UHF MILITARY EQUIPMENT

CHAPTER FIVE

T-217/GR TRANSMITTER
MD-129/GR MODULATOR-POWER SUPPLY

1.0 GENERAL

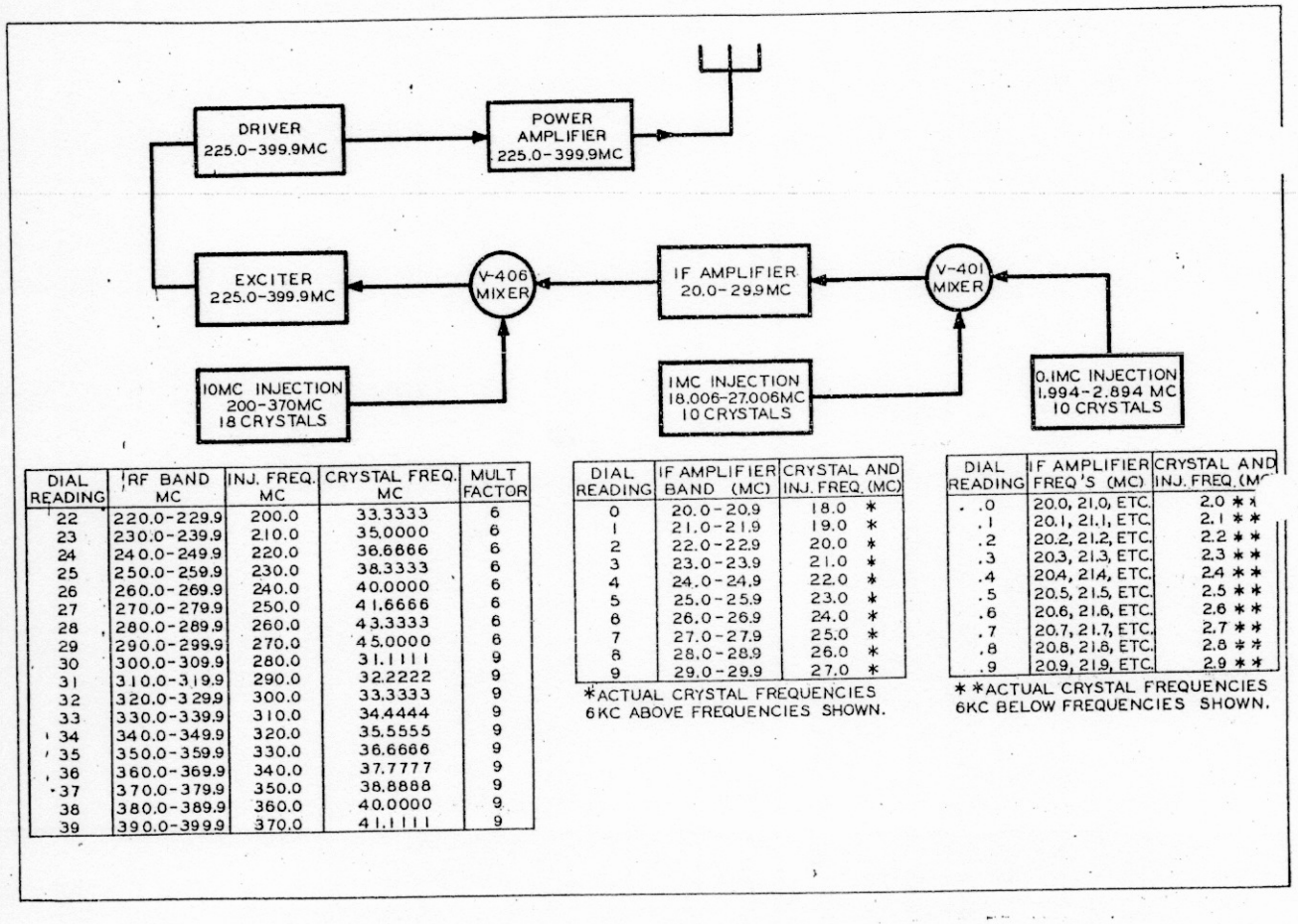
The type T-217/GR transmitter is a multi-channel transmitter, utilizing three crystal controlled oscillators. Transmitter T-217A/GR differs from the T-217/GR in that the T-217A/GR is a continuous duty transmitter. Likewise, modulator-power supply MD-129A/GR is rated for continuous duty. Several views of the transmitter and modulator-power supply are shown in Figures 5-25 through 5-28.

1.1 Frequency System

The transmitter will operate on any one of 1800 frequencies spaced at 0.1 mc intervals. There are 1750 frequencies spaced at 0.1 mc intervals in the UHF band extending from 225.0 to 399.9 mc. However, the frequency system employed is capable of providing 50 additional frequencies spaced at 0.1 mc intervals from 220.0 to 224.9 mc. Therefore, the transmitter will operate on 1800 crystal controlled frequencies spaced at 0.1 mc intervals from 220.0 to 399.9 mc. The transmitter is tuned by a motor-driven frequency selector unit. The frequency diagram is shown in Figure 5-1.

There are three frequency injection systems, which are controlled by the three crystal controlled oscillators. The 10 mc injection system tunes from 200.0 to 370 mc in 10 mc steps, a total of 18 steps. The 1 mc injection system tunes from 18 to 27 mc in 1 mc steps, a total of 10 steps. The 0.1 mc injection system tunes from 2 to 2.9 mc in 0.1 mc steps, a total of 10 steps. The output of the 0.1 mc injection system and the 1 mc injection system are fed to a mixer. The sum of the frequencies in the output of the mixer is from 20.0 to 29.9 mc, which will be in 0.1 mc steps, a total of 100 steps. These frequencies are fed to the i-f amplifier, which is tuned in 0.1 mc steps. The output of the i-f amplifier

(20.0 to 29.9 mc) and the output of the 10 mc injection system (200.0 to 370.0 mc) are fed to another mixer. The sum of the frequencies in the output of this mixer is from 220.0 to 399.9 mc, which will be in 0.1 mc steps, a total of 1800 steps. These frequencies are amplified in the exciter, driver, and power amplifier stages.



DIAL READING	RF BAND MC	INJ. FREQ. MC	CRYSTAL FREQ. MC	MULT FACTOR
22	220.0-229.9	200.0	33.3333	6
23	230.0-239.9	210.0	35.0000	6
24	240.0-249.9	220.0	36.6666	6
25	250.0-259.9	230.0	38.3333	6
26	260.0-269.9	240.0	40.0000	6
27	270.0-279.9	250.0	41.6666	6
28	280.0-289.9	260.0	43.3333	6
29	290.0-299.9	270.0	45.0000	6
30	300.0-309.9	280.0	31.1111	9
31	310.0-319.9	290.0	32.2222	9
32	320.0-329.9	300.0	33.3333	9
33	330.0-339.9	310.0	34.4444	9
34	340.0-349.9	320.0	35.5555	9
35	350.0-359.9	330.0	36.6666	9
36	360.0-369.9	340.0	37.7777	9
37	370.0-379.9	350.0	38.8888	9
38	380.0-389.9	360.0	40.0000	9
39	390.0-399.9	370.0	41.1111	9

DIAL READING	IF AMPLIFIER BAND (MC)	CRYSTAL AND INJ. FREQ. (MC)
0	20.0-20.9	18.0 *
1	21.0-21.9	19.0 *
2	22.0-22.9	20.0 *
3	23.0-23.9	21.0 *
4	24.0-24.9	22.0 *
5	25.0-25.9	23.0 *
6	26.0-26.9	24.0 *
7	27.0-27.9	25.0 *
8	28.0-28.9	26.0 *
9	29.0-29.9	27.0 *

*ACTUAL CRYSTAL FREQUENCIES 6KC ABOVE FREQUENCIES SHOWN.

DIAL READING	IF AMPLIFIER FREQ'S (MC)	CRYSTAL AND INJ. FREQ. (MC)
.0	20.0, 21.0, ETC.	2.0 **
.1	20.1, 21.1, ETC.	2.1 **
.2	20.2, 21.2, ETC.	2.2 **
.3	20.3, 21.3, ETC.	2.3 **
.4	20.4, 21.4, ETC.	2.4 **
.5	20.5, 21.5, ETC.	2.5 **
.6	20.6, 21.6, ETC.	2.6 **
.7	20.7, 21.7, ETC.	2.7 **
.8	20.8, 21.8, ETC.	2.8 **
.9	20.9, 21.9, ETC.	2.9 **

**ACTUAL CRYSTAL FREQUENCIES 6KC BELOW FREQUENCIES SHOWN.

Figure 5-1. Transmitter T-217/GR Frequency Block Diagram

There are 18 crystals in the 10 mc injection system, 10 crystals in the 1 mc injection system, and 10 crystals in the 0.1 mc injection system, a total of 38 crystals to obtain 1800 crystal controlled channels.

The crystals in the 10 mc injection system are type CR-32/U, operated in a thermostatically controlled crystal oven. The crystal frequency is multiplied 6 times when the transmitter is tuned to any frequency from 220.0 to 299.9 mc and the crystal frequency is multiplied 9 times when the transmitter is tuned from 300.0 to 399.9 mc. The 18 output frequencies from the 10 mc injection system are in 10 mc steps from 200.0 to 370.0 mc.

The crystals in the 1 mc injection system are type CR-23/U. The 10 output frequencies are in 1 mc steps from 18.0 to 27.0 mc.

The crystals in the 0.1 mc injection system are type CR-18/U. The 10 output frequencies are in 0.1 mc steps from 2.0 to 2.9 mc.

NOTE: Referring to the chart in Figure 5-1, note that in the 1 mc injection system the actual crystal frequencies are 6 kc above the frequencies shown, while in the 0.1 mc injection system the actual crystal frequencies are 6 kc below the frequencies shown.

1.2 Tuning System

A motor-driven frequency selector is used to permit rapid change of the operating frequency. The frequency selector unit has three rotary output shafts that select the proper crystal units and tunes various circuits to establish a particular operating frequency. All circuits, except the power amplifier, are tuned directly by these output shafts. The power amplifier is tuned by a servo system. The servo system uses a resistance-type bridge, which is set up by rotary switches that are driven by the three rotary output shafts of the frequency selector unit.

The three output shafts of the frequency selector unit are called the 10 mc, the 1 mc and the 0.1 mc shafts. The 10 mc shaft rotates in 18 incremental steps, each step representing 10 mc. The 1 mc shaft rotates in 10 incremental steps, each step representing 1 mc. The 0.1 mc shaft rotates in 10 incremental steps, each step representing 0.1 mc. By combining the outputs of these shafts and applying the mechanical sum to tuning of the various circuits, any one of 1800 frequencies in the range of 220.0 to 399.9 mc may be selected as explained below.

The 10 mc injection system (Main oscillator and frequency multiplier-amplifier sections) is tuned in 18 ten mc steps by the 10 mc shaft, which also operates the main oscillator crystal selector switch to select one of 18 crystal units.

The 1 mc injection system is tuned in 10 one mc steps by the 1 mc shaft, which also operates the 1 mc crystal selector switch to select one of 10 crystal units.

The 0.1 mc injection system is tuned in 10 tenth mc steps by the 0.1 mc shaft, which also operates the 0.1 mc crystal selector switch to select one of 10 crystal units.

The i-f amplifier is tuned by the 1 mc and 0.1 mc shafts, the rotations of which are combined in a differential tuning mechanism to produce 100 tenth mc steps.

The exciter and driver are tuned in 180 one mc steps by the 10 mc shaft (18 positions) and the 1 mc shaft (10 position) whose rotary motions are combined in a differential mechanism to produce 180 rotational positions.

The power amplifier is <u>not</u> tuned directly by the output shafts, but by a servo system which takes its information from a resistance-type servo bridge. This bridge is set up by the rotary switches driven by the 10 mc, the 1 mc, and the 0.1 mc shafts, which produces 360 one-half mc steps. In transmitters with serial number below 1000, this bridge is set up by the rotary switches driven by the 10 mc and the 1 mc shafts, which produces 180 one mc steps.

1.3 Frequency Example

As an example case of frequency selection, assume that one wishes to tune the transmitter to an output frequency of 395.5 mc. One of the 10 pre-set channels (assume channel 10) is set to 395.5 mc by turning the knurled disks to 395.5 as indicated on the dials. The CHANNEL SELECTOR switch is turned to channel 10. The frequency selector motor starts and produces a mechanical output that tunes the transmitter properly in the following manner:

10 mc injection system	370.0 mc
1 mc injection system	23.006 mc
0.1 mc injection system	2.494 mc
Exciter, Driver & Power Amplifier	395.5 mc

In this case, the main oscillator in the 10 mc injection system is tuned to 41.1111 mc, which when multiplied 9 times, results in a frequency of 370.0 mc.

1.4 Power Output

The power output of the T-217/GR transmitter is 100 watts nominal. The output impedance is 52 ohms. The output from the power amplifier is sampled by a device known as a directional coupler, which provides power-output and standing-wave-ratio information to a front panel meter. A low-pass filter is used in the output circuit. The second and third harmonics of the output frequency is down 40 db and all other harmonics are down 60 db. The carrier noise level is 40 db below 95% modulated carrier level. The output frequency stability is $\pm$ 10 kc.

1.5 Audio System

The power amplifier is plate modulated by voice or a 1020 cps tone. The power amplifier can be modulated up to 95%. The distortion is less than 12% as measured through the rectified carrier sidetone circuit with 95%

modulation and 20 db audio compression. The audio bandwidth is 400 to 3000 cps when narrow band is used, and is 200 to 20,000 cps when broad band used.

1.6 Power Requirements

The transmitter and modulator-power supply operates from either 115 or 230 volts, single phase, 50 to 60 cycles power source. The power factor is 88%. All fuses for the transmitter and modulator-power supply are located in the modulator-power supply unit.

1.7 Construction

The transmitter contains 9 sub-chassis which may be removed individually from the basic frame. Each sub-chassis is electrically connected to the system by a cable that plugs into a receptacle on the basic frame. The sub-chassis are as follows:

Unit

Main oscillator
Frequency mult-amp
I-F oscillator
Exciter
Driver
Power-amplifier
Servo-amplifier
Monitor amplifier
Frequency selector

The modulator-power supply is built up on an inside-out type of construction on one main frame. There are no sub-assemblies.

The location of the 9 sub-shassis in the transmitter are shown in Figure 5-27 and Figure 5-28.

1.8 Block Diagram

A block diagram of the T-217 transmitter is shown in Figure 5-2. This diagram shows that the Servo System is controlled by the 10 mc, 1 mc, and 0.1 mc auto-positioners. In transmitters with serial numbers below 1000 the Servo System is controlled by only the 10 mc and 1 mc autopositioners.

T-217/GR TRANSMITTER
MD-129/GR MODULATOR-POWER SUPPLY

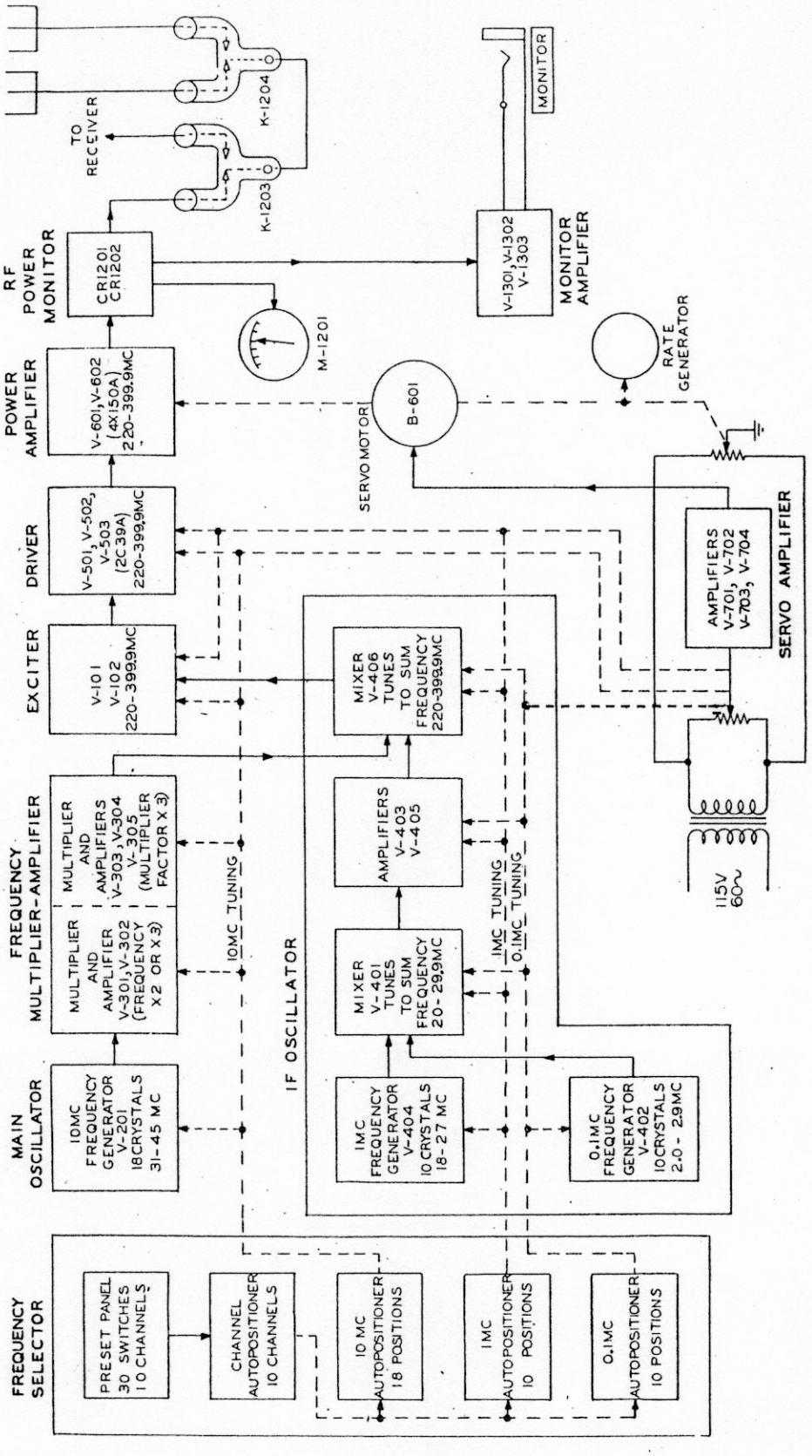


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Figure 5-2. Radio Transmitter T-217/GR, Complete Block Diagram

2.0 THEORY OF OPERATION

The individual circuits of the transmitter and modulator-power supply will now be considered in detail.

Three of the nine sub-chassis included in the transmitter are incorporated in the frequency generating system. These are the Main Oscillator, the Frequency Multiplier-Amplifier, and the I-F Oscillator. The outputs of the three crystal oscillators are multiplied, amplified and mixed together in order to provide the desired frequency for the Exciter.

2.1 Main Oscillator

Referring to Figure 5-3, the Main Oscillator employs a Butler circuit and consists of: V-201, type 12AT7, a high mu duo-triode; a bank of 18 type CR-32/U crystal units with a crystal switch, all inside a temperature-controlled crystal oven; a bank of 18 coils with associated switch; and other circuit elements. The oscillator consists of a grounded grid amplifier followed by a cathode follower which in turn couples back into the grounded grid stage through the crystal.

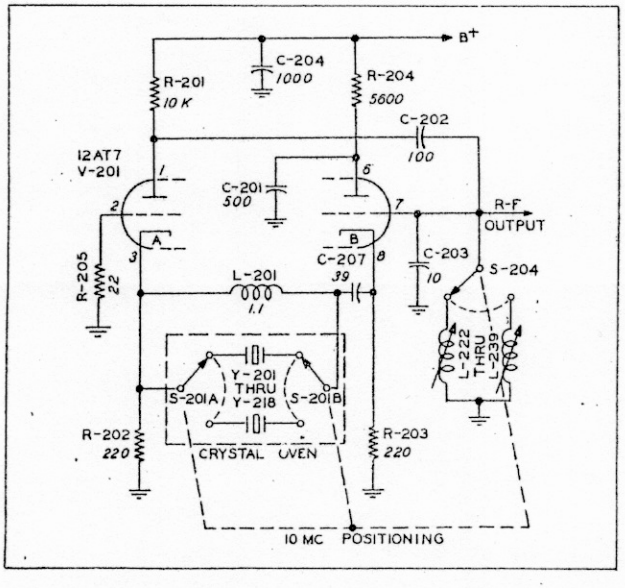

Figure 5-3. Main Oscillator, Simplified Schematic

To understand the operation of this oscillator imagine a random positive pulse appearing at the cathode, pin 3, of the grounded grid amplifier, V-201A. Since the grid is grounded through a 22 ohm resistor, a rise in cathode voltage will cause a decrease in plate current and therefore an increase in plate voltage. This positive pulse is coupled to the grid of the cathode follower, V-201B. The cathode voltage follows the grid voltage so that the positive pulse is coupled back to the cathode of the grounded grid amplifier through the crystal. The crystal presents a low impedance path only at series resonance. Thus oscillations are generated by the stage and sustained by the feedback loop. The plate load of the grounded grid amplifier is the tuned circuit C-203 in parallel with one of 18 inductances selected by the 10 mc autopositioner output shaft. The frequency of oscillation can be adjusted over a small range by adjusting the tuning of the plate circuit. This circuit is normally adjusted so that the frequency of oscillation is precisely as desired, thereby eliminating any inaccuracy in the frequency of the crystal unit. A 1.1 microhenry inductance, L-201, is used to resonate with the stray circuit capacities at approximately 30 mc. The oscillator signal is fed to V-301 through a capacitor and a soldered connection connecting the oscillator unit with the frequency-multiplier amplifier unit.

The crystal is maintained at a constant temperature by the thermostatically controled crystal oven. The crystal oven operates on 115 volts a-c and includes two heater elements and two thermostats. One heater element has a rating of approximately 70 watts and is employed to bring the oven to operating temperature rapidly when the equipment is first turned on. The second heater element has a rating of approximately 30 watts and operates intermittently to maintain the oven at the proper temperature (75° C $\pm 5^{\circ}$C).

2.2 Frequency Multiplier-Amplifier

Referring to Figure 5-4, the circuit elements mounted upon this sub-chassis act together to multiply the output of the main oscillator by either six or nine. This provides eighteen frequencies spaced 10 mc apart in the range of 200.0 to 370.0 mc.

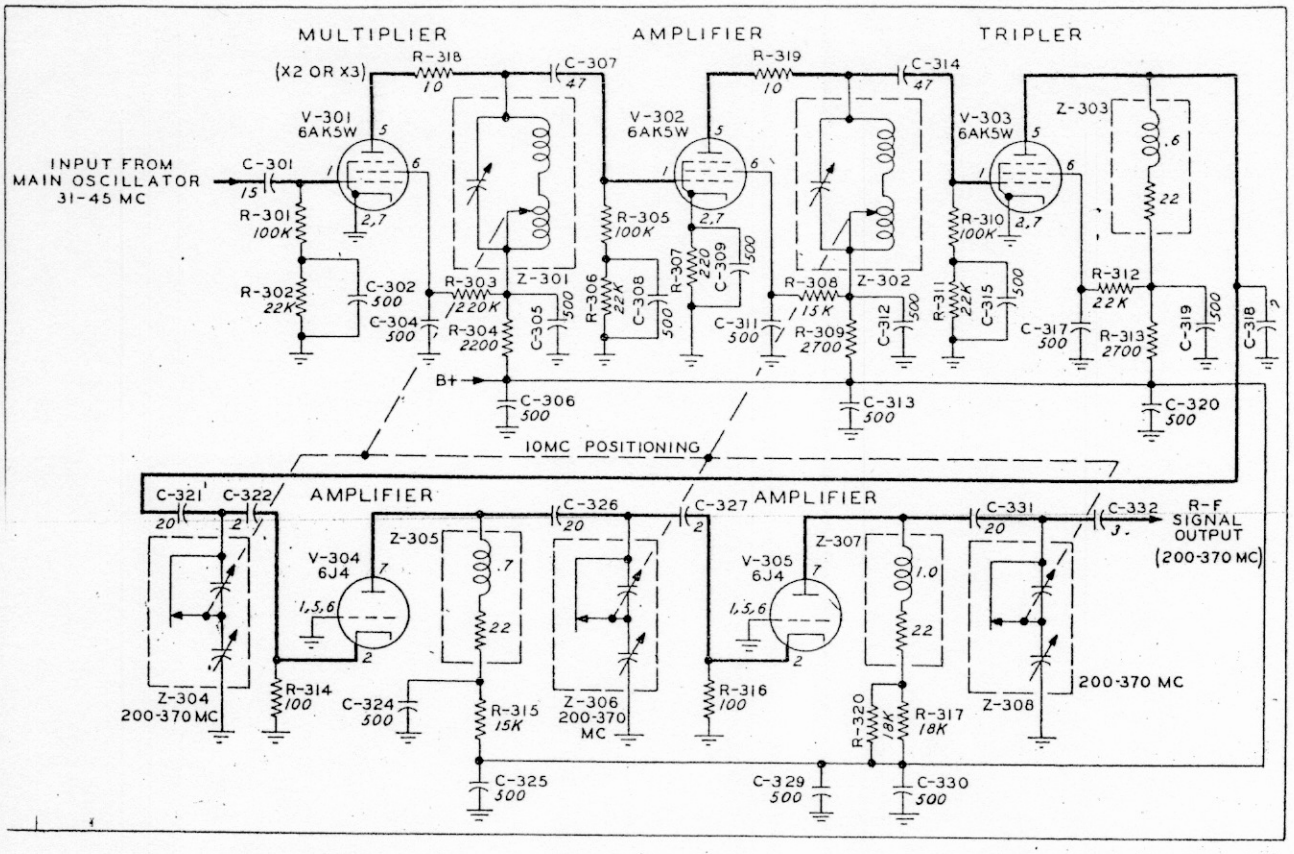

Figure 5-4. Frequency Multiplier-Amplifier, Simplified Schematic

The output signals from the main oscillator are coupled through C-301 to V-301 which is the first stage of the frequency multiplier-amplifier. Here, either the second or third harmonic of the main oscillator frequency is selected (by the parallel tuned tank, Z-301, in the plate circuit), and amplified. This harmonic is then coupled through C-307 to V-302 where it is amplified further. Z-301 and Z-302 are the plate tanks of V-301 and V-302, respectively. Each consists of an eighteen turn tapered toroidal coil in series with a high frequency trimmer coil, both of which are in parallel with a variable capacitor to provide low frequency padding. The eighteen turn coil is wound on a form in such

a way that each turn of the coil may be contacted by a switch arm. The switch arm is driven in eighteen steps by the frequency selector unit. The tanks may consequently be tuned in increments of 3.3333 mc each, between 66.6666 and 123.3333 mc.

After the signal is amplified by V-302, it is coupled through C-314 to V-303 where it is tripled before being further amplified in the cascade amplifiers V-304 and V-305. These three amplifier stages employ a special r-f tuner circuit represented on the schematic as Z-304, Z-306 and Z-308. These tuners are a unique device and because they require very precise alignment adjustment it is important that they be thoroughly understood. They are described in the following section. These tuners are ganged together and driven by the frequency selector unit. They are tuned in increments of 10 mc each between the limits of 200.0 to 370.0 mc. The output of the frequency multiplier-amplifier is coupled through C-332 to the cathode of the final mixer, V-406, on the I-F oscillator sub-chassis.

2.3 R-F Tuners

In the last three stages of the frequency multiplier-amplifier, in the exciter and in the driver, special r-f tuners are used. Each of these sub-chassis includes three separate tuners which are ganged together, and are driven by one of the autopositioner shafts, or by differential outputs of two shafts. These tuners cover the wide frequency range necessary by simultaneously changing both the capacitance and the inductance of their elements as they are positioned by the frequency selector unit.

Figure 5-5 illustrates the principal elements of a typical tuner of the type used. This r-f tuner consists of a variable capacitor and variable inductor which are rotated simultaneously so that in 180° of rotation the resonant frequency changes linearly 180 mc or 1 mc per degree. The variable capacitor consists of two stator plates and three rotor plates, the front and rear of which are radially slotted for the purpose of alignment adjustments. The inductive loop consists of the inductance stator rod, the inductance ring and the inductance rotor rod.

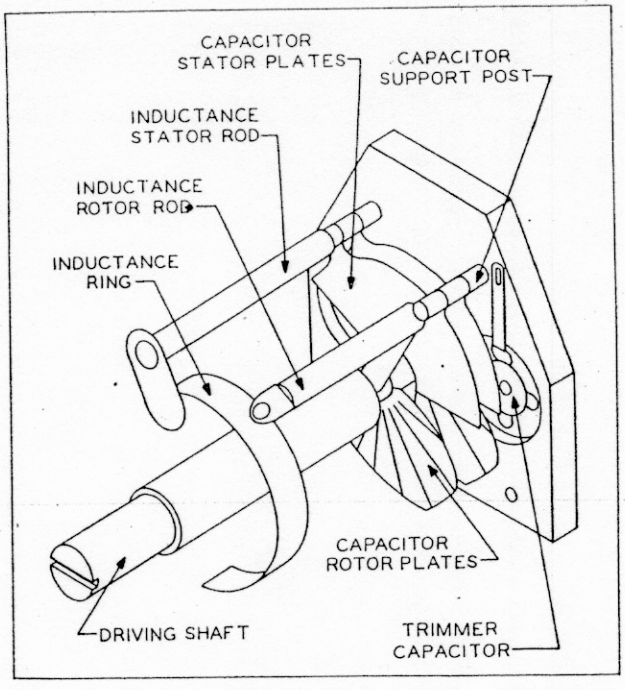

Figure 5-5. R.F. Tuner,
Principal Elements

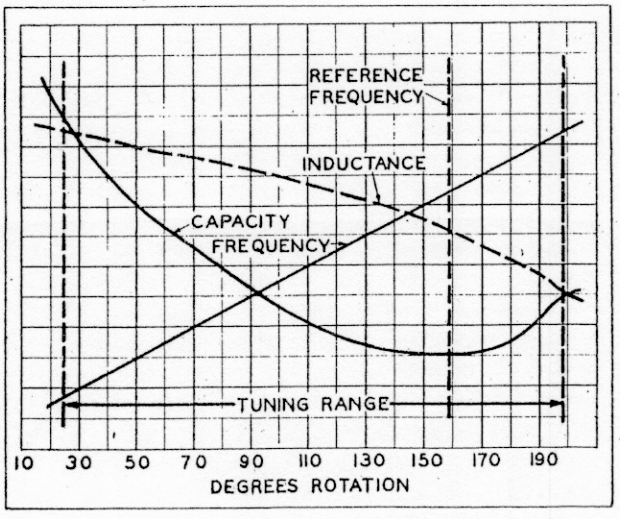

Figure 5-6. R.F. Tuner,
Tuning Curves

Figure 5-6 illustrates the manner in which the inductance and capacitance change to produce the required resonant frequency as the tuning elements are rotated. It will be noted that the point of minimum capacitance does not correspond to the maximum frequency of the tuning range. The point at which the inductance rotor rod is exactly in line with the short capacitor support bar, is used as a reference point in the tracking procedures.

The capacitor rotor plates are divided into 20 degree sectors by slots which are cut well down toward the center of the plates. The two plates on each tuner which are so slotted, have their slots staggered so that the slots on one plate correspond to the center of the sectors on the other plate. If the capacitor rotor plates are rotated in ten degree increments (10 mc), at each position at which the rotor comes to rest, one sector of one or the other of the plates will be just half engaged with the stator. Tracking of these tuners over the frequency range is accomplished by bending, in the proper direction, the sector which is half engaged at each of the tracking frequencies.

2.4 I-F Oscillator

Referring to Figure 5-7, the I-F Oscillator consists of the 0.1 mc and 1 mc oscillators, the first mixer V-401, amplifier stages V-403 and V-405, and the second mixer V-406. The purpose of this circuit is to provide to the mixer, V-406, an injection signal at any of 100 frequencies spaced 100 kc apart in the range of 20.0 to 29.9 mc. When any of these frequencies and the output frequency of the frequency multiplier-amplifier are added together in the mixer, V-406, it makes available to the excitor a signal of some particular frequency to be amplified and finally emerge as the output of the power amplifier. To accomplish this purpose, two crystal oscillators are employed, their outputs being added together and amplified before being impressed upon the grid of the mixer V-406.

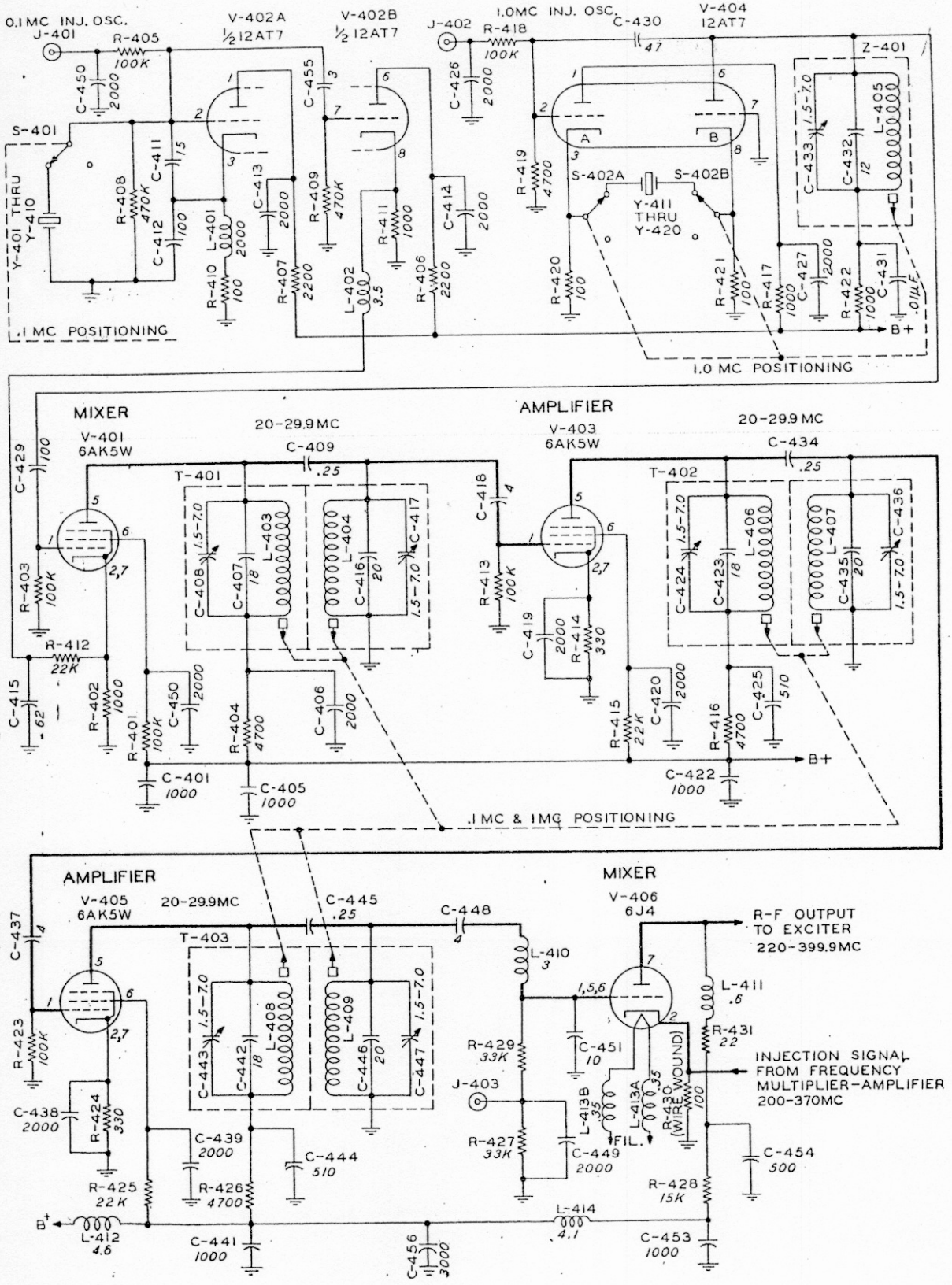

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Figure 5-7. I.F. Oscillator, Simplified Schematic (Serial Numbers 0-2331)

The first of these two oscillators is composed of half of V-402 and its associated circuitry. This is funadmentally a Colpitts oscillator with the output taken from the grid circuit to minimize harmonic output. The various crystals, Y-401 to Y-410, are selected by S-401 which is driven by the 0.1 mc shaft. This oscillator output, as determined by the selected crystal, is at a frequency of 1.994 to 2.894 mc in steps of 100 kc (0.1 mc).

The output from this oscillator is coupled through C-455 to the grid of the other half of the duo-triode V-402. This triode section, used as a cathode-follower, acts as a buffer between the oscillator and the mixer, V-401. The output from this cathode-follower is coupled to the cathode of the mixer, V-401, through L-402 and R-412.

The second oscillator upon this sub-chassis is a Butler oscillator composed of both triode sections of V-404. Crystals Y-411 to Y-420 are the frequency control items for this oscillator, and the plate tank, Z-401, is permeability tuned. The output frequency, as determined by the crystals, ranges from 18.006 to 27.006 mc in steps of one mc. Crystal selector switch S-402, and the tuning of Z-401 are both controlled by the one mc shaft. The output from this oscillator is coupled to the control grid of the mixer, V-401, through C-429.

With these two independent inputs to the mixer, V-401, there will appear at the output of the mixer the sum of the two input frequencies. Since one input may vary from 1.994 to 2.894 mc in ten steps of 100 kc, and the other input may vary from 18.006 to 27.006 mc in ten steps of one mc, this output sum-frequency may vary from 20.0 to 29.9 mc in 100 steps of 100 kc. T-401 contains the plate tank for V-401 as well as the grid tank for the amplifier, V-403.

The output from V-401 is coupled to the grid of V-403 through C-409 and C-418. V-403 and V-405 are both r-f amplifiers with T-402 and T-403 functioning exactly as did T-401.

T-401, T-402 and T-403 are all permeability tuned by a rack which is driven by two cam shafts, the sum of whose positions determines the position of the rack. These two cams are driven by the 1 mc shaft and the 0.1 mc shaft. The position of the rack is therefore simultaneously affected by these two inputs, and as a consequence will position the shaft in 100 incremental steps, each step corresponding to.0.1 mc. T-401, T-402 and T-403 are then tuned over the range from 20.0 to 29.9 mc in steps of 100 kc each.

The output from V-405 is coupled to the grid of the mixer V-406 through C-445 and C-448. Since the output of the frequency mulitplier-amplifier appears at the cathode of this mixer, the output of the stage as appearing at the plate will be the sum of these two frequencies. There is then available as an input to the exciter any desired frequency from 220.0 to 399.9 mc in 100 kc increments.

The mixer stage, V-406, was converted as of serial no. 2331 (approx.) from a cathode-grid mixer to a cathode-plate mixer as shown in Figure 5-8. The plate of V-406 is now shunt fed through the secondary of T-403.

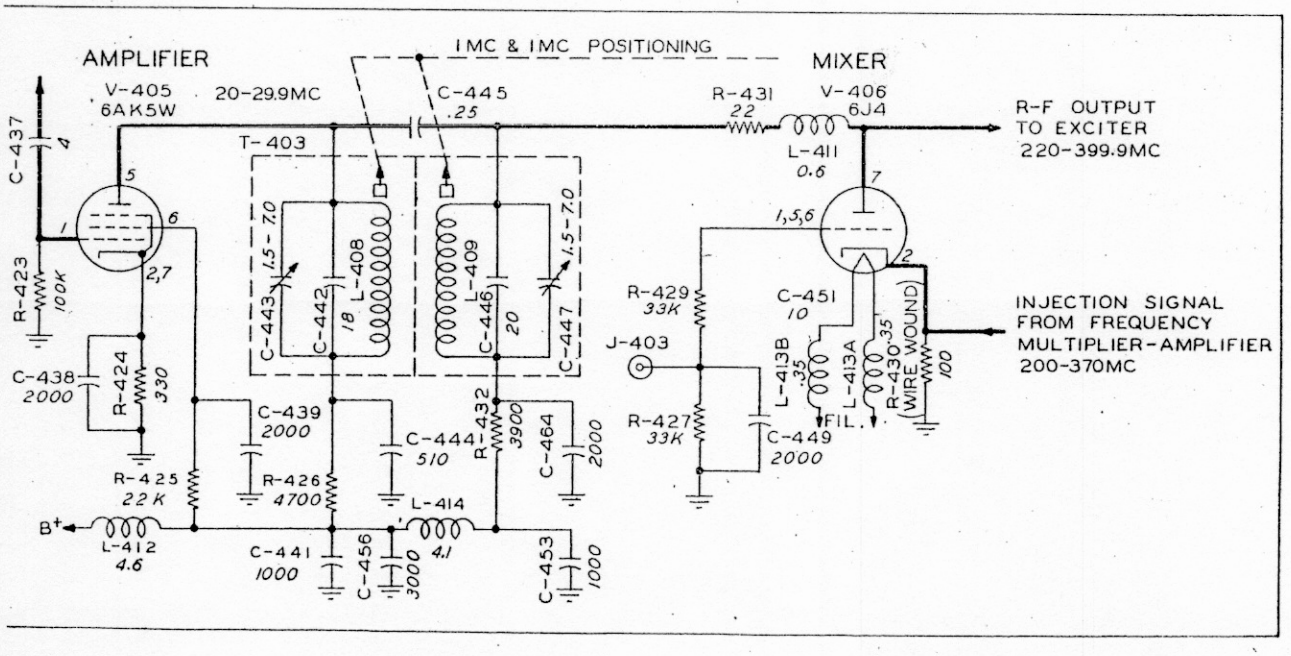

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Figure 5-8. I-F Oscillator; Second Mixer for Serial Numbers following No. 2331

2.5 Exciter

The r-f signal from the mixer, V-406, is sufficiently amplified in the excite to provide adquate input to the driver stages. (See Figure 5-9.)

Three tuned circuits and two amplifier stages are mounted upon the exciter sub-chassis. Z-101, Z-102 and Z-103 are tuned over the range of 220.5 to 399.5 mc in steps of 1 mc, by the action of a differential driven by the 10 mc and 1 mc autopositioners. Each position of these tuners corresponds to the center frequency in each 1 mc band. These tanks are r-f tuners of the type previously described in the section describing R-F Tuners, and act to discriminate against undesired signals. V-101 and V-102 are grounded grid amplifiers with inputs to their cathodes. Cathode resistors R-101 and R-103 are each 100 ohm wire-wound resistors. The fact that they are wire-wound causes them to look like a high impedance to the uhf signal therefore holding the loading of Z-101 and Z-102 to a minimum. Z-104 and Z-105 are the r-f plate loads to V-101 and V-103 respectively.

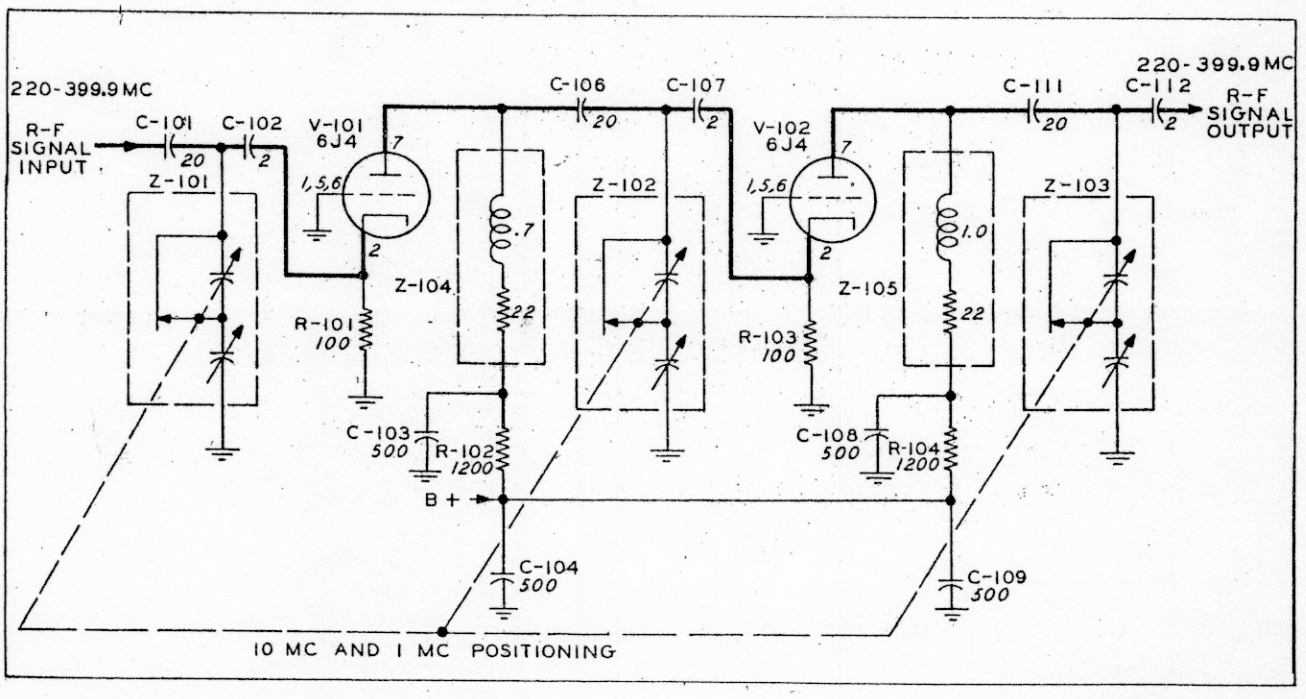

Figure 5-9. Exciter, Simplified Schematic

2.6 Driver

Referring to Figure 5-10, the driver amplifies the output of the exciter and provides approximately 15 watts of uhf power to drive the final power amplifier.

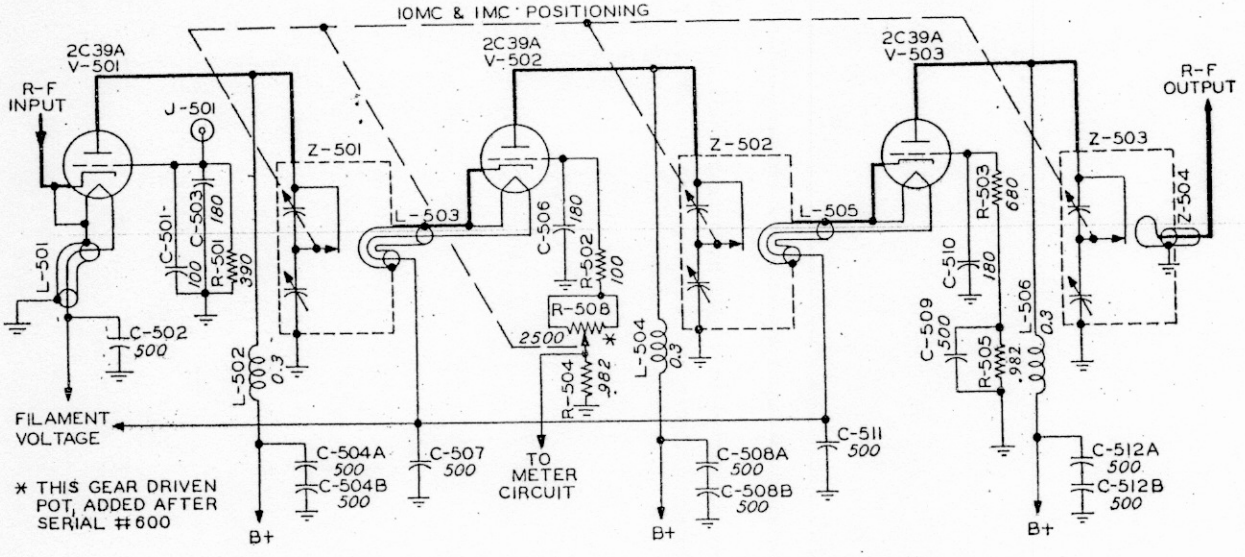

Figure 5-10. Driver, Simplified Schematic

The output from the exciter is coupled to the cathode of V-501, which is the first of three stages mounted upon the driver sub-chassis. V-501, V-502 and V-503 are all grounded grid amplifiers, their plate tanks being Z-501, Z-502 and Z-503, respectively. These tanks are r-f tuners similiar to the type described in the section on R-F Tuners. They are tuned over the range of 220.5 to 399.5 mc in steps of 1 mc, by the action of a differential driven by the 10 mc and 1 mc autopositioners. Each position of these tuners correspond to the center frequency in each 1 mc band. Interstage coupling is accomplished by bringing the concertric filament supply leads, and consequently the cathode loop, into close proximity with the inductance stator rod in the r-f tuners. Output coupling from the driver is provided by a loop, Z504, inserted into Z-503. To cool the tubes, the driver blower forces air into the driver compartment.

The gear driven potentiometer R-508 was added after serial number 600 to provide variable bias on V-502 to attain a more uniform power output.

2.7 Power Amplifier

The function of the power amplifier is to amplify the output of the driver to the required 100 watts output. It is automatically tuned over the frequency range of 220.2 to 399.7 mc by means of a servo amplifier system as explained later. Each position of the tuned circuits in the power amplifier correspond to the center frequency of each 1/2 mc band.

The power amplifier is basically a tuned grid-tuned plate push-pull amplifier operating at Class C, and using two 4X150A beam tetrode tubes. Input to and output from the power amplifier employs inductive coupling in both grid and plate circuits. The plate and grid circuits used are tuners of the parallel line type, which are rolled up for convenience of tuning.

Figure 5-11 is presented as an aid in visualizing the construction of the power amplifier since it is difficult to see in the equipment. Note that the power amplifier is completely enclosed in a box having a transverse partition which separates the grid and plate circuits. Figure 5-11 shows the two 4X150A tubes side by side, mounted on the transverse partition. The grids are coupled through C-602 and C-603 to the grid tuner and the plates are connected directly to the plate tuner. Connection to the screen is made through screen contact fingers. To cool the tubes, the power amplifier blower forces air into the power amplifier compartment. The parallel lines of the grid and plate circuits (tuners) make up about 300 degrees of a circle, one end of which is coupled to the grid or plate and the other end of which is permanently shorted. On these circular segments rides a shorting bar (also called wiping fingers), which is automatically positioned by means of the servo drive system which selects a certain length arc to correspond with the frequency of operation. Accompanying the shorting bar is an injection loop (on the grid side) or a pick-up loop (on the plate side). The grid and plate tuners are geared together by means of a loaded gear train which is part of the power amplifier assembly.

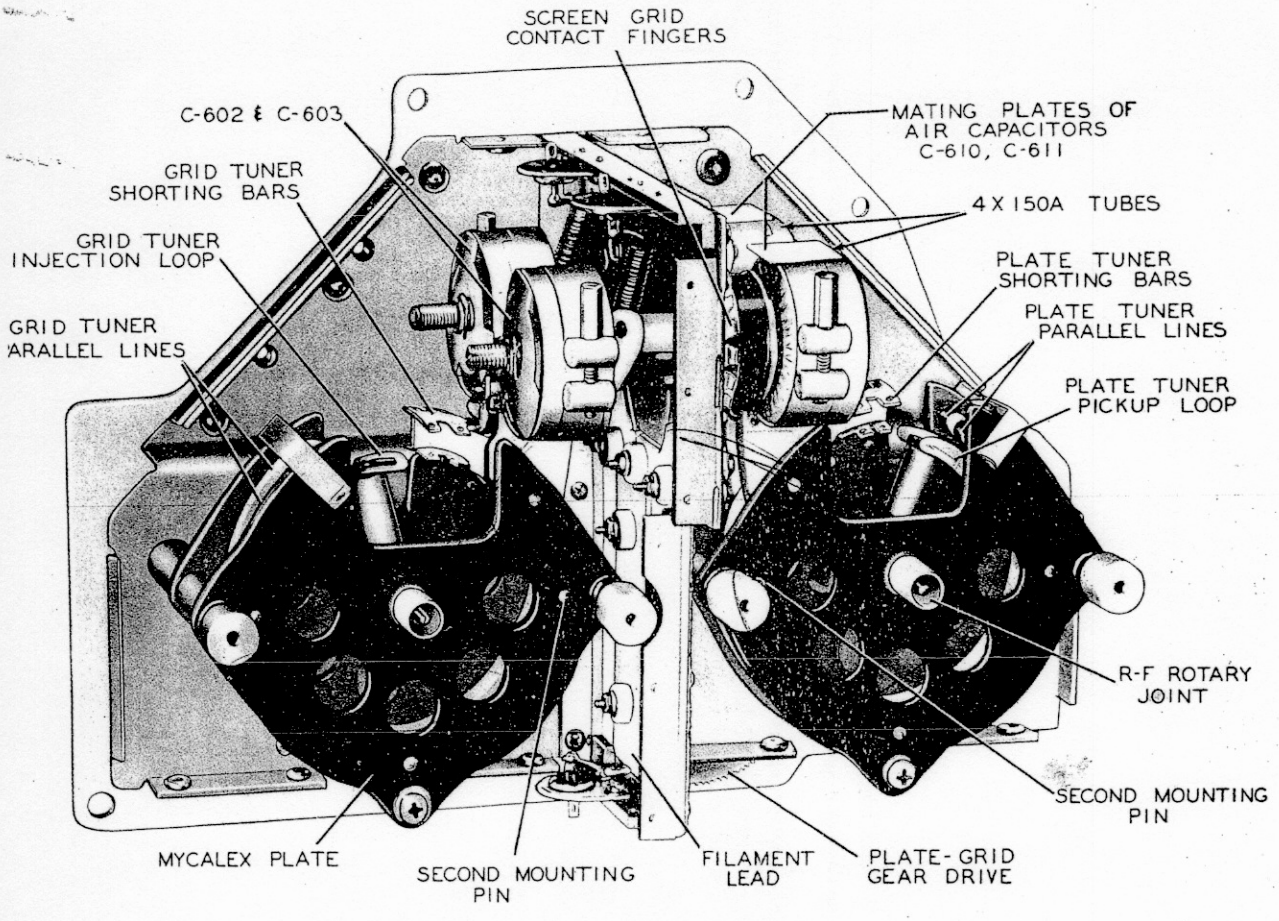

Figure 5-11. Power Amplifier With Side Removed Showing Details of Construction.

A simplified schematic of the power amplifier is shown in Figure 5-12. The two 4X150A grids are capacitively coupled to the grid lines through C-602 and C-603. These are special cylindrical capacitors, constructed to duplicate the distributed capacitive and inductive elements in the plate circuit. This, of course, is to permit accurate tracking of the grid and plate circuits. These grid capacitors are adjustable over a narrow range to aid in tracking. The grid voltage is developed across chokes L-601 and L-602. The grid bias is the sum of -47 volts fixed bias and whatever grid leak bias is developed across R-602 and R-603 by the d-c grid current. Normal bias is about -85 volts, corresponding to about 4 ma grid current per tube. The sum of the grid currents is indicated in the "P.A. Grid" position of the front panel meter.

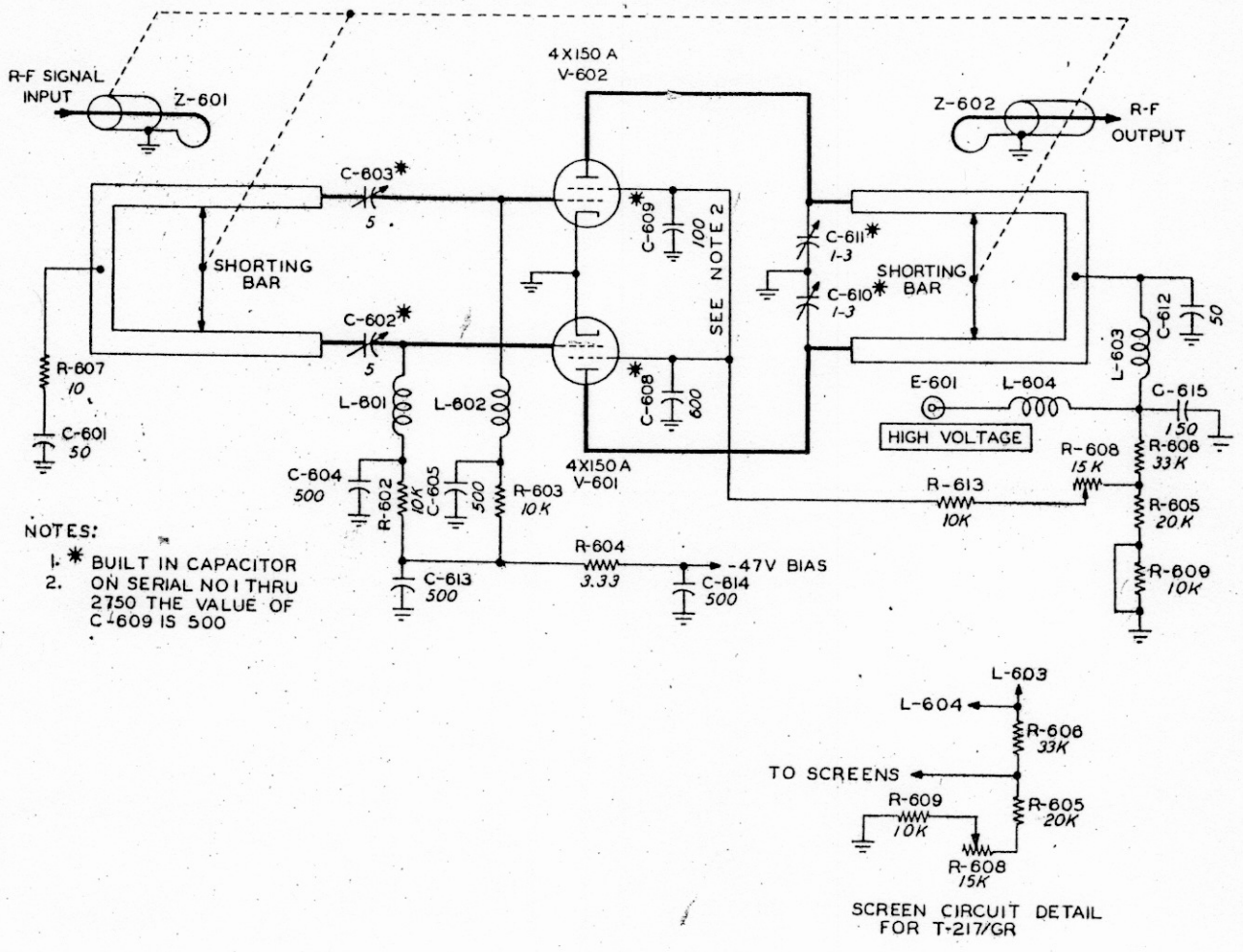

Figure 5-12. Power Amplifier Used in T-217A/GR Simplified Schematic

The screens are supplied with about 250 volts d-c through the bleeder composed of R-605, R-606, R-608 and R-609 and are directly bypassed to ground through a sandwich type capacitor. Control over the screen grid voltage is provided by means of R-608. This potentiometer should be adjusted only after circuit changes have been made, such as changing of the power amplifier tubes or after the power amplifier has been re-aligned. To increase the power output, screen voltage should be increased to a maximum of 300 volts or until there is a maximum of 450 ma plate current. These two conditions should not be exceeded across the frequency range of the equipment. If the adjustment of R-608 can not provide sufficiently high screen voltage or plate current, the bus wire which shorts out R-609 may be clipped. This will increase the screen grid voltage slightly.

The plate lines are attached directly to the plates of the 4X150A tubes by means of low inductance straps. Trimmer capacitors C-610 and C-611 are used for tracking and to compensate for the slight capacity variations when changing tubes. The plate and grid lines are by-passed at the "cold" ends by C-601 and C-612. In addition, a parasitic suppressor R-607 is installed in series with the grid line and its bypass, C-601.

The input and output loops are fastened to the structures carrying the shorting bars. This permits them to be coupled to the low impedance points of the tank circuits at all times which helps in reducing the harmonic output. These loops are mounted on a special piece of coaxial line, which enters the tuning shafts and leave the power amplifier through rotating joints which are terminated in "type N" 52 ohm coaxial connectors. From an operating and maintenance standpoint the most important parts of the power amplifier are the "shorting bars" which are actually made up of eight spring fingers. The position of the short circuit established by these shorting bars determines the resonant frequency of these parallel line tanks. It follows that they must all make positive contact to the line at all times to insure power output and reset accuracy.

2.8 Servo System

Most of the tuning of the transmitter is done directly from the autopositioner output shafts, but since this method of tuning is not adaptable to the power amplifier, a servo system of tuning is used. The servo system is made up on two sub-assemblies, the Servo Amplifier and the Servo Drive.

A servo system is an electrical-mechanical device that translates a mechanical motion or setting into electrical energy which can be amplified any desired amount and then translated back to mechanical energy to perform a certain task. In other words a servo system is an amplifier system for mechanical energy. A servo system depends upon an electrical bridge circuit which has two variable legs. The input leg (a potentiometer) is adjusted by a positioning device, such as an autopositioner in the case of transmitter T-217/GR. Changing the setting of the input leg of the bridge throws the bridge out of balance causing a signal to be applied to the servo amplifier. This signal is amplified any desired amount and the output applied to a servo motor which responds to the amplified signal. The motor runs performing the desired tuning but it also restores the bridge to balance by adjusting the output leg in the bridge circuit. When the bridge is again balanced, there is no longer an error signal applied to the servo amplifier and the servo system is in equilibrium.

2.9 Servo Bridge Circuit

Referring to Figures 5-13 and 5-14, the servo bridge is at first glance not easy to see, but it consists essentially of R-1205 as the input leg, and R-601 as the output leg. A 60 cycle signal is taken from one of the secondaries of T-1202 and impressed across R-1205 which is a wire wound resistor with adjustable taps. Adjacent taps of this resistor are connected to adjacent contacts of S-1202A as shown in Figure 5-15. As the 10 mc autopositioner shaft drives S-1202A, a predetermined portion of R-1205 is picked off by the common contacts of S-1202A. This portion of resistance picked off of

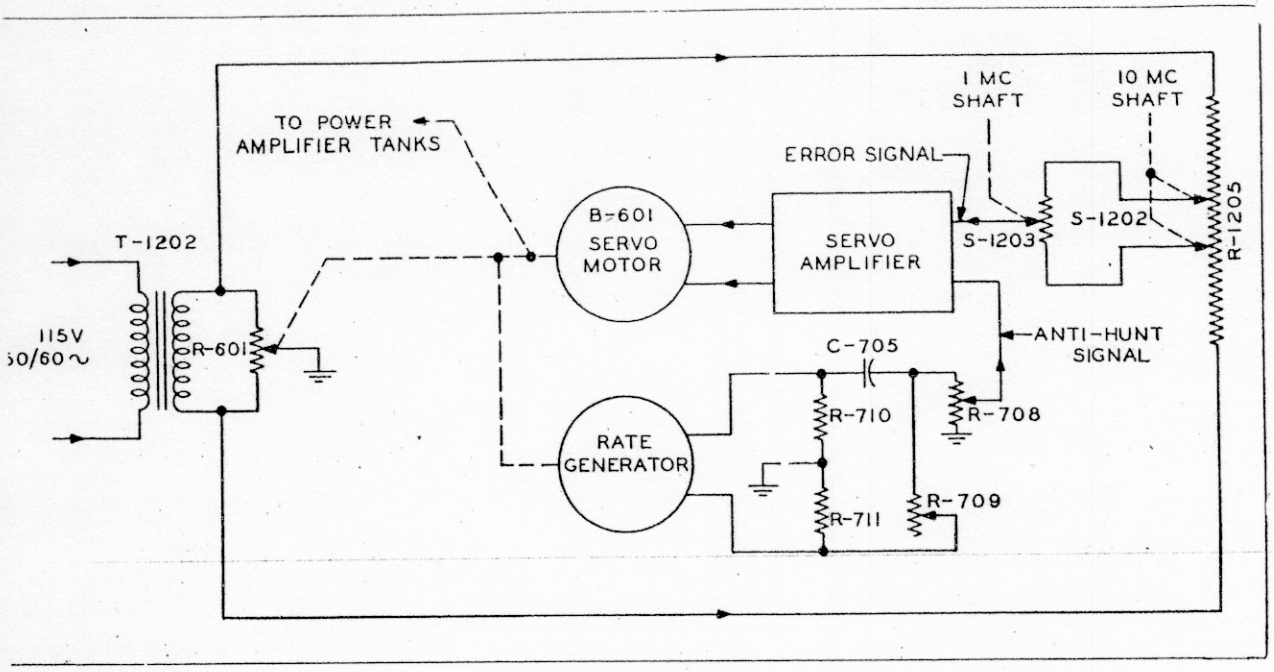

Figure 5-13. Servo System, Block Diagram (Serial Numbers 0 - 1000)

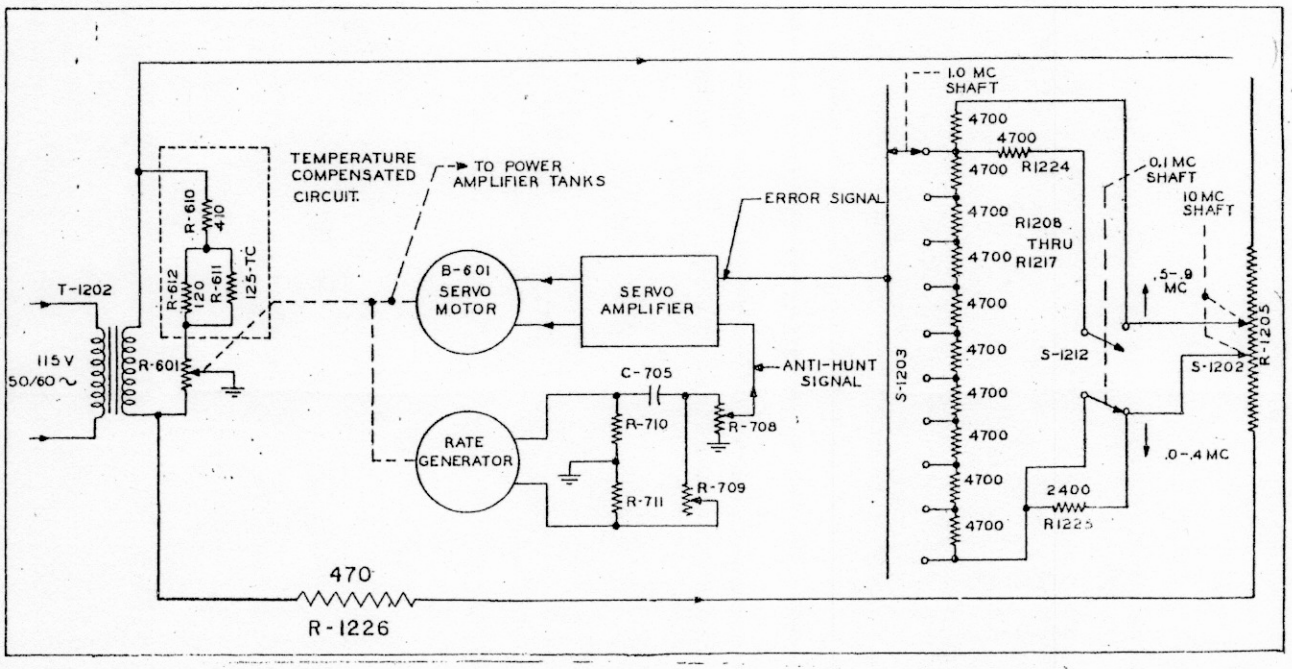

Figure 5-14 Servo System Block Diagram
(Serial Numbers after 1000 approx.)

R-1205 represents a 10 mc range of frequencies as seen by the servo amplifier. As a vernier adjustment to provide 1 mc tuning information, switch S-1203, driven by the 1 mc autopositioner selects a position somewhere along the series of resistors R-1208 through R-1217. One end of this chain of resistors represents the 0.0 mc point while the opposite end represents the 9.0 mc point.

To provide power amplifier tuning at half megacycle intervals, S-1212 and its associated circuits were added on equipments after serial No. 1000. When the 0.1 mc shaft is positioned to any point between 0.0 mc and 0.4 mc, inclusive, the action of S-1203 is exactly as in the original models. When the 0.1 mc shaft is positioned to any point between 0.5 mc and 0.9 mc, R-1225 is placed in series with one end of the 1 mc voltage divider, and R-1224 is placed parallel with R-1217 at the other end. The addition of these resistors does not change the effective resistance of the voltage divider, but does change the electrical position of the taps to provide the same function as would a 20 position voltage divider. At this same serial number the temperature compensating network consisting of R-610, R-611 and R-612 was added. (See Figure 5-14). This network acts to change the value of resistance in one leg of the servo input bridge in a direction suitable to correct the tuning drift of the power amplifier due to temperature change. To maintain balance in the bridge legs R-1226 was added to counter-balance the temperature compensating network.

Across this elaborate system of resistances, selected by the 10 mc, 1 mc and 0.1 mc autopositioners, the 60 cycle voltage is impressed. At any one instant of time one end of this chain of resistances will be positive and the other end will be negative. At some point along the chain (depending on the setting of R-601) there will be a null point or ground. The servo amplifier is looking for this null point and adjusts R-601 to it. When R-601 is adjusted to the null point the error signal is removed from the servo amplifier.

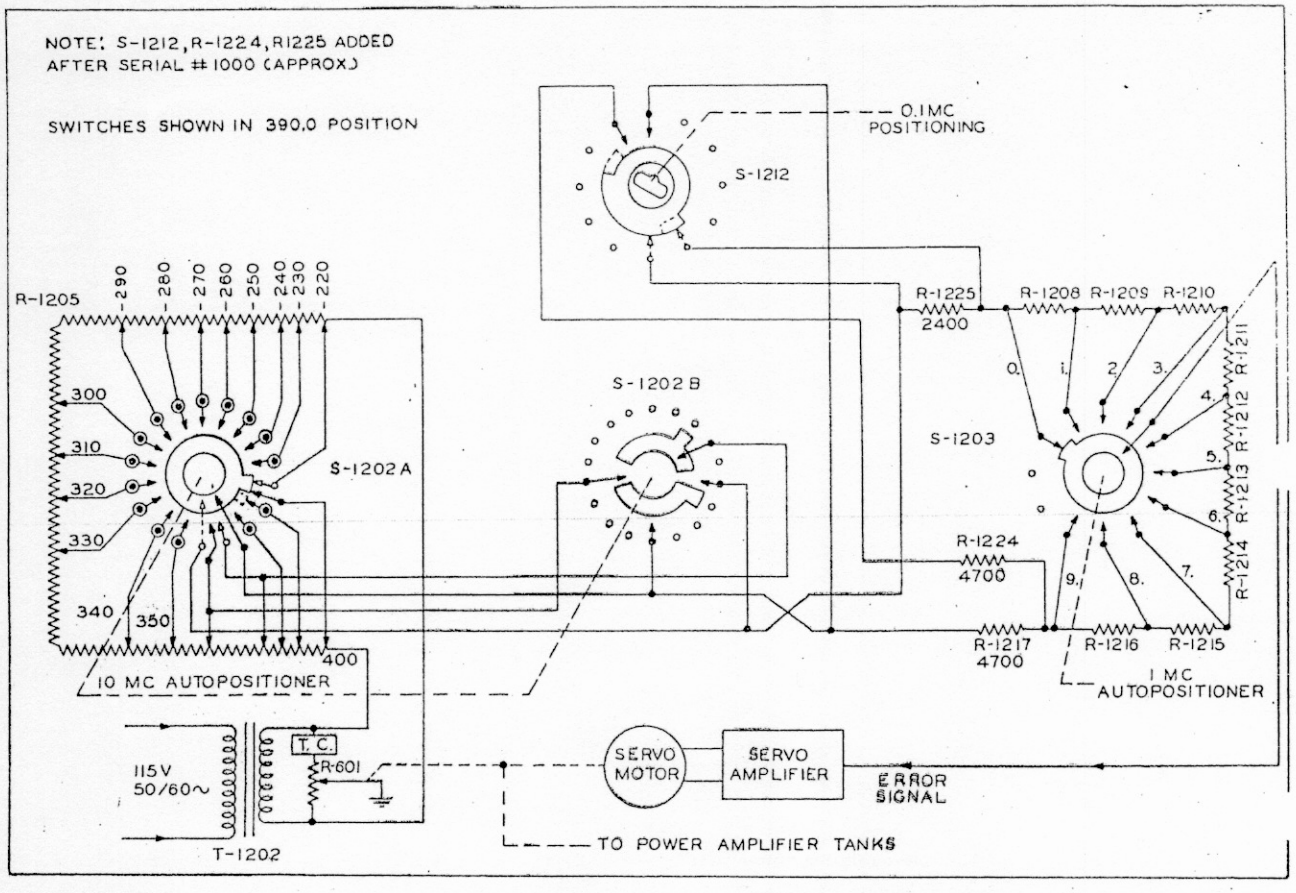

Figure 5-15. Servo Input, Simplified Schematic (Serial Numbers after 1000 approx.)

2.10 Servo Amplifier

Referring to Figure 5-16, the 60 cycle signal appearing at the common contact of S-1203 is applied through R-701 to the grid of the first stage of the servo amplifier, V-701A. The output from V-701A is taken from a resistance-capacitance phase shifter made up of R-704 and C-704. Since the signal voltage appearing at the cathode is 180 degrees out of phase with that appearing at the plate, the phase of the output of the voltage divider may be varied over a wide range by varying R-704.

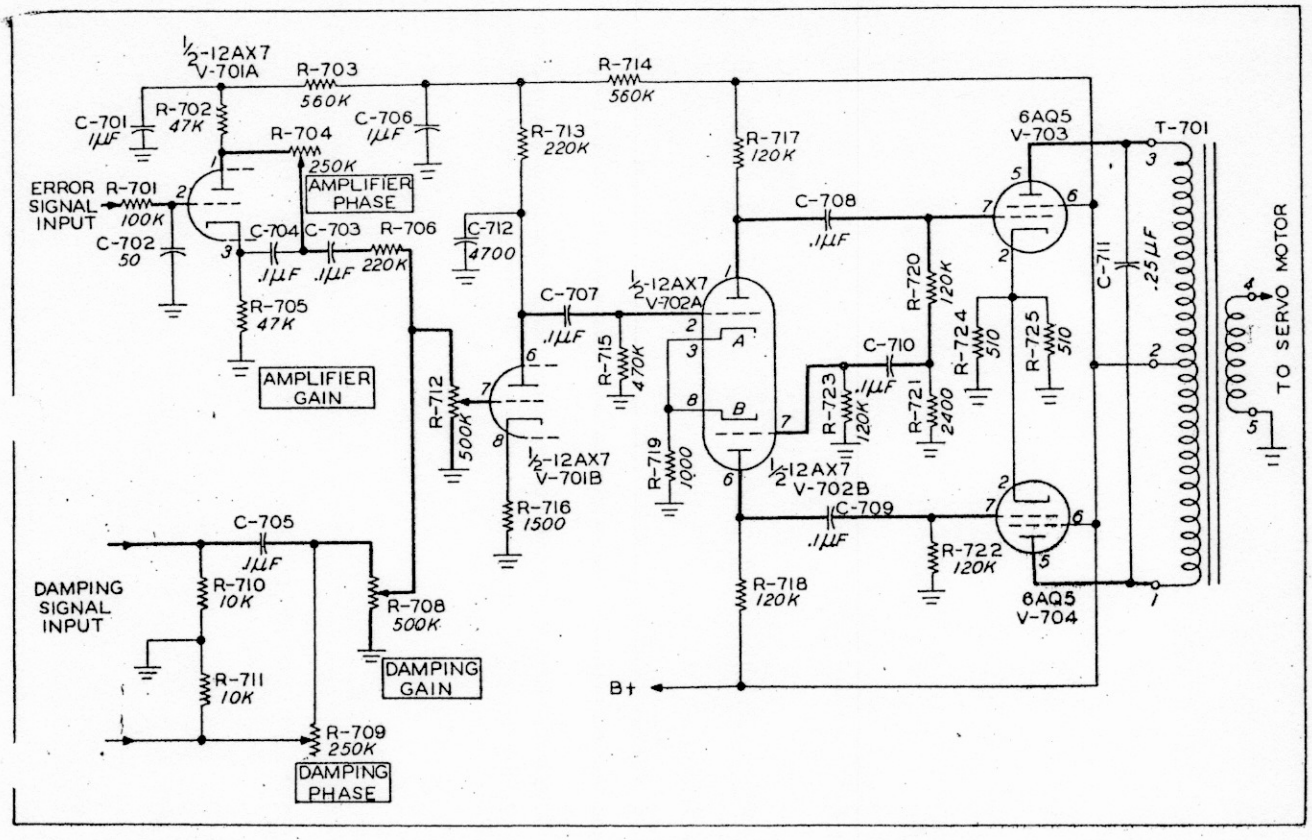

Figure 5-16. Servo Amplifier, Simplified Schematic

R-704 is adjusted to provide a 90 degree signal for the control phase on the motor. This signal is coupled to the mixing resistor, R-712, which is the grid resistor of V-701B.

A negative feed-back voltage, used as an anti-hunt signal, obtained from the rate generator on the servo motor, is also applied to the mixing resistor, R-712. The phase of this feed-back voltage is adjusted by varying R-709, and its amplitude is controlled by R-708.

The combined value of these two 60 cycle signals appears across R-712 and the amplitude of the resultant voltage appearing at the grid of V-701B is determined by the setting of the movable arm of this potentiometer. Output from V-701B is coupled through C-707 to the grid of V-702A where it is amplified before being applied to V-703 through C-708. A portion of the signal appearing at the grid of V-703 is selected by a voltage divider consisting of R-720 and R-721, and coupled back to the grid of V-702B through C-710.

The signal output from V-702B, coupled to the grid of V-704 through C-709, is of the proper phase and amplitude to drive V-704 in push-pull operation with V-703. The primary of the output transformer, T-701, appears as the plate load to this push-pull stage, and the secondary voltage is used to drive the servo motor, B-601.

2.11 Servo Drive

The stators of both the servo motor and the rate generator are excited by a 60 cycle voltage taken from the primary of T-1202. The output voltage from the servo amplifier acts to excite the rotor of the servo motor, B-601, causing the motor to run. As the servo motor turns, it serves three functions; (1) it tunes the plate and grid tanks of the power amplifier; (2) it rotates the center arm of R-601, and (3) it turns the rotor of the rate generator. This rate generator forms the negative feed-back loop that was mentioned in the discussion of the Servo Amplifier. The 60 cycle output of this rate generator is directly proportional to the speed of its rotation and the phase of the output voltage depends upon the direction of rotation, hence, the faster it is being rotated by the servo motor, the greater will be the feed-back in opposition to the 60 cycle signal voltage developed at the output of V-701A. The speed of the servo motor, and consequently the amplitude of the negative feed-back to the amplifier, are limited by the torque in the driven elements. With large values of error signal there is no change in the speed of the servo motor for a change in error signal. (See Figure 5-17). The effective error signal is the algebraic sum of the original error signal and the negative feed-back voltage.

Near the null point these two voltages cancel and the effective error signal is zero. The servo motor will therefore stop turning without hunting back and forth about the null point.

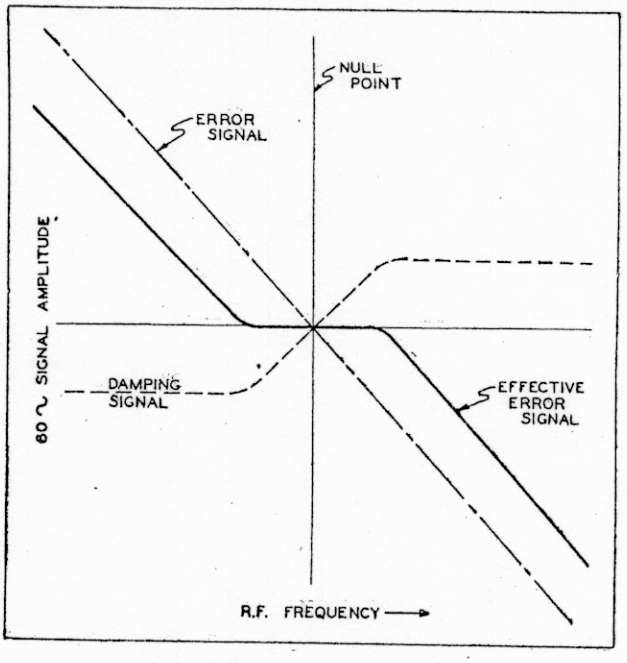

Figure 5-17. Servo Error Signal Graph

Since the amplitude and phase of the error signal at the grid of V-701A depends upon the position of the arm of R-601 for any given setting of the 0.1 mc, 1 mc, and 10 mc autopositioners, the servo motor will turn, moving the arm of R-601, until this error signal voltage drops to zero.

2.12 Output Network

Referring to Figure 5-30, the output of the power amplifier is available at the coaxial connector J-602. This output if fed through the coaxial cable, W-1201 to the low pass filter Z-1201. This is a coaxial filter employing five tuned stubs to discriminate against frequencies above 450 mc.

The output of this filter is connected to the R-F Power Monitor. Here two directional couplers are used to give two sampling voltages. The output from one of these directional couplers serves to indicate power output, supply an input to the Monitor Amplifier, and is used in the calibration of the standing wave ratio indicator. The output from the other directional coupler provides standing wave ratio indication in conjunction with M-1201 by measuring reflected power.

The output of the R-F Power Monitor is connected through coaxial cable W-1202 to the antenna transfer relay K-1203. This is a coaxial relay, and works in conjunction with the push-to-talk circuit, transferring the antenna from the receiver coaxial connector, J-1213 to the transmitter coaxial cable, W-1202 when the push-to-talk circuit is energized. The circuitry is so arranged that the antenna is transferred before the high voltage is applied. The movable contact of K-1203 is connected to the movable contact of the antenna selector relay, K-1204. This is another coaxial relay and acts to connect W-1203 to either the directional or the omni-directional antenna.

2.13 Monitor Amplifier

Referring to Figure 5-18, a portion of the output voltage of the directional coupler, which samples forward power and is incorporated into the R-F Power Monitor, is used as the input to the Monitor Amplifier.

This input signal is connected to the grid of half of V-1301 through C-1301. Potentiometer R-1301 controls the level of the signal at the input grid. The output of this first stage is coupled to the grid of the second half of V-1301 through C-1302. This second stage acts as a phase inverter to drive the push-pull output stage with outputs being taken from both the plate and cathode circuits. These outputs are coupled to the two halves of V-1302 through C-1303 and C-1304, respectively. Output transformer T-1301 has a split and balanced secondary. The two halves of this secondary are connected in series

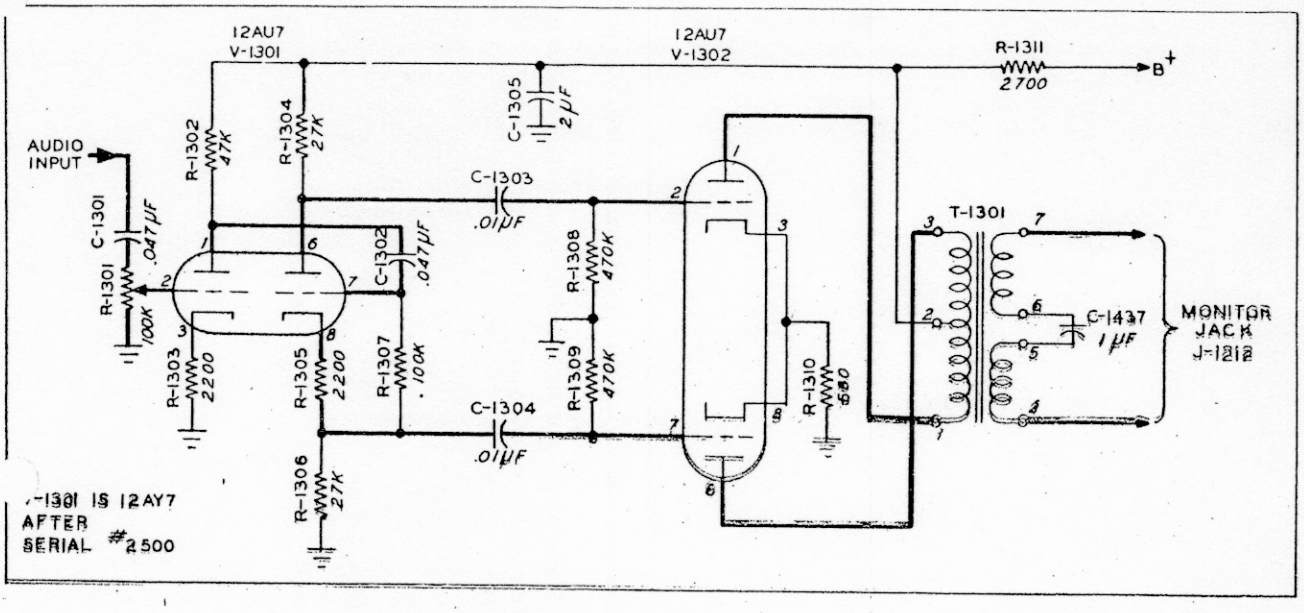

Figure 5-18. Monitor Amplifier, Simplified Schematic

through a capacitor, C-1437, in the Modulator-Power. The 600 ohm output from this secondary circuit is impressed across the monitor jack, J-1212 and is also made available to the local control unit through connection to the Modulator-Power Supply.

2.14 Modulator-Power Supply

The MD-129/GR Modulator-Power Supply illustrated in Figure 5-26, serves two main functions. It provides all necessary power to Transmitter T-217/GR and it modulates the transmitter. With the advent of the continuous duty version of the transmitter, T-217A/GR, it was found necessary to increase the capabilities of the modulator-power supply. The Modulator-Power Supply MD-129A/GR includes a re-designed high voltage power supply which produces a high voltage output (approximately 900 to 1000 volts depending on conditions of loading, etc). Also included is another intake fan. Air is drawn in through the two louvers on the front panel and is exhausted through a screen on the rear of the case and side openings.

2.15 Power Supply Block Diagram

Refer to Figure 5-19 for the power supply block diagram. Note the four power supplies; low voltage, bias, relay, and high voltage, the four being supplied by three transformers. The filament transformer has primary power applied as soon as the main switch is thrown. The low voltage transformer depends on a time relay and case interlocks and the high voltage transformer depends on the bias interlock and the push-to-talk relay to be closed before primary power is applied to them.

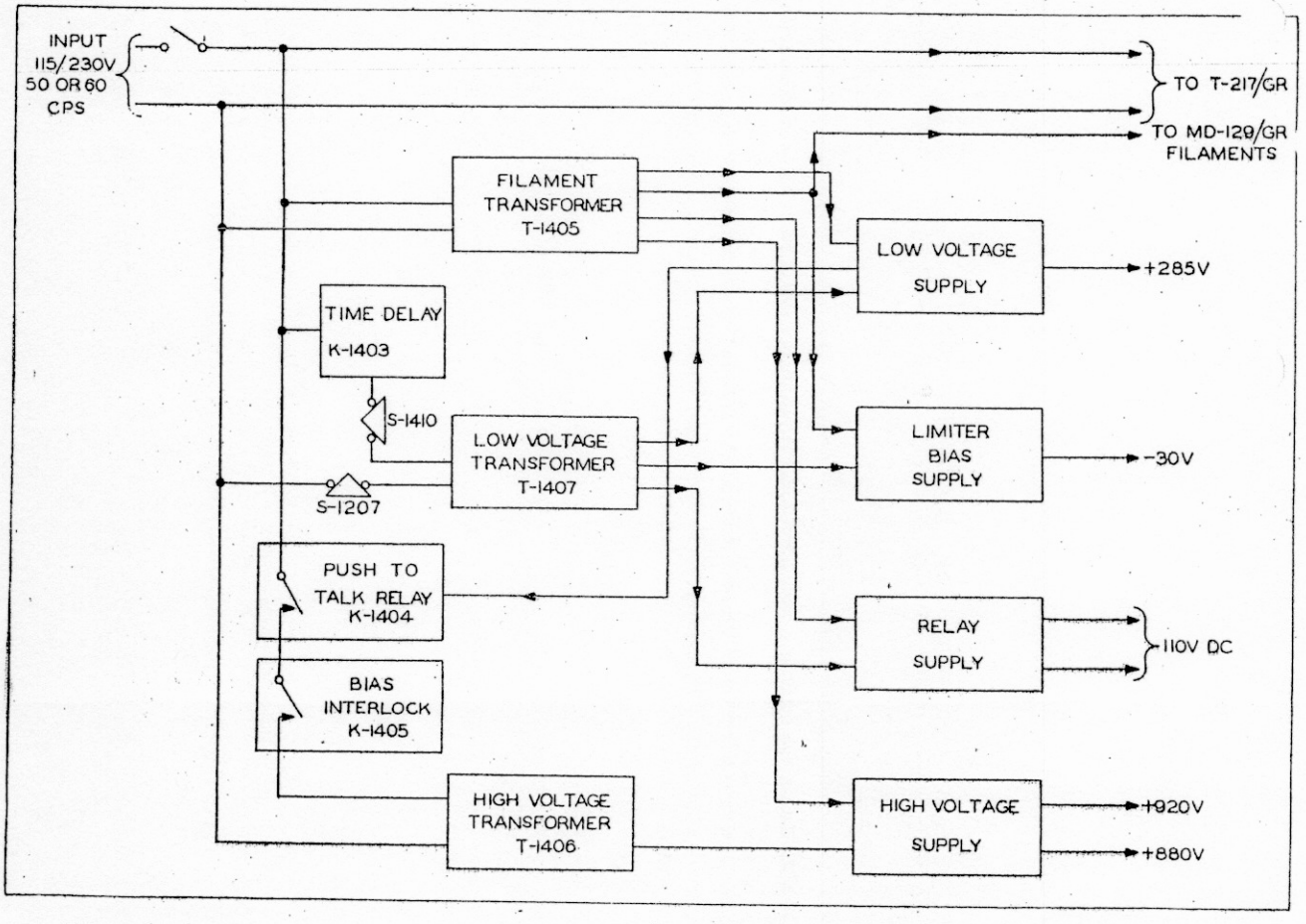

Figure 5-19. Power Supply, Block Diagram

2.16 Power Input Circuit

Refer to Figure 5-20 for the partial schematic of the power supply. An input voltage of either 115 or 230 volts at either 50 or 60 cycles is required to operate the equipment. S-1401 is the main power on-off switch. On MD-129A/GR a cam driven switch, S-1401B, opens the other power input line. The ganged switches S-1407, S-1408 and S-1409 act to connect the split primaries of T-1405, T-1406 and T-1407 in either series or parallel, depending upon the input voltage. S-1406, also ganged with S-1407, S-1408 and S-1409 serves to select the proper number of turns on the overload trip mechanism in S-1401, for the supply voltage used.

2.17 Filament Supply

Referring to Figure 5-20, the filament transformer, T-1405, has four secondaries. One of these secondaries supplies filament power for the audio section of Modulator-Power Supply MD-129/GR and for the limiter bias rectifier tubes; one secondary supplies filament power for the high voltage rectifier tubes, one secondary supplies filament power for the low voltage rectifier tubes and the fourth secondary supplies filament power for the relay rectifier.

2.18 Low Voltage Supply

Referring to Figure 5-20, the low voltage transformer, T-1407, is excited through the contacts of the thermal time delay relay, K-1403, and the interlock switches, S-1401 and S-1207. K-1403 allows the filaments to warm sufficiently before the application of plate voltage to the rectifiers, while S-1410 and S-1207 make it impossible to accidentally excite the power transformers while either MD-129/GR or T-217/GR is outside of its dust cover. Two type 3B28 tubes, V-1415 and V-1416, serve as full wave, low voltage rectifiers. The low voltage filter is composed of two sections. The first section consists of the parallel tuned circuit L-1403 and C-1431, followed

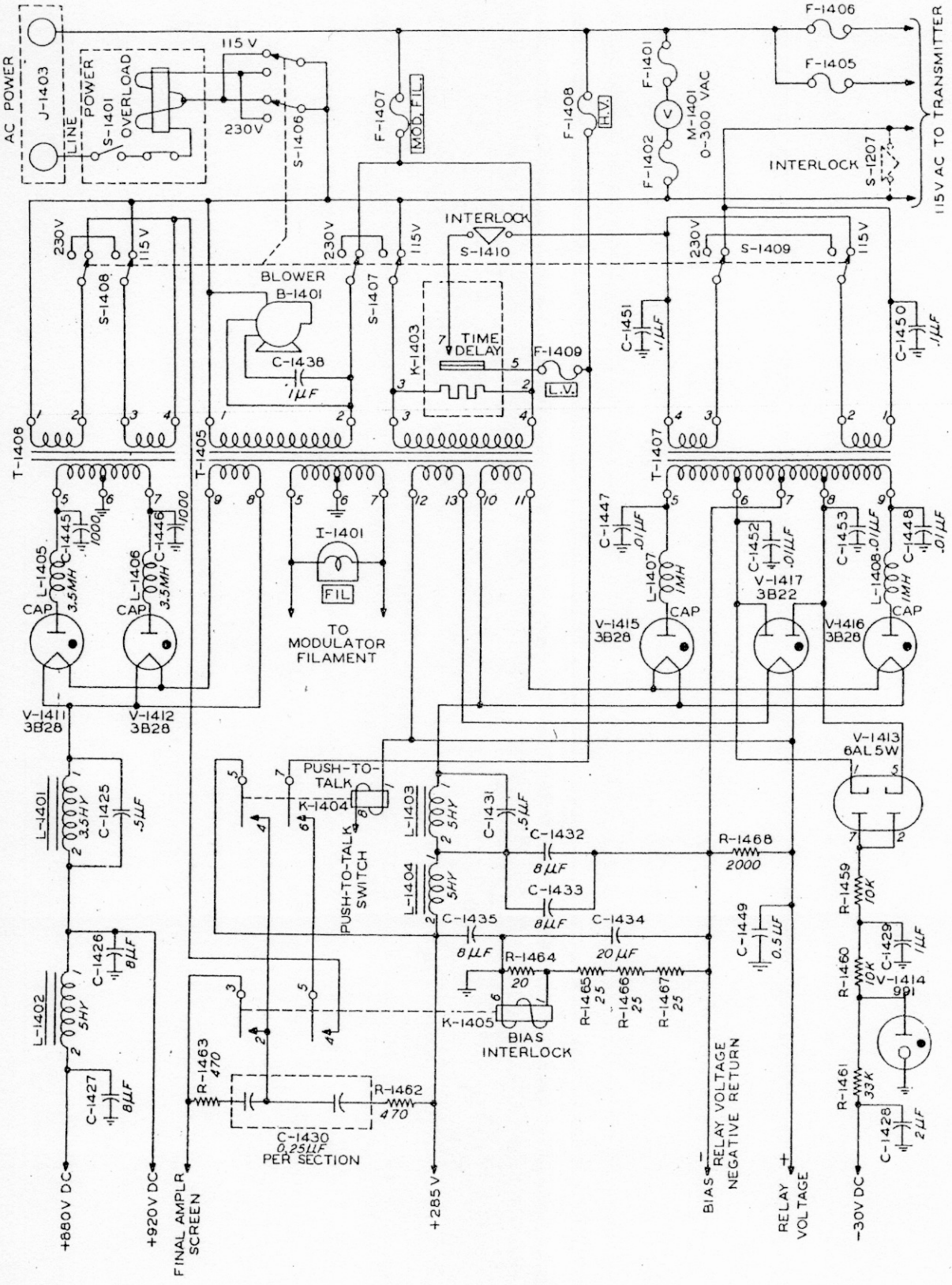

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Figure 5-20. Power Supply, Partial Schematic

by two eight microfarad capacitors, C-1432 and C-1433 in parallel. L-1403 and C-1431 give maximum attenuation to the ripple frequency. C-1432 and C-1433 are returned to the center tap of the low voltage transformer, T-1407. The second filter section consists of L-1404 and C-1435.

Referring to Figure 5-20 and Figure 5-29, Power and Control Circuits Simplified Schematic, with the push-to-talk relay, K-1404, de-energized, this 285 volt supply is connected only to the servo amplifier in the transmitter, which draws about 100 ma. from the supply. Since this current flows through the series resistors R-1464, R-1465, R-1466 and R-1467, the center tap of T-1407 is at a negative potential of slightly less than nine volts. The coil of the bias interlock relay, K-1405, is in parallel with R-1464. The resistance of this coil is approximately 27 ohms and it requires 200 ma. to actuate the relay, therefore the total output current from the 285 volt supply must be about 470 ma. before K-1405 will become energized.

With the push-to-talk relay energized, the 285 volt supply is connected to all of the 285 volt circuits except the screens of the modulator tubes, V-1407 and V-1408. The total output current from the supply is now increased to a value in excess of the 470 ma. required to close K-1405. As K-1405 closes, the 285 volt supply is connected to the screens of the modulator tubes. The high voltage transformer, T-1406, is excited through the contacts of K-1404 and K-1405. With all the 285 volt circuits connected to the supply, the total current through the series resistors R-1464, R-1465, R-1466 and R-1467 is increased to approximately 550 ma. This places the center tap of T-1407 at a negative potential of about 47 volts. This negative 47 volts is used as the bias supply.

2.19 Relay Supply

Referring to Figure 5-20, a second rectifier supplied by the low voltage transformer provides the necessary 110 volts for operation of the relays. This is a type 3B22 tube, V-1417, operating as a full wave rectifier, the output of which is left unfiltered. Since the potential at the center tap of

T-1407 varies between a negative 9 and a negative 47 volts, the positive or cathode side of the rectifier will vary between 100 and 62 volts, but the total voltage between cathode and center tap will remain essentially constant at 110 volts. R-1468 acts as a bleeder, drawing about 55 ma.

2.20 Limiter Bias Supply

Referring to Figure 5-20, the third rectifier associated with the low voltage transformer provides a regulated 30 volts bias for the limiter incorporated within the audio section of MD-129/GR. A 6AL5W, V-1413, acts as a full wave rectifier with the cathodes connected to T-1407. R-1459 and R-1460 are voltage dropping resistors while a type 991 tube, V-1414, serves as a voltage regulator. C-1429 serves as a filter capacitor, further reducing the ripple voltage.

2.21 High Voltage Supply

Referring to Figure 5-20, the primary of the high voltage transformer, T-1406, is excited through the contacts of K-1404 and K-1405. Two type 3B28 tubes, operating as a full wave rectifier, are connected to the secondary. The first filter section is composed of L-1401, C-1425 and C-1426. L-1401 and C-1425 are parallel tuned to give a high impedance to the ripple frequency, while C-1426 acts as a low impedance to this frequency. The 920 volt supply for the modulator plates is taken off after the first filter section. The second filter section composed of L-1402 and C-1427 further filters this high voltage for the 880 volt supply to the transmitter. Referring to Figure 5-31, this circuit passes through one secondary of the modulation transformer, T-1404, before going to J-1406 and on to the transmitter. In MD-129A/GR the safety switch S-1411 was added to short out the high voltage capacitors when the unit is removed from the case.

2.22 Audio Section

The audio amplifier employed is capable of amplifying signals from a level of minus 45 dbm to a level sufficient to modulate the transmitter up to 95%.

Two audio bandwidths are provided by the use of a bandpass filter for narrow bandwidth, and omission of this same filter for broad bandwidth. The limiter employed has been designed to allow not more than two db increase in output for a 20 db increase in input power.

Referring to Figure 5-21, the input audio transformer, T-1401, has two separate primary windings. Winding 1-2 is used only for microphone input from J-1401. When the microphone is plugged into J-1401 and the push-to-talk button pressed, relay K-1401 becomes energized to turn the transmitter carrier on.

The second winding 3-4-5-6, designed for remote control operation provides 600 ohms termination for the remote microphone and serves as a split and balanced input from E-1401 and E-1402 or from terminals G and H of J-1404. Normally the NORMAL-EMERG switch S-1402 is in the NORMAL position in which case this second primary winding is used only for audio frequency voltage. In this case another pair of wires closes a circuit which causes the transmitter carrier to be turned on. However, a single pair of wires to a remote control unit can be used to perform both functions if S-1402 is placed in the EMERG position. The ground circuit to operate K-1401 is then completed through both sections of S-1402 and through the remote microphone when the push-to-talk button is pressed.

Two tubes, V-1418 and V-1419, on serial numbers 0-2950 are used as voltage limiters to limit the voltage appearing across the line to less than 140 volts when S-1402 is in the EMERG position. Closing of the contacts on K-1401 also applies a negative voltage to the grids of these tubes to stop them from drawing current. Circuit constants are such that the voltage across C-1436 is just slightly less when the remote microphone push-to-talk switch is closed then when it is not closed.

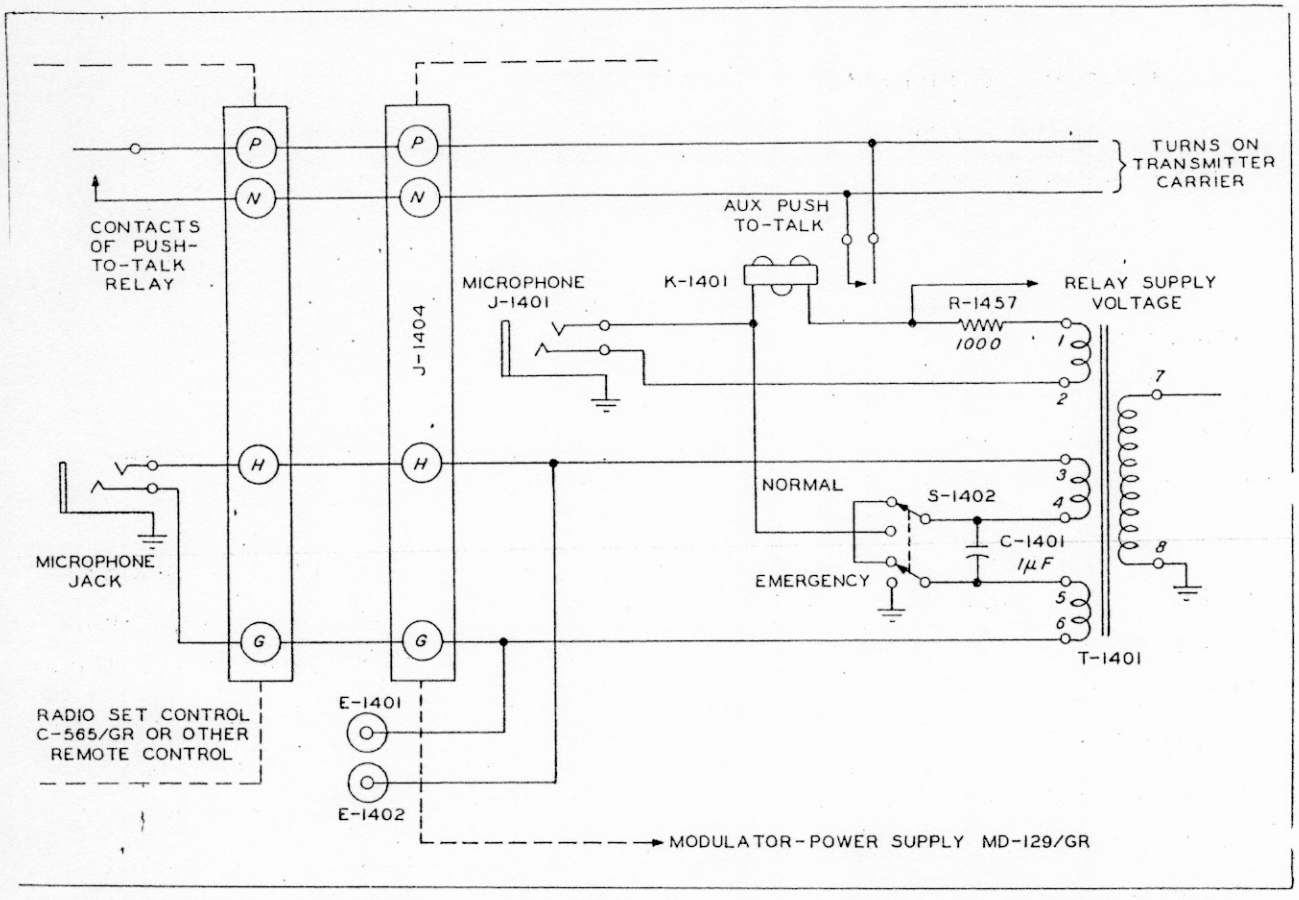


Figure 5-21. Input Circuit to Audio Transformer

Referring to Figure 5-31, the secondary of the input transformer T-1401 is connected to the grid of the first amplifier stage, half of V-1401, through the dual potentiometer, R-1401, which serves as the AUDIO GAIN control. This two section potentiometer provides the necessary attenuation for both high and low level inputs.

The output from this first half of V-1401 is taken from the plate circuit and coupled through C-1404 to the grid of the second half of the same tube. The bandpass filter, Z-1401, narrows the bandwidth to 400-3,000 cps. With S-1403 in the BROAD position, this bandpass filter is by-passed and the bandwidth is increased to 200-20,000 cps.

The output from this second triode section, as it appears across R-1407, is coupled to the primary of the inter-stage transformer, T-1402, through the limiter.

The output from T-1402 drives the two halves of V-1403 in push-pull, and the output from this stage drives the two halves of V-1404 in push-pull. V-1405 and V-1406 are driven by the two halves of V-1404 and also operate in push-pull. Two negative feedback loops, one composed of R-1430 and C-1411, and the other composed of R-1431 and C-1412, couple from the plates of V-1405 and V-1406 respectively, back to the cathodes of V-1404 to improve the frequency response and minimize distortion of the amplifier.

Coupling between the push-pull stage consisting of V-1405 and V-1406, and the modulator output stage, V-1407 and V-1408, is through T-1403. C-1416 and C-1417, connecting primary to secondary of T-1403, act to minimize the high frequency distortion of the amplifier.

The push-pull output stage, consisting of V-1407 and V-1408, works into the output transformer T-1404. Three separate secondaries are employed on this transformer. One secondary carries the high voltage for the transmitter and consequently supplies the modulation for the transmitter. The second secondary winding is center tapped, and supplies a balanced audio output of up to 50 watts across 600 ohms to the auxiliary connector J-1405. The third secondary winding on T-1404 supplies the signal for the limiter rectifier described in the next section.

A portion of the modulated high voltage output at J-1406 is rectified by V-1410 and serves in conjunction with M-1402 to indicate percentage of modulation.

2.23 Limiter

In order to provide a uniformly high output from the modulator, and consequently insure a constant and high level of modulation without the possibility of over modulation, a limiter is used. This limiter is essentially a self balancing bridge in a compressor circuit and, when properly adjusted, will permit only about a two db increase in output from the amplifier for a 20 db increase in input voltage.

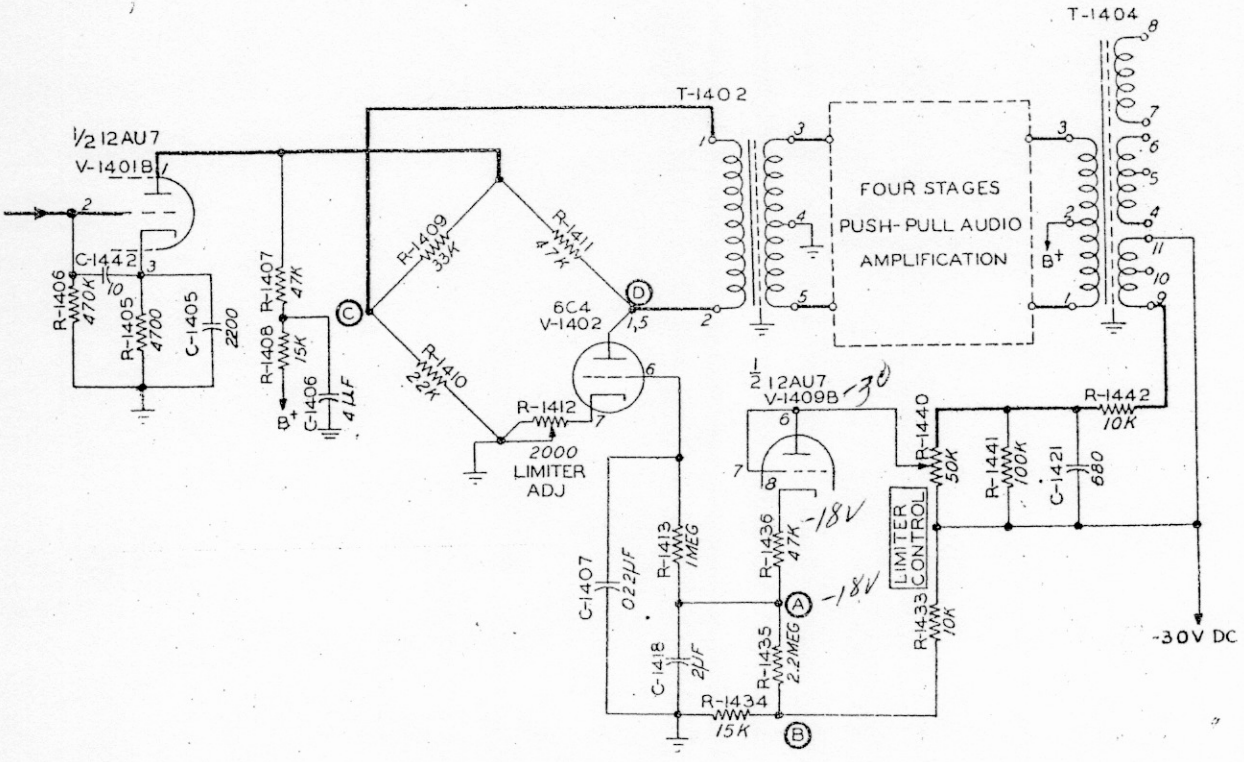


Figure 5-22. Modulator Limiter, Simplified Schematic

As may be seen in Figure 5-22, the output from the second half of V-1401 is impressed across the bridge in one direction, and the interstage transformer, T-1402, is connected to the output of the bridge. The leg of the bridge containing V-1402 is actually the variable impedance element. Below the threshold of compression, this tube is operating near cut-off because of the bias on the grid. This bias, or the voltage at point "A", is determined by two factors: the voltage at point "B" on the voltage divider across the negative 30 volt supply, and the amount of conduction through V-1409. The amount of conduction of V-1409 is a function of the difference between cathode and plate voltages. The voltage on the plate of this tube is a function of the magnitude of the signal appearing on T-1404. As the voltage on T-1404 increases, conduction in V-1409 will increase,

and consequently the amount of compression will increase. The voltage at point "B" is approximately negative 18 volts due to the values of R-1433 and R-1434. The voltage at point "A" will vary between this value when V-1409 is not conducting to a value of approximately negative six volts for full compression. (Since this is a high impedance circuit, this voltage cannot be readily measured. Any attempt to measure this voltage will distrub the operation of the limiter).

The threshold of compression may be adjusted by R-1440. C-1418 acts to filter the voltage at point "A" while C-1407 further filters the actual signal on the grid of V-1402. R-1412 is used to adjust the compression to the specified two db increase of output for 20 db increase in input voltage, and to compensate for tube variations in V-1402.

The voltage appearing across the primary winding of T-1402 is the voltage between points "C" and "D" in Figure 5-22. The voltage from point "C" to ground is approximately two-fifths of the output voltage of V-1401 because of the values of R-1409 and R-1410. The voltage from point "D" to ground is slightly less than the output voltage of V-1401. Hence, the voltage from C to D impressed on the primary of transformer T-1402 is approximately one-half of the output voltage of V-1401 when V-1409 is not conducting.

When R-1440 is adjusted for the threshold of compression, any increase in output will cause a positive voltage to be impressed on the negative grid voltage of V-1402 due to rectification of V-1409. This means less negative grid bias on V-1402, and in turn means a lowered internal resistance from plate to cathode of V-1402. Lowering the internal resistance of V-1402 reduces the voltage from point "D" to ground, which reduces the voltage impressed across the primary of T-1402, which tends to reduce the output voltage of the modulator. Circuit constants in the bridge, consisting of R-1409, R-1410, R-1411 and V-1402, and the rectifier consisting of V-1409 and filter elements, are such that a 20 db increase in input level will result in only a 2 db increase in output level when R-1440 is adjusted for the threshold of compression at the lower input level.

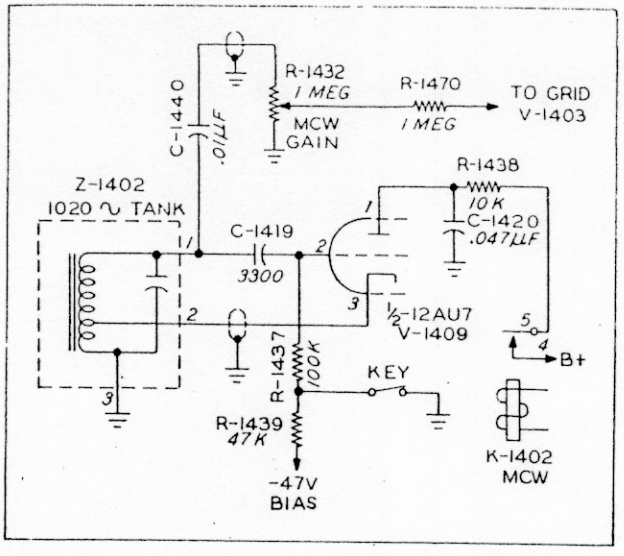


Figure 5-23. MCW Oscillator, Simplified Schematic

2.24 MCW Oscillator

Referring to Figure 5-23, the second half of V-1409 is used in a audio oscillator circuit to provide a 1020 cycle tone for MCW operation. Operation of the VOICE-MCW CARRIER ON switch, S-1404, to the MCW CARRIER ON position energizes K-1404 and the MCW relay K-1402. As the MCW relay is energized, voltage is applied to the plate of V-1409. This tube is employed in a 1020 cps oscillator. Closing the key removes the -47 volt bias from the tube permitting it to oscillate. The 1020 cps tank, Z-1402, is the frequency determining element, and output is taken from the potentiometer, R-1432, in the grid circuit. This output is coupled through R-1470 to the grid of V-1403, from where it is amplified and finally used to modulate the carrier.

3.0 FREQUENCY SELECTOR UNIT

The frequency selector unit in the T-217 transmitter is identical to and interchangeable with the frequency selector unit in the R-278 receiver. The frequency selector unit is explained in detail in CHAPTER FOUR, Section 3.0.

4.0 MECHANICAL DRIVE SYSTEM FOR TRANSMITTER TUNING

The mechanical drive system for transmitter tuning is shown in Figure 5-24. The frequency selector unit mechanically drives the tuning mechanism of the following units: Main Oscillator, Frequency Mulitplier-Amplifier, Exciter, Driver, Servo System and I-F Oscillator.

4.1 Frequency Selector Unit Mechanical Drive

The frequency selector unit mechanical drive system in the T-217 transmitter is identical to the frequency selector unit mechanical drive system in the R-278 receiver since they are a part of the frequency selector unit. For a description of this drive system refer to CHAPTER FOUR, Section 4.1.

4.2 Main Oscillator Unit Tuning

Referring to Figure 5-24, the main oscillator unit crystal-selector switch and coil-selector switch are driven from the 10 mc autopositioner shaft through a 3:1 gear reduction. Since the 10 mc autopositioner shaft makes six revolutions per tuning cycle, these selector switches make two complete revolutions per cycle. The first revolution provides 18 rotor positions for the selection of the proper crystal and coil for the selected frequency. The second revolution occurs at the time the tuners of the frequency mulitplier-amplifier unit are in the unused 180 degrees of their tuning cycle.

4.3 Frequency Multiplier-Amplifier Unit Tuning

The tuning shaft of the frequency multiplier-amplifier is driven by the 10 mc autopositioner shaft through two stages of gear reduction which provide a

speed reduction of 6:1. Thus, the tuners make 1 revolution per tuning cycle. The first 180 degrees of rotation provide the 18 operating positions of the tuners. The second 180 degrees of rotation return the tuners to the beginning point of their cycles. The gears employed in the reduction drive are of the split spring-loaded type to reduce possible inaccuracy due to backlash.

The tuners of the frequency multiplier are driven by the tuning shaft through a system of spur gears which, with the exception of the gears driving the toroidal step tuners, are also of the split spring-loaded type.

4.4 Exciter and Driver Tuning

The r-f tuners used in the exciter and driver units are tuned in 1 mc increments over the frequency range of 220.5 to 399.5 mc. To accomplish this, a mechanical differential is employed. The output from the 10 mc shaft is introduced to a planetary gear system. The output from the 1 mc shaft is also introduced to this gear system through a rocker arm driving a pinion gear. This rocker arm is raised or lowered by a cam on the 1 mc shaft. This cam has its periphery radius-stepped, so that the rocker arm always comes to rest on circle segments with increasing radius as the frequency decreases from the nine position through the zero position. The output from this planetary gear system is then a differential combination of the 1 mc and the 10 mc shafts.

4.5 Servo System Tuning

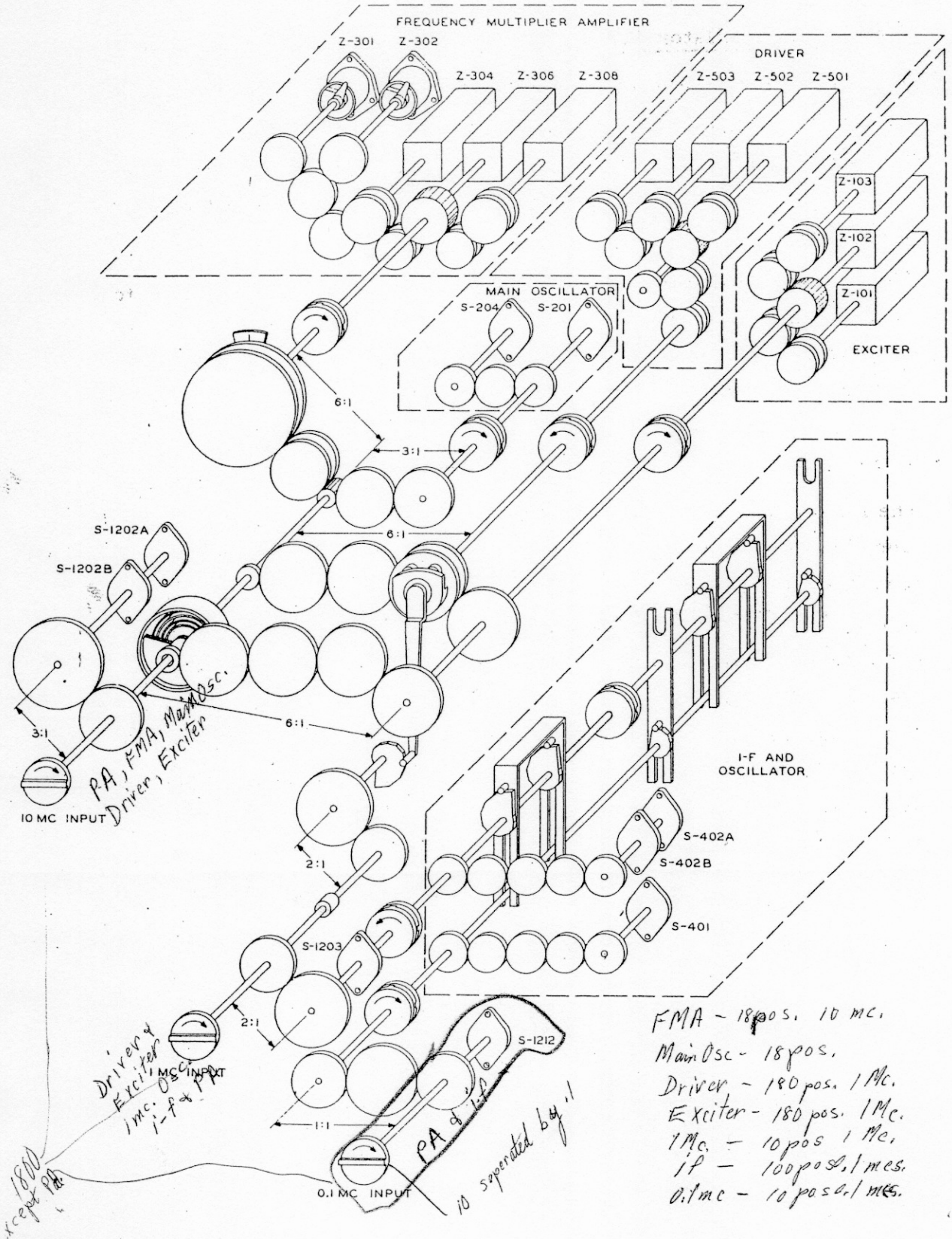
The three switches employed in the servo system are positioned by the 1 mc and the 10 mc shafts. S-1202A and S-1202B are simultaneously positioned by the output from the 10 mc shaft, and S-1203 is positioned by the 1 mc shaft. In equipments after serial No. 1000, S-1212 was added and it is positioned by the 0.1 mc shaft.

4.6 I-F Oscillator Tuning

The i-f oscillator unit receives two mechanical inputs on two parallel tuning shafts. The input from the 0.1 mc autopositioner is geared 1:1 through an idler gear and the input from the 1 mc autopositioner is geared 2:1 since the 1 mc autopositioner makes two revolutions for one tuning cycle.

The 0.1 mc input is used alone to operate S-401, the crystal selector switch in the low frequency oscillator. The 1 mc input is used alone to operate S-402A and S-402B, the crystal selector switches for the high frequency oscillator, and to operate the tuning core table associated with Z-401. This tuning core table is raised and lowered by a pair of cams which are actuated by the rotation of the 1 mc shaft.

The i-f transformers, T-401, T-402 and T-403, are permeability-tuned by a differential tuning core table which combines the inputs from the 1 mc and the 0.1 mc autopositioners to provide 100 tuning steps. The cams mounted on the floating 1 mc tuning shaft position the tuning core table in ten steps. The cams mounted on the 0.1 mc tuning shaft displace this 1 mc tuning shaft in 10 steps to provide a vernier adjustment of the tuning core table position. The Oldham-type sliding coupler permits the floating 1 mc tuning shaft to be thus displaced.



138/5
5/58

Figure 5-24. Tuning System, Mechanical Diagram

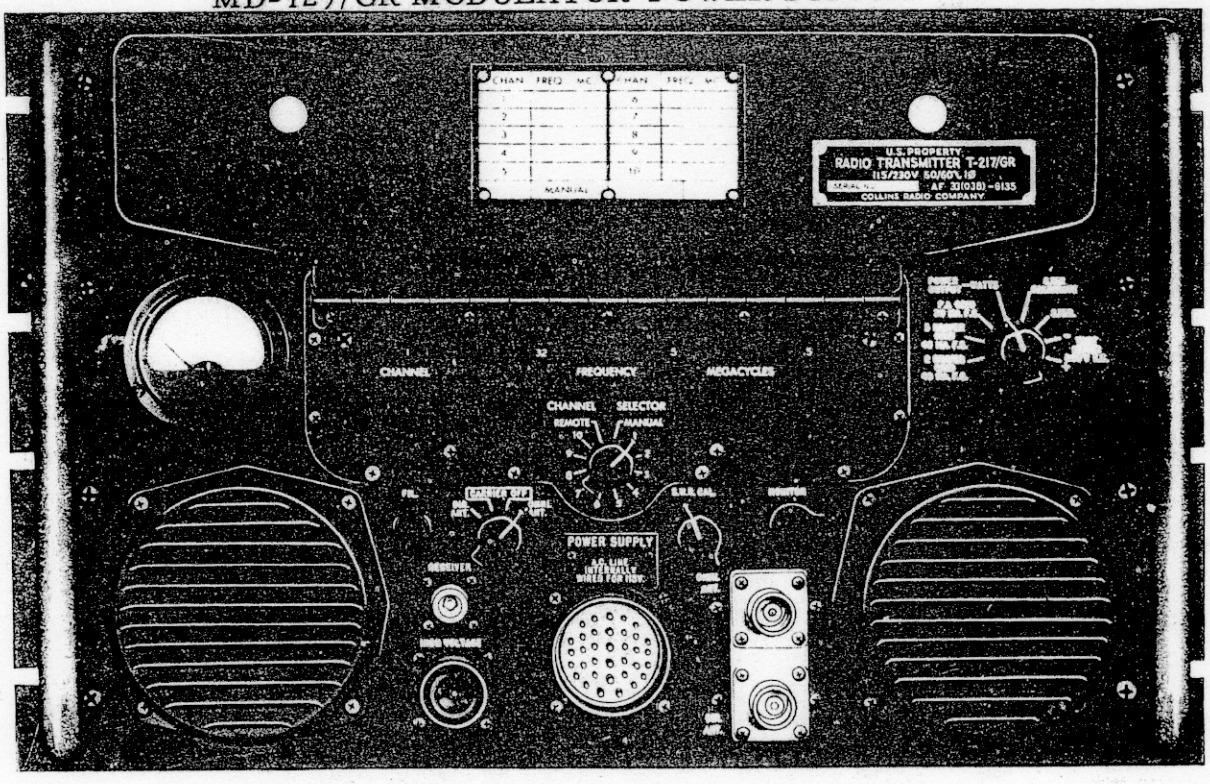


Figure 5-25. Radio Transmitter T-217/GR, Front Panel.

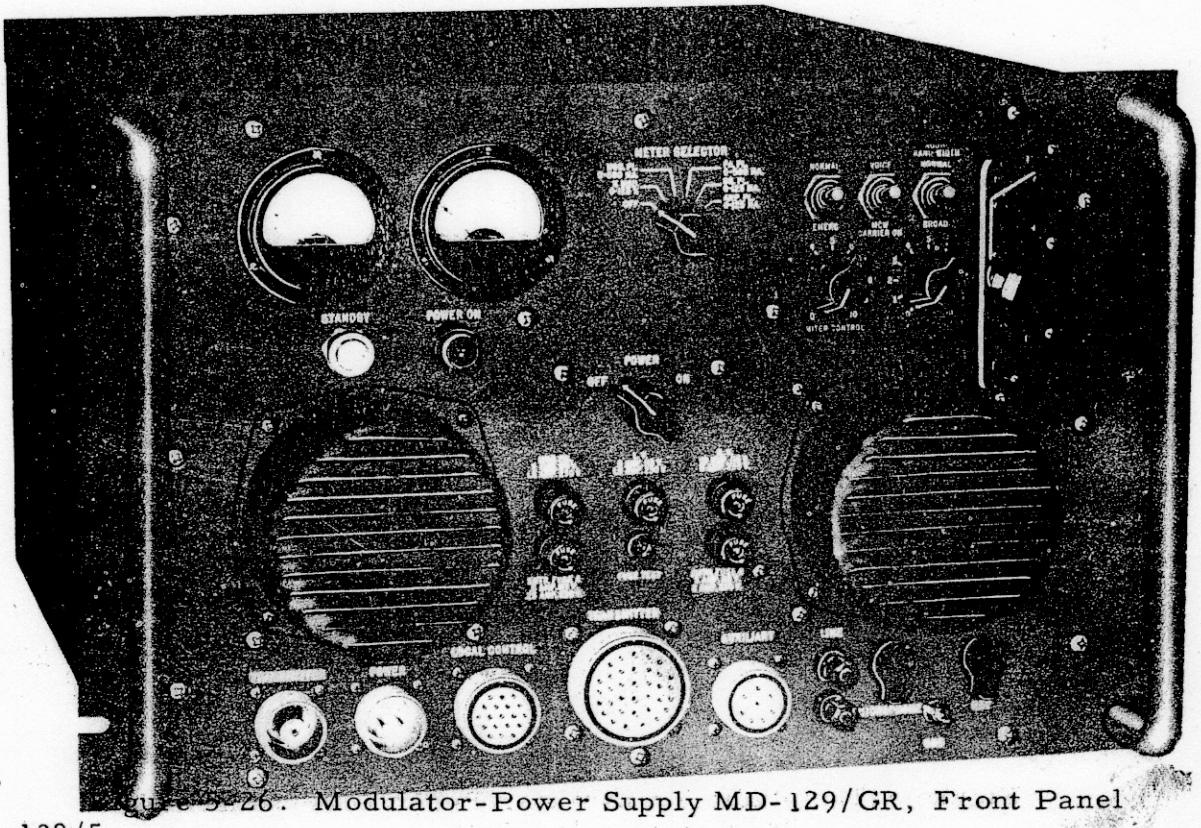


Figure 5-26. Modulator-Power Supply MD-129/GR, Front Panel

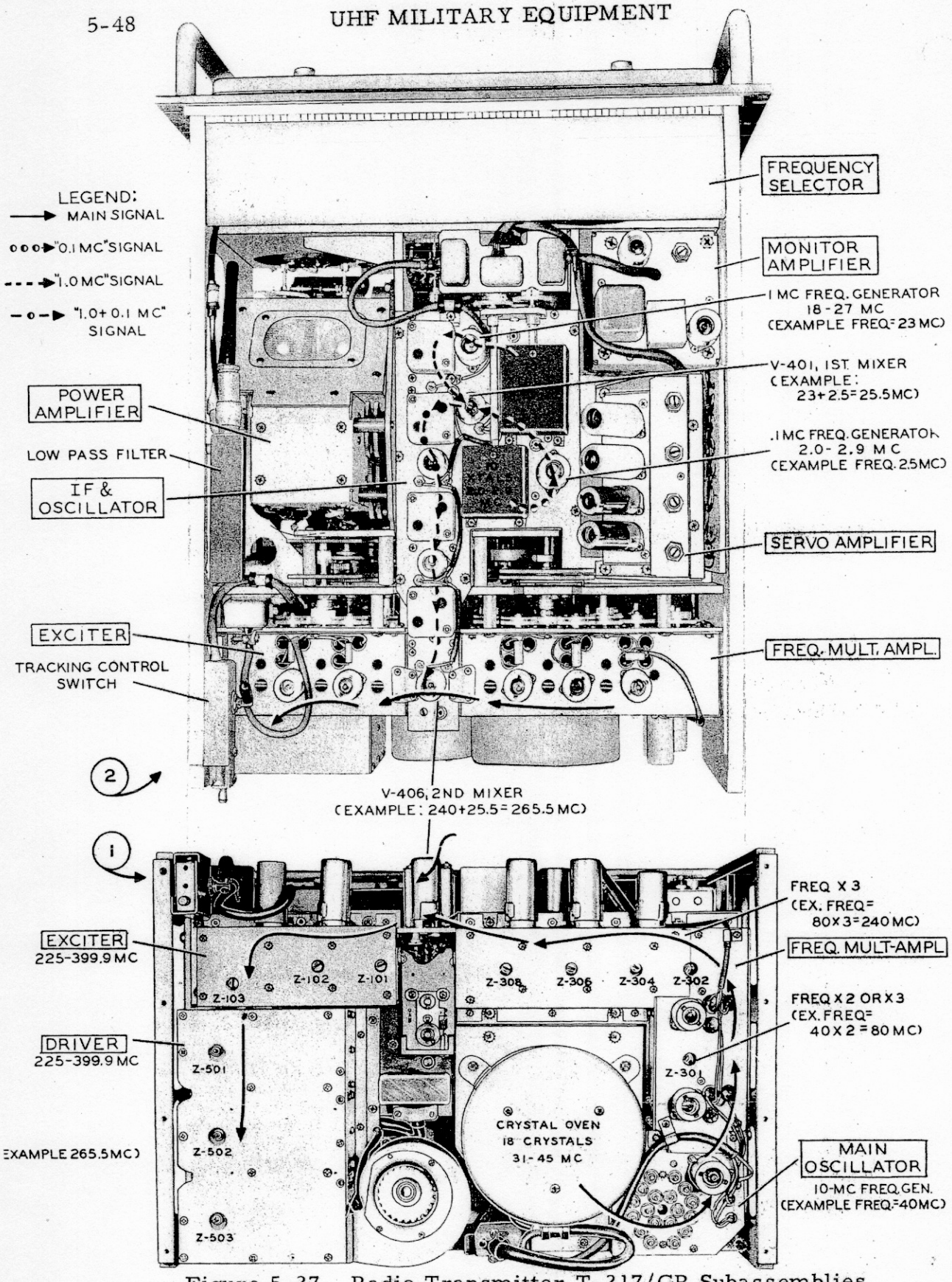


Figure 5-27. Radio Transmitter T-217/GR Subassemblies With Signal Flow Paths.

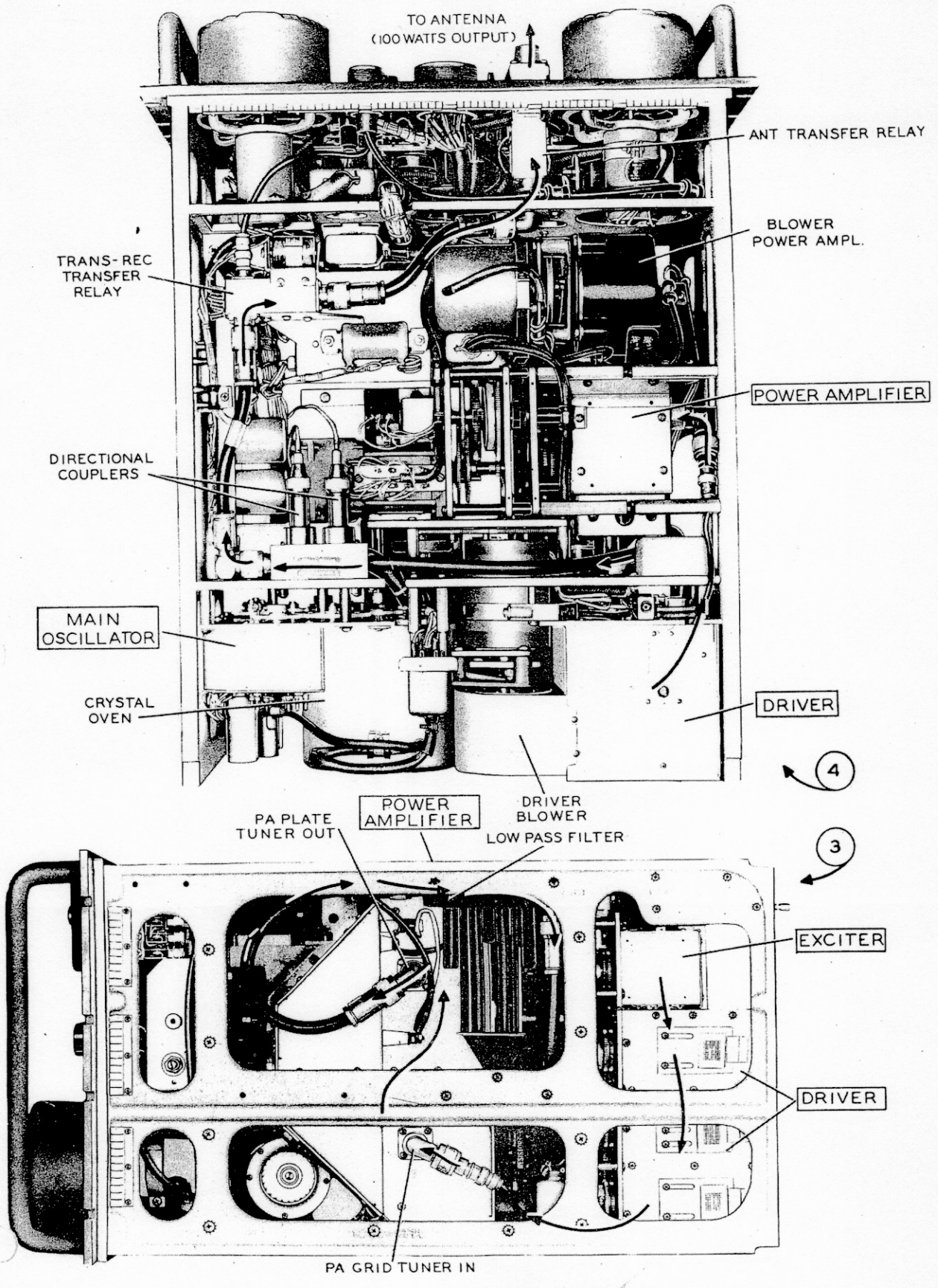
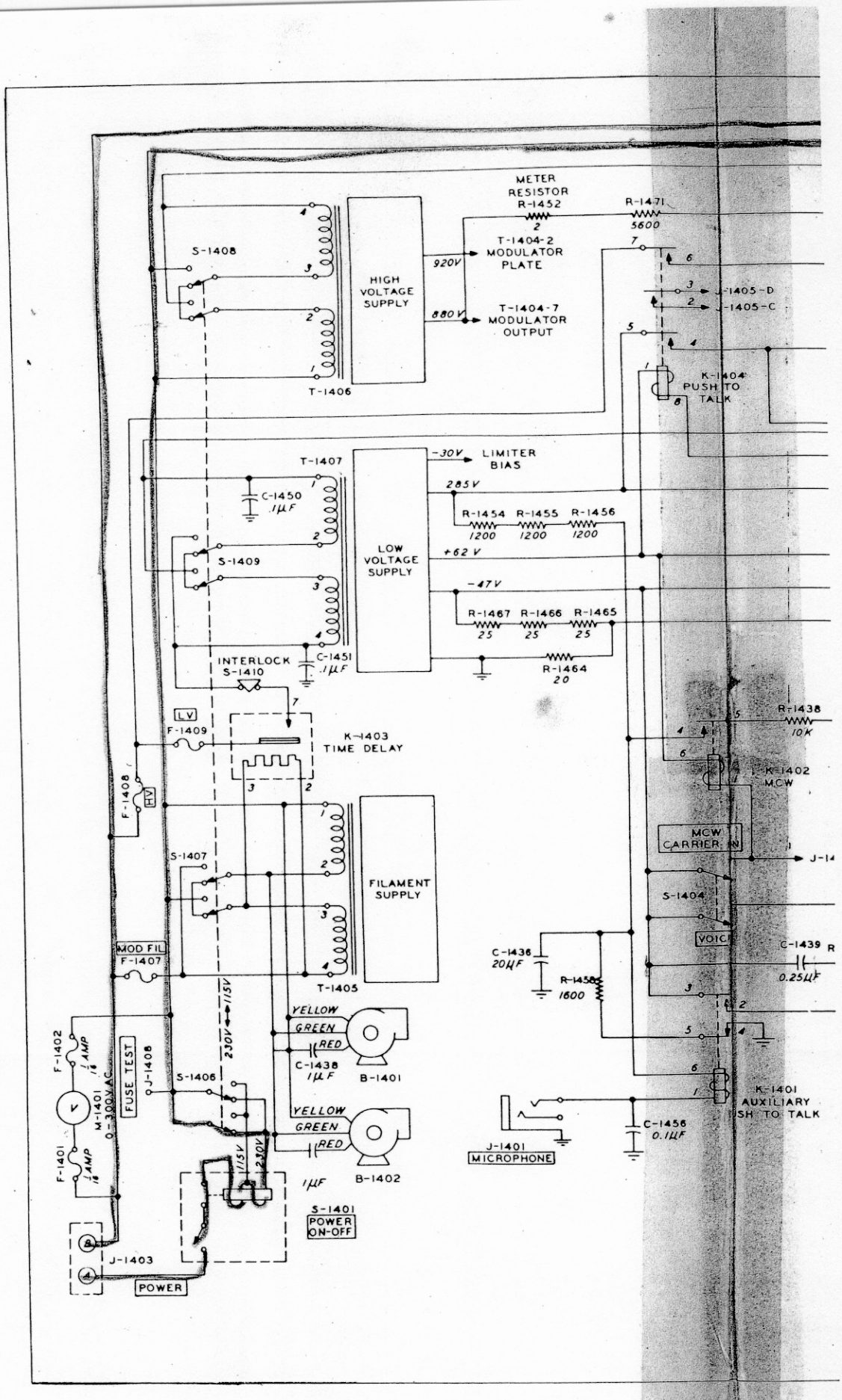
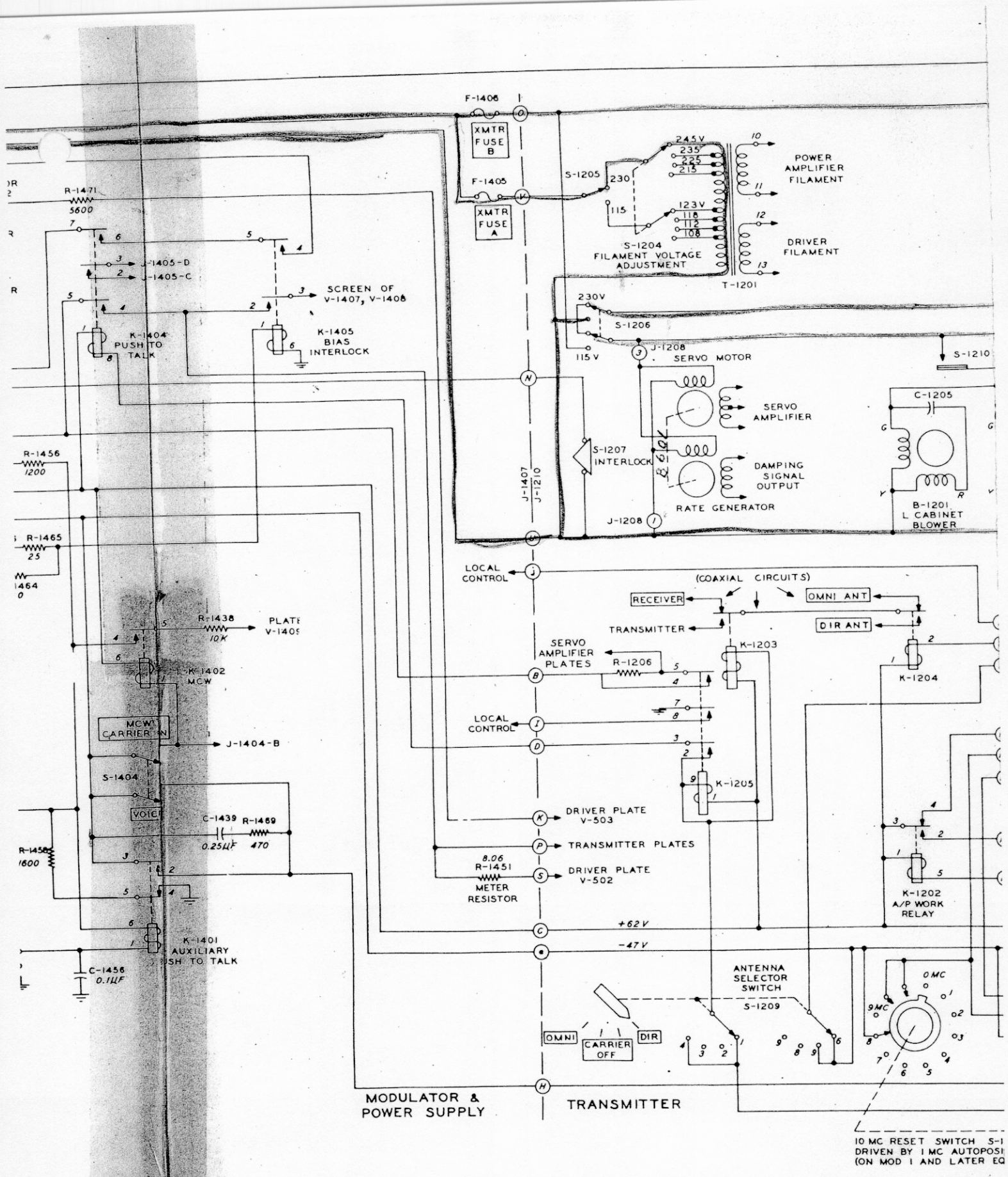


Figure 5-28. Radio Transmitter T-217/GR Subassemblies With Signal Flow Paths.


METER RESISTOR R-1452
R-1471 5600
S-1408
T-1406
HIGH VOLTAGE SUPPLY
920V
880V
T-1404-2 MODULATOR PLATE
T-1404-7 MODULATOR OUTPUT
J-1405-D
J-1405-C
K-1404 PUSH TO TALK
T-1407
C-1450 .1μF
S-1409
LOW VOLTAGE SUPPLY
-30V LIMITER BIAS
285V
R-1454 1200
R-1455 1200
R-1456 1200
+62 V
-47V
R-1467 25
R-1466 25
R-1465 25
R-1464 20
INTERLOCK S-1410
C-1451 .1μF
LV
F-1409
K-1403 TIME DELAY
F-1408
HV
S-1407
FILAMENT SUPPLY
MOD FIL F-1407
T-1405
R-1438 10K
K-1402 MCW
MCW CARRIER ON
J-14
S-1404
VOICE
C-1436 20μF
R-1458 1600
C-1439 0.25μF
R
YELLOW
GREEN
RED
C-1438 1μF
B-1401
B-1402
F-1402 1/4 AMP
F-1401 1/4 AMP
M-1401 300V AC
FUSE TEST
J-1408
S-1406
230V
115V
1μF
S-1401 POWER ON-OFF
J-1403
POWER
K-1401 AUXILIARY PUSH TO TALK
C-1456 0.1μF
J-1401 MICROPHONE


F-1406
XMTR FUSE B
F-1405
XMTR FUSE A
S-1205
245 V
235
225
215
230
115
123 V
118
112
108
S-1204 FILAMENT VOLTAGE ADJUSTMENT
T-1201
POWER AMPLIFIER FILAMENT
DRIVER FILAMENT
230 V
S-1206
115 V
J-1208
SERVO MOTOR
S-1210
SERVO AMPLIFIER
S-1207 INTERLOCK
DAMPING SIGNAL OUTPUT
RATE GENERATOR
J-1208
C-1205
B-1201 L CABINET BLOWER
R-1471 5600
J-1405-D
J-1405-C
SCREEN OF V-1407, V-1408
K-1404 PUSH TO TALK
K-1405 BIAS INTERLOCK
J-1407
J-1210
R-1456 1200
R-1465 25
R-1464 0
LOCAL CONTROL
(COAXIAL CIRCUITS)
RECEIVER
OMNI ANT
TRANSMITTER
DIR ANT
SERVO AMPLIFIER PLATES
R-1206
K-1203
K-1204
R-1438 10K
PLATE V-1405
K-1402 MCW
MCW CARRIER ON
J-1404-B
S-1404
VOICE
C-1439 0.25μF
R-1469 470
R-1458 1600
K-1205
DRIVER PLATE V-503
TRANSMITTER PLATES
8.06 R-1451 METER RESISTOR
DRIVER PLATE V-502
K-1202 A/P WORK RELAY
+62 V
-47 V
K-1401 AUXILIARY PUSH TO TALK
C-1456 0.1μF
ANTENNA SELECTOR SWITCH
S-1209
OMNI
CARRIER OFF
DIR
0 MC
9 MC
MODULATOR & POWER SUPPLY
TRANSMITTER
10 MC RESET SWITCH S-1
DRIVEN BY 1 MC AUTOPOSI
(ON MOD I AND LATER EQ

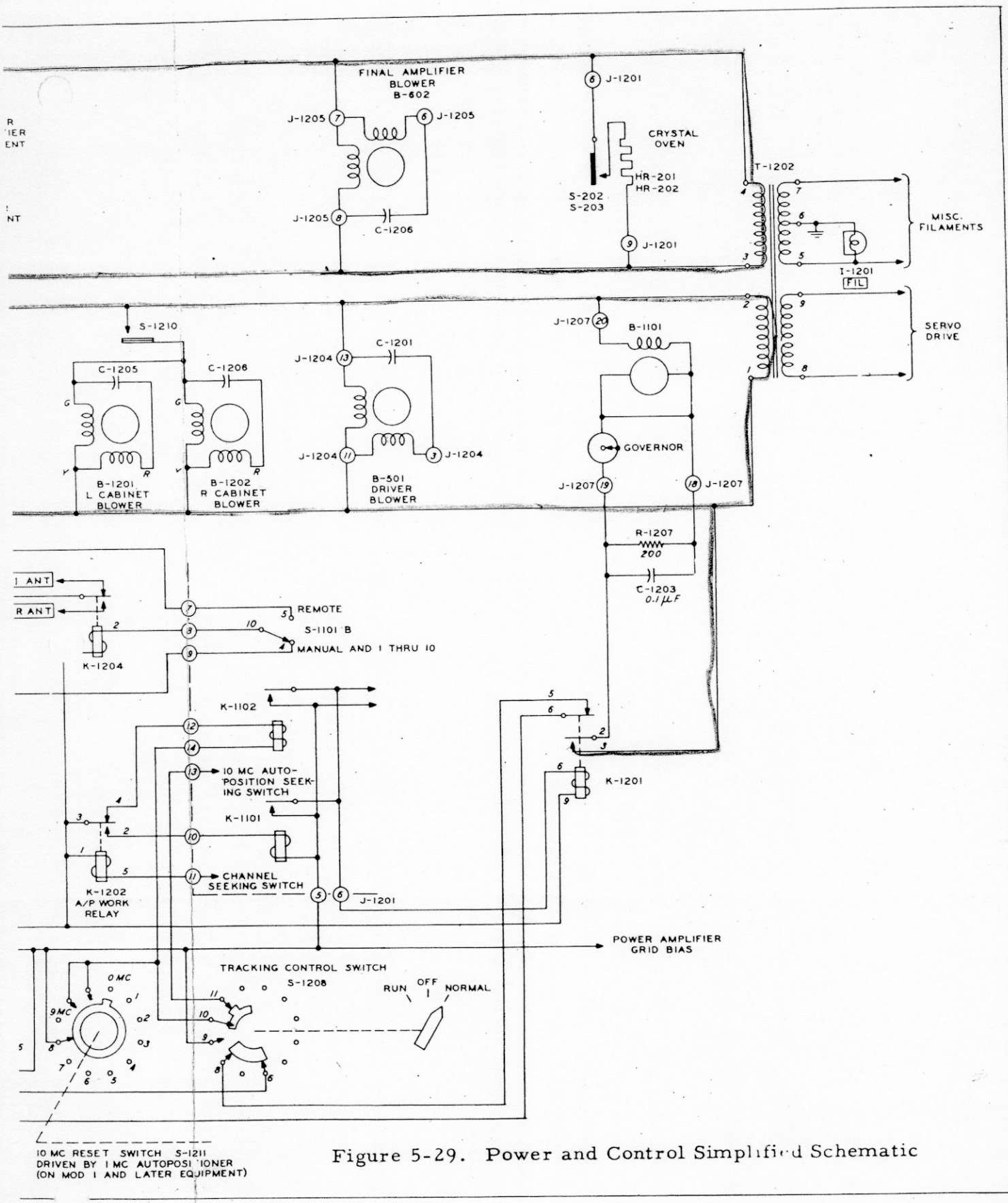
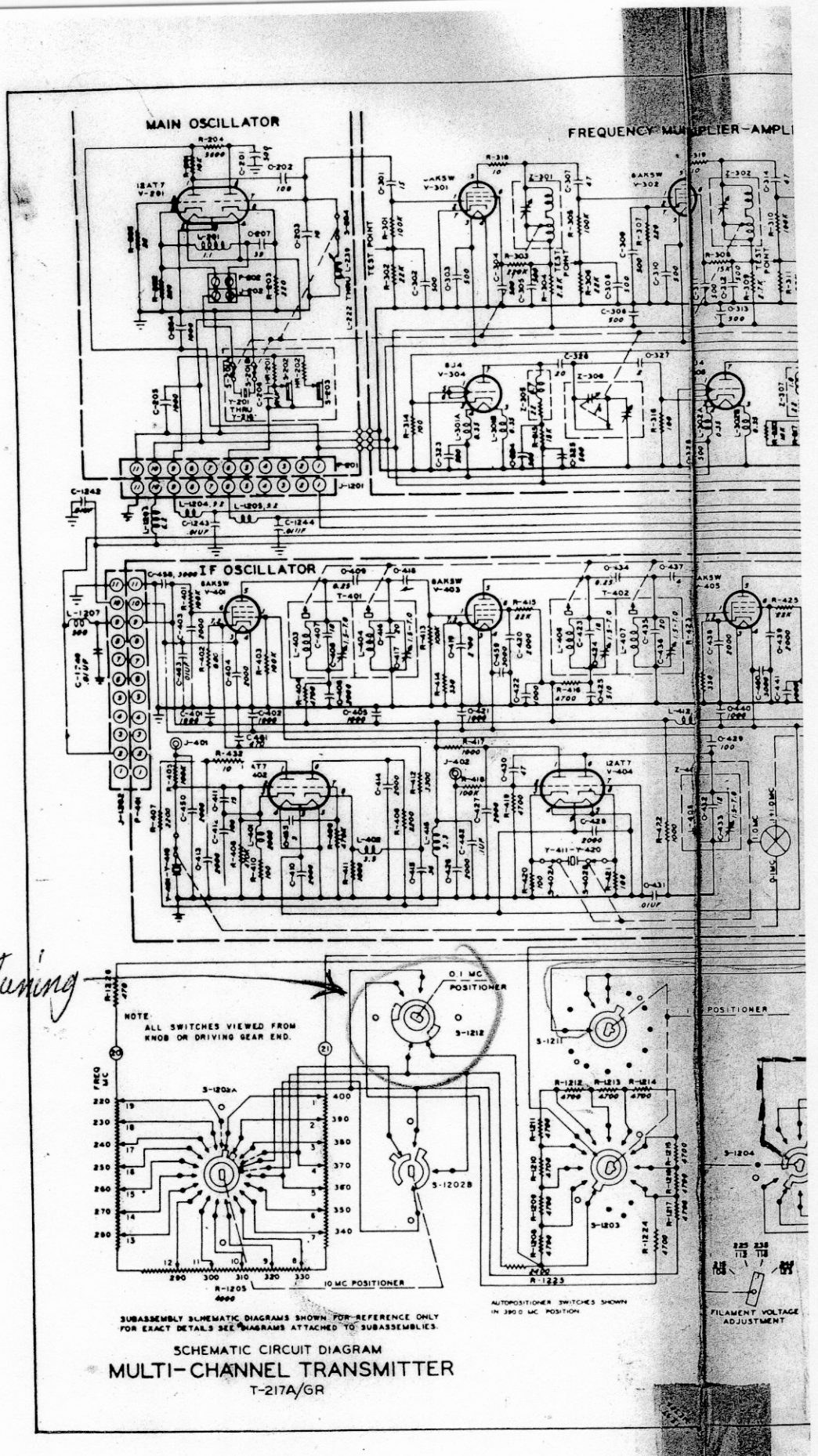


Figure 5-29. Power and Control Simplified Schematic

1mc Osc. 18.006+X

1mc Osc. 1.994+.X

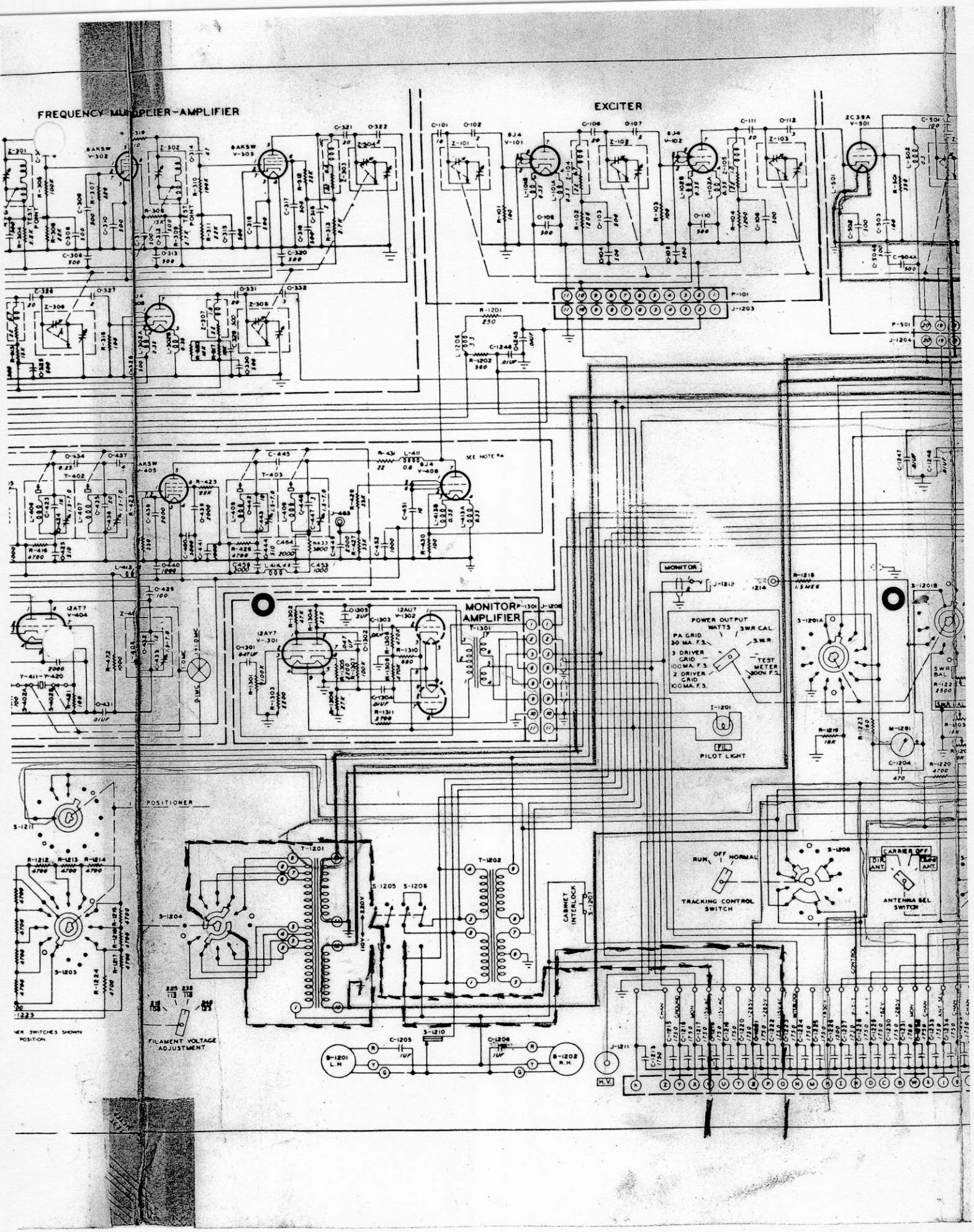
if = 20+X.X



SCHEMATIC CIRCUIT DIAGRAM

MULTI-CHANNEL TRANSMITTER

T-217A/GR


FREQUENCY MULTIPLIER-AMPLIFIER
EXCITER
MONITOR AMPLIFIER
POWER OUTPUT WATTS
SWR CAL.
PA GRID 30 MA. F.S.
3 DRIVER GRID 100 MA. F.S.
2 DRIVER GRID 100 MA. F.S.
TEST METER 300V F.S.
PILOT LIGHT
TRACKING CONTROL SWITCH
ANTENNA SEL SWITCH
CABINET INTERLOCK
FILAMENT VOLTAGE ADJUSTMENT
POSITIONER

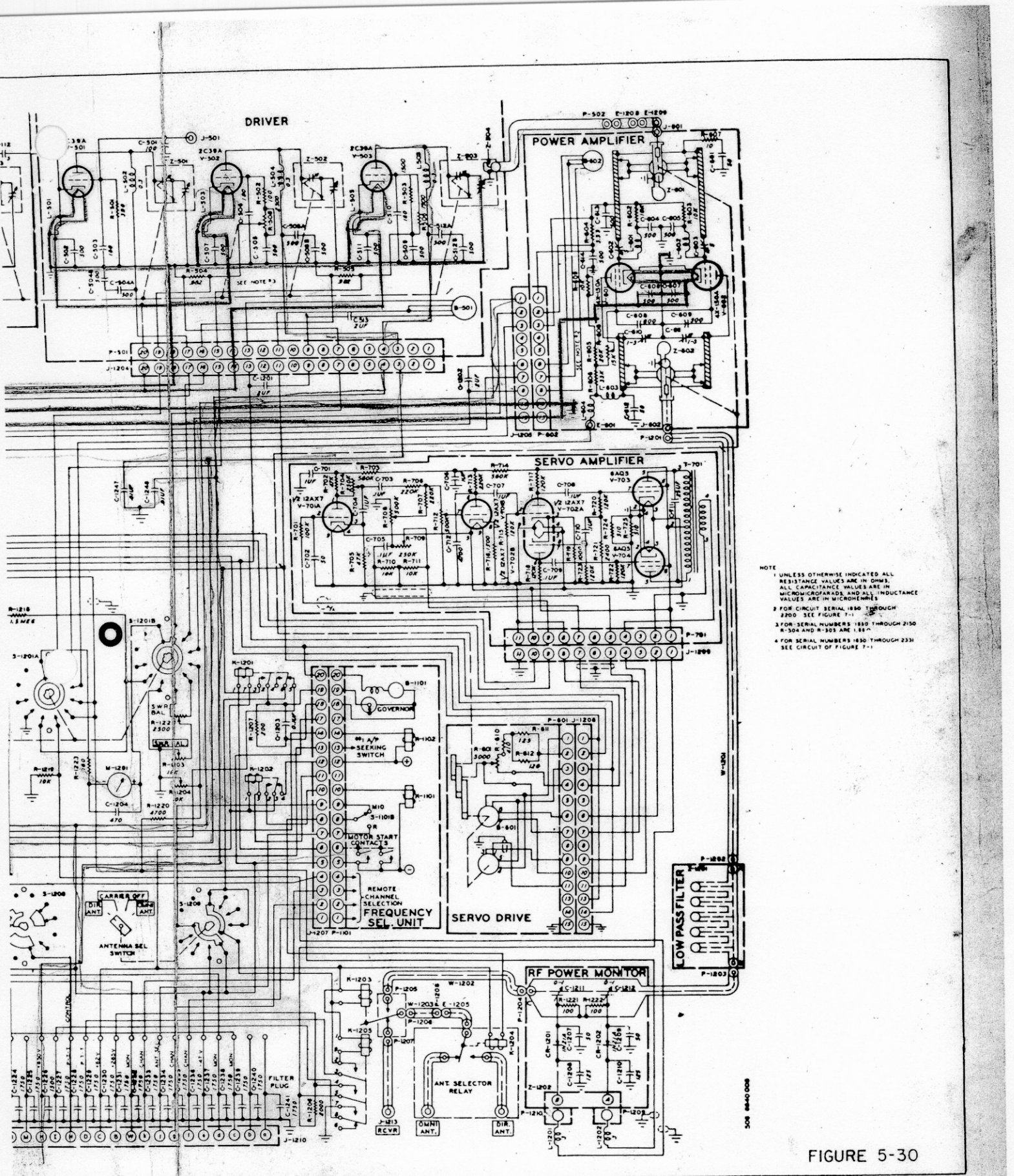
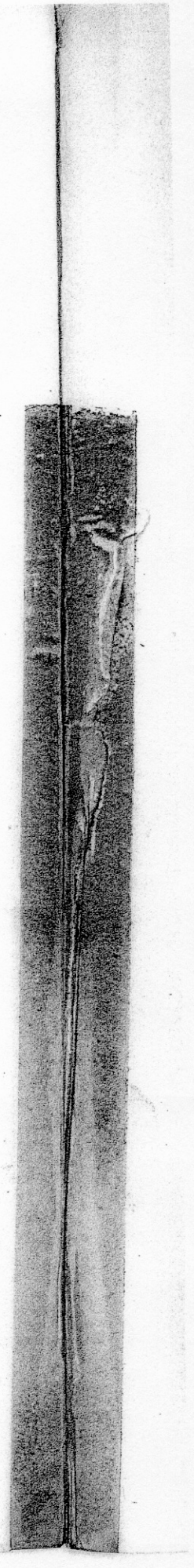
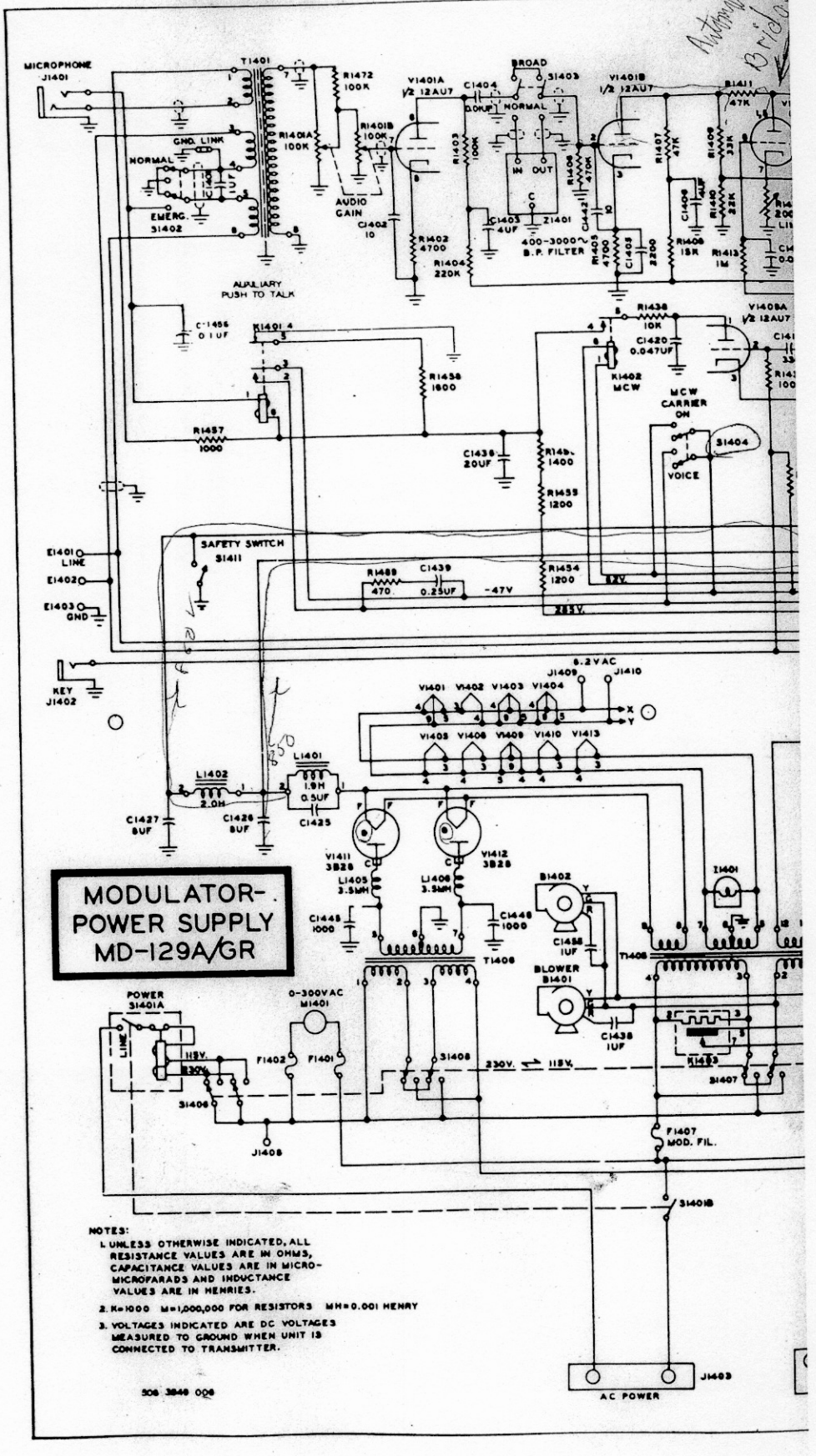

DRIVER
POWER AMPLIFIER
SERVO AMPLIFIER
SERVO DRIVE
FREQUENCY SEL UNIT
REMOTE CHANNEL SELECTION
ANTENNA SEL SWITCH
CARRIER OFF
DIR. ANT.
OWN ANT.
ANT. SELECTOR RELAY
RF POWER MONITOR
LOW PASS FILTER
FILTER PLUG
GOVERNOR
SEEKING SWITCH
MOTOR START CONTACTS
SWR BAL
RCVR
NOTE
1 UNLESS OTHERWISE INDICATED ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2 FOR CIRCUIT SERIAL 1850 THROUGH 2200 SEE FIGURE 7-1
3 FOR SERIAL NUMBERS 1850 THROUGH 2150 R-504 AND R-505 ARE 1.8Ω
4 FOR SERIAL NUMBERS 1630 THROUGH 2331 SEE CIRCUIT OF FIGURE 7-1

FIGURE 5-30




MODULATOR-
POWER SUPPLY
MD-129A/GR
MICROPHONE J1401
T1401
R1472 100K
R1401A 100K
R1401B 100K
AUDIO GAIN
GND. LINK
NORMAL
EMERG. S1402
AUXILIARY PUSH TO TALK
V1401A 1/2 12AU7
C1404 .04UF
BROAD
S1403
NORMAL
V1401B 1/2 12AU7
R1411 47K
R1403 100K
R1402 4700
R1404 220K
C1403 4UF
Z1401
400-3000~ B.P. FILTER
R1407 47K
R1409 33K
R1410 22K
R1408 18K
R1413 1M
C1405 2200
C1406 .04UF
C1402 10
C1455 0.1UF
R1401 4
R1438 10K
C1420 0.047UF
V1408A 1/2 12AU7
K1402 MCW
MCW CARRIER ON
S1404
VOICE
R1436 1800
R1437 1000
C1436 20UF
R1454 1400
R1453 1200
SAFETY SWITCH S1411
E1401 LINE
E1402
E1403 GND
R1489 470
C1439 0.25UF
-47V
-125V.
KEY J1402
6.3 VAC
J1409
J1410
V1401 V1402 V1403 V1404
V1405 V1406 V1409 V1410 V1413
L1401 1.9H
L1402 2.0H
0.5UF
C1425
C1427 8UF
C1426 8UF
V1411 3B28
V1412 3B28
L1405 3.5MH
L1406 3.5MH
C1445 1000
C1446 1000
T1406
B1402
C1455 1UF
BLOWER B1401
C1438 1UF
Z1401
POWER S1401A
LINE
115V.
230V.
0-300VAC M1401
F1402
F1401
S1408
J1408
230V. ⇌ 115V.
S1407
F1407 MOD. FIL.
S1401B
J1403
AC POWER
NOTES:
1. UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICRO-MICROFARADS AND INDUCTANCE VALUES ARE IN HENRIES.
2. K=1000 M=1,000,000 FOR RESISTORS MH=0.001 HENRY
3. VOLTAGES INDICATED ARE DC VOLTAGES MEASURED TO GROUND WHEN UNIT IS CONNECTED TO TRANSMITTER.
508 3848 008

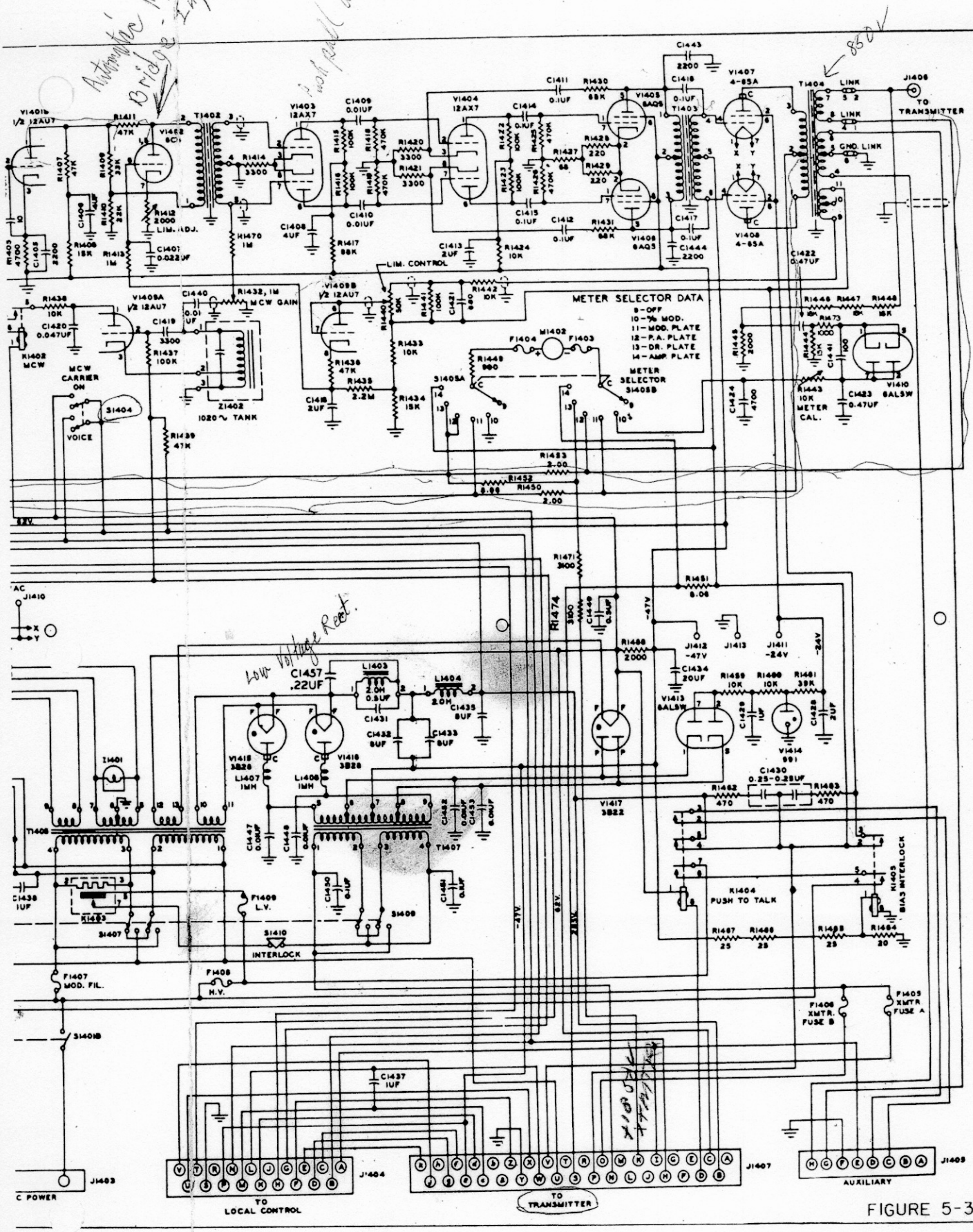

METER SELECTOR DATA
8 - OFF
10 - % MOD.
11 - MOD. PLATE
12 - P.A. PLATE
13 - DR. PLATE
14 - AMP. PLATE
METER SELECTOR S1405B
S1405A
MCW CARRIER ON
S1404
VOICE
MCW
MCW GAIN
1020 ~ TANK
LIM. CONTROL
LIM. ADJ.
PUSH TO TALK
INTERLOCK
S1410
F1407 MOD. FIL.
F1408 H.V.
F1409 L.V.
F1405 XMTR FUSE A
F1406 XMTR. FUSE B
TO TRANSMITTER
TO LOCAL CONTROL
AUXILIARY
C POWER
LOW VOLTAGE REG.
-47V
-24V
6.3V
215V

FIGURE 5-31