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# INSTRUCTION MANUAL

HAMMARLUND

# FOUR·20

TRANSMITTER

# FOUR·11

MODULATOR

HAMMARLUND MANUFACTURING CO., INC.
460 West 34th Street · : : New York 1, N.Y.

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# INSTRUCTION MANUAL

HAMMARLUND

# FOUR·20

**TRANSMITTER**

SECTION 1

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# FOUR·11

**MODULATOR**

SECTION 2

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# FOUR·20

## TRANSMITTER

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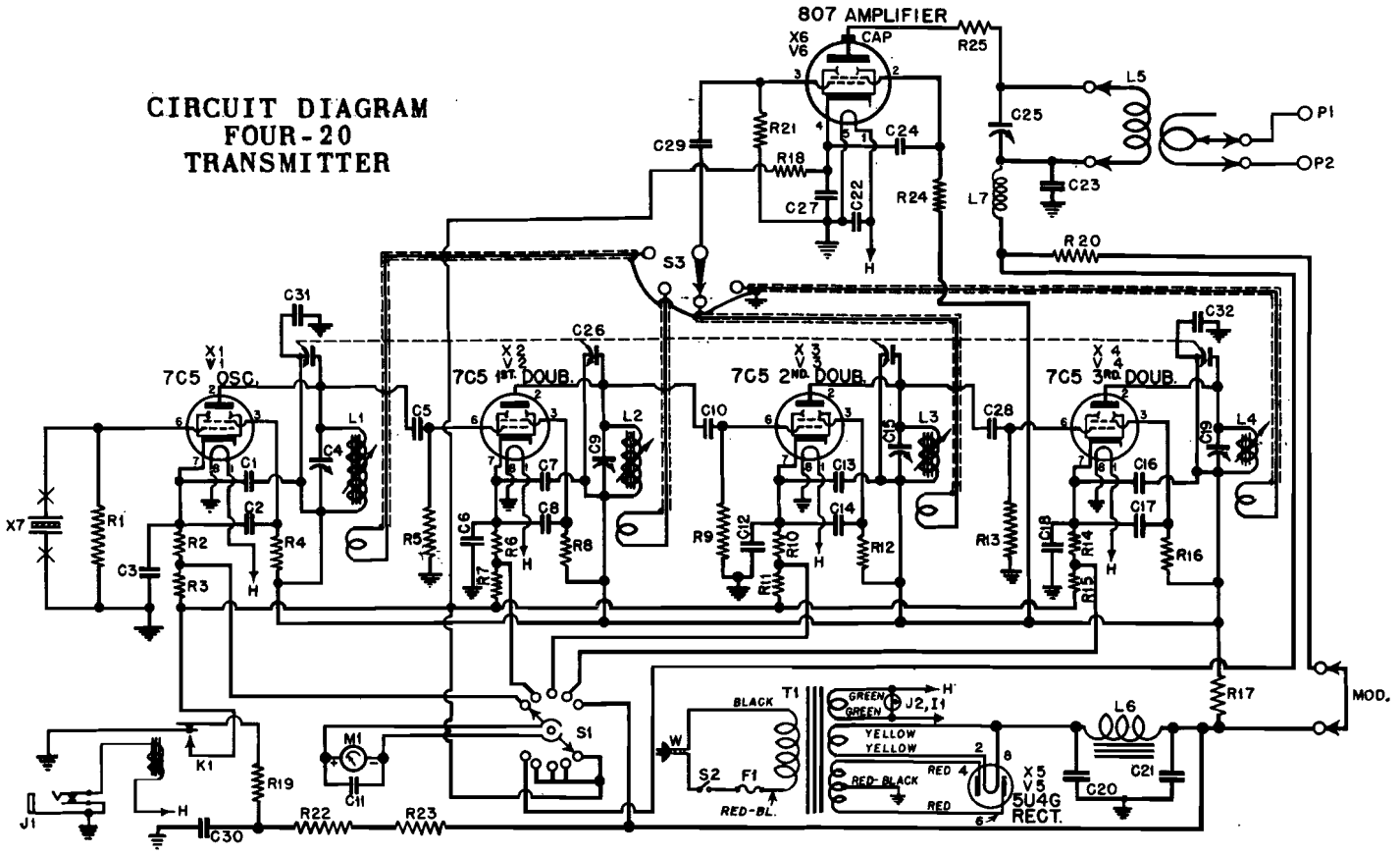
# CIRCUIT DIAGRAM FOUR-20 TRANSMITTER



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# INTRODUCTION

THE HAMMARLUND MODEL FOUR-20 TRANSMITTER is a completely self-contained crystal controlled unit designed for operation in any part of the 3.5, 7, 14, 27 and 28 Mc amateur bands. It has a conservative power output rating of 20 watts on all bands. Although primarily intended for crystal controlled operation with a crystal whose fundamental frequency is within the 3.5 to 4 Mc amateur bands, this unit may be excited from a variable frequency oscillator having an output in the same range and fed into the crystal socket. Provision is made for cw-telegraph keying and also for telephone modulation. When telephone modulation is used, a separate unit such as a Hammarlund Four-11 Modulator may be used. A small high-speed relay is included within the unit for telegraph keying. Operating power for this relay is supplied by the unit and it is necessary only to connect a telegraph key to the transmitter. The oscillator and multiplier circuits are of the sharply resonant type rather than the lower efficiency broad band types so commonly used. Circuits of this type assure the highest possible efficiency. Single dial control of the oscillator and multiplier circuits is possible through the use of mono-sequence tuning. (The features of this system are disclosed in U.S. Patent #2,388,233.) The oscillator portion has been carefully engineered and designed to obtain a maximum frequency stability for for a given crystal. The power required from the crystal is negligible and therefore drift due to the heating of the crystal by radio frequency currents is practically non-existent. A milliammeter is included with a switching arrangement to permit the metering of each R.F. tube.

The Hammarlund Four-20 Transmitter is 8-1/4" high, 15-1/4" wide, and 9-1/2" deep. The total weight is 31 lbs.

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# DESIGN

7C5LT beam tubes are used in the oscillator and three frequency multiplier stages in a mono-sequence tuning system. An 807 tube is used as a power amplifier. Excitation to the grid of the power amplifier is taken from the oscillator or any one of the multiplier stages by means of a selector switch. Plug-in coils are used in the output circuit of the power amplifier. These plug-in coils are accessible by removing the top cover of the transmitter and are equipped with an output coupling arrangement with an adjustable tap to permit matching the output of the transmitter to any of the conventionally used antenna feeder systems. This output system will match a line of any impedance between 50 and 600 ohms. The power supply uses a 5U4G full wave rectifier tube in a conventional power supply and filter circuit and provides ripple free plate power to all stages.

Panel controls are provided for tuning the oscillator and multiplier stages, the power amplifier output circuit, and for the metering system. A switch is provided on the front panel for turning the power on and off and a pilot light indicates when the power is on. A crystal socket on the rear of the unit is designed to accept a modern type crystal holder having a pin diameter and spacing equivalent to the Signal Corps type FT-243 holder.

A telephone jack is mounted on the rear for the purpose of plugging in a telegraph key. A terminal block is provided for connections to the modulator and two feed-through bushings provide a means for connection to the R.F. transmission line.

# OPERATION

After unpacking the transmitter make sure that all tubes are properly fitted into their respective sockets and that the plate cap is in place on the 807 amplifier tube. This transmitter operates on a standard 105-120 volt A.C. 50 to 60 cycle power line. If you are uncertain as to the power available, check with your local power company office.

Insert the proper output coil for the band in which you wish to operate and adjust the frequency

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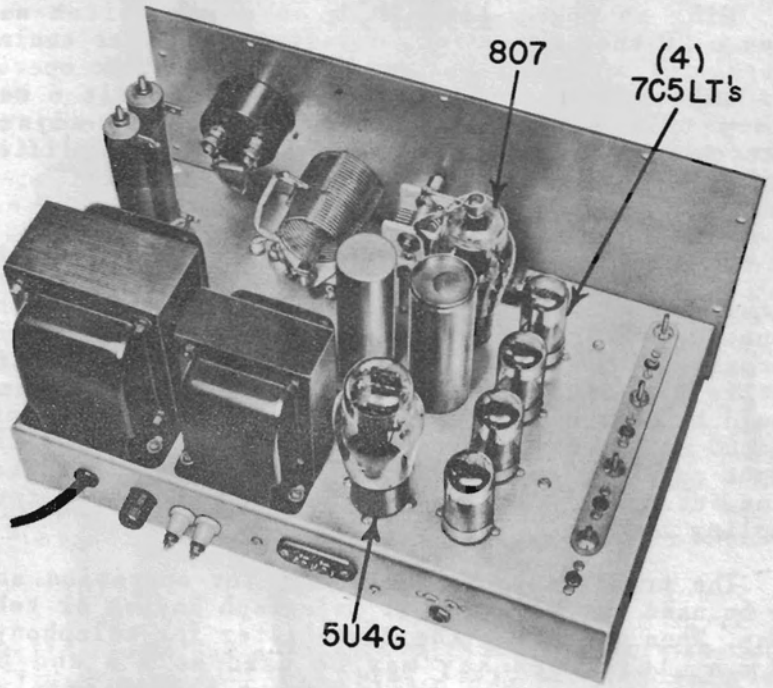


selector switch to a corresponding frequency. Insert the crystal in its socket at the rear of the transmitter and connect the antenna transmission line to the antenna terminals. Adjust the meter selector switch to read cathode current of the multiplier which corresponds to the frequency band you wish to use.

*Note: The meter switch is marked 'osc.', '1st D', '2nd D', '3rd D', and 'amp.'. If operation is to be on 28 MC set this switch to '3rd D', if operation is to be at 14 MC set switch to '2nd D', and if operation is to be at 7 MC set the switch to '1st D', and if the operation is to be at 3.5 MC set the switch on 'osc.'.*

If the transmitter is to be used for telephone modulation connect the modulator to the terminals marked 'modulator' at the rear of the chassis. If the transmitter is to be used for cw-telegraph operation be sure that these terminals are short-circuited before turning on the power.

Be sure that the cover is in place on the top of the unit, with all fasteners securely locked.

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Plug in power cord, turn on power switch and allow a 20 second warm up. Adjust the exciter tuning control for minimum meter reading. (For 3.5 Mc operation adjust this control clockwise to obtain 6 ma. higher than minimum meter reading.) Next adjust plate current switch to AMP. and adjust the amplifier tuning control for minimum current.

When properly loaded, the amplifier plate current will be approximately 60 ma. If the plate current is higher than this value adjust the tap on the output coupling coil until the minimum reading is approximately 60 ma. Likewise, if the minimum current is less than the above value, an adjustment should be made on this tap. A minimum reading of more than 60 ma. generally indicates *too many* turns in the output coupling coil. A minimum reading of *less* than 60 ma. usually indicates too few turns in the output coupling coil.

The transmitter is now ready for operation and may be used for either c.w. telegraph keying or telephony. When operating the transmitter for telephony, the c.w. telegraph key may be used as a stand-by operate switch or the leads from a telephone plug may be brought out to an auxiliary switch for this purpose.

## REALIGNMENT PROCEDURE

The mono-sequence tuning system has been carefully aligned at the factory and should not be tampered with unless a vital part such as a coil is replaced in which case the unit should be returned to the factory for realignment. The adjustments for this system are the screwdriver adjustments seen to the left of the 7C5LT tubes, looking down at the chassis, facing the front panel. The adjustments with the screwdriver slots surrounded by a hexagon nut are the capacity trimmers, and the screwdriver adjustments in the ends of the threaded shafts are the inductance trimmers.

The realignment procedure below must be followed carefully.

A 3400 KC crystal and a 4000 KC crystal will be required.

Turn the meter selector switch to 'osc.'.

1. Insert the 4000 KC crystal. Set the exciter tuning control to 80 on scale. Adjust the oscillator

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capacity trimmer for a minimum reading, and then *reduce* the trimmer capacity until the meter reads approximately 6 MA. higher than the minimum.

2. Replace the 4000 KC crystal with a 3400 KC crystal. Set the exciter tuning control to 28[illegible] degrees. Adjust the *inductance* trimmer for a minimum plate current reading, and then rotate the inductance trimmer counter clockwise until the plate current increases approximately 6 MA.

Replace the 3400 KC crystal with the 4000 KC crystal and re-adjust the trimmer capacity as in 1 and repeat 2. Keep repeating 1 and 2 until a change is no longer necessary in either the trimmer capacity or inductance adjustment.

3. Insert the 4000 KC crystal. Set the meter selector switch to 1st D. Adjust the exciter tuning control to [illegible]80 on scale. Adjust the 1st doubler capacity trimmer for a *minimum* reading of the meter. Replace the 4000 KC crystal with a 3400 KC crystal. Rotate the exciter tuning control to 28[illegible] degrees. Adjust the first doubler *inductance* trimmer for a minimum reading of the meter.

Repeat these two procedures until the plate current in the first doubler stage is minimum on each frequency when the exciter tuning control is at the specified setting. *Check to be sure that these settings correspond to the exact position of this control which produces the correct oscillator plate current reading as described in steps 1 and 2.*

Repeat the same procedure for the second and third doubler stages. When properly aligned, the current in all multiplier stages will be at a minimum at the proper setting of the exciter tuning control, and the oscillator plate current will be approximately 6 MA. higher than its minimum.

## ANTENNA SUGGESTIONS

The antenna system is perhaps one of the most important parts of any radio installation. No amount of power output from a transmitter will be useful for communication purposes unless that power is radiated. The best performance will be realized with the use of a more or less complicated array consisting of a radiator with a reflector and one or more directors, or with some other system such as a rhombic, 'V' beam, etc. Such antennae are described in various handbooks and manuals generally *available*

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from your dealer. Considerable study is required in order to understand the operation of such arrays, and much care must be exercised in their erection and adjustment. The results derived from the use of such arrays will repay the user many fold for his efforts.

The output circuit of the Hammarlund 'Four-20' transmitter is capable of adjustment to match the feeder systems of all popular arrays, as well as a simple antenna system.

The more simple radiating systems comprise a dipole radiator connected to the transmitter by means of a balanced transmission line as shown in **Fig.** 1, a 'folded dipole' antenna as shown in **Fig.** 2, or even a vertical radiator as shown in **Fig.** 3. These systems while rather elementary, will perform quite satisfactorily.

An antenna system incorporating a balanced transmission line feeder system is recommended above all others, whether the radiator is an array, a folded dipole, or a simple half wave dipole. An unbalanced feeder system will radiate a part of the energy before it reaches the radiator. This reduces the power fed to the radiator and is likely to produce feedback in the audio system, in the receiver, etc. because of radiation, from the portion of the line within the operating room.

## MAINTENANCE

The Hammarlund Four-20 Transmitter should give long and satisfactory service without need for repair. The first source of trouble is most likely to be the tubes and in case of failure they should be checked by a reliable technician. The 2nd most common source of trouble may be found in a large assortment of small resistors and capacitors. The chart below gives the value of voltages between the tube sockets and ground or the B negative side of the circuit. These values are measured with a meter having a D.C. resistance of 1000 ohms per volt. Measurements are made with the crystal removed from this socket and with the line voltage of 117 V A.C. A chart is also included showing the approximate resistance to ground for each tube socket terminal. On measuring resistances to ground be sure that the power plug is removed from the wall socket.

## WARNING

These measurements should be made by an experienced technician using the proper precautions to

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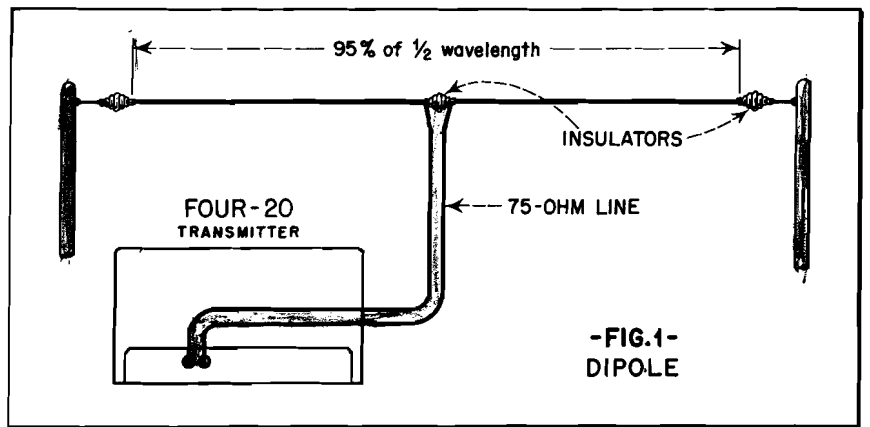
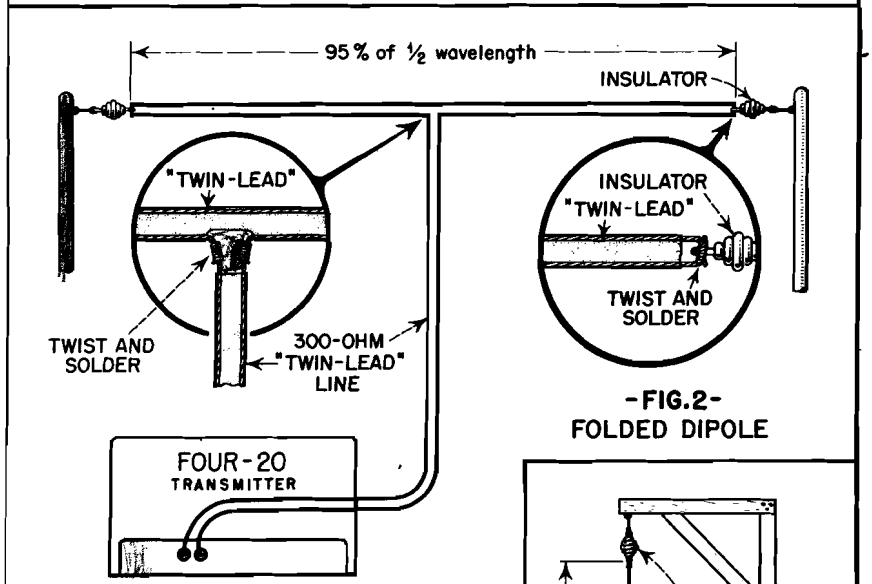



-FIG.1-
DIPOLE




-FIG.2-
FOLDED DIPOLE

SIMPLE RADIATING SYSTEMS SUGGESTED FOR USE WITH FOUR-20 TRANSMITTER

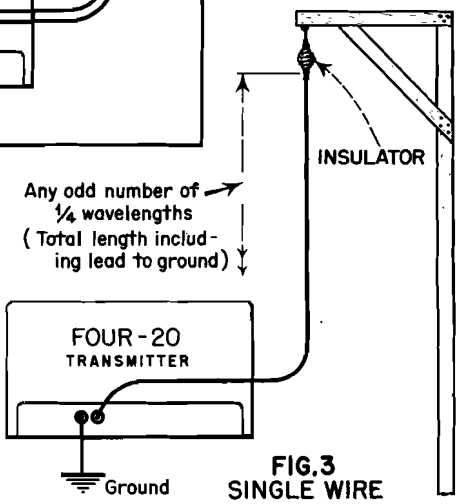



FIG.3
SINGLE WIRE

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prevent accidental bodily contact with any of the electrical circuits. While the potentials in this unit may not be extremely high, accidental contact with a 'live' circuit could be dangerous. The unit should be returned to the factory for all such checks, as the manufacturer can not assume any responsibility for accidental electrical shock to persons making 'live' circuit checks.

## RESISTANCE MEASUREMENTS BETWEEN SOCKET TERMINALS AND GROUND USING A 1000 OHM PER VOLT METER

Plate current switch to AMP. "ON"-"OFF" switch "OFF".

| Tube | 7C5 Osc. | 7C5 1st. D. | 7C5 2nd D. | 7C5 3rd D. | 807 Amp. | 5U4G Rect. |
|---|---|---|---|---|---|---|
| Pin 1 | | | | | | |
| Pin 2 | 6700 | 6700 | 6700 | 6700 | 21700 | |
| Pin 3 | 28700 | 28700 | 28700 | 28700 | 18000 | |
| Pin 4 | | | | | | |
| Pin 5 | | | | | | |
| Pin 6 | 22000 | 270,000 | 270,000 | 270,000 | | |
| Pin 7 | *415 | *415 | *415 | *415 | | |
| Pin 8 | | | | | | |
| CAP | | | | 5300 | | |

*With the relay armature held by hand in the operate position. (Key closed).

Line voltage 117 V.A.C. Key closed. No crystal plugged in.

1000 ohm per volt voltmeter used to measure all D. C. voltages.

| Tube | 7C5 Osc. | 7C5 1st. D. | 7C5 2nd D. | 7C5 3rd D. | 807 Amp. | 5U4G Rect. |
|---|---|---|---|---|---|---|
| Pin 1 | 6.3 A.C. | 6.3 A.C. | 6.3 A.C. | 6.3 A.C. | 6.3 A.C. | |
| Pin 2 | 270 | 270 | 270 | 270 | 200 | 500 |
| Pin 3 | 210 | 210 | 210 | 210 | | |
| Pin 4 | | | | | 7.5 | 485 A.C. |
| Pin 5 | | | | | | |
| Pin 6 | | | | | | 485 A.C. |
| Pin 7 | 11 | 11 | 11 | 11 | | |
| Pin 8 | | | | | | |
| Plate Cap | | | | | 470 | |

NOTE: A license from the Federal Communications Commission is required to operate a transmitter.

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | PART NUMBER |
|---|---|---|---|
| C1 | CAPACITOR, Fixed mica, 2700 mmf. ±10%, 500WVDC | Oscillator plate by-pass | 23009-19 |
| C2 | CAPACITOR, Same as C1 | Oscillator screen by-pass | 23009-19 |
| C3 | CAPACITOR, Fixed mica, 5000 mmf. ±20%, 500WVDC | Oscillator cathode by-pass | 23069-9 |
| C4 | CAPACITOR, Variable, 25 mmf. (APC) | Oscillator padding | 11725-G1 |
| C5 | CAPACITOR, Fixed mica, 100 mmf. ±10%, 500WVDC | 1st doubler grid coupling | 23001-23 |
| C6 | CAPACITOR, Same as C1 | 1st doubler cathode by-pass | 23009-19 |
| C7 | CAPACITOR, Same as C1 | 1st doubler plate by-pass | 23009-19 |
| C8 | CAPACITOR, Same as C1 | 1st doubler screen by-pass | 23009-19 |
| C9 | CAPACITOR, Same as C4 | 1st doubler padding | 11725-G1 |
| C10 | CAPACITOR, Same as C5 | 2nd doubler grid coupling | 23001-23 |
| C11 | CAPACITOR, Same as C1 | Meter by-pass | 23009-19 |
| C12 | CAPACITOR, Same as C1 | 2nd doubler cathode by-pass | 23009-19 |
| C13 | CAPACITOR, Same as C1 | 2nd doubler plate by-pass | 23009-19 |
| C14 | CAPACITOR, Same as C1 | 2nd doubler screen by-pass | 23009-19 |
| C15 | CAPACITOR, Same as C4 | 2nd doubler padding | 11725-G1 |
| C16 | CAPACITOR, Same as C1 | 3rd doubler plate by-pass | 23009-19 |
| C17 | CAPACITOR, Same as C1 | 3rd doubler screen by-pass | 23009-19 |
| C18 | CAPACITOR, Same as C1 | 3rd doubler cathode by-pass | 23009-19 |
| C19 | CAPACITOR, Same as C4 | 3rd doubler padder | 11725-G1 |
| C20 | CAPACITOR, Dykanol 4 mfd. ±10% 600WVDC | Power supply filter | 23843-3 |
| C21 | CAPACITOR, Dry electrolytic 16 mfd. 600WVDC. | Power supply filter | 23842-13 |

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | PART NUMBER |
|---|---|---|---|
| C22 | CAPACITOR, Fixed mica, 10,000 mmf. ±10%, 300WVDC | P. A. Heater by-pass | 23015-13 |
| C23 | CAPACITOR, Fixed mica, 1000 mmf. ±10%, 1200WVDC | P. A. Plate supply by-pass | 23040-235 |
| C24 | CAPACITOR, Same as C22 | P. A. Screen by-pass | 23015-13 |
| C25 | CAPACITOR, Spec. HFA, Variable 50 mmf. | P. A. Tuning | 11033-G25 |
| C26 | CAPACITOR, Variable, 4-gang, 35 mmf., 600VRMS | Oscillator multiplier tuning | 11738-1 |
| C27 | CAPACITOR, Same as C22 | P. A. Cathode by-pass | 23015-13 |
| C28 | CAPACITOR, Same as C5 | 3rd doubler grid coupling | 23001-23 |
| C29 | CAPACITOR, Same as C1 | P. A. Grid coupling | 23009-19 |
| C30 | CAPACITOR, Tubular paper, Waxed, .05 mfd. +30-10%, 600WVDC | Keying click filter | 23912-2 |
| C31,32 | CAPACITOR, Molded mica 8200 mmf. ±10%, 500WVDC | By-pass | 23019-11 |
| E1 | FUSEHOLDER, Bakelite body, for panel mtg. | Holder for F1 | 15923-1 |
| F1 | FUSE, 3 amp. 250 Volt | Overload protection | 15928-8 |
| I1 | LAMP, 6-8 V., 0.15 amp., single contact, min. bayonet base, Mazda #47 | Pilot light | 16004-1 |
| J1 | JACK, Phone, 3 circuit | Telegraph Key connection | 6087-1 |

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | PART NUMBER |
|---|---|---|---|
| J2 | LAMPHOLDER, Panel Mtg., min. bayonet base, ruby jewel, for 7/16" mtg. hole | Holder for I1 | 16093-2 |
| K1 | RELAY, Continuous duty, 6 V A.C. supply, 10 ohm coil resist. | Telegraph keying | 15875-1 |
| L1 | COIL, Assembly, 80 Meter | Oscillator Tank | 29812-G1 |
| L2 | COIL Assembly, 40 Meter | 1st Doubler Tank | 29812-G2 |
| L3 | COIL Assembly, 20 Meter | 2nd Doubler Tank | 29812-G3 |
| L4 | COIL Assembly, 10 Meter | 3rd Doubler Tank | 29812-G4 |
| * L5 | TANK COIL, with 5-pin base, Coil inductance- 34 to 44 uh. Link inductance- 9.7 to 11.88 uh | P.A. Tank 80 Meter | 29829-1 |
| | Coil induct.- 9.8 to 11 uh. Link induct. - 6.84 to 8.36 uh. | P.A. Tank 40 Meter | 29829-2 |
| | Coil induct.- 3.4 to 3.9 uh. Link induct.- 3.06 to 3.74 uh. | P.A. Tank 20 Meter | 29829-3 |
| | * Coil induct.- 0.9 to 1.15 uh. Link induct.- 1.17 to 1.44 | P.A. Tank 10 Meter | 29829-4 |

* 10 Meter coil furnished with transmitter. 20, 40 and 80 Meter coils may be purchased from your dealer.

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | |
|---|---|---|---|
| L6 | FILTER REACTOR, 15 hen. @160 MA.DC. 160 ohms DC, Chicago Transf. spec. #3405 | Power Supply filtering | 2981 |
| L7 | CHOKE COIL, 5 pie, 2.1 ±10% MH, 35 ohm DC resist., Dist. Cap. 1 mmf. Current 125 MA. | Power Supply filtering | 609-G1 |
| M1 | METER, Panel type, 0-100 MA.DC. with 50 division scale | Indicator | 16344-1 |
| | KNOB, bar, black phenolic with white indicator line, for 1/4" shaft | For C25 | 16166-1 |
| | KNOB, bar, black pheno., white indicator line, for 1/4" shaft | For S1,S3 & C26 | K26083-1 |
| P1 | INSULATOR, Feed-thru, 6-32 x 1-1/4" stud, for 5/16" mtg. hole, porcelain bushings | | 16133-1 |
| P2 | INSULATOR, Same as P1 | | 16133-1 |
| R1 | RESISTOR, Fixed composition, 22000 ohm ±10%, 1/2 W | Oscillator grid resistor | 19309-81 |
| R2 | RESISTOR, Fixed composition, 390 ohm ±10%, 1 W | Cathode biasing | 19310-39 |
| R3 | RESISTOR, Fixed composition, 27 ohm ±10%, 1/2 W | Oscillator meter shunt | 19309-11 |

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TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | |
|---|---|---|---|
| R4 | RESISTOR, Fixed composition, 22000 ohm ±10%, 1 W | Oscillator screen dropping | 19310-81 |
| R5 | RESISTOR, Fixed composition, 270,000 ohm, ±10%, 1/2 W | 1st Doubler grid resistor | 19309-107 |
| R6 | RESISTOR, Same as R2 | 1st Doubler Cathode resistor | 19310-39 |
| R7 | RESISTOR, Same as R3 | 1st Doubler Meter shunt | 19309-11 |
| R8 | RESISTOR, Same as R4 | 1st Doubler screen dropping | 19310-81 |
| R9 | RESISTOR, Same as R5 | 2nd Doubler grid resistor | 19309-107 |
| R10 | RESISTOR, Same as R2 | 2nd Doubler Cathode biasing | 19310-39 |
| R11 | RESISTOR, Same as R3 | 2nd Doubler meter shunt | 19309-11 |
| R12 | RESISTOR, Same as R4 | 2nd Doubler screen dropping | 19310-81 |
| R13 | RESISTOR, Same as R5 | 3rd Doubler grid resistor | 19309-107 |
| R14 | RESISTOR, Same as R2 | 3rd Doubler cathode biasing | 19310-39 |
| R15 | RESISTOR, Same as R3 | 3rd Doubler meter shunt | 19309-11 |
| R16 | RESISTOR, Same as R4 | 3rd Doubler screen dropping | 19310-81 |
| R17 | RESISTOR, Fixed, Wirewound, 1500 ohm ±10%, 25 W | Oscillator Mult. plate dropping | 19429-22 |

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | |
|---|---|---|---|
| R18 | RESISTOR, Fixed, Wirewound, 100 ohm ±10%, 5 W | P.A. Cathode biasing | 19431-17 |
| R19 | RESISTOR, Fixed, Wirewound, 200 ohm ±10%, 10 W | Key click filter | 19430-20 |
| R20 | RESISTOR, Fixed composition, 27 ohm ±10%, 1 W | P.A. Meter shunt | 19310-11 |
| R21 | RESISTOR, Fixed composition, 8200 ohm ±10%, 2W | P.A. Grid resistor | 19304-40 |
| R22 | RESISTOR, Assembly with thru-bolt mtg. hdwre., 2500 ohm ±10%, 50 W | Artificial Power Supply load | 19433-224 |
| R23 | RESISTOR, Same as R22 | Artificial Power Supply load | 19433-224 |
| R24 | RESISTOR, Fixed, Wirewound, 15,000 ohm ±10%, 10 W | P.A. Screen dropping | 19430-58 |
| R25 | RESISTOR, Wirewound, 4 ohm ±5%, 5W | Parasitic suppression | 15277-1 |
| S1 | SWITCH, Wafer, 1-gang, 2 pole, 2-5 position | Meter selector switch | 15809-2 |
| S2 | SWITCH, Toggle, SPST, 3 amp. 250 V., panel mtg. | Power On-Off switch | 15807-2 |
| S3 | SWITCH, Wafer, 1-gang, 1 pole, 4 position | Band switch | 15829-2 |

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | PART NUMBER |
|---|---|---|---|
| T1 | TRANSFORMER, Power, Electro-static shielding, 115 V. Pri., Sec. 6.6V.-3 amp. max., 5V.-3 amp., 475V.-0.170 MA | Power supply | 4801-2 |
| V1 | VACUUM Tube, 7C5 | Oscillator | 16265-1 |
| V2 | VACUUM Tube, 7C5 | 1st Doubler | 16265-1 |
| V3 | VACUUM Tube, 7C5 | 2nd Doubler | 16265-1 |
| V4 | VACUUM Tube, 7C5 | 3rd Doubler | 16265-1 |
| V5 | VACUUM Tube, 5U4G | Power rectifier | 16215-1 |
| V6 | VACUUM Tube, 807 | Power amplifier | 16230-1 |
| X1 | SOCKET, Locktal, Mtg. plate molded in bakelite | For V1 | 15944-30 |
| X2 | SOCKET, Same as X1 | For V2 | 15944-30 |
| X3 | SOCKET, Same as X1 | For V3 | 15944-30 |
| X4 | SOCKET, Same as X1 | For V4 | 15944-30 |
| X5 | SOCKET, Octal, molded in bakelite mtg. plate with 4 gnd. ears. | For V5 | 16083-1 |
| X6 | SOCKET, 5 prong, mtg. plate molded in mica-bakelite | For V6 | 15944-11 |
| X7 | SOCKET, for crystal, ceramic base, contact centers 1/2" | Crystal Holder | 16092-1 |
| X8 | SOCKET, Wafer, 5-prong, Steatite base | For L5 | 16137-2 |

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | PART NUMBER |
|---|---|---|---|
| | TERMINAL STRIP, Bakelite base 1-1/2" mtg. centers, 2 screw terminals | Modulator input connection | K4904-2 |
| (qty.2) | TERMINAL, Insulated | Transmission line insulators | 6284-1 |
| | LINE CORD, with plug, 2 #18 conductors, rubber insulated, with pronged rubber plug attached, cable 7-1/2 ft. long. | Primary Power Connection | K6143-1 |

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# FOUR·11

## MODULATOR

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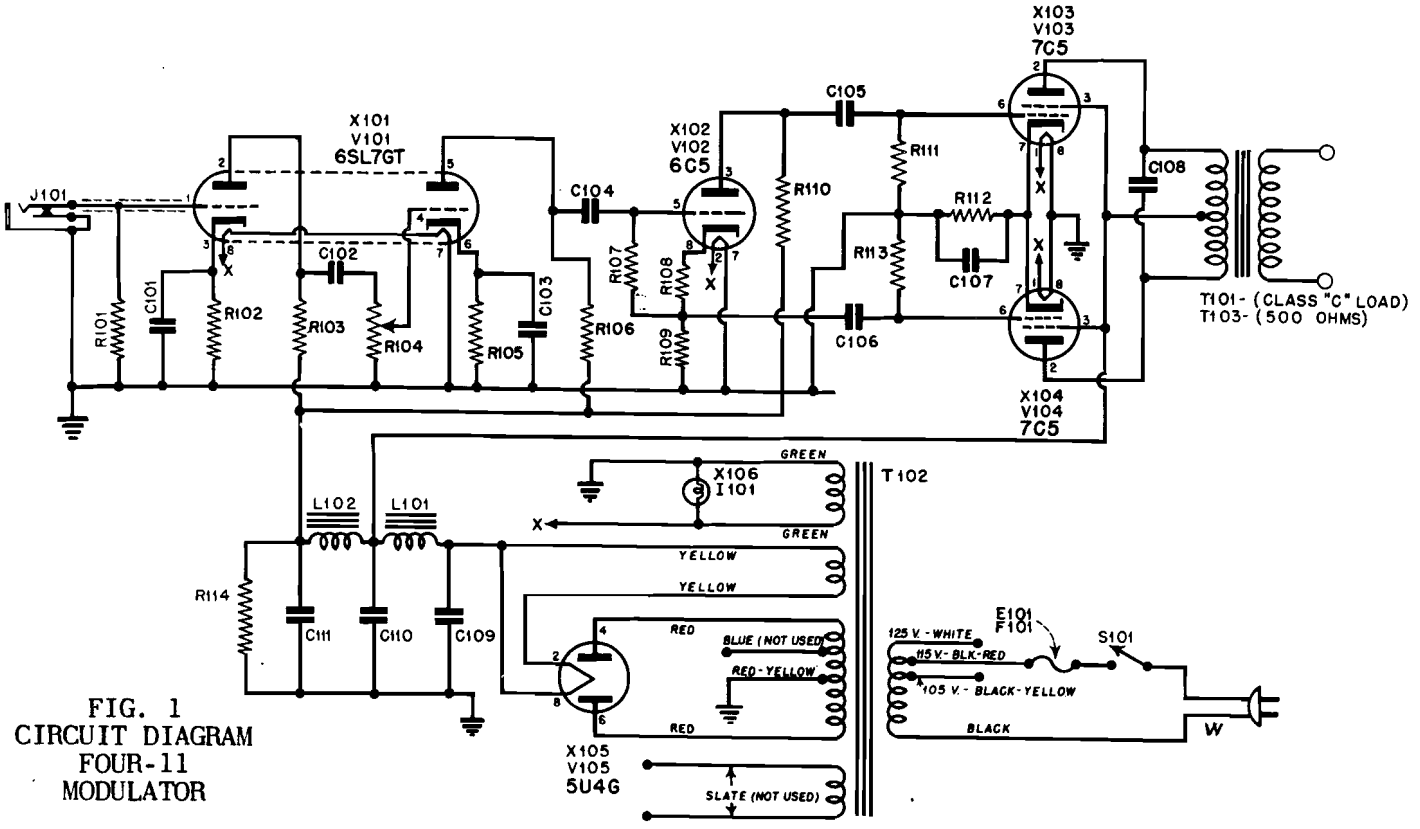


FIG. 1
CIRCUIT DIAGRAM
FOUR-11
MODULATOR

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# INTRODUCTION

THE HAMMARLUND TYPE FOUR-11 MODULATOR is a completely self-contained amplifier unit, equipped with an output transformer designed to modulate a Class "C" R.F. amplifier having an input power rating up to 28 watts. The unit is also available with an output impedance of 600 ohms for use as a microphone pre-amplifier.

The power gain is greater than 110 db, with an output of over 11 watts with less than 5% distortion. The over-all noise level inherent within the amplifier is at least 43 db below the maximum undistorted output with the gain full on. The frequency response is shown in Fig. 2 . The amplifier is designed to have a 'flat response between 200 and 3000 cycles, with the output dropping off rapidly above 3000 cycles. The output also drops off at the low frequency end of the spectrums being approximately -9 db at 100 cycles.

This is a desirable feature for voice communication. The response is flat over the most usable voice frequencies. Both the very low and very high frequencies, are attenuated so that the power is concentrated in the most useful part of the frequency spectrum. The attenuation of the higher frequencies also aids materially in reducing the higher sidebands in radio telephony which are a cause of cross modulation between adjacent signals, commonly referred to as 'splatter'.

A standard telephone jack is conveniently located in the front panel to receive the microphone plug. This is a high impedance input, to be used with a standard crystal microphone.

The volume control, on-off switch, and pilot light are also located on the front panel. The power cord is brought out through a grommet on the rear skirt of the chassis, and the output terminals are also in the rear, adequately covered to guard against accidental contact with dangerous potentials.

The Hammarlund Four-11 Modulator is 8-1/4" high, 15-1/4" wide, and 9-1/2" deep. The total weight is 41 lbs.

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# DESIGN

The schematic diagram of the Four-11 Modulator is shown in Fig. 1. A 6SL7 twin triode tube is used in a cascaded amplifier circuit, followed by a 6C5 triode in a special single tube phase inverter system. The power stage consists of two 7C5LT beam power tubes in push-pull.

The R-C network in the cascaded amplifier stage is arranged to discriminate against the very low frequencies, and the 8200 uuf capacitor across the output transformer reduces the high frequency response.

A 5U4G rectifier tube in a conventional power supply system provides plate power for the entire amplifier. The power supply system provides ample filtering to assure hum-free operation.

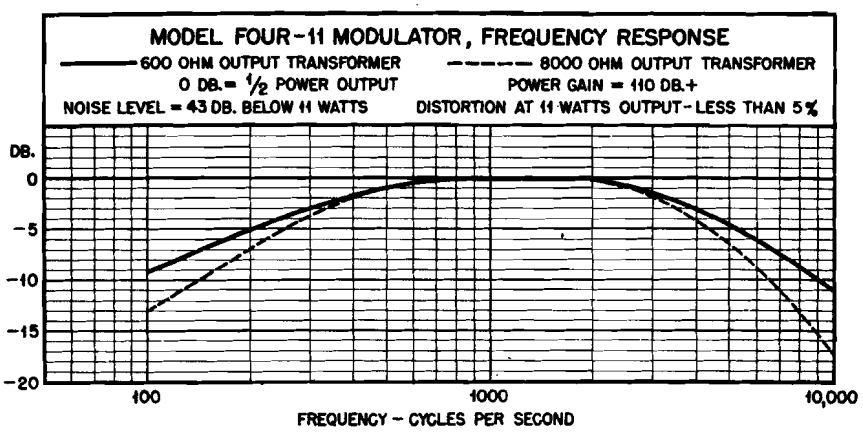


Fig. 2

## OPERATION

Carefully remove the Four-11 Unit from its carton, and be sure that all tubes are properly seated in their respective sockets. Be sure that all packing is removed from around the tubes.

If the unit is equipped with an output transformer for modulating a transmitter direct, the nameplate will read Class 'C' Load. If the unit is equipped with a 600 ohm output, the nameplate will be marked 600 ohm load. In either case, connect the amplifier into its normal load.

Be sure that the cover is in place on top of the unit, with the fasteners securely locked. Plug

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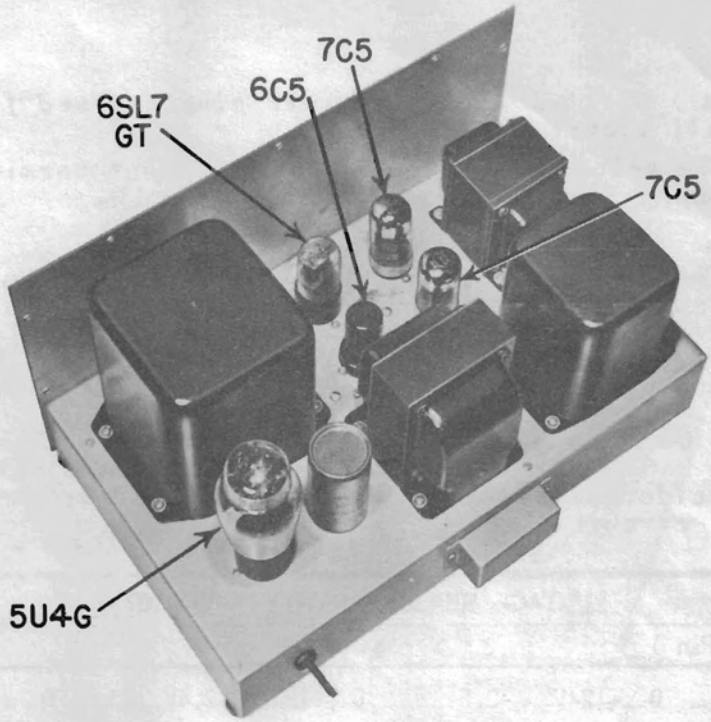


the line cord into a 115 V A.C. 60 cycle power outlet, and plug a crystal microphone cord into the microphone socket. Turn the unit on and allow about 15 seconds for the tubes to heat up.

The unit is now in working condition.

*Caution* - This equipment is designed to operate from a standard 105-120 volt 50 or 60 cycle A.C. power system. If in doubt as to the type of power available, consult your local power company.

## MAINTENANCE

There are no adjustments to be made to the Four-11 Modulator unit except the gain control, which is an operating adjustment. This equipment has been carefully manufactured in accordance with the highest standards and should give long trouble-free service.

In the event of improper operation, first test all tubes and replace those which may be weak or faulty. If trouble still persists, check resistance values. Values should be as indicated in the chart

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Fig. 4 . *Do this with the power plug removed from the wall socket.*

The voltages between each tube socket terminal and ground (chassis) are shown in Fig. 3 .

## WARNING

These measurements should be made only by an experienced technician using the proper precautions to prevent accidental bodily contact with any of the electrical circuits. While the potentials in this unit may not be extremely high, accidental contact with a 'live' circuit could be dangerous. The unit should be returned to the factory for all such checks, as the manufacturer can not assume any responsibility for accidental electrical shock to persons making 'live' circuit checks.

**VOLTAGE MEASUREMENTS TO GROUND**

| | Pin 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| X101 | 0 | +124V | +2.5 | 0 | +120V | +2.4V | 0 | 6.3V A.C. |
| X102 | 0 | 6.3V A.C. | +180V | | 0.05V | | 0 | +88 |
| X103 | 6.3V A.C. | +334V | +336V | | | 0 | +17.5V | 0 |
| X104 | 6.3V A.C. | +334V | +336V | | | 0 | +17.5V | 0 |
| X105 | | +355V | | 405V A.C. | | 405V A.C. | | +355V |

Across terminals of: C111 ---------+330V
R108 ---------+3.75V

Fig. 3

**RESISTANCE MEASUREMENT TO GROUND**
(With Standard Ohm Meter)

| | Pin 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| X101 | 5.0 meg | 285K | 5.6K | 1.6 meg | 320K | 5.6K | 0 | 0 |
| X102 | 0 | 0 | 120K | | 2 meg | | 0 | 105K |
| X103 | 0 | 20K | 20K | | | 260K | 200 | 0 |
| X104 | 0 | 20K | 20K | | | 260K | 200 | 0 |
| X105 | | 20K | | 470 | | 400 | | 20K |

Resistance across R114: 20K

Fig. 4

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | PART NUMBER |
|---|---|---|---|
| C101 | CAPACITOR, Tubular paper, .25 mfd. +30-10%, 200WVDC | Cathode resistor by-pass | 23912-20 |
| C102 | CAPACITOR, Fixed mica, 2500 mmf. ±20%, 500WVDC | Amplifier grid coupling | 23069-6 |
| C103 | CAPACITOR, Same as C101 | Cathode resistor by-pass | 23912-20 |
| C104 | CAPACITOR, Same as C102 | Phase reversing tube grid coupling | 23069-6 |
| C105 | CAPACITOR, Tubular paper, .02 mfd. +30-10%, 400WVDC | P.A. grid coupling | 23912-24 |
| C106 | CAPACITOR, Same as C105 | P.A. grid coupling | 23912-24 |
| C107 | CAPACITOR, Dry electrolytic metal tube, 8 mfd. -0% +100%, 150WVDC | P.A. Cathode resistor by-pass | 23073-11 |
| C108 | CAPACITOR, Fixed mica, 8200 mmf. ±10%, 500WVDC | Audio padding | 23019-11 |
| C109 | CAPACITOR, Dykanol, 1.0 mfd. ±10%, 1000WVDC | Power supply filter capacitor | 23843-4 |
| C110 | CAPACITOR, Dry electrolytic, metal tube, 16 mfd. -0% +75%, 450WVDC | Power supply filter | 23073-33 |
| C111 | CAPACITOR, Same as C110 | Power supply filter capacitor | 23073-33 |
| E101 | FUSEHOLDER, for 3AG fuse. | Holder for F101 | 15923-1 |
| F101 | FUSE, 2 amp., (3AG) | Overload protection | 15928-7 |

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TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | PART NUMBER |
|---|---|---|---|
| I101 | LAMP, 6-8 V., .25 amp., min. bayonet base, blue bead | Pilot light | 16026-1 |
| J101 | JACK, three circuit | Microphone connection | 6087-1 |
| L101 | CHOKE, 15 henries, 160MADC, 160 ohms. | Power supply filter reactor | 4994 or 2981 |
| L102 | CHOKE, Same as L101 | Power supply filter reactor | 4994 or 2981 |
| N101 | KNOB | For R104 | 26083-1 |
| R101 | RESISTOR, 0.5 watt, 4.7 megohm ±10%, fixed composition | Input grid resistor | 19309-137 |
| R102 | RESISTOR, Fixed composition, 5600 ohm ±10%, 0.5 watt | Cathode biasing | 19309-67 |
| R103 | RESISTOR, Fixed composition 270,000 ohm ±10%, 0.5 W. | Plate resistor | 19309-107 |
| R104 | POTENTIOMETER 'Log' curve, no switch, 2 meg. ±20% | Volume control | 15359-4 |
| R105 | RESISTOR, Same as R102 | Cathode biasing | 19309-67 |
| R106 | RESISTOR, Same as R103 | Plate resistor | 19309-107 |
| R107 | RESISTOR, Fixed composition, 2.2 megohm ±10%, 0.5 W. | Grid resistor | 19309-129 |

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP. | FUNCTION | PART NUMBER |
|---|---|---|---|
| R108 | RESISTOR, Fixed composition, 4700 ohm ±10%, 0.5 W | Cathode biasing | 19309-65 |
| R109 | RESISTOR, Fixed composition, 100,000 ohm ±10%, 0.5 W | Phase reversing | 19309-197 |
| R110 | RESISTOR, Fixed composition, Same as R109 | Phase reversing | 19309-97 |
| R111 | RESISTOR, Same as R103 | P.A. Grid resistor | 19309-107 |
| R112 | RESISTOR, Wirewound, fixed 300 ohm ±10%, 5 W. | P.A. Cathode biasing | 19431-23 |
| R113 | RESISTOR, Same as R103 | P.A. Grid resistor | 19309-107 |
| R114 | RESISTOR, Fixed, wirewound, 20,000 ohm ±10%, 10W. | Power supply bleeder | 19430-62 |
| S101 | SWITCH, Toggle, SPST, 3a. 250V. | On-Off power switch | 15807-2 |
| T101 | TRANSFORMER, Audio, Pri. 8500 ohm. 100 DC MA., 8000 ohm. Secondary 100 DC MA., Max. of 25 watts | Output transformer. (Used on Class 'C' Unit). | 15743-1 |
| T102 | TRANSFORMER, Power, 6.3V. @7.0 amp. | Power supply | 4998 or 4801 |
| T103 | TRANSFORMER, Audio, 600 ohms. | Output transformer (Used on 500 ohm Unit). | 4845 |
| V101 | VACUUM Tube 6SL7GT | Voltage amplifier tube | 16213-3 |
| V102 | VACUUM Tube, 7C5 | Power amplifier | 16265-1 |
| V103 | VACUUM Tube, 7C5 | Power amplifier | 16265-1 |

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## TABLE OF REPLACEABLE PARTS

| SCHEMATIC DESIG. | NAME OF PART & DESCRIP, | FUNCTION | PART NUMBER |
|---|---|---|---|
| V104 | VACUUM Tube, Same as V103 | Power amplifier | 16265-1 |
| V105 | VACUUM Tube, 5U4G | Power rectifier | 16215-1 |
| X101 | SOCKET, Tube, octal, saddle mtg. with ground ears | Tube socket for V101 | 16083-1 |
| X102 | SOCKET, Same as X101 | Socket for V102 | 16083-1 |
| X103 | SOCKET, Tube, Locktal, mtg. plate molded in bakelite | Socket for V103 | 15944-30 |
| X104 | SOCKET, Same as X103 | Socket for V104 | 15944-30 |
| X105 | SOCKET, Same as X101 | Socket for V105 | 16083-1 |
| X106 | SOCKET, Lampholder & jewel, min. bayonet base | Pilot light | 16093-5 |
| W | LINE CORD AND PLUG | Primary power connection | 6143-1 |

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