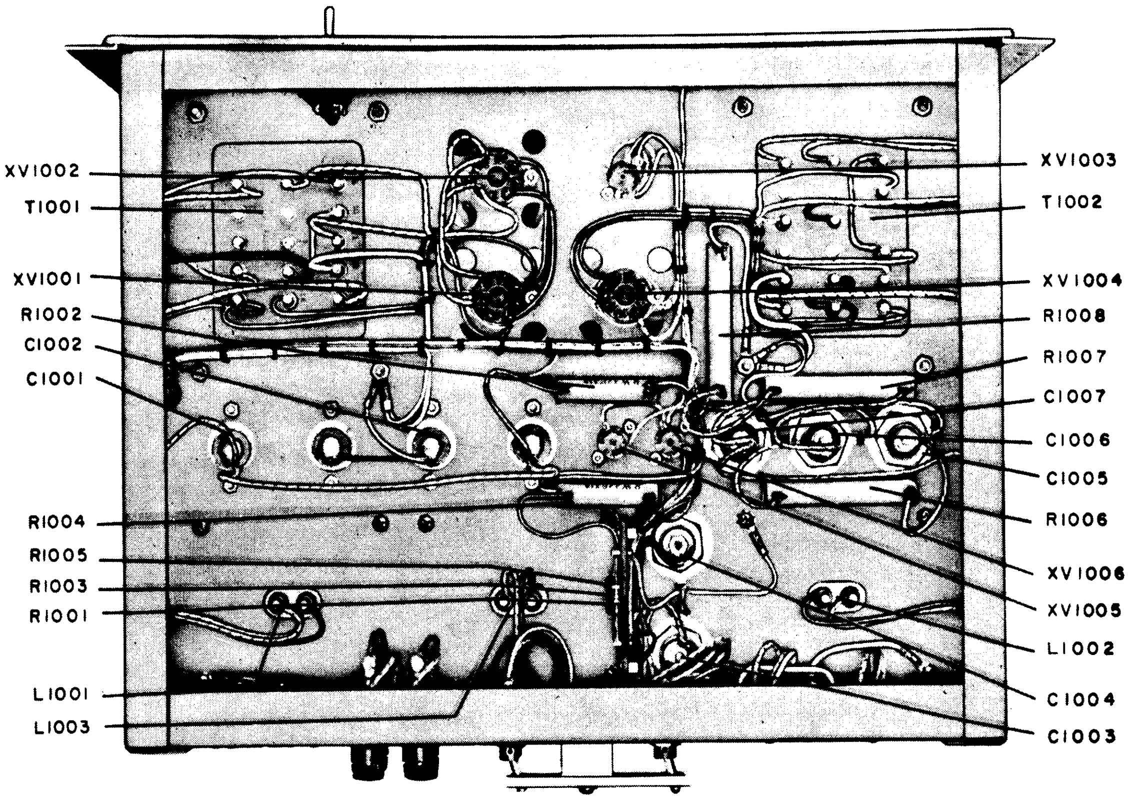
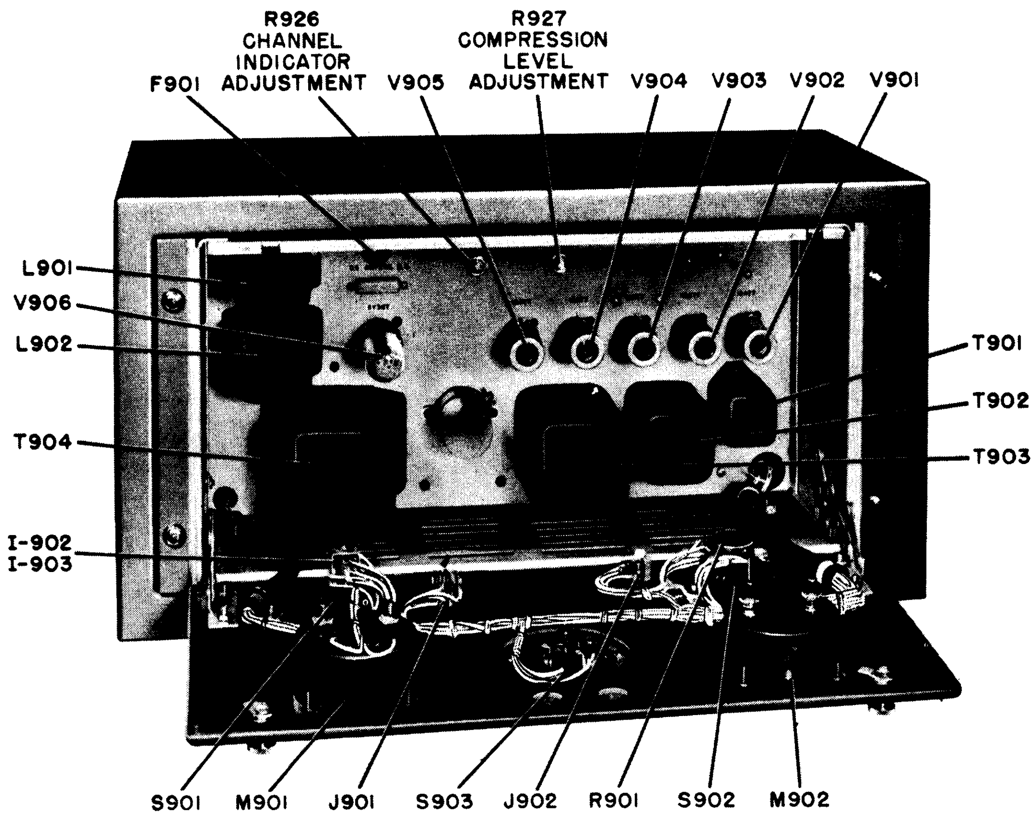


Figure 7-59. Power Supply PP-454/FRT-5, Case Removed, Bottom View, Location of Parts



Figur 7-60. Transmitt r Control C1362/FRT-24, Fr nt Pan l Lowered, Locati n f Parts