

UHF MILITARY EQUIPMENT
CHAPTER THREE
T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

1.0 GENERAL

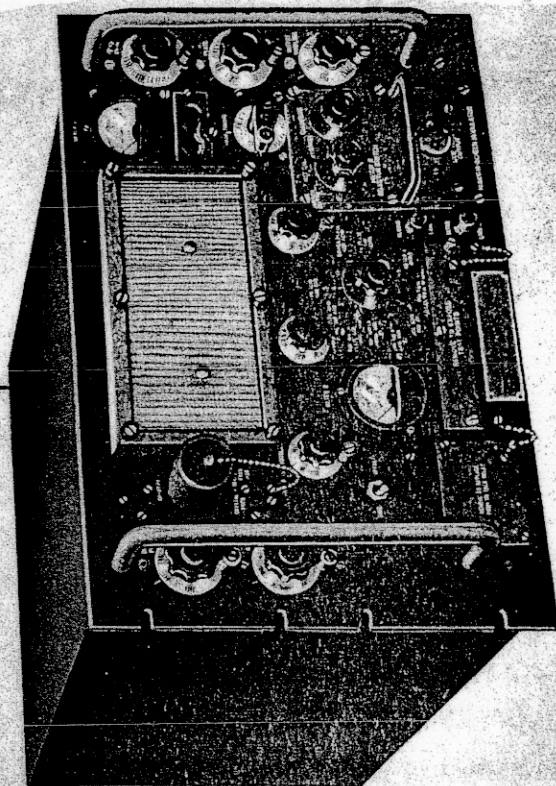
1.1 T-282/GR Transmitter

The T-282/GR Transmitter (Figure 3-1) is a single channel crystal-controlled transmitter capable of supplying 100 watts into a 52 ohm load. The transmitter circuitry consists of a crystal-controlled oscillator-tripler, 1st doubler, 2nd doubler, buffer amplifier, driver-tripler amplifier, and power amplifier. An antenna change-over relay, receiver muting, push-to-talk voice operation, and monitoring facilities are also provided. The frequency range of the transmitter is ²²⁰225.0 mc to ⁴⁰⁰399.9 mc. The transmitter can be tuned to any frequency in this band by using the proper crystal and tuning the r-f circuits. The output coupling circuit is unbalanced, one side being grounded, and it is designed to work into a 52 ohm transmission line of the coaxial type. The power output and percentage modulation of the transmitter may be checked on a calibrated meter on the transmitter. Side tone output permits the operator to aurally monitor the audio component of the transmitted signal.

The over-all frequency stability for the entire frequency range is + 10 kc. The equipment will be ready for operation five minutes after it is turned on and should be within 10 kc of the required frequency after twenty minutes. The transmitter may be operated continuously at temperatures ranging from -29°C (-20°F) to $+55^{\circ}\text{C}$ ($+131^{\circ}\text{F}$).

All tubes used in the transmitter are listed in Table 3-2 and all fuses are listed in Table 3-4. The various panel controls and adjustment points of the transmitter are shown in Table 3-6 and Figure 3-2.

RADIO TRANSMITTER T-282/GR



MODULATOR-POWER SUPPLY MD-141/GR

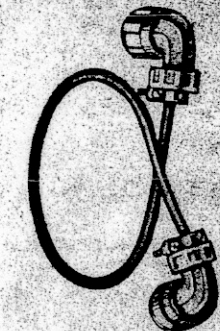
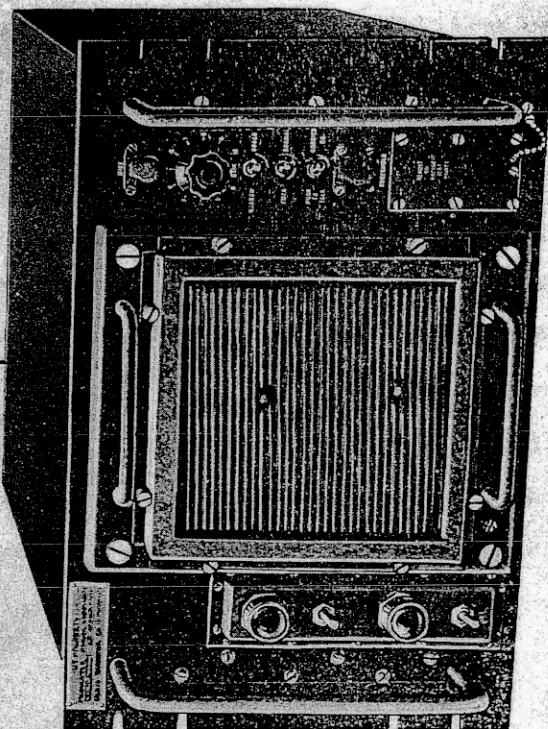
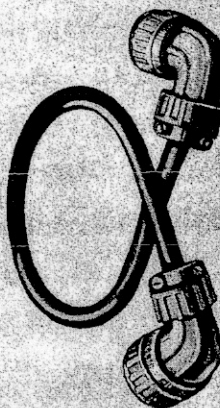
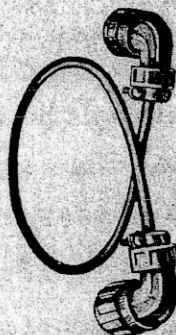
RF CABLE ASSEMBLY
CG-693/UCABLE ASSEMBLY, POWER, ELECTRICAL
CX-2017/URF CABLE ASSEMBLY
CG-693/U

Figure 3-1. Radio Transmitter T-282/GR, Modulator-Power Supply MD-141/GR, and Interconnecting Cables.

1.2 MD-141/GR Modulator-Power Supply

All references to Modulator-Power Supply MD-141/GR (Figure 3-1) are also applicable to Modulator-Power Supply MD-141A/GR, with the exception of the duty cycle (determined by transformer T202). Modulator-Power Supply MD-141A/GR may be operated continuously at temperatures ranging from -29°C (-20°F) to $+55^{\circ}\text{C}$ ($+131^{\circ}\text{F}$). Modulator-Power Supply MD-141/GR must be operated intermittently (ratio of "carrier on" to "carrier off" of one minute to five minutes) at temperatures exceeding $+30^{\circ}\text{C}$ ($+86^{\circ}\text{F}$).

The MD-141/GR Modulator-Power Supply consists of a modulator and power supply in one integral unit. The modulator has provisions for a 50 ohm or 600 ohm input impedance. The 50 ohm input impedance is for local operation using a T-17 or similiar type carbon microphone; the 600 ohm input impedance is used for remote operation over a 600 ohm line. Audio amplifiers are used to amplify the incoming signal to the desired level for modulating the power amplifier in the transmitter. Automatic modulation limiting maintains the average modulation at a high level. An audio signal input of -45 dbm is sufficient to permit 95 percent modulation. The audio frequency response of the equipment, for broad band transmission, does not vary more than 4 db between 200 and 20,000 cps. When using narrow band transmission, the response is down less than 5 db at 400 cps and 3,000 cps, with 1,000 cps as reference level, and down a minimum of 10 db at 200 cps and 5,000 cps. The audio distortion does not exceed 10 percent when: the rf carrier is modulated 95 percent; the audio signals are between 200 and 20,000 cps; the audio input level is -45 dbm ; and the automatic modulation limiting circuit is in operation.

The power supply provides high and low dc voltages as well as bias voltages for the modulator and transmitter. The power supply also supplies filament voltages for the modulator and ac voltage to the transmitter for the filament transformers and blower in the transmitter.

This equipment will operate on either of the following ac sources: 105 to 125 volts, single phase, 50 to 60 cps; or, 210 to 250 volts, single phase, 50 to 60 cps. Table 3-1 is a summary of the power input requirements, with the "BUCK-BOOST" switch, on the rear of the modulator-power supply, turned to the "BOOST" position.

All tubes used in the modulator-power supply are listed in Table 3-3 and all fuses are listed in Table 3-5. The various panel controls and adjustment points of the modulator-power supply are shown in Table 3-7 and Figures 3-3 and 3-4.

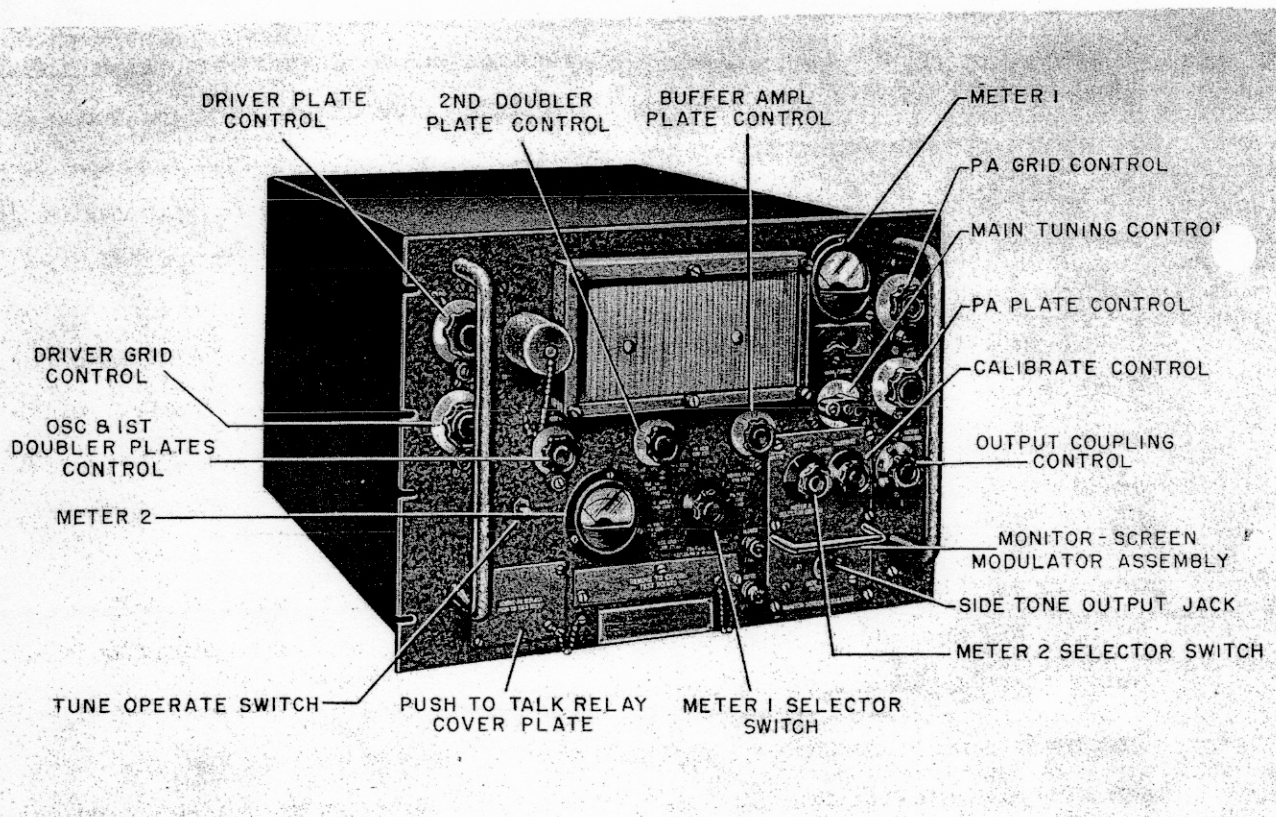


Figure 3-2. Radio Transmitter T-282/GR, Front Panel

T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

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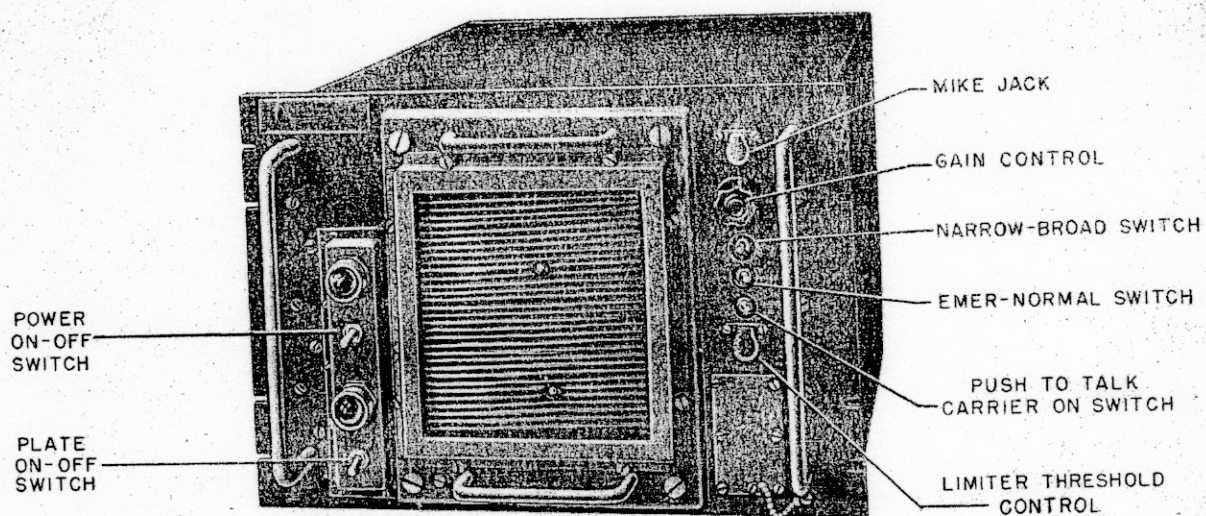


Figure 3-3. Modulator-Power Supply MD-141/GR, Front Panel

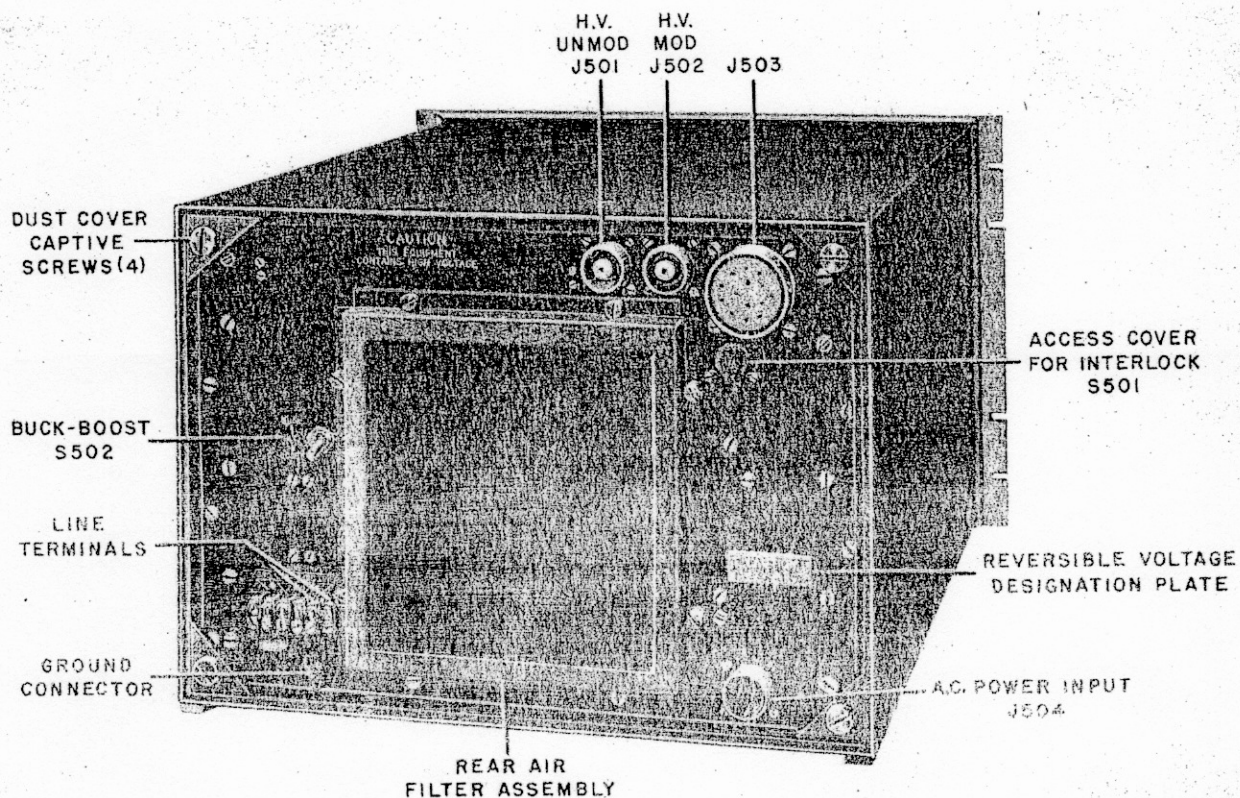


Figure 3-4. Modulator-Power Supply MD-141/GR, Rear View

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Voltage Supply	120 W, 95 Percent Modulated Carrier			Carrier Off		
	Amperes	Watts	Power Factor	Amperes	Watts	Power Factor
115	12.5	1250	0.87	3.4	380	0.97
230	6.25	1250	0.87	1.7	380	0.97

Table 3-1. Power Input Requirements

Quantity	JAN Type Number	Reference Symbol	Function
1	6AH6	V601	Oscillator-tripler
1	5763	V602	First doubler
1	5763	V603	Second doubler
1	5763	V706	Screen modulator
1	832A	V604	Buffer amplifier
1	4X150A	V901	Tripler-driver
1	4X150A	V902	Power amplifier
2		V903	Power amplifier
1	12AT7	V701A	Side-tone amplifier
		V701B	Modulation monitor amplifier
1	12AX7	V702A	Modulation monitor amplifier
		V702B	Modulation monitor rectifier
3	OB2	V703	Voltage regulator
		V704	Voltage regulator
		V705	Voltage regulator

Table 3-2. Tube Complement of Radio Transmitter T-282/GR

T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

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Quantity	JAN Type Number	Reference Symbol	Function
1	6C4	V301	Narrow band amplifier
1	12AX7	V302	Phase inverter
2	6BA6	V303	Audio frequency amplifier
		V304	Audio frequency amplifier
2	6AQ5	V305	Modulator driver
		V306	Modulator driver
2	811-A	V201	Modulator
	or	V202	Modulator
	811		
1	6AL5W	V203	Automatic modulator limiter
1	5R4WGY	V105	Bias voltage rectifier
2	3B28	V101	High voltage rectifier
		V102	High voltage rectifier
2	3B28	V103	Low voltage rectifier
		V104	Low voltage rectifier

Table 3-3. Tube Complement of modulator-Power Supply MD-141/GR

Quantity	Bussman Type	Rating	Reference Symbol	Function
1	MJB	1/100 amp, 250 V	F801	"METER 1" protection
1	MDL	Slow-Blow, 1 amp, 250 V	F803	B801 blower motor protection
2	MJW	1/16 amp, 250 V	F901 F902	V901 screen protection V902, V903 screen protection

Table 3-4. Fuse Complement of Radio Transmitter T-282/GR

Quantity	Bussman Type	Rating	Reference Symbol	Function
2	MDL	Slow-Blow, 1 amp, 250 V	F101 F103	B401 blower motor protection Low voltage power supply protection
2	MTH	8 amp, 250 V	F102 F201	High voltage power supply protection 230 V supply line
1	AGC	3 amp, 250 V	F104	Filament and bias supply protection
1	ABC	15 amp, 250 V	F202	115 V supply line

Table 3-5. Fuse Complement of Modulator-Power Supply MD-141/GR

Name	Function
METER 1 SELECTOR SWITCH	Selects circuit to be metered
METER 2 SELECTOR SWITCH	Selects power output or percentage modulation indication
METER 1	Indicates plate and grid currents
METER 2	Indicates power output or percent modulation
CALIBRATE	Control to calibrate "METER 2" before reading percent modulation
SIDE TONE OUTPUT	Jack to connect headset plug for monitoring transmission
TUNE-OPERATE	Switch to reduce power output
MAIN TUNING	Tuning control
DRIVER PLATE	Tuning control
DRIVER GRID	Tuning control
OSC & 1st DOUBLER PLATES	Tuning control
2nd DOUBLER PLATE	Tuning control
BUFFER AMPL PLATE	Tuning control
PA GRID	Tuning control
PA PLATE	Tuning control
OUTPUT COUPLING	Tuning control

Name	Function
POWER ON-OFF	Turns power on and off
PLATE ON-OFF	Turns plate voltage on and off
MIKE	Jack to insert microphone plug
GAIN	Controls audio gain
NARROW-BROAD	Switches narrow band amplifier in or out
EMER-NORMAL	Switches connections on line input transformer
PUSH TO TALK-CARRIER ON	Switch to keep carrier on or to permit control with microphone switch
LIMITER THRESHOLD	Controls modulation limiting
BUCK-BOOST	Switch to increase or decrease voltage supplied to primary of all power transformers

Table 3-7. Controls of Modulator-Power Supply MD-141/GR

2.0 THEORY OF OPERATION

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

2.1 Oscillator-Tripler

Referring to Figure 3-5, crystal Y-601 in crystal oven A-601, together with the cathode and first and second grids of tube V-601 (6AH6), comprise a modified Pierce oscillator derived from a Colpitts oscillator. Note that the resonant circuit which represents the electrical characteristics of the crystal is shunted by capacitors C-601 and C-605 in series, forming the capacitive voltage divider, with the cathode connected to the common point, which is characteristic of the Colpitts oscillator. The relative values of C-601 and C-605 (which, in this case, are equal) control the amount of feedback used to sustain oscillations. C-602 serves as a blocking capacitor, Resistor R-603 is the screen dropping resistor, C-605 the screen bypass, and L601 an rf choke to keep radio frequencies out of the power supply. Resistor R-601 is the grid resistor of the oscillator, and resistor R-602 and capacitor C-603 comprise a grid circuit decoupling filter. When the

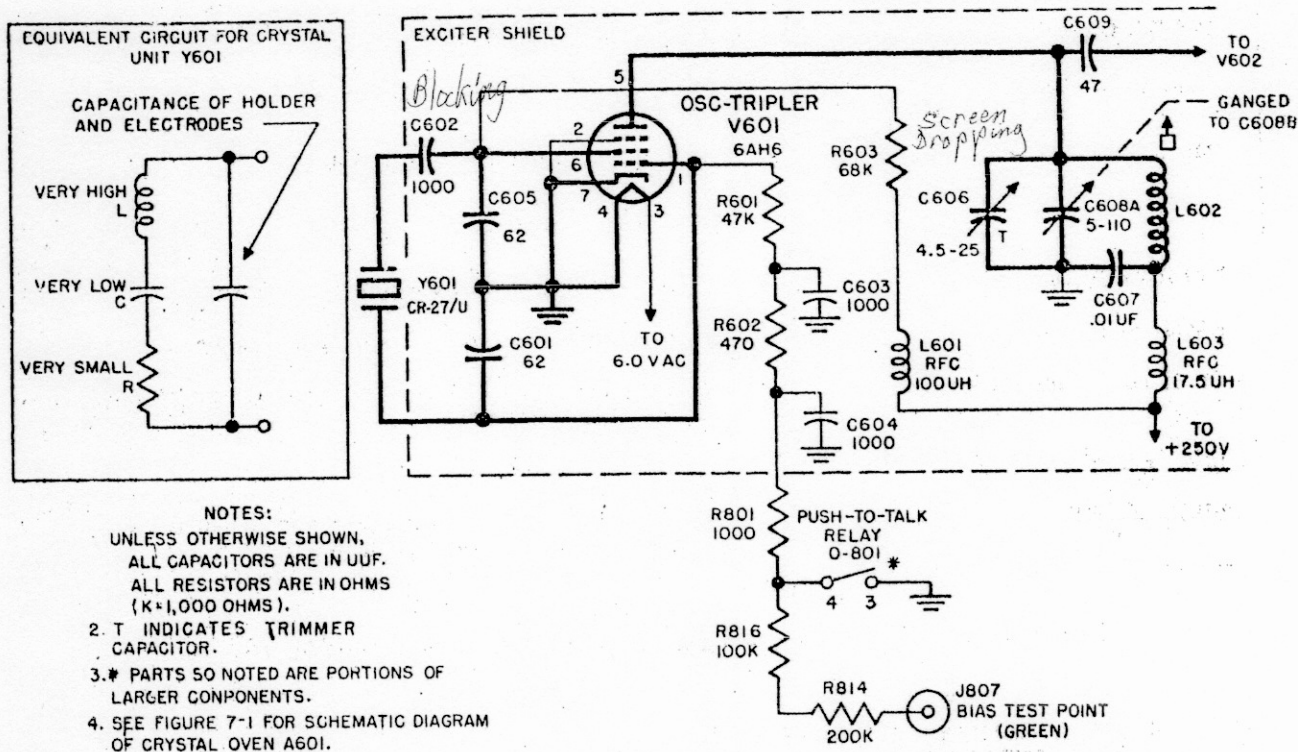


Figure 3-5. Radio Transmitter T-282/GR, Oscillator-Tripler, Simplified Schematic

transmitter is keyed on, the low side of R-602 is grounded through R-801 and relay 0-801. In this condition V-601 operates class C with grid leak bias. R-801 is the grid current meter shunt, and feed-through capacitor C-604 is the rf bypass. Grid No. 3 is at ground potential and hence serves as an electrostatic shield for the plate circuit of the tube which is therefore only electron coupled to the rest of the tube. The plate load coil L-602 is tuned by capacitors C-608A and C-606 to the third harmonic of the crystal frequency. Capacitor C-608A is ganged to capacitor C-608B. C-606 is a trimmer used to adjust tracking with the other circuits at the high frequency end of the band. Tracking at the low frequency end is adjusted by permeability tuning of L-602. The rf choke L-603 and capacitor C-607 are a plate decoupling network. Both grid No. 2 and the plate of V-601 receive their dc potentials from the plus 250-volts output of the low voltage supply.

2.2 First and Second Doublers

Referring to Figures 3-6 and 3-7, the first doubler (V-602) and the second doubler (V-603) are both class C rf amplifiers. R-605 in the first doubler and R-609 in the second doubler protects these tubes from high plate currents in the event of loss of excitation. The plate tank of the first doubler is comprised of L-604 and C-608B. High frequency tracking is accomplished by tuning C-612 and low frequency tracking is accomplished by permeability tuning L-604. This circuit is tuned to twice the input frequency (six times the crystal frequency). The plate and screen voltages of the first doubler are taken from the 250 volt low voltage power supply. Both the first and second doubler stages use a type 5763 tube.

In the grid circuit of the second doubler, R-608 and C-616 are used as a decoupling filter and R-802 is the meter shunt for the grid circuit. The plate tank of the second doubler is comprised of L-607 and C-621. C-621 is a split stator capacitor with its rotor grounded. The opposite ends of coil L-607 are therefore at equal but opposite polarities with respect to ground. C-622 serves to improve the symmetry of the entire circuit with respect to ground so that the coupling to the following push-pull stage is symmetrical and balanced. This plate tank is tuned to twice the input frequency (twelve times the crystal frequency). The plate and screen voltages of the second doubler are taken from the 250 volt low voltage power supply.

2.3 Buffer Amplifier

Referring to Figure 3-8, the buffer amplifier stage consists of the push-pull beam power amplifier tube V-604. This is an 832A tube operating as a class C amplifier. Each grid is capacitively coupled to the second doubler stage. Part of the bias for this stage is supplied from a voltage divider in the bias supply through decoupling filter R-612 and C-625.

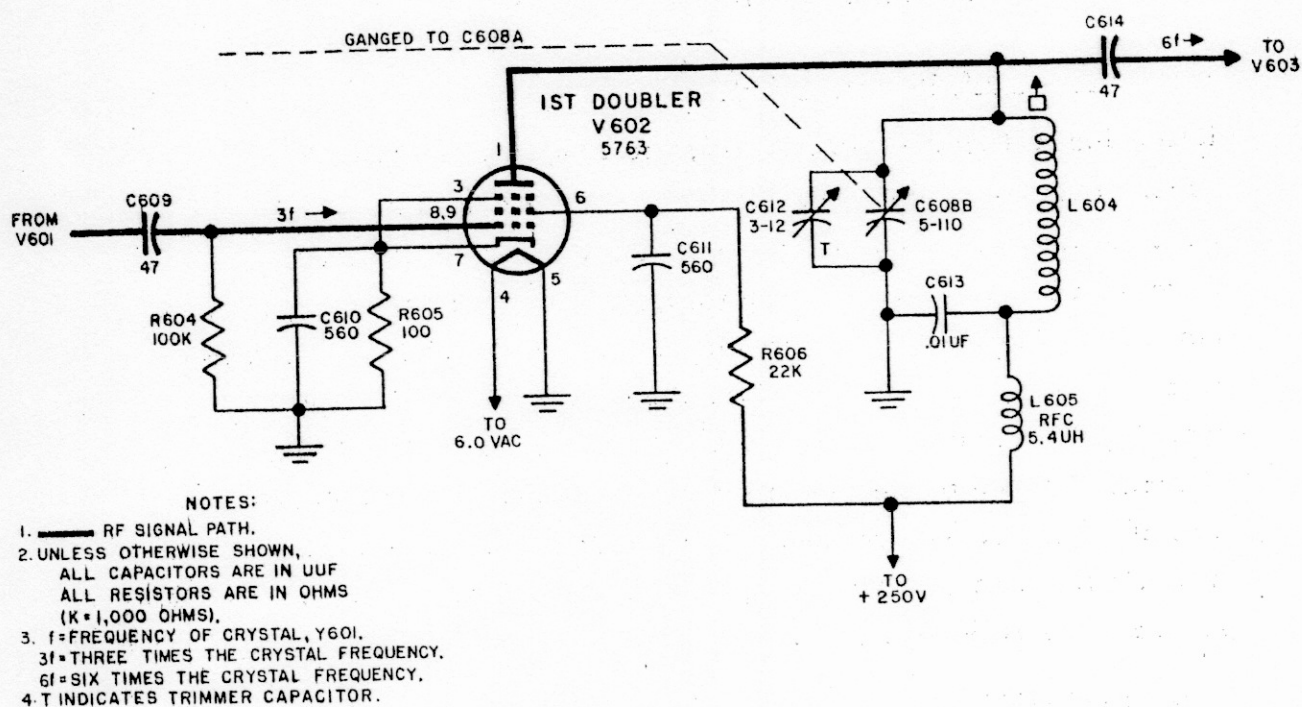


Figure 3-6. Radio Transmitter T-282/GR, First Doubler, Simplified Schematic

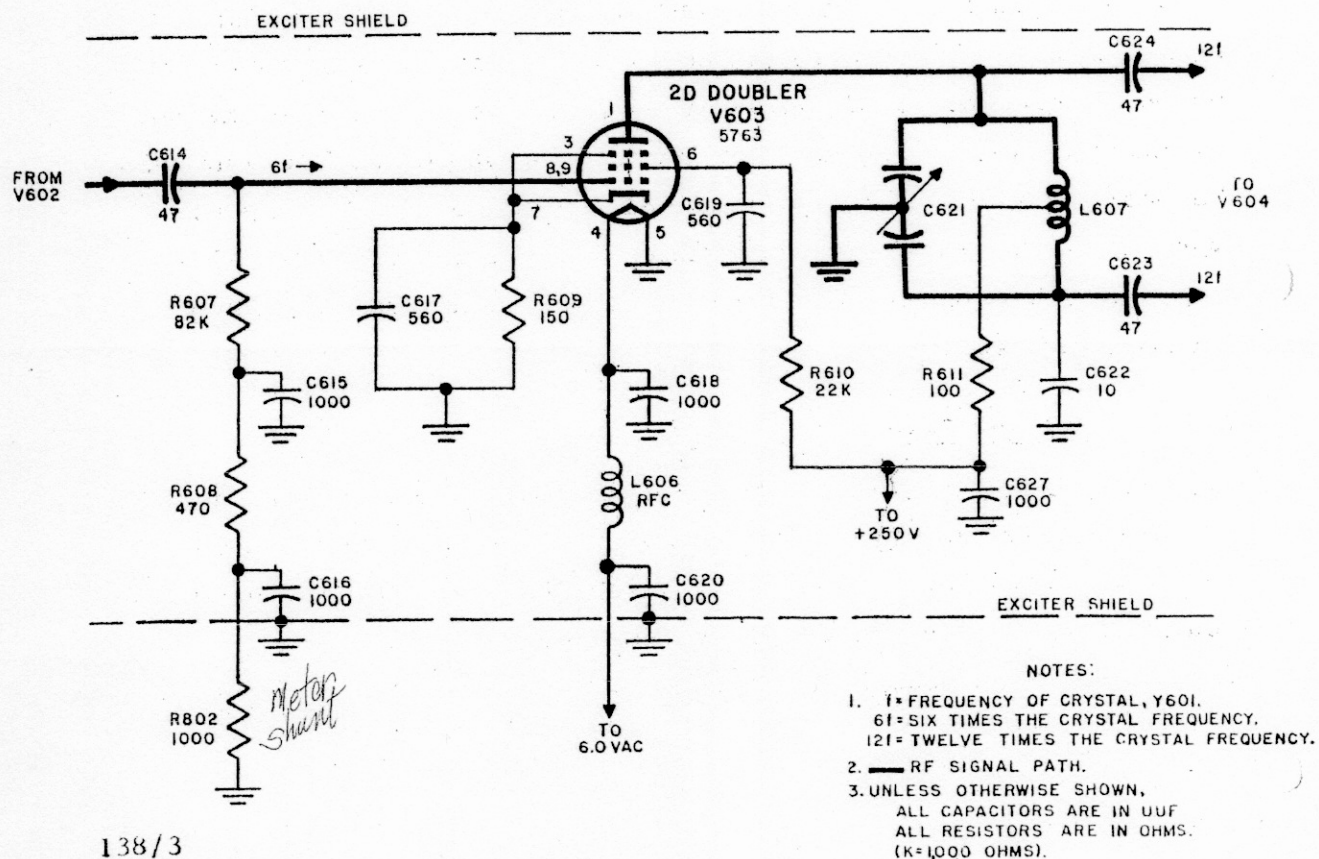
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Figure 3-7. Radio Transmitter T-282/GR, Second Doubler, Simplified Schematic

T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

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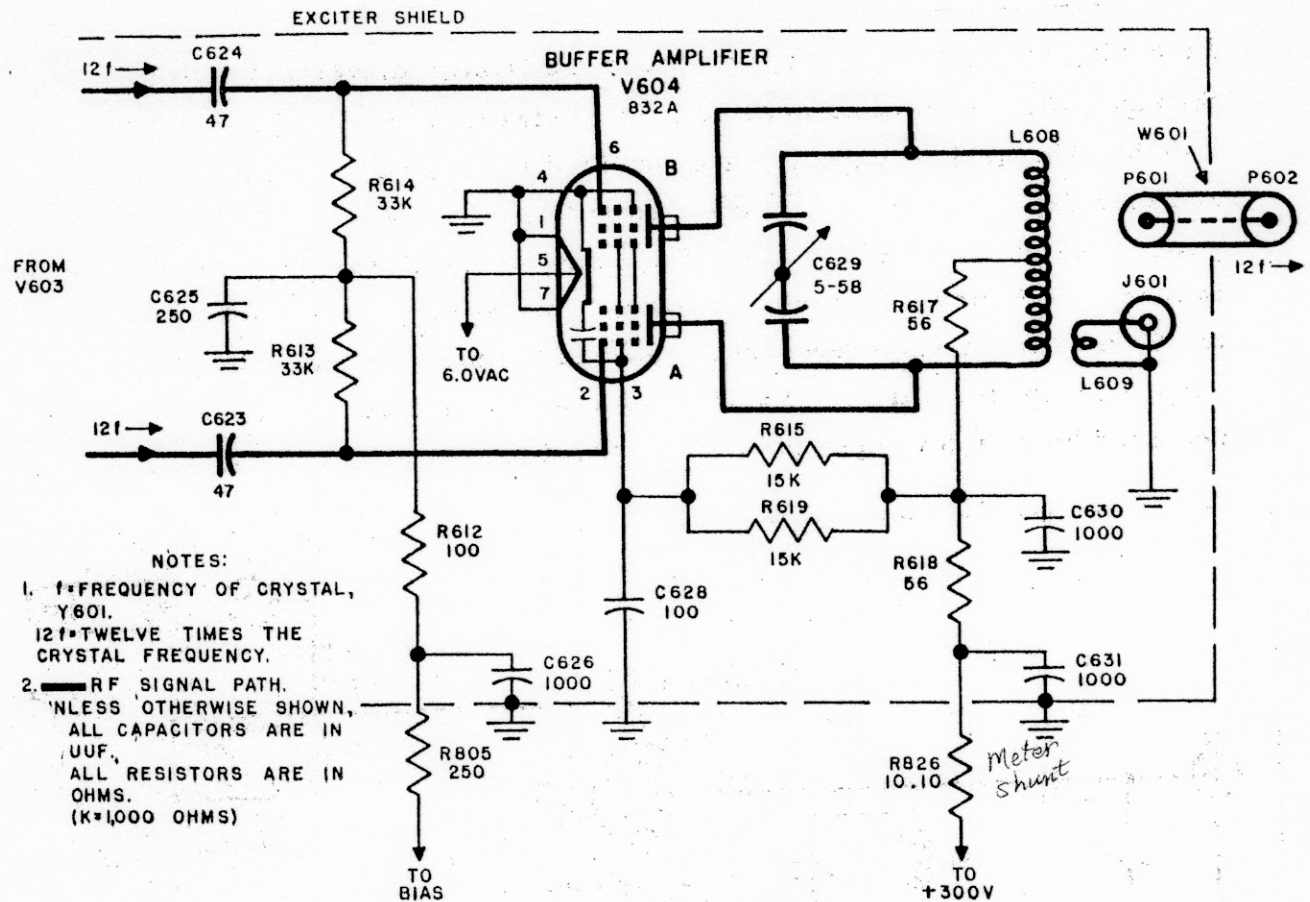


Figure 3-8. Radio Transmitter T-282/GR, Buffer Amplifier, Simplified Schematic

The remainder of its operating grid bias is provided by grid current flow through resistors R-613 and R-614. Resistor R-805 is the grid current meter shunt. Plate and screen voltages are supplied from the 300 volt output of the low voltage power supply. R-826 is the meter shunt for both the screen and plate currents. R-615 and R-619 connected in parallel make up the screen dropping resistor. C-628 is the screen bypass capacitor. L-608 and the split stator capacitor C-629 comprise the tank circuit for the output of this stage. This circuit is connected from plate to plate of the push-pull tube. The plate voltage is fed to the center tap of L-608 through resistor R-617. R-617 and C-630 comprises a decoupling filter. This stage is link coupled to the next stage through a coaxial cable.

2.4 Tripler-Driver

Referring to Figure 3-9, the rf input to the tripler-driver is introduced through J-901 to an impedance matching network made up of C-917 and C-926. The grid tank circuit is comprised L-902 and the stray wiring and tube capacitances. The tube used in this stage is a 4X150A beam power tube operated as a class C frequency tripler. The grid circuit is tuned to 12 times the crystal frequency and the plate circuit is tuned to 36 times the crystal frequency. Part of the bias for this stage is supplied from the minus 100 volt bias power supply and the balance of the required bias is developed by grid current flow through grid resistors

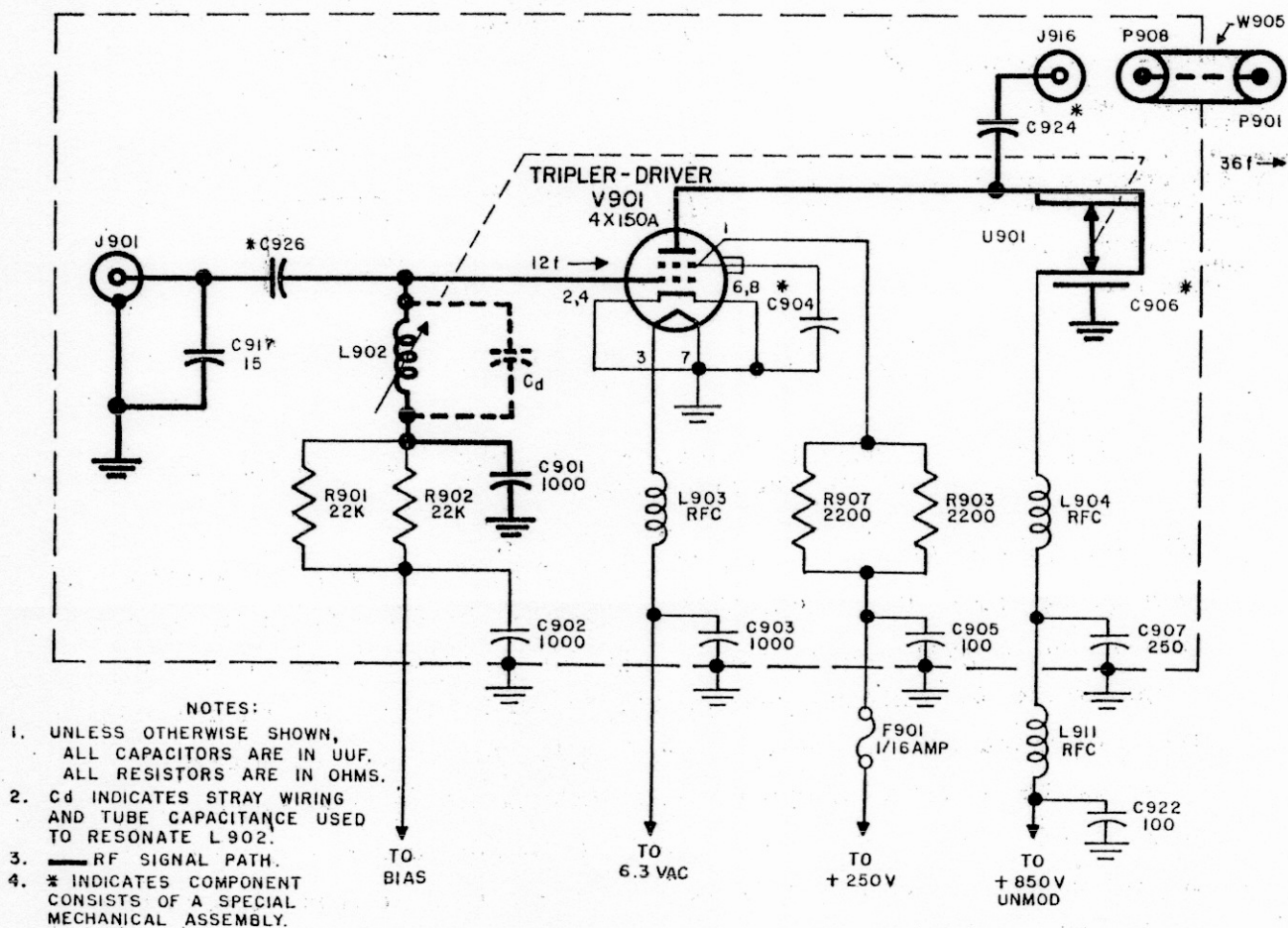


Figure 3-9. Radio Transmitter T-282/GR, Tripler-Driver, Simplified Schematic

T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

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R-901 and R-902. C-901 and C-902 function as rf bypass capacitors. The screen grid voltage is fed through R-903 and R-907 connected in parallel. C-905 is the screen bypass capacitor. The screen is protected by a 1/16 ampere fuse F-901. The plate circuit is a tuned stub type of circuit.

2.5 Tuned Stub Assemblies

At frequencies above 300 megacycles, the inductances and capacities that are used in conventional radio transmitters have values that are too large for these frequencies. Components built with the correct values would be too small to be practical and the efficiency would be low. To obtain good results at these frequencies a transmission line type of tank circuit is used.

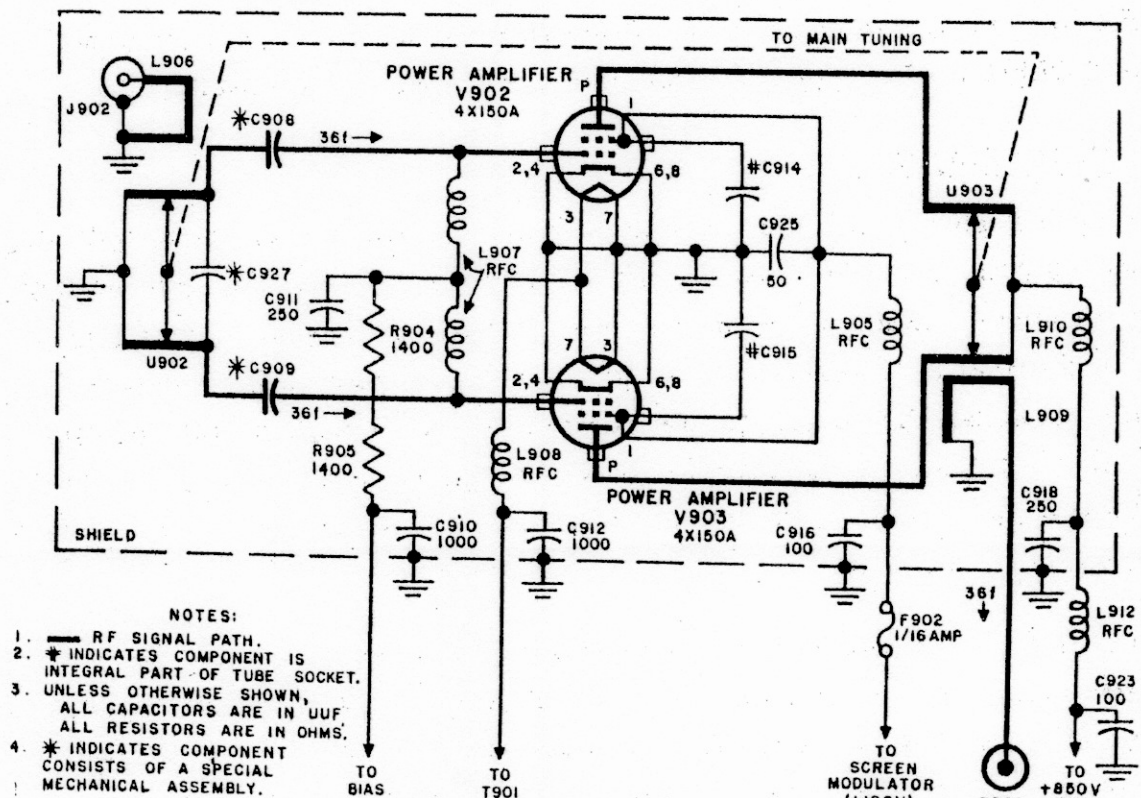


Figure 3-10. Radio Transmitter T-282/GR, Power Amplifier, Simplified Schematic

A quarter wavelength of transmission line that is shorted at one end will look like a high impedance at the open end. All of the capacity and inductance are distributed about the conductors of the line. These can be utilized as the grid or plate tank circuit of a stage. They have a very high Q and the efficiency is very good. All tank circuits operating at these frequencies use either a resonant line tank or a tuned cavity as the resonant element. In the T-282 Transmitter there are three such tuned line circuits. The plate of the driver and the grid and plate of the power amplifier are such circuits. The line is formed in the shape of the circumference of a circle. The frequency is changed by a shorting bar that will physically change the length of the line. The line being in the form of a circle can have its shorting bar rotated on a shaft and arm. As the shaft is rotated the shorting bar will slide around the line changing its length. Contact is made to the line by contact fingers mounted on the end of the arm which is rotated by the shaft. For an example of this type of construction see Figures 3-11 and 3-12.

2.6 Power Amplifier

Referring to Figure 3-10, the PA stage of this transmitter is a push-pull stage using 4X150A tubes. The grids are connected to the ends of a tuned line tank circuit through capacitors C-908 and C-909. These capacitors are made as a part of the final tube sockets. The grid tank is coupled to the previous stage by a special link coupling. RF current is fed through the rf transmission line from the driver and is caused to flow through the grid housing or case. This current sets up magnetic lines around the case which excite the grid tank. For the exact current and magnetic flow see Figure 3-11.

Grid bias is fed to the grids through decoupling circuits made up of R-904 and R-905 connected in series and C-911. This bias is then fed to the grids through two rf chokes, L-907. The two cathodes are connected to ground. There are four separate cathode leads coming out of the 4X150A tube. All of these leads are connected to the ground to reduce the lead inductance. This will allow the cathode to be at exact ground potential. Modulated, plus 190 volts is brought in through a 1/16 amp fuse F-902. This voltage is fed

T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

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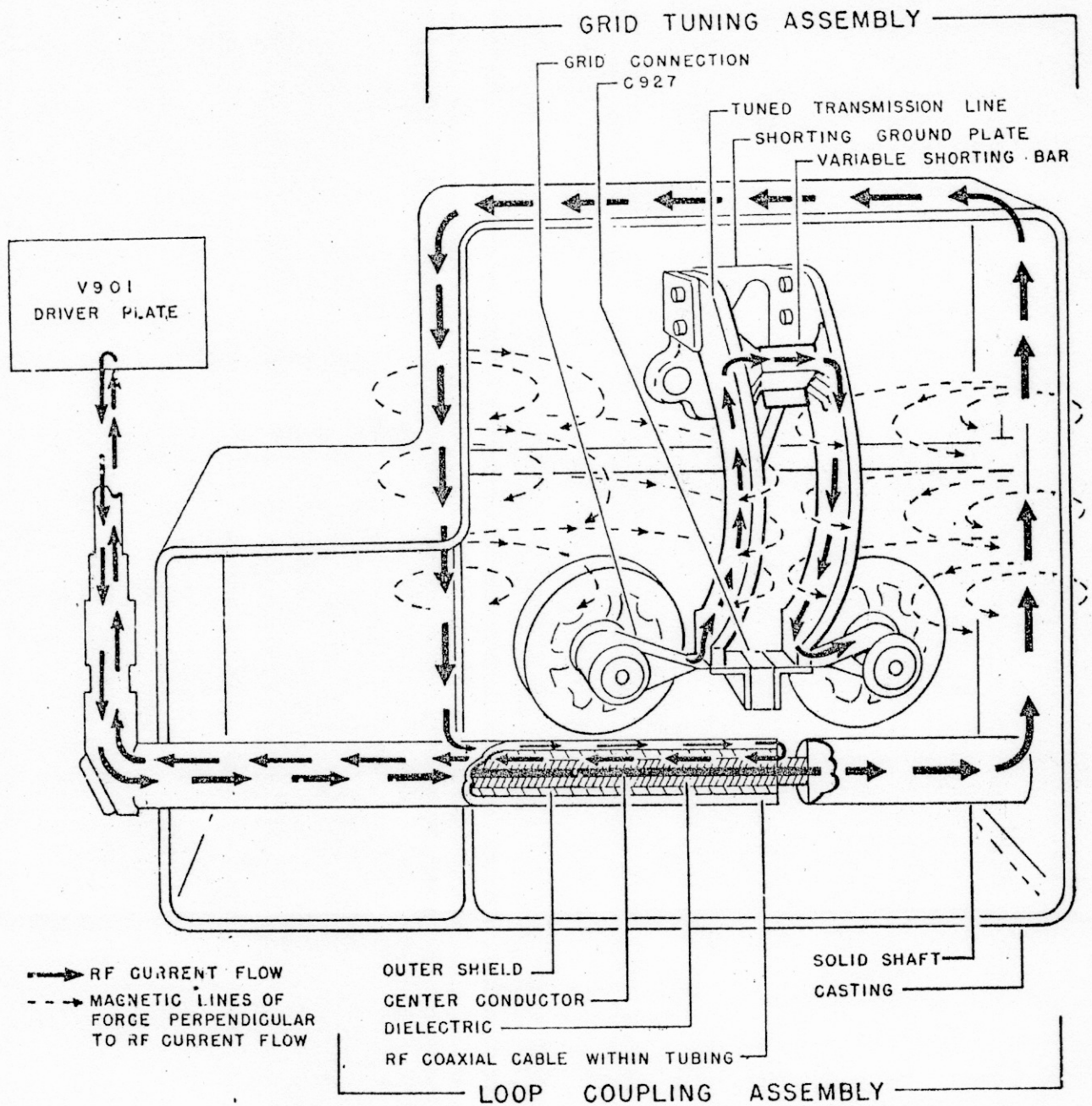


Figure 3-11. Radio Transmitter T-282/GR, Power Amplifier Input Circuit

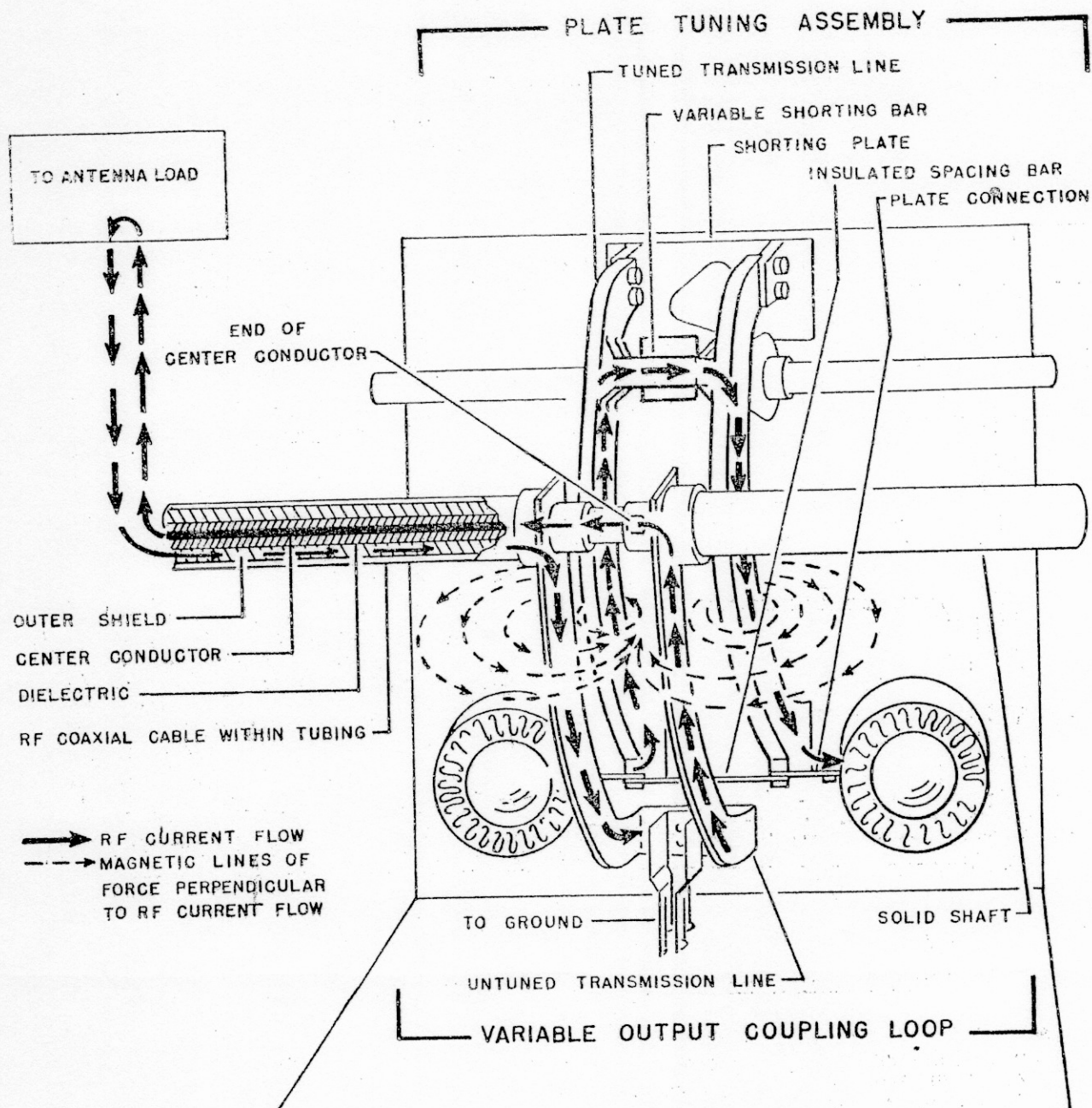


Figure 3-12. Radio Transmitter T-282/GR, Power Amplifier Output Circuit

through an rf choke L-905 and connected to the screen grids of the two tubes. Capacitors C-916 and C-925 are the rf bypass capacitors. These are part of the decoupling circuit between the "B" plus and the screens. Two capacitors C-914 and C-915 are built as a part of the PA tube sockets. These capacitors in series with the lead inductance in the screen circuit form a series resonant circuit from the tube screens to ground. This assures that the screens are at exact ground potential as far as the signal is concerned. The plate tank is a balanced line connected from plate to plate of the push-pull output tubes. As the rf current flows in the tank, magnetic lines of force are produced and they cut the turn of the coupling loop. This induces current in the loop, which is fed to the antenna output connector through the antenna relay, low-pass filter, and the directional coupler.

2.7 Screen Modulator

Referring to Figure 3-13, components of the screen modulator circuit are located in the monitor-screen modulator assembly. V-706, connected as a triode and used as a cathode follower, is the screen modulator tube. The plate is connected through three OB2 voltage regulator tubes that are connected in series to the plus 850 volt unmodulated power supply.

The dc bias to this tube is the difference between the voltage drop across the cathode resistor and the voltage drop across a portion of potentiometer R-719. This potentiometer is connected between the plus 250 volt power supply and ground. The tap is adjusted to obtain the correct grid bias on the tube. This bias determines the amount of plate current that will pass through the tube, which in turn determines the voltage across the cathode resistor. This voltage (approximately 190 volts) is applied as screen voltage to the power amplifier stage. Therefore, the potentiometer adjusts the screen voltage on the power amplifier stage. A portion of the audio voltage from the modulated high voltage is fed through capacitor

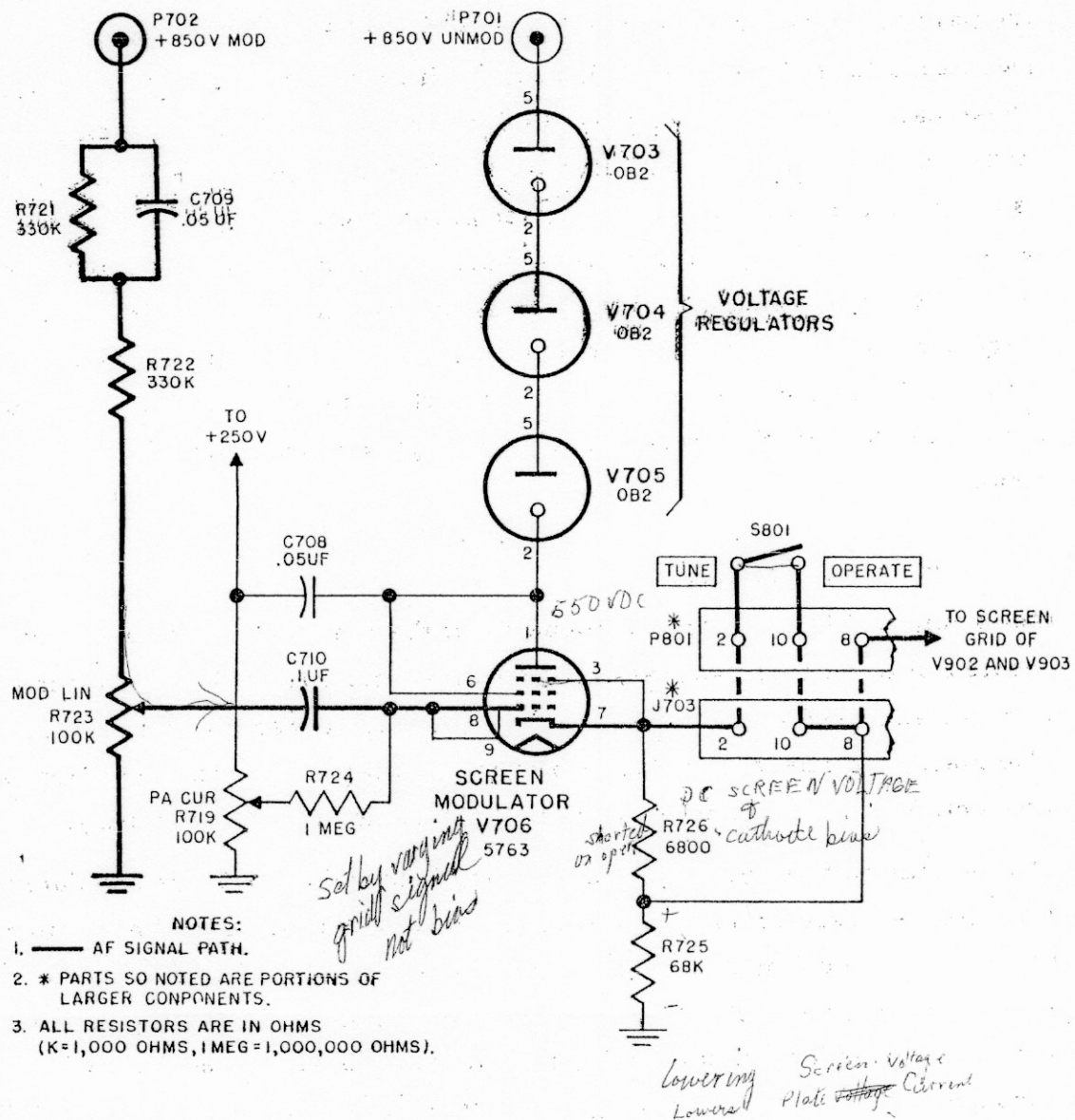
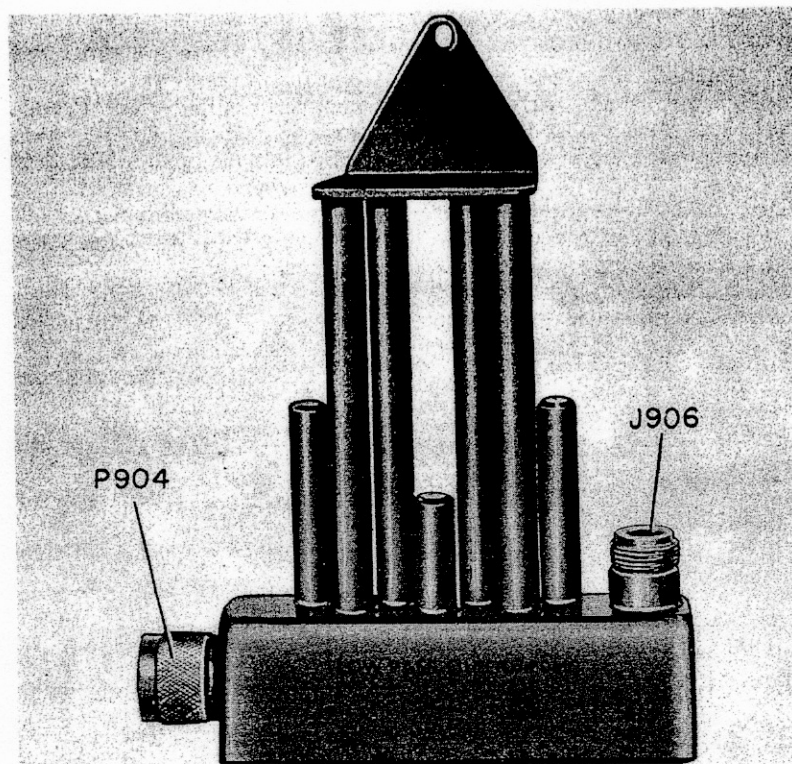


Figure 3-13. Radio Transmitter T-282/GR, Screen Modulator, Simplified Schematic

C-710 to the grid of the screen modulator tube. This audio voltage on the grid of the screen modulator tube causes the screen voltage on the power amplifier stage to vary at the audio rate. The amount of audio voltage that is fed to the grid of the screen modulator tube is adjusted by potentiometer R-723 so that the modulated output of the transmitter is linear. The tune-operate switch S-801 reduces the screen voltage on the power amplifier stage by inserting an additional resistor R-726 in the cathode circuit of the screen modulator tube. This resistor reduces the plate current of the screen modulator tube, which in turn will reduce the voltage drop across the cathode resistor R-725. Since the voltage drop across R-725 is the screen



RF FILTER Z901

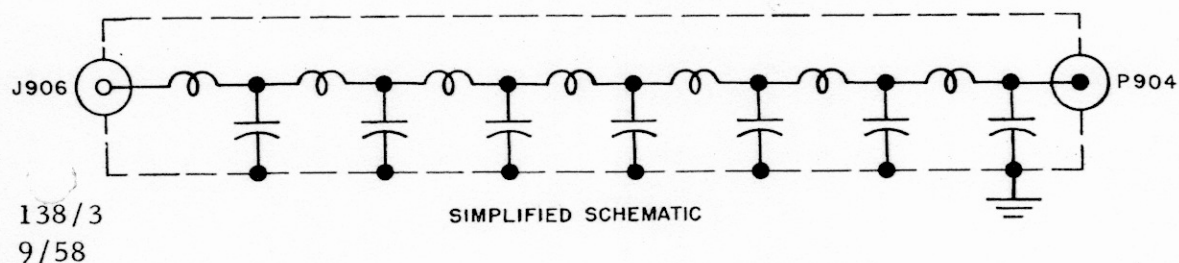


Figure 3-14. Radio Transmitter T-282/GR, R-F Filter

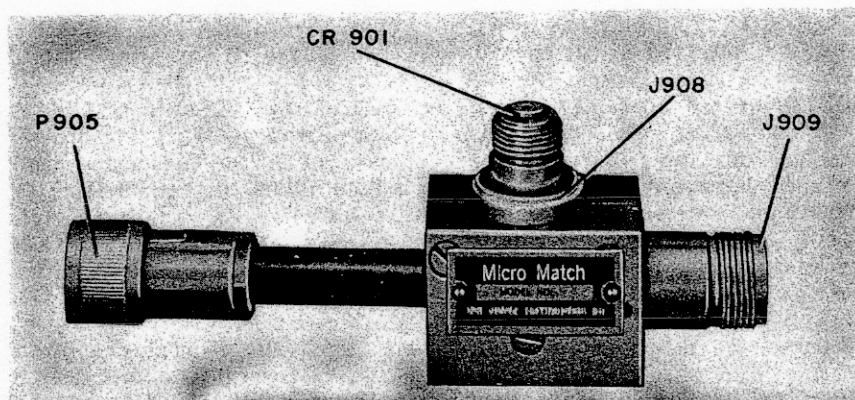
voltage for the power amplifier stage, this drop in screen voltage will reduce the power output of the transmitter.

2.8 RF Filter

Referring to Figure 3-14, the low-pass rf filter Z-901 is designed to minimize harmonic radiation from the transmitter. It consists of several sections of transmission line used as circuit elements. The approximate equivalent circuit is similar to that of a filter using lumped elements of inductance and capacitance. The filter is replaceable as an entire unit. The filter will attenuate all frequencies above approximately 420 mc.

2.9 Directional Coupler

Referring to Figure 3-15, the directional coupler consists of a short section of transmission line from which a sample of the transmitter power is obtained by a combination of inductive and capacitive coupling. The two



DIRECTIONAL COUPLER DC901

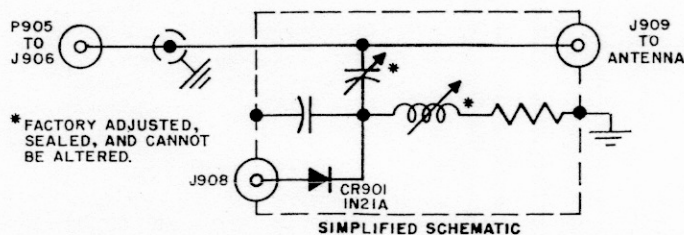


Figure 3-15. Radio Transmitter T-282/GR,
Directional Coupler

components of coupling are additive in the forward direction (toward the antenna) and subtractive (cancel each other) in the reflected direction. The sample of power is rectified by crystal diode CR-901. With reasonably small standing wave ratios (less than 2 to 1), the resultant output from CR-901 is proportional to the power radiated by the antenna. This dc output, which varies at an audio rate (due to modulation), is conveyed to the input jack J-702 of the monitor-screen modulator section through a coaxial cable.

2.10 RF Power Measurement

Referring to Figure 3-16, rectified carrier output from the directional coupler DC-901 goes through connectors P-906 and J-702 to the rotor of "METER 2" Selector Switch S-701. When the switch is operated to the "CARRIER WATTS" position, "PWR CAL" resistor R-701, in series with "METER 2", serves as the meter multiplier and calibrator adjustment for the rf power measurements.

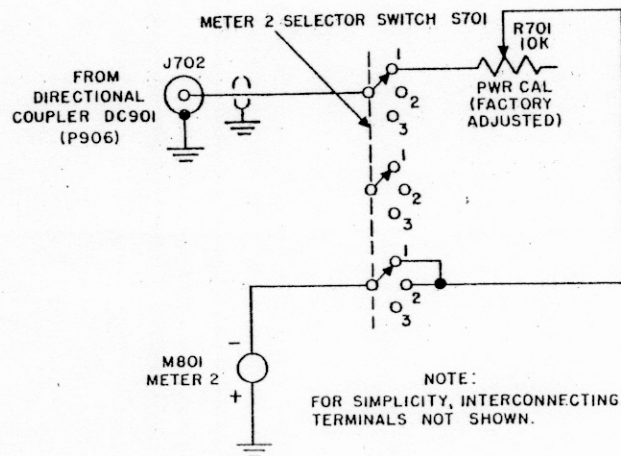


Figure 3-16. Radio Transmitter T-282/GR, R-F Power Measurement, Simplified Schematic

2.11 Percent of Modulation Measurement

Referring to Figure 3-17, before modulation measurements can be made, "METER 2" must be calibrated. "METER 2" Selector Switch is operated to the "SET CAL" position, completing a circuit from J-702 through "CALABRATE" variable resistor R-702, resistor R-703 and "METER 2" to ground. When "METER 2" Selector Switch S-701 is operated to the "% MOD" position, the audio frequency component of the input from the directional coupler is coupled from the "CALIBRATE" variable resistor R-702 through capacitor C-701 to the grid of the amplifier tube V-702A. This is one-half of a 12AX7 tube. Resistors R-703 and R-704 in series with "CALABRATE" resistor R-702 form a voltage divider to ground. R-707 is the grid resistor and R-709 is the plate load resistor. Cathode bias is provided by the lower part of "MOD CAL" variable resistor R-716 which is also part of an inverse feedback circuit from tube V-701B (1/2 12AT7). The output of tube V-702A is coupled by capacitor C-702 to the grid of amplifier V-701B. The grid resistor of this stage is R-711 and the plate load resistor is R-712. Bias is supplied to this stage by cathode resistor R-714. Part of the output of the stage is coupled from the plate of the tube through capacitor C-704 and dropping resistor R-715 to variable resistor R-716, thus providing inverse feedback to the cathode circuit of V-702A. The magnitude of the inverse feedback is so great that the overall gain of amplifiers V-701B and V-702A is very small. These stages receive their dc plate voltage from the 250-volt supply through a filter made up of resistor R-710 and capacitor C-703.

Capacitor C-705 couples the output of tube V-701B to tube V-702B which is connected as a diode and provides the rectified current measured by "METER 2", using R-717 as a meter multiplier resistor. When the modulation monitor is properly calibrated and the carrier is 100% modulated, this rectified current will cause the pointer of "METER 2" to deflect to the 100% mark. In the absence of any modulation, current still flows through diode connected V-702B. This zero-signal current is balanced out by bleeding some of the cathode current from V-701B through the "METER 2". These two currents are opposite and will cancel one another.

T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

3-25

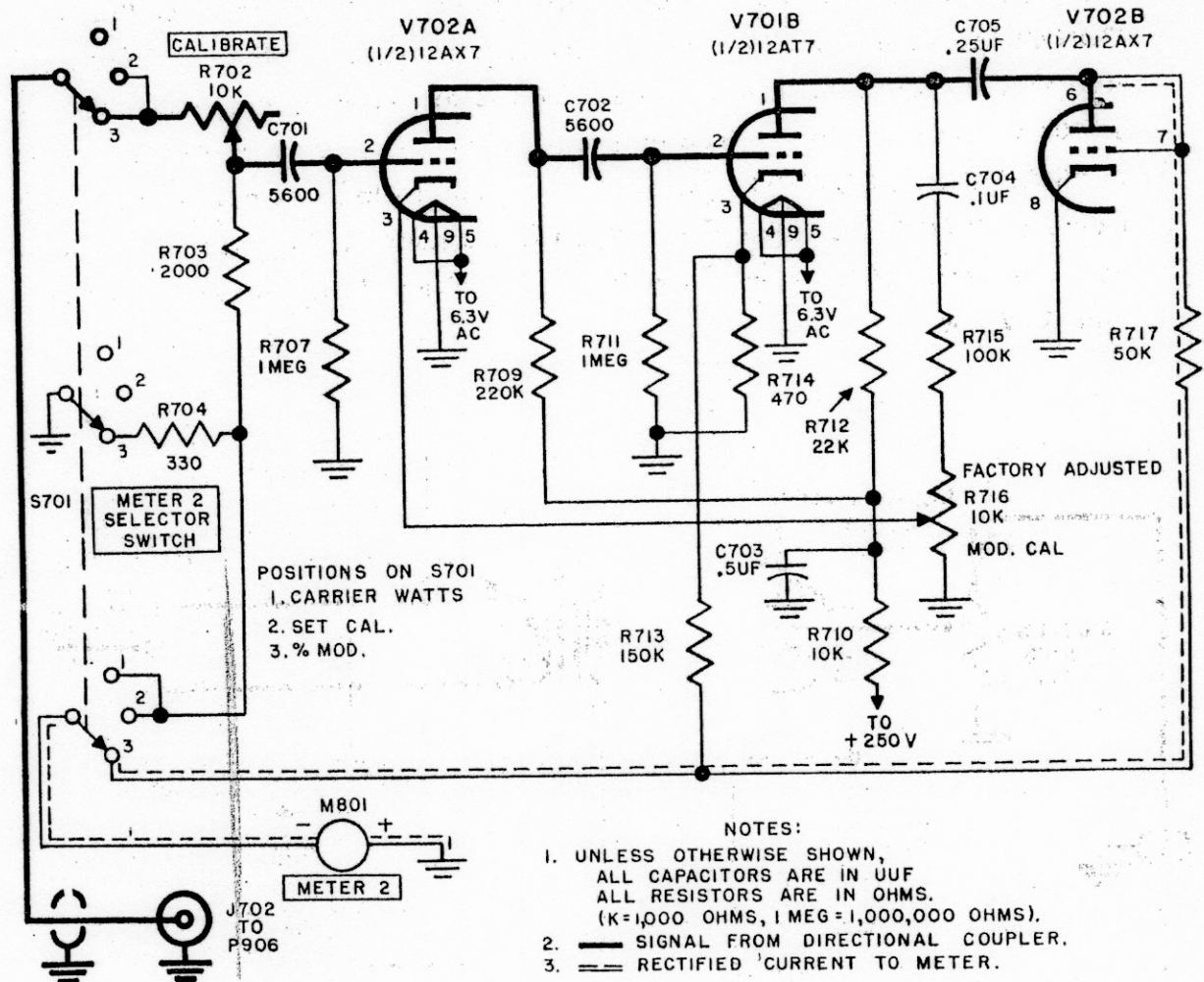


Figure 3-17. Radio Transmitter T-282/GR, Percent Modulation Measurement, Simplified Schematic

2.12 Aural Monitoring

Referring to Figure 3-18, the audio component of the input to the monitor circuit is coupled to the grid of amplifier tube V-701A, through "SIDE TONE" variable resistor R-705 which functions as a volume control. Resistor R-708 is for cathode bias and the primary winding of transformer T-701 is the plate load. The output from the secondary of T-701 is brought to "SIDE TONE OUTPUT" jack J-701 where headphones may be plugged in. Resistor R-803 and capacitor C-802 form a humbucking circuit which cancels out some of the power supply ripple voltage in the plate circuit of tube V-701A.

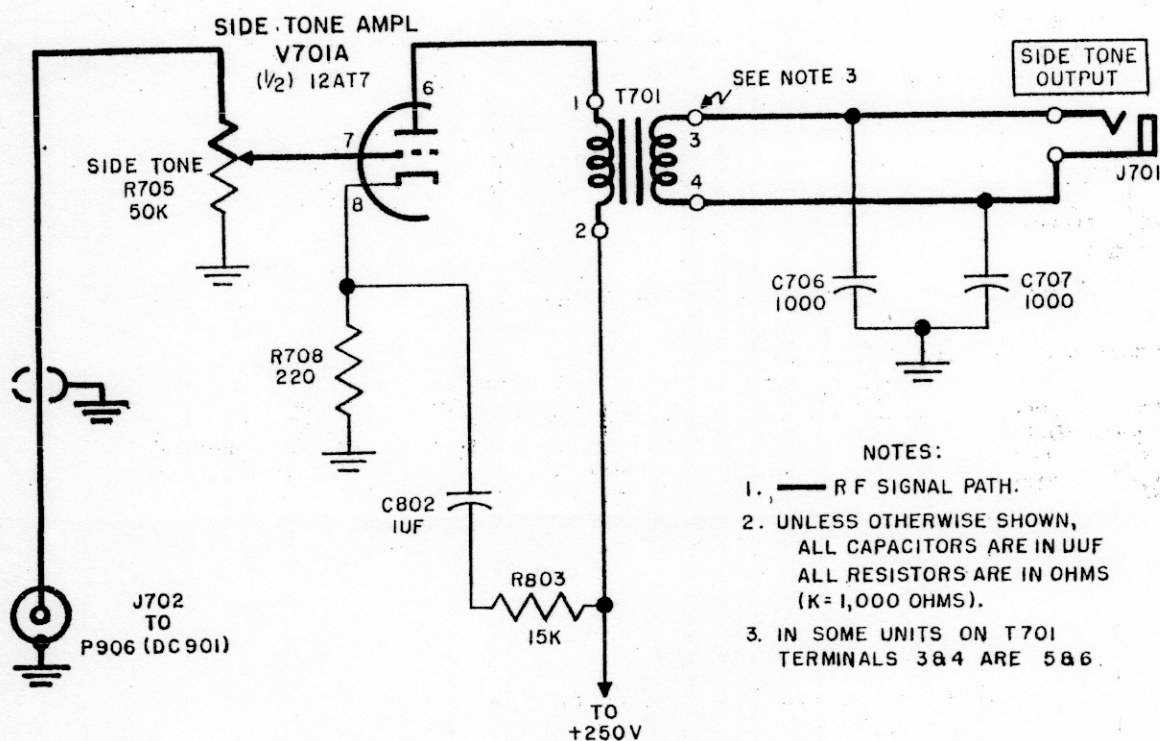


Figure 3-18. Radio Transmitter T-282/GR, Side Tone Output Circuit, Simplified Schematic

2.13 Metering Circuits

Referring to Figure 3-31, "METER 1" on the transmitter functions as a milliammeter and measures the grid and plate currents in most of the rf stages. These grid and plate currents are measured when "METER 1" Selector Switch S-802 is in positions 1 through 8. When the "METER 1" Selector Switch is in position 9, the terminals of "METER 1" are brought out through fuse F-801 to meter jacks on the front panel. These are J-809 and J-810. These two meter jacks may be connected by jumpers to other jacks for the purpose of making voltage measurements at certain test points.

2.14 Current Measurements

Meter shunt resistors are inserted in series with those circuits in which the dc current is to be measured. As the "METER SELECTOR SWITCH" is operated to each of the metering positions, "METER 1" is connected in parallel with the respective shunt resistor and the current divides between the meter shunt and the meter. The factor by which the indicated current must be multiplied is shown on each position of the "METER SELECTOR SWITCH". Meter multiplier resistor R-819, permits the shunt resistors to be a higher value.

2.15 Voltage Measurements

The voltage jacks are all color coded. The two jacks J-809 and J-810 which are connected to the meter are colored red and black. The red indicates the positive terminal of the meter and the black indicates the negative terminal of the meter. On the voltage jacks the red indicates that the jack is positive with respect to ground, green indicates that the jack is negative with respect to ground and black is the ground terminal.

The meter terminals may be connected to the voltage jacks with short jumpers after the cover plate is removed from the test jacks. This cover is marked "REMOVE TO EXPOSE TEST POINTS". To make voltage measurements, turn "METER SELECTOR SWITCH" to position 9. This will connect the meter

to the meter jacks. The multipliers for each position are connected in the circuit of each test jack. For each jack, the full scale value of the meter is indicated on the rear side of the test jack cover plate. Also, the average reading that should be obtained at each jack is shown on the rear side of the test jack cover plate.

2.16 Transmitter Mechanical System

For the following discussion, refer to Figure 3-19. All tuned circuits, within the transmitter, are tuned to resonance at the proper frequency by individual front panel controls. Most of the controls are ganged together in such a manner that each circuit is roughly tuned with a single front panel control.

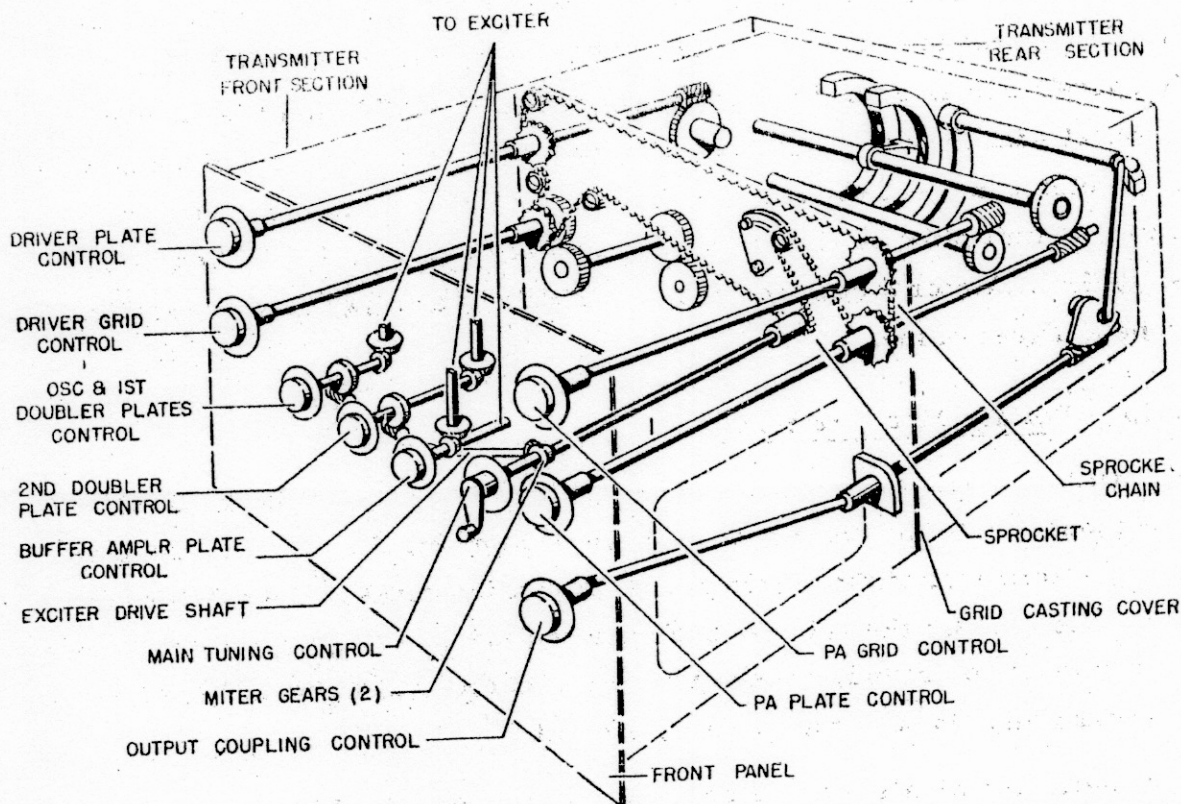


Figure 3-19. Radio Transmitter T-282/GR, Tuning Control Drive Mechanism

This eliminates the possibility of tuning individual circuits to an undesired harmonic, thus transmitting on the wrong frequency. The "MAIN TUNING" control is coupled to the exciter sub-assembly by miter gears and a shaft that is mounted parallel to the front panel. At the same time, the main shaft is coupled to the controls of the driver and final stages by a set of sprockets and a drive chain.

All transmitter front panel controls, except the "BUFFER AMPR PLATE" and "OUTPUT COUPLING" controls, are ganged together and coarse set with the "MAIN TUNING" control. As the "MAIN TUNING" control is rotated to obtain the desired operating frequency, pins on the exciter sub-assembly worm wheels, and pins on the chain sprockets, engage and drive stop collar pins on the individual tuning control shafts. When the desired setting is obtained, the "MAIN TUNING" control dial lock is then made finger tight. This prevents any of the individual tuning controls from turning the "MAIN TUNING" control. Fine tuning, by means of the individual front panel controls, is limited to 20% of the range of the "MAIN TUNING" control by stop collar pins on the individual tuning control shafts.

2.17 Audio Input Circuits

The audio section has provision for a 50 ohm or 600 ohm input impedance. The 50 ohm input impedance is for local operation using a T-17 or similar type carbon microphone; the 600 ohm input impedance is used for remote operation over a 600 ohm line.

Referring to Figure 3-30, the input transformer T-301 has two primaries, a low impedance microphone winding, terminals 1 and 2, and a 600 ohm split winding, terminals 3, 4, 5 and 6. The secondary of the transformer is connected to the dual potentiometer R-306 and resistor R-308. This network presents a constant 50,000 ohm load to the input transformer T-301 and also serves as a gain control for the modulator unit.

2.18 Narrow Band Amplifier

Referring to Figure 3-20, the output of the gain control R-306 is fed through two paths. The first path is to the input to the narrow band amplifier and the second path is to a switch which will bypass the narrow band amplifier.

The audio signal is fed through capacitors C-315 and C-305 to the grid of V-301. This is a type 6C4 tube which is used as a narrow band amplifier. The cathode and the grid of this stage are operated at a minus 100 volts and the plate is operated at ground potential. Band pass filter Z-301 shunted at the input by R-309 and at the output by R-310 and R-311 form the output load to the tube. This filter will pass only frequencies between 400 and 3000 cycles. Resistors R-310 and R-311 form a voltage divider across the output of the filter such that the gain of this stage is unity.

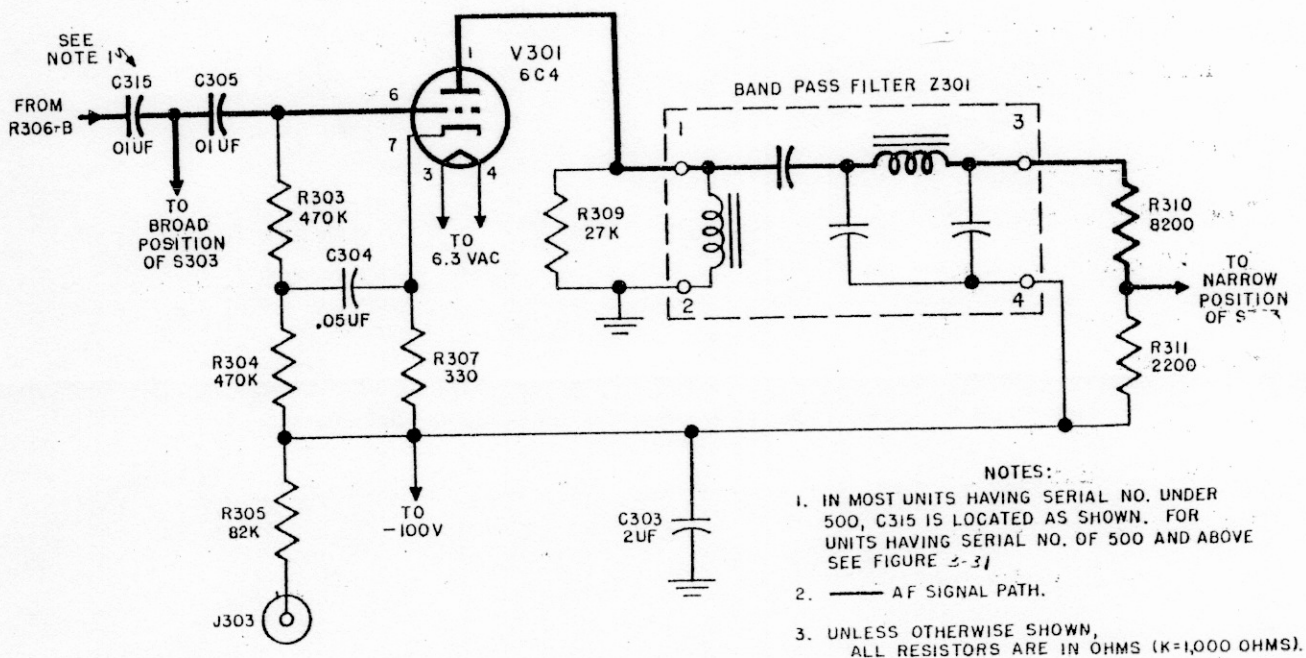


Figure 3-20. Modulator-Power Supply MD-141/GR, Narrow Band Amplifier, Simplified Schematic

This output feeds one side of the "NARROW-BROAD" switch. A tap between capacitors C-315 and C-305 provides the input to the other side of the "NARROW-BROAD" switch. While this switch is in the broad position the narrow band amplifier is bypassed from the circuit.

2.19 Phase Inverter

Referring to Figure 3-21, the purpose of this stage is to convert from single ended to push-pull output in order to drive the following push-pull stage. The audio input to V-302A is fed from the gain control R-306 when the "NARROW-BROAD" switch is in the BROAD position and is fed from the narrow band amplifier when the switch is in the NARROW position. This stage amplifies the signal and drives the grid of V-303. A small portion

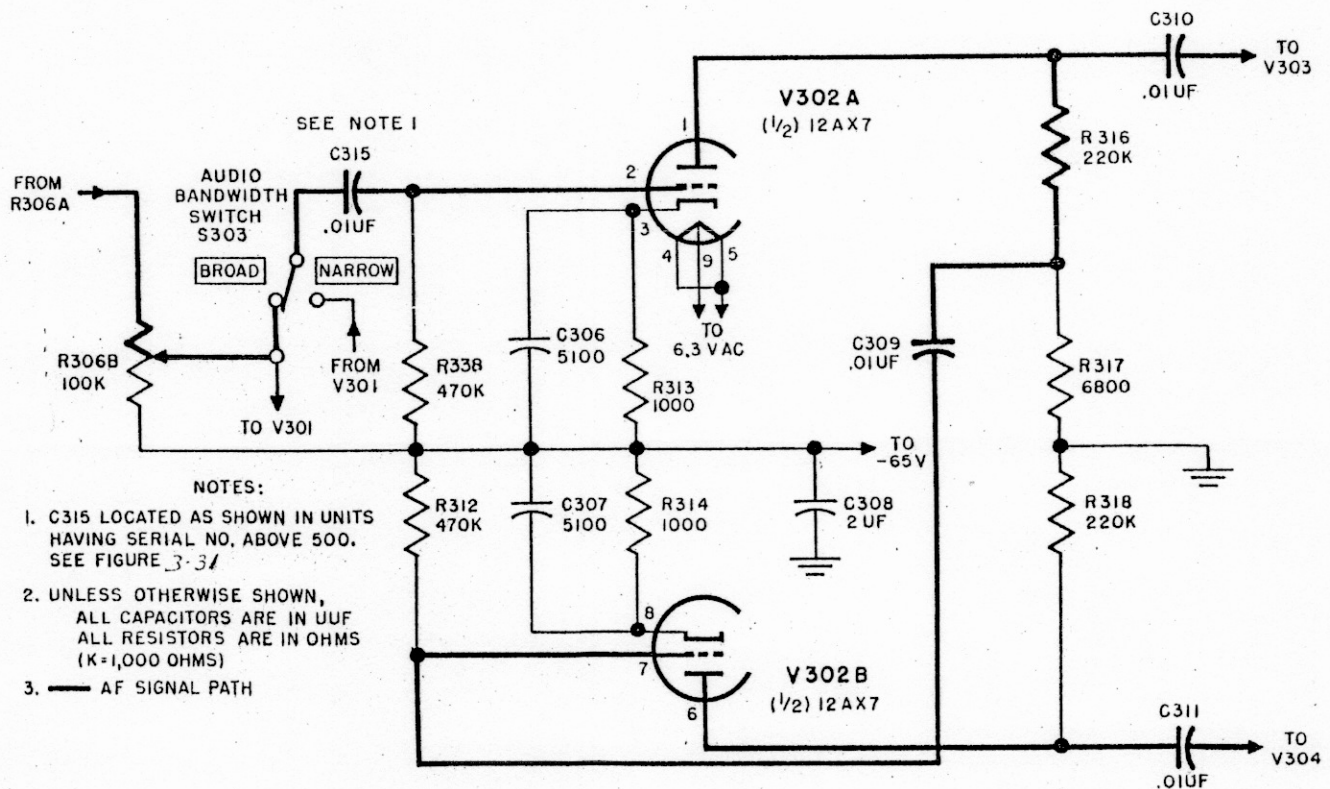
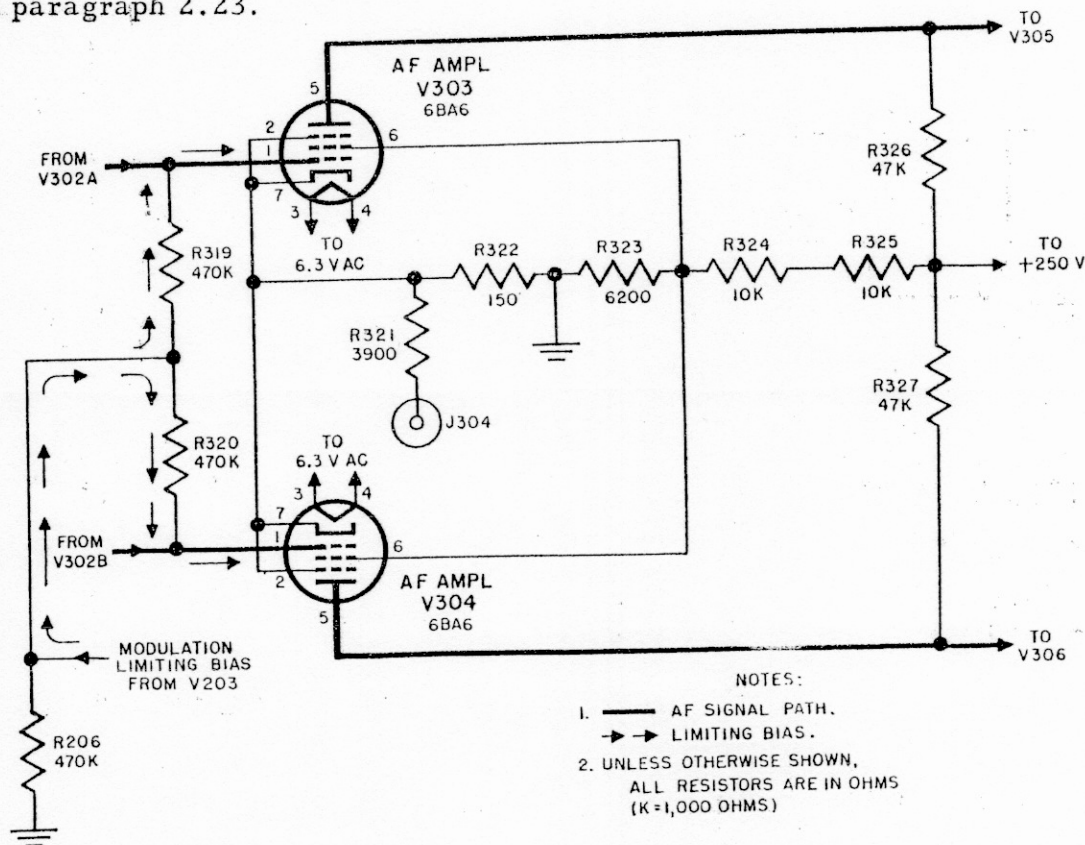


Figure 3-21. Modulator-Power Supply MD-141/GR, Phase Inverter, Simplified Schematic

of the signal from the plate of V-302A is fed back to the grid of V-302B. The grid and plate of V-302A are 180 degrees out of phase therefore the grids of V-302A and V-302B are 180 degrees out of phase. V-302B amplifies the out of phase signal and drives the grid of V-304. In this manner the two grids of V-303 and V-304 are driven 180 degrees out of phase. The cathodes and grids of this stage are operated at a minus 65 volts and the plates are operated at ground potential.

2.20 AF Amplifier

Referring to Figure 3-22, this stage is a conventional push-pull amplifier stage. The input is capacity coupled from the phase inverter stage. Two type 6BA6 tubes designated as V-303 and V-304 are used in this stage. R-319 and R-320 are the grid resistors and the common resistor R-206 is the ground return. There is a negative voltage applied across this common resistor which provides automatic limiting of the modulation and is discussed in paragraph 2.23.



2.21 Modulator Driver Stage

Referring to Figure 3-23, the modulator driver stage is a push-pull stage with negative or inverse feedback. The input is capacity coupled from the previous stage. C-312 and C-313 are the coupling capacitors and R-329 and R-331 are the grid resistors. The two cathodes are tied together and the common cathode resistor R-330 furnishes all of the bias for the stage. The output is transformer coupled to the modulator stage. The plate voltage for the previous stage is fed from the plates of this stage through resistors R-328 and R-332. This forms the feedback loop for the modulator driver stage.

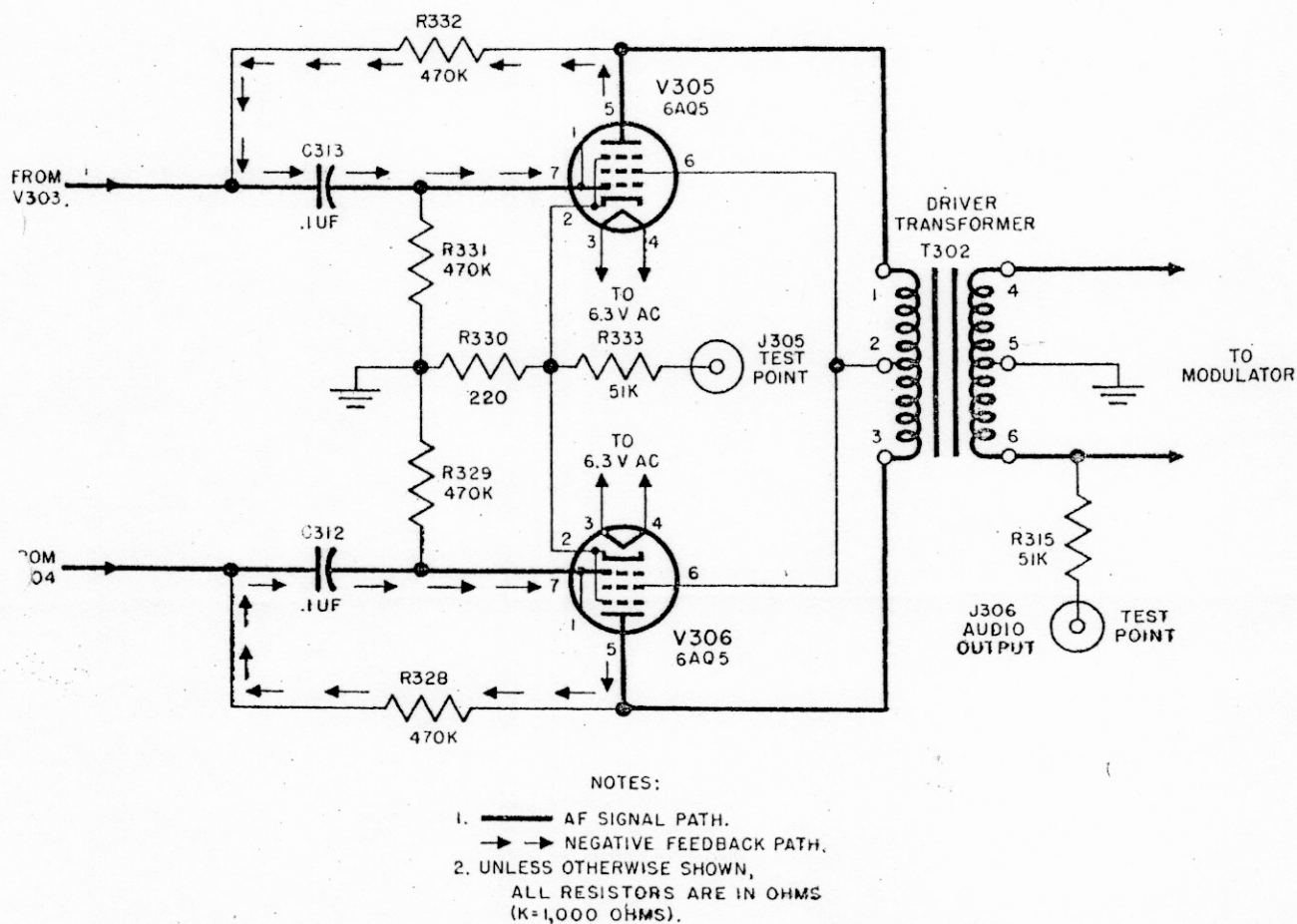


Figure 3-23. Modulator-Power Supply MD-141/GR, Modulator Driver, Simplified Schematic

2.22 Modulator Stage

Referring to Figure 3-24, the audio signal is coupled to this stage by inter-stage transformer T-302. The signal is fed to the grids of the two type 811 tubes used in this stage. These tubes, V-201 and V-202, are operated as a zero-bias class B audio stage. Each end of the primary of the modulation transformer T-201 is connected to one of the two plates and the center tap is connected to the "B" plus for the stage. There is a gap connected across the primary of the modulation transformer to protect the transformer from excessive audio voltages.

The secondary of the modulation transformer is made up of two windings. One winding is connected in series with the high voltage to the power amplifier stage in the transmitter. This provides the high level modulation for the transmitter. The second winding is used in conjunction with the "AUTOMATIC MODULATION LIMITER". The two ends of this winding are connected to the two plates of the limiter rectifier. The center tap of the winding is connected to the control voltage for the limiter. For the operation of this stage see paragraph 2.23.

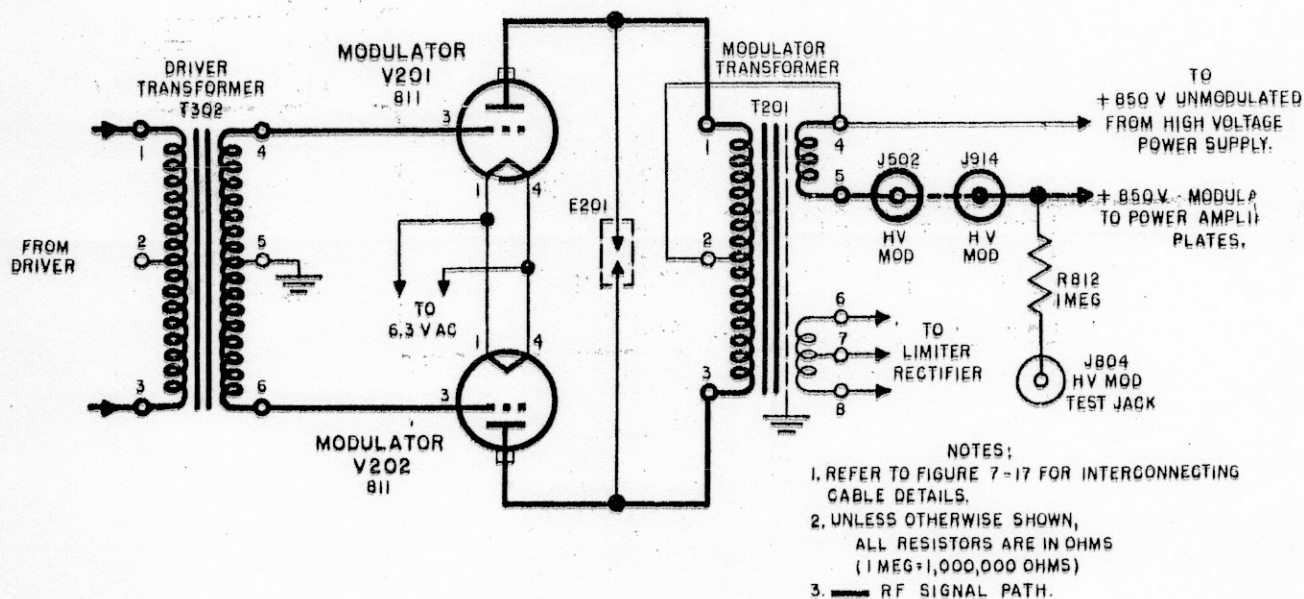


Figure 3-24. Modulator-Power Supply MD-141/GR, Modulator, Simplified Schematic

2.23 Automatic Modulation Limiter

Referring to Figure 3-25, the second output winding of the modulation transformer T-201 is brought out to terminals 6, 7 and 8 on the transformer case. This winding is connected such that the center tap is connected to a variable source of "B" plus voltage. The plus 250 volt supply is fed through a voltage divider to ground. This divider is comprised of resistors R-334 and R-336 with a variable resistor R-335 between them. The variable resistor is the limiter threshold control.

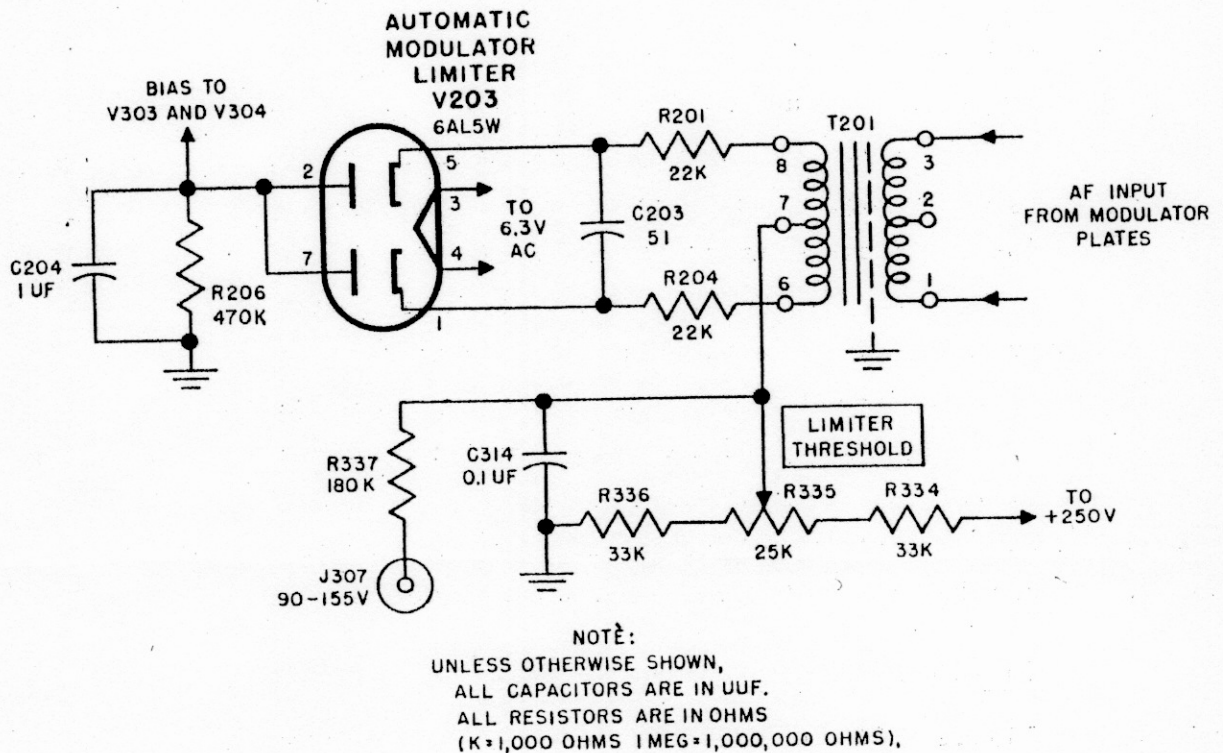


Figure 3-25. Modulator-Power Supply MD-141/GR, Automatic Modulation Limiter, Simplified Schematic

This control will set the dc voltage level appearing at the cathodes of the limiter tube V-203. This is a type 6AL5 tube. The voltage that will appear at the cathodes of the limiter tube will be the resultant of the dc voltage and the audio signal voltage induced in the secondary winding of the transformer. When the negative peaks of audio exceed the dc voltage, the cathode that is on the negative peak will be negative with respect to the plate of the tube. When this condition exists the tube will conduct and the plate will be driven in a negative direction. As the audio level increases there will be a greater negative voltage developed on the plates of the limiter tube. This negative voltage will bias the grids of the modulator AF amplifier and reduce the gain of the amplifier. This is a delayed automatic gain control actuated by the audio level of the modulator.

2.24 Power Input Circuit

Referring to Figure 3-30, the MD-141/GR modulator-power supply operates from either 115 volts or 230 volts. In either case the input power enters the modulator-power supply case at the power plug on the back. This plug is labeled J-504. The power is fed through an RF line filter composed of L-501, L-502, C-504 and C-505. From this RF filter the power goes through the off-on power switch S-403. After the power switch there is a jumper that may be connected in one of two positions. One way the jumper will connect the set for 115 volt operation and the other way it will connect the set for 230 volt operation. Depending on the line voltage to be used, fuse F-201 or F-202 will be in the circuit. These two inputs feed an autotransformer T-202 that will deliver the proper voltage to the power supplies.

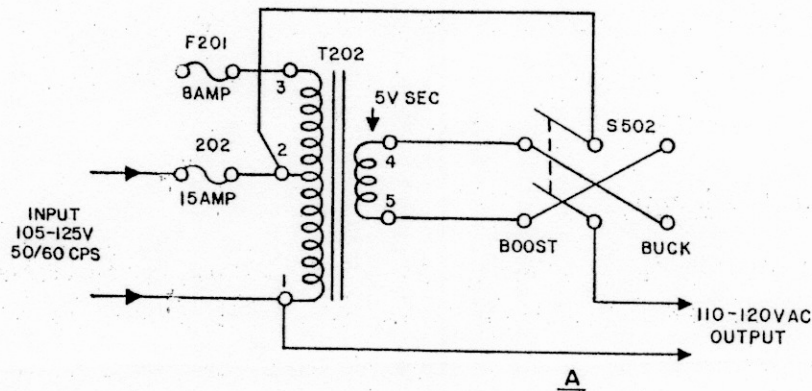
2.25 115/230 Volt Operation

Referring to Figure 3-26, there are two windings on the autotransformer T-202. One winding is conventional autotransformer winding. The three leads from this winding are labeled 1, 2 and 3. When the line voltage is 230 volts the input power is fed to terminals 1 and 3. These are the ends of the winding. When the line voltage is 115 volts the input power is fed to terminals 1 and 2. This is one half of the winding. All operation of

T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

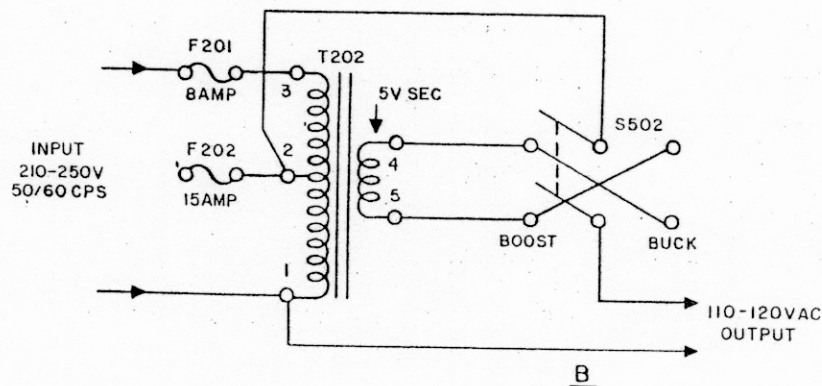
3-37

the transmitter is at the 115 volt level. When the line voltage is 230 volts the autotransformer steps the voltage down to 115 volts. When the line voltage is 115 volts the input to the autotransformer is the same as the output. To provide a correction for the input line voltage, there is a "BUCK-BOOST" switch on the back of the modulator unit. The second winding on the autotransformer is a 5 volt winding. This winding is connected to the "BUCK-BOOST" switch which acts as a reversing switch for the 5 volt winding which is in series with the autotransformer winding. When the 5 volt winding is aiding the output of the autotransformer the "BUCK-BOOST" switch will be in the boost position and when the 5 volt winding is opposing the output of the autotransformer the "BUCK-BOOST" switch will be in the buck position. This adjustment will allow for a correction of 5 volts increase or decrease in the line voltage that is applied to the set.



THROW S502 TO BOOST IF INPUT
BELOW 115 VAC.

THROW S502 TO BUCK IF INPUT
ABOVE 115 VAC.



THROW S502 TO BOOST IF INPUT
BELOW 230 VAC.

THROW S502 TO BUCK IF INPUT
ABOVE 230 VAC.

NOTE:
FOR SIMPLICITY, INTERCONNECTING
TERMINAL BOARDS ARE NOT SHOWN.

138/3 9/58 Figure 3-26. Modulator-Power Supply MD-141/GR,
Line Adjustment Circuit, Simplified Schematic

2.26 Bias Supply

The adjusted output voltage from transformer T-202 is used to feed all of the other power supplies in the transmitter. The primary circuits to the bias supply are shown in Figure 3-27. In the modulator unit the front access door interlock and the air interlock are in series with the primary power. In the transmitter, the air filter interlock, the monitor-screen modulator interlock and the air interlock are all in series with this circuit. With all of the interlocks closed the power is connected to the power input circuit of the bias supply. Fuse F-104 is in series with this circuit. All of the negative bias voltages used in the transmitter are developed in this power supply. These voltages range from a -100 volts to a -35 volts.

2.27 Low Voltage DC Supply

The adjusted primary power to the low voltage DC supply goes through the contacts of the plate relay to the primary of the power transformer in the low voltage supply. The other side of this primary winding is connected to the common power lead from the main switch. Fuse F-103 is in series with this circuit. For a simplified circuit diagram see Figure 3-28. The output of this power supply is +300 volts and +250 volts.

2.28 High Voltage DC Supply

The adjusted output of the supply power is fed to the high voltage transformer which is in parallel with the low voltage transformer primary. The diagram of this circuit is shown in Figure 3-29. The output of the supply is fed to the transmitter direct and also to the secondary of the modulation transformer. This provides both a modulated and an unmodulated high voltage to the transmitter. The unmodulated high voltage also feeds the plates of the modulator stage. The unmodulated voltage to the transmitter is fed to the driver plate and to the plate circuit of the screen modulator tube V-706. The modulated high voltage is fed to the plates of the final stage and also to the grid of the screen modulator tube. Only the audio portion of this voltage is used to drive the grid. The output of the high voltage DC supply is 850 volts.

T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

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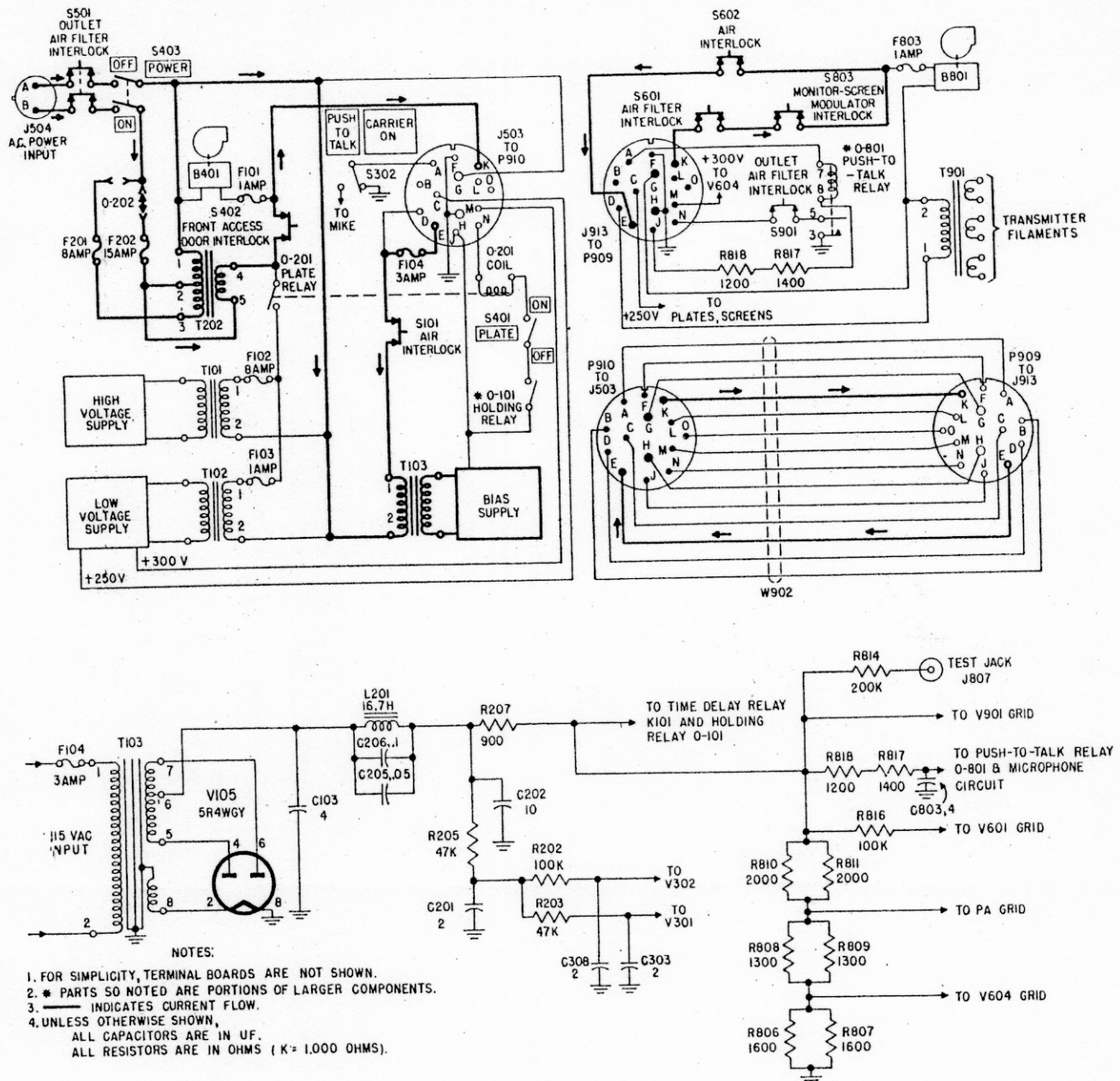


Figure 3-27. Bias Supply, Simplified Schematic

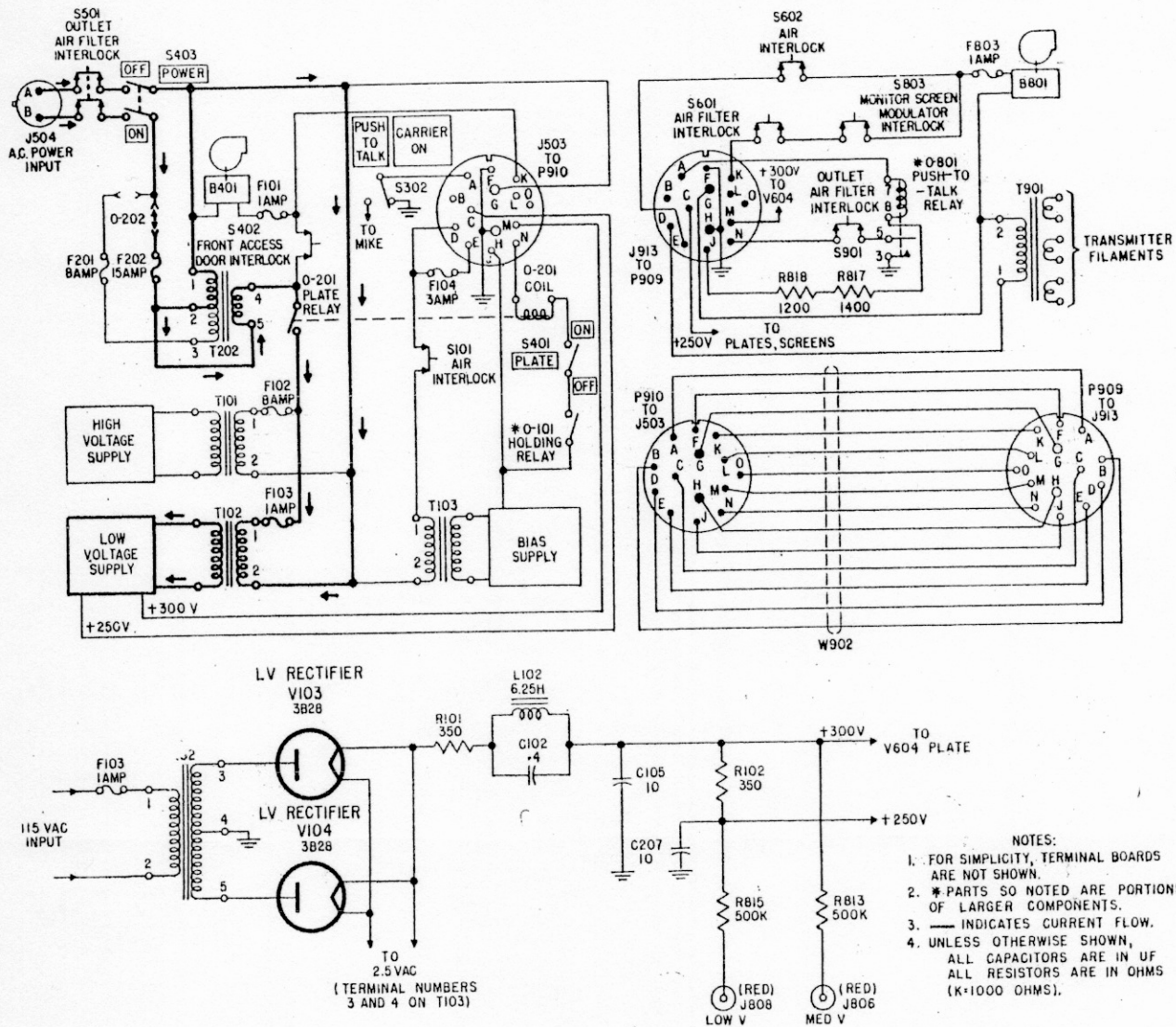


Figure 3-28. Low Voltage D-C Supply, Simplified Schematic

T-282/GR TRANSMITTER
MD-141/GR MODULATOR-POWER SUPPLY

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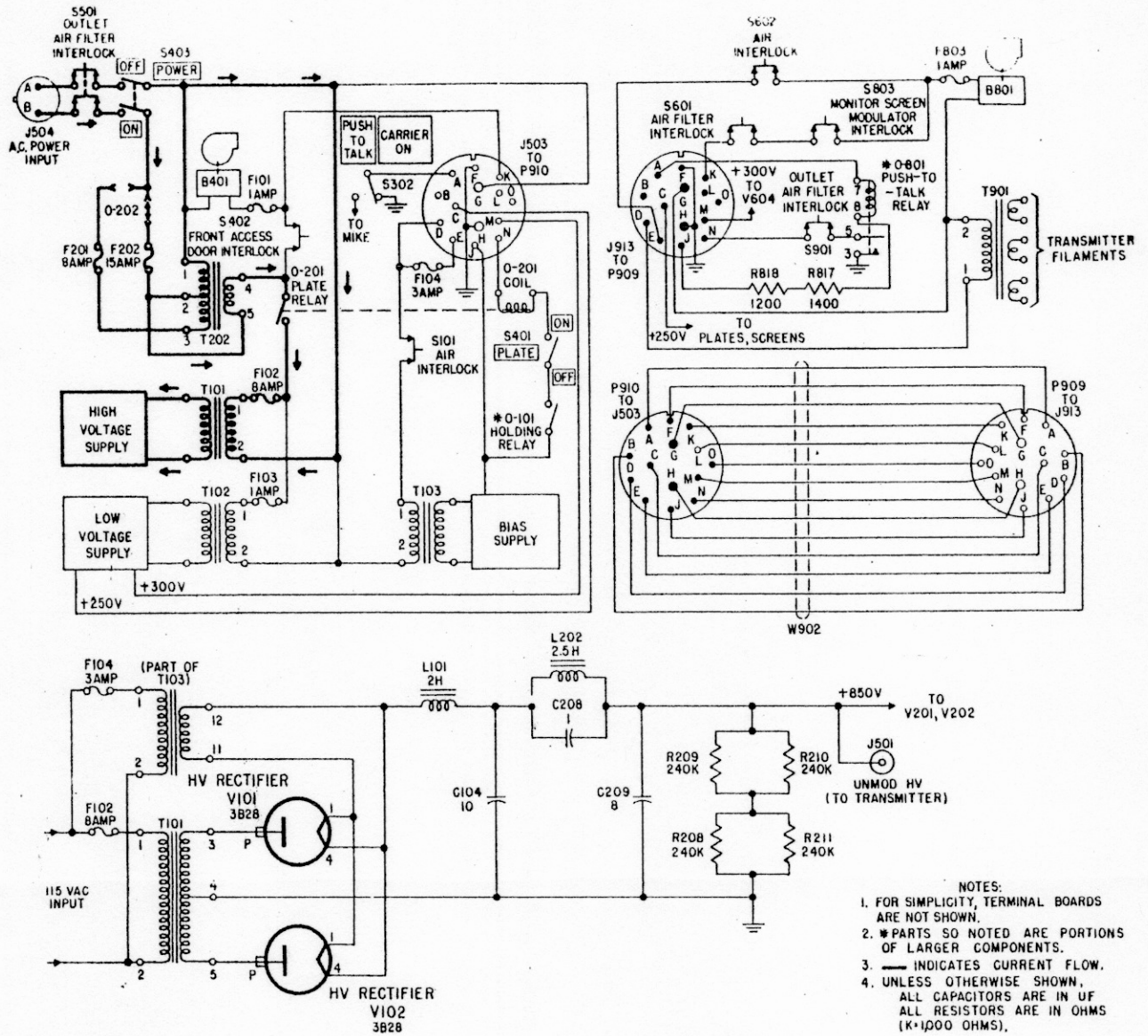


Figure 3-29. High Voltage D-C Supply, Simplified Schematic

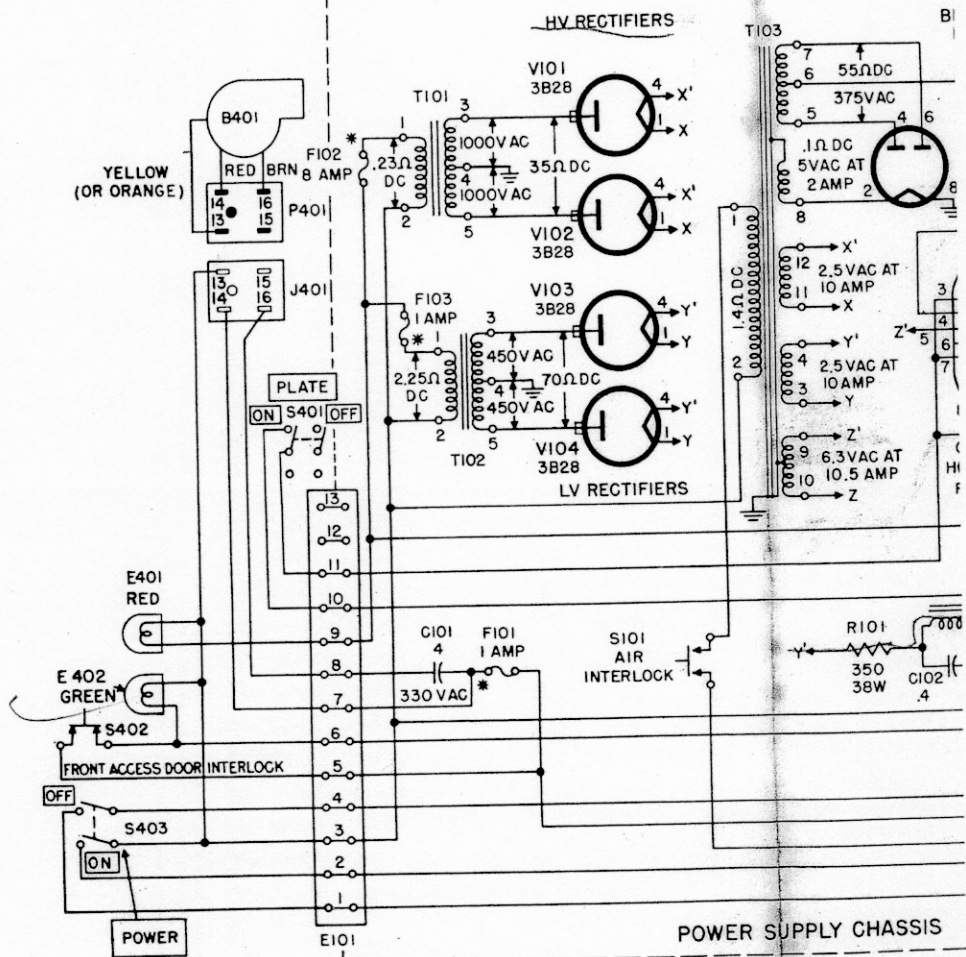
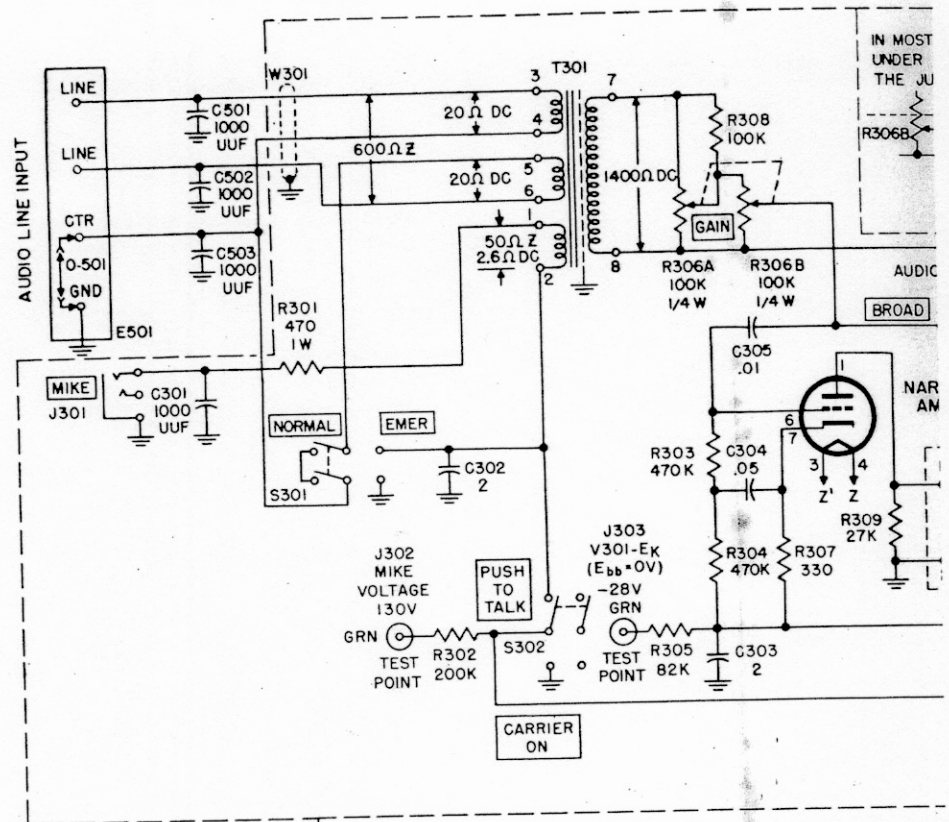
2.29 Time Delay Operation

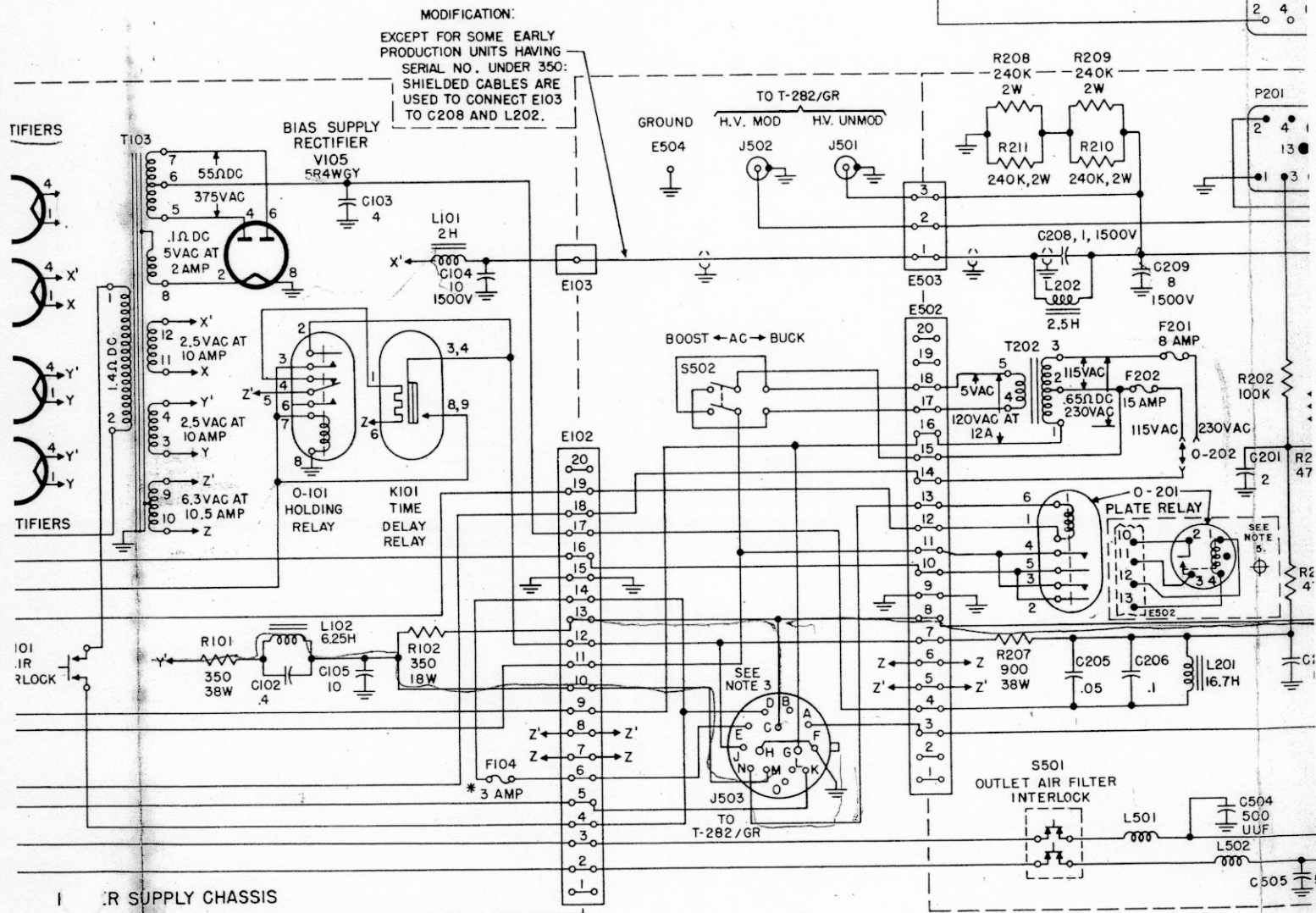
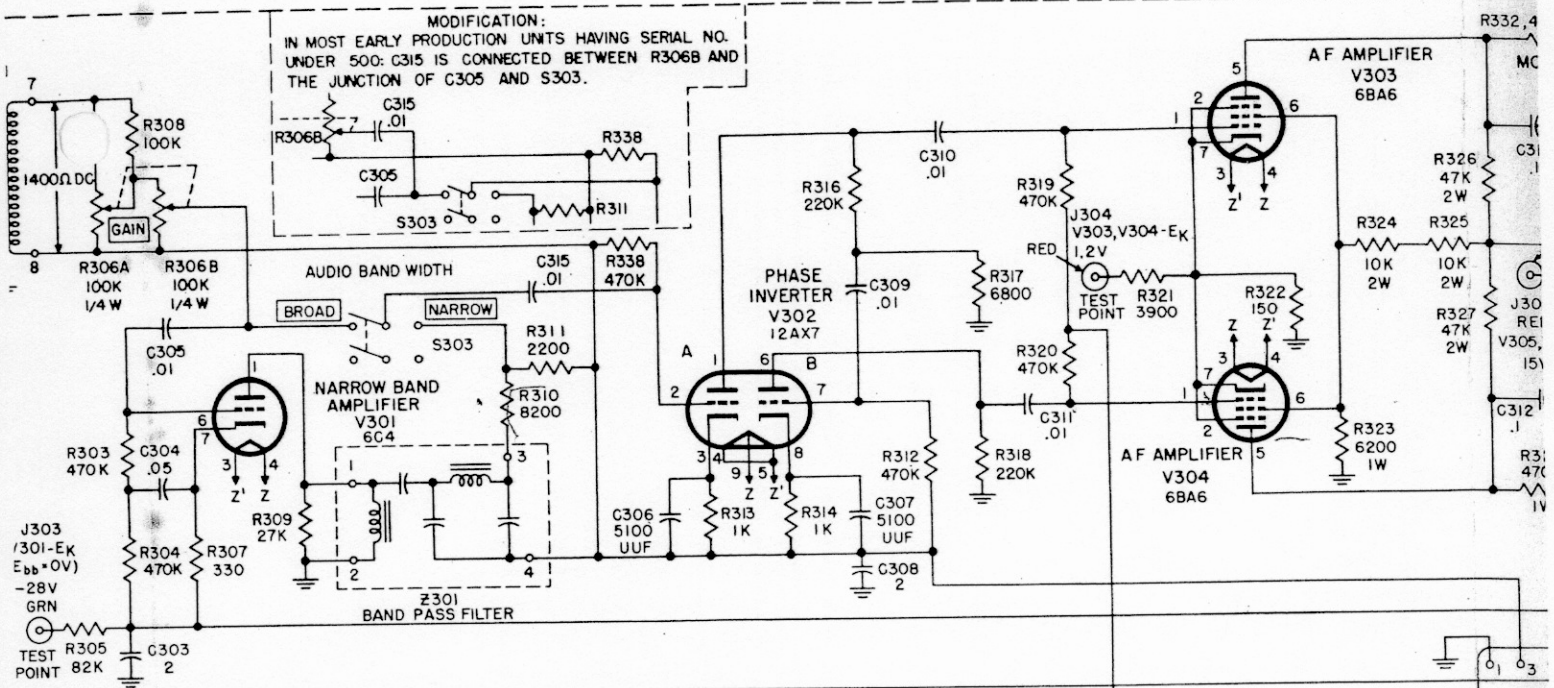
Referring to Figure 3-30, the time delay relay K-101 in conjunction with holding relay 0-101 keeps the plate relay 0-201 from being energized until a time of one minute has elapsed. The time delay relay is a temperature operated device. Terminals 1 and 6 are the heater. This circuit is connected to the filament winding of the filament transformer with one pair of contacts in the holding relay in series with one side of the line. The contacts in the holding relay, terminals 4 and 5, are closed as long as the holding relay is in the unenergized position. This causes the filament or heater in the time delay relay to heat as soon as the set is turned on. After the one minute of time has elapsed, the bimetal bar in the time delay relay will have altered its shape such that the contacts in this relay will close and the -100 volts on its terminals 3 and 4 will be applied to the winding of the holding relay 0-101. As the holding relay operates, the contacts between terminals 2 and 3 of the holding relay will close and hold this relay closed until the set is turned off. Also, when the contacts between 2 and 3 close, the -100 volts is applied through the plate switch to the winding of plate relay 0-201. The closing of the holding relay also opens the circuit to the heater of the time delay relay. Thus, there is no voltage applied to the heater of the time delay relay during the operation of the set; only while it is warming up.

2.30 Voltage Measurements in the Modulator

There is a panel on the modulator unit with test jacks to measure the various voltages in the modulator unit. "METER 1" on the transmitter may be used with the "METER SELECTOR SWITCH" in position 9 to make most of the measurements available at the jacks on the modulator unit. The meter multiplier resistor for each circuit is incorporated in each circuit to be measured. For each jack, the full scale value of the meter is indicated on the rear side of the test jack cover plate. Also, the average reading that should be obtained at each jack is shown on the rear side of the test jack cover plate.

Freq. Range
 200 400 Mc.
 ice or Modified Colpitts Oscillator
 1B6
 3X2X2X3





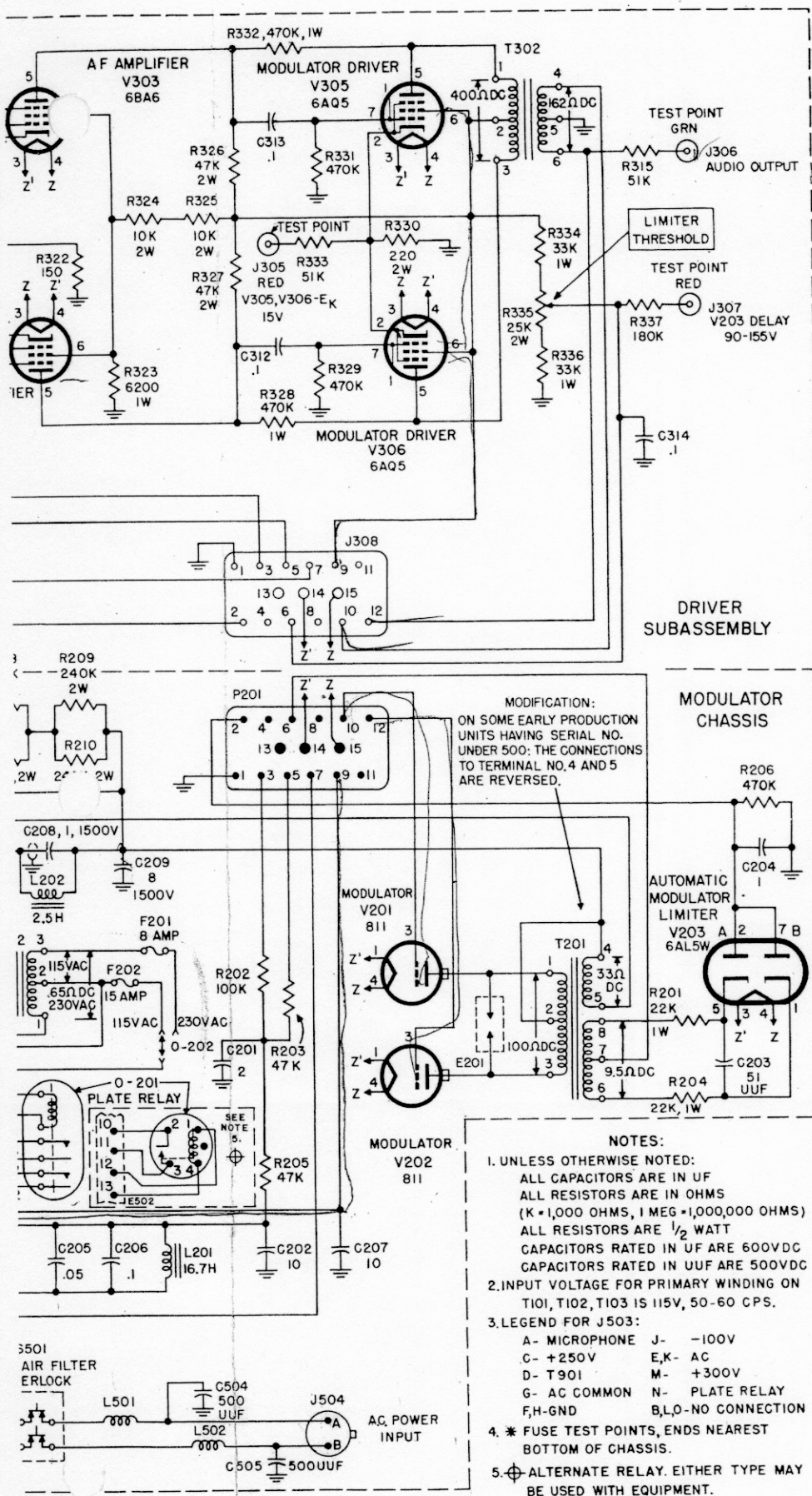


Figure 3-30 Modulator-Power Supply MD-141/GR, Schematic Diagram.

3 uv input modulation 30% 1Kc
will produce at least 10db SN at least 10db

1st. Butler CR-32/U
2nd " CR-23/U
1st i-f three tuned circuits
16.4 mc. primary purpose
good image rejection
2nd i-f three stages of
amplification 6 mcs. primary
purpose selectivity.

$r-f \text{ minus } 1st\ i-f = \text{Xtal freq.}$

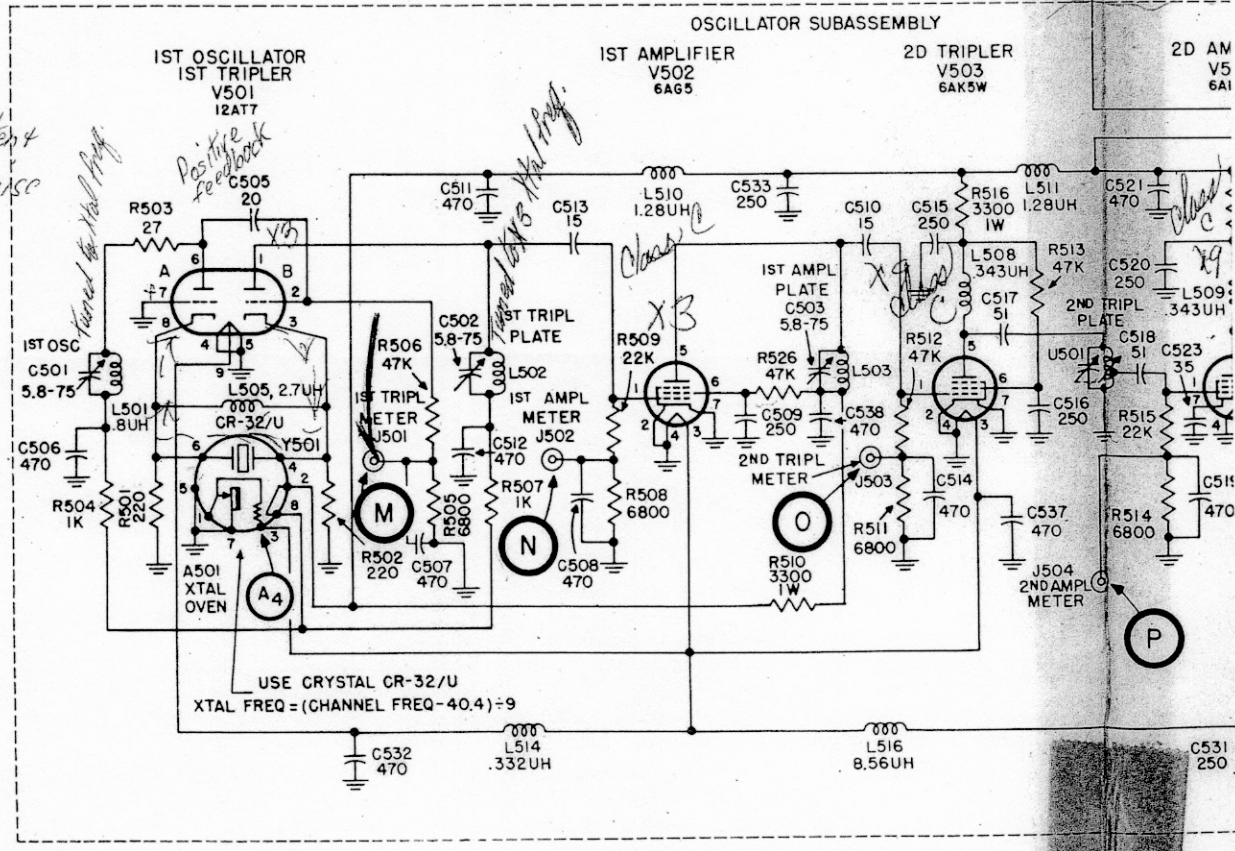
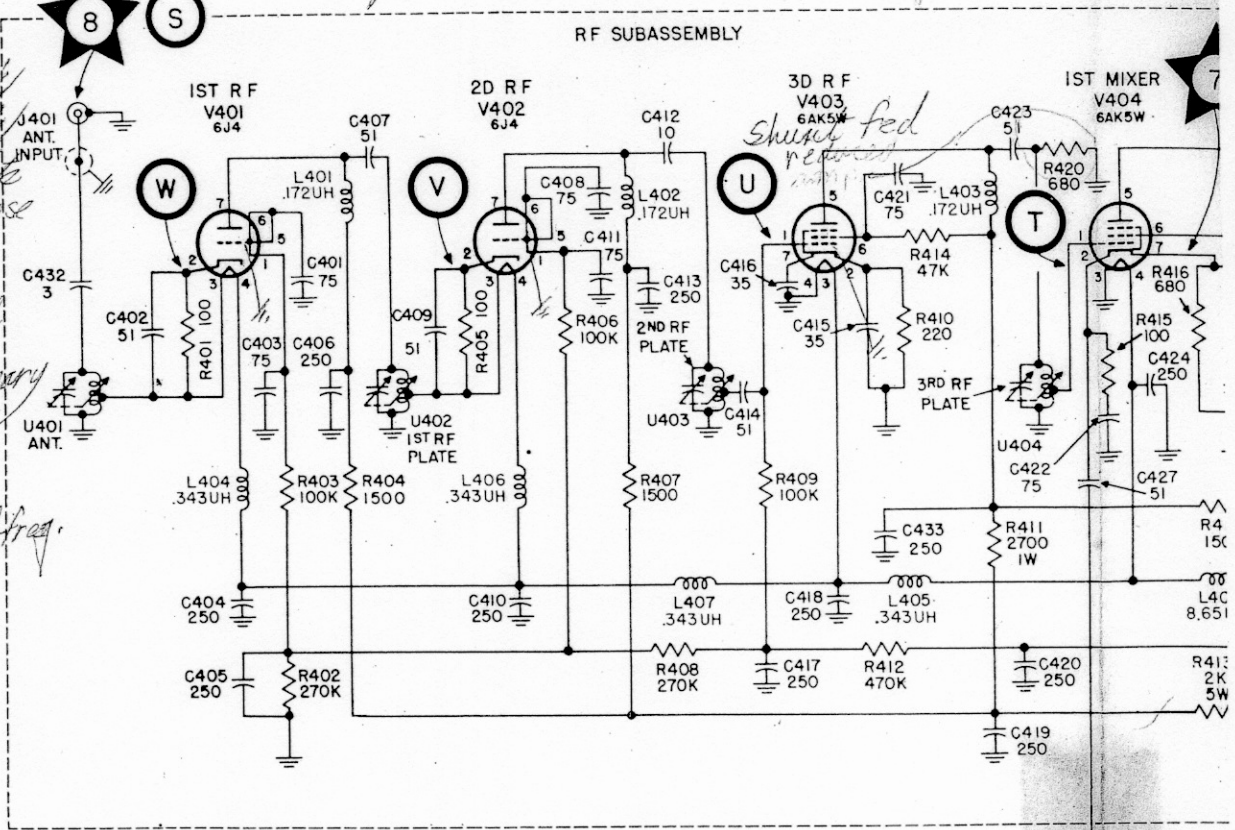
9
 $\text{wave freq} = r-f \pm (2\ i-f)$

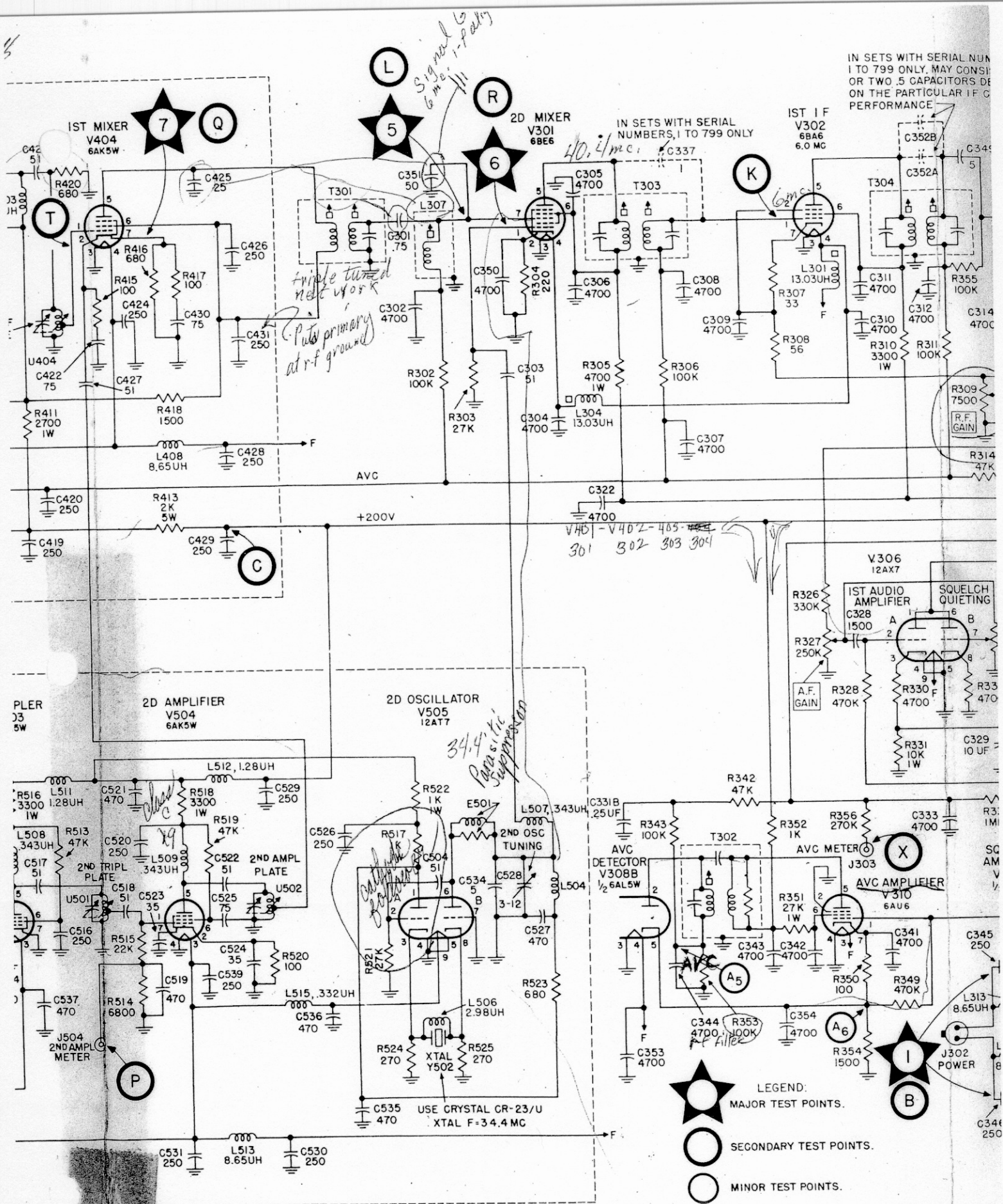
$r-f = 80.8$

$i-f = (f_s - f_o)$

$f_i = 2(f_s - f_o)$

$f_i = 2f_o - f_s$
uses series Noise Limiter &
squell circuit for noise
control





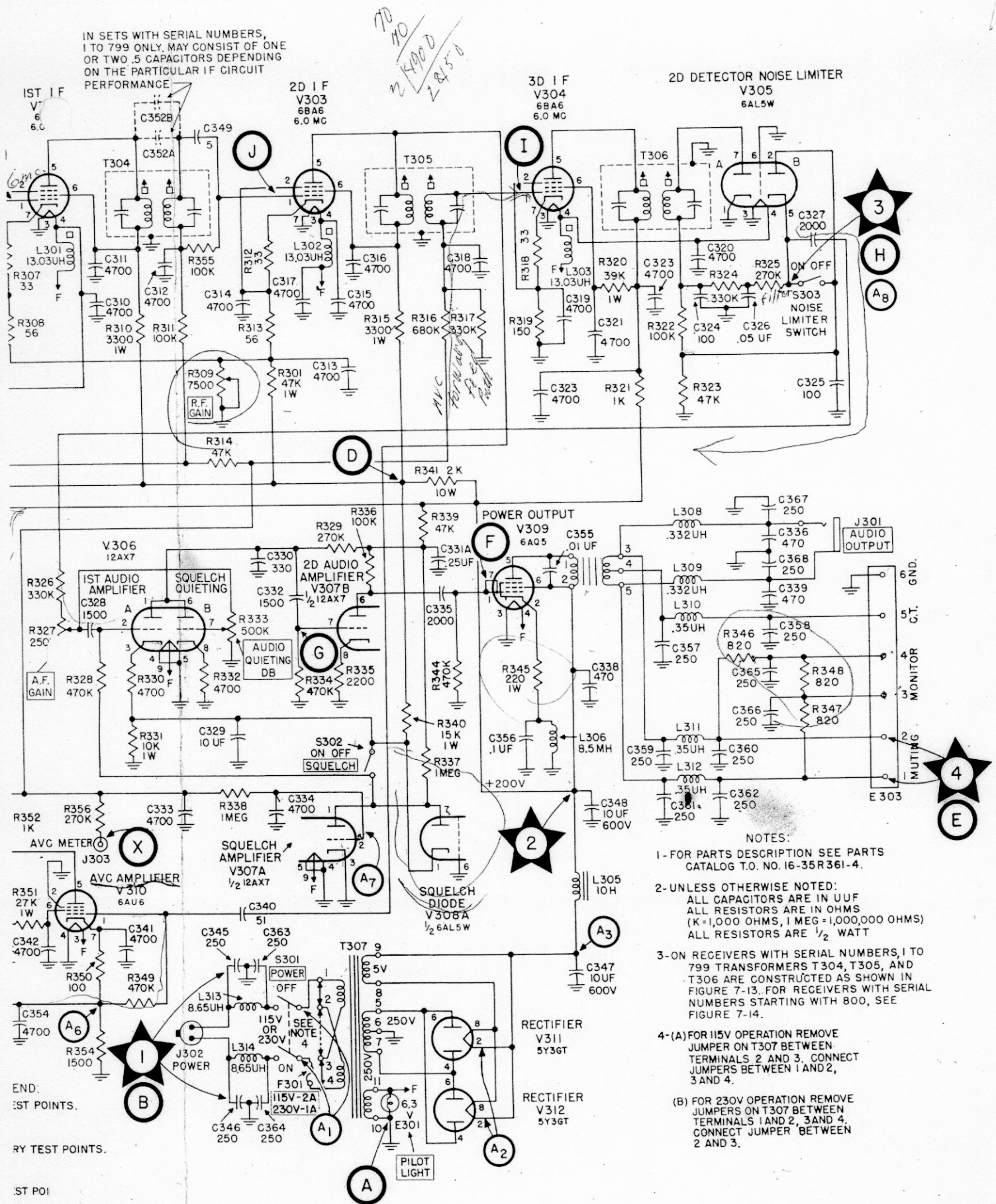


Figure 2-7 Radio Receiver R-361/GR

