106A AMPLIFIER

CONTENTS

1. GENERAL

1.01 This section describes the 106A amplifier. The important electrical and mechanical features are discussed in detail, and installation information is also included.

1.02 This amplifier is a two-stage, a-c operated type and is intended for use as a line amplifier in connection with radio broadcasting and loudspeaker circuits. When used on program lines, no isolating transformers are required due to the high quality of the input transformer T1 and output transformer T2. The amplifier may be used also as a general purpose amplifier for applications where moderate gain and low power levels are satisfactory.

1.03 The 106A amplifier is designed to operate between impedances of 600 ohms, under which condition it has a maximum gain of approximately 45.0 db. While the winding arrangement of the input transformer T1 permits strapping for 150 ohms impedance on its primary side, use of this strapping on the 106A amplifier is not advisable. If used on this amplifier, the internal input impedance of the latter is approximately 200 ohms. In addition, the amplifier has a high impedance input of 10,000 ohms for bridging across a 600-ohm circuit. With this arrangement the gain is approximately 20 db. A monitoring arrangement also is provided.

1.04 The amplifier has a gain control potentiometer which has nineteen 2 db steps of attenuation and an "off" position. The front mat is equipped with an a-c power switch and a plastic lens behind which is a pilot lamp to indicate when the amplifier is energized.

1.05 The component parts of the 106A amplifier are assembled on a recessed metal panel 19 inches wide and 7 inches high which is designed for mounting on a standard relay rack, or in an apparatus cabinet.

1.06 Front and rear views of the 106A amplifier are shown in Figs. 1a and 1b, respectively.

1.07 Performance data for the 106A amplifier are shown in Table 1.

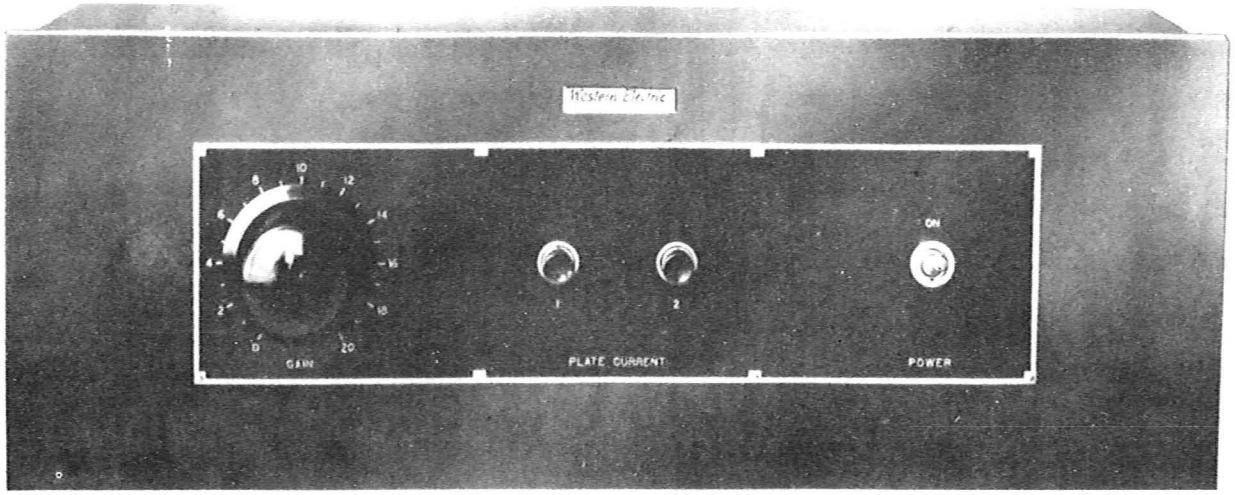


Fig. 1a - 106-Type Amplifier - Front View

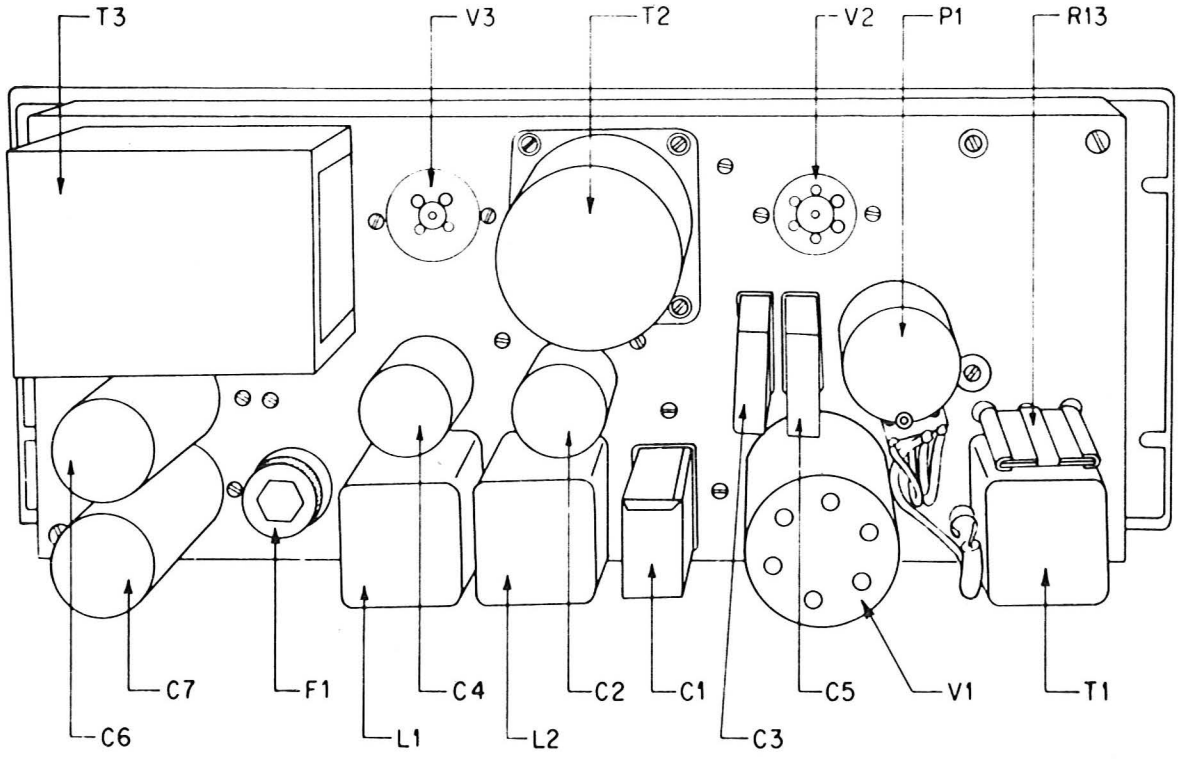


Fig. 1b - 106-Type Amplifier - Rear View

TABLE 1

106A AMPLIFIER - TYPICAL OPERATING CHARACTERISTICS

INPUT ARRANGEMENT (Note 1)	MAXIMUM 1000-CYCLE GAIN WHEN OPERATING BETWEEN NOMINAL SOURCE AND LOAD IMPEDANCES	GAIN CONTROL	AMPLIFIER TERMINALS TO WHICH INPUT SHOULD BE CONNECTED	INPUT CIRCUIT - TERMINAL STRAPPING ARRANGEMENTS	SOURCE IMPEDANCE	IMPEDANCE LOOKING INTO THE INPUT TERMINALS	OUTPUT CIRCUIT - TERMINALS USED (Note 2)	LOAD IMPEDANCE INTO WHICH THE AMPLIFIER IS DESIGNED TO OPERATE	INTERNAL OUTPUT IMPEDANCE	NOISE (MAX. GAIN) (Note 3)	FREQUENCY CHARACTERISTICS	OUTPUT POWER
High Gain	45 db	Adjustable in 19 Steps of 2 db per Step	1 & 2	None	600 Ω	600 Ω	11 & 12	600 Ω	600 Ω	43 dba	+ 1 db −30 − 15,000 ~	+28 dbm or 600 Milliwatts with Less than 1% Distortion
Bridging	20 db		7 & 8	None	600	600						

Note 1: Although the windings of the input transformer can be connected for 150 ohms, the arrangement is not specified for this amplifier. It causes the internal impedance of the latter to become approximately 200 ohms.

Note 2: Additional winding on output transformer (terminals 13 and 14) has impedance of 40 ohms and is used for monitoring purposes only.

Note 3: Measured with 2B noise measuring set (LINE input, dummy plugs in SOUND jacks, K3 to FLAT and K4 to 144).

Table 1 - 106A Amplifier - Typical Operating Characteristics

2. TRANSMISSION AND CIRCUIT FEATURES

(A) Basic Amplifier Circuit

2.01 The amplifier part of the circuit (Fig. 2, Page 11) is basically a two-stage audio frequency voltage amplifier employing pentode-type electron tubes in both the input and output stages.

2.02 The audio signal is fed into the primary winding of the input transformer T1. The secondary winding of this transformer is connected across the gain control potentiometer P1. The signal is then fed from the movable arm of P1 to the grid of the first stage amplifying tube V1. The plate circuit of V1 is resistance-coupled to the grid circuit of the second stage amplifying tube V2. The plate circuit of the latter is transformer-coupled to the output terminals of the amplifier. The output of the amplifier is designed to operate into an impedance of 600 ohms. A low impedance monitoring arrangement is provided.

2.03 The 106A amplifier operates directly from any 105 to 125-volt, 50-60 cycle, a-c supply. A power supply, incorporated in the amplifier, provides means for stepping up this voltage to required value for the operation of the amplifying tubes, and for rectifying and filtering the supply.

(B) Input Circuit

2.04 The internal input impedance of the 106A amplifier is 600 ohms. A choice of two input connections is provided, which allows the amplifier to be used either as a 600-ohm input line amplifier, or as a high impedance input bridging amplifier. Fig. 2 shows the input arrangement for each use.

(C) First Stage Tube Connections

2.05 The first stage employs a W.E. 310B electron tube V1. This is a high gain pentode type electron tube designed for low hum level operation. The control grid (cap connection) obtains its bias from the voltage drop across resistors R3, R4 and R5 which are in the cathode circuit of V1. The audio signal is impressed on the control grid of V1 from the movable arm of potentiometer P1. The latter is used to adjust the over-all gain of the amplifier.

2.06 The screen grid of V1 is supplied a positive voltage from one end of R6.

2.07 The suppressor grid is connected to the cathode at the electron tube socket.

(D) Interstage Circuit

2.08 The interstage circuit consists essentially of resistance coupling made up of the resistor R7 (through which the d-c voltage is supplied to the plate of V1 tube), the coupling capacitor C3 and the resistor R9 which is in the grid circuit of V2.

(E) Second Stage Tube Connections

2.09 The second stage employs a W.E. 336A electron tube V2. The latter is a medium gain pentode-type electron tube which delivers a maximum audio power output of approximately 1/2-watt with less than 1 per cent distortion as used in the 106A amplifier. The control grid obtains its bias from the voltage drop across resistors R10, R11 and R15 which are in the cathode circuit of V2. The audio signal is impressed on the control grid of V2 from one side of the capacitor C3.

2.10 The screen grid is supplied a positive voltage by being connected to terminal 5 of the output transformer T2.

2.11 The plate of V2 is connected to terminal 6 of transformer T2. The resistor R8 and capacitor C1 are part of the feed-back circuit which is described in Part 2(G) of this section.

(F) Output Circuit

2.12 The output circuit has an internal impedance of 600 ohms and consists of the two secondary windings of T2. One winding (terminals 3 and 4) is connected to terminals 11 and 12 of the amplifier and is used as the 600-ohm amplifier output source.

2.13 The other secondary winding (terminals 1 and 2) of transformer T2 is connected to terminals 13 and 14 of the amplifier. This winding is used for monitoring where desired and has an impedance of approximately 40 ohms. This winding delivers an output which is about 20 db below the main output of the amplifier and may be used to feed a head set or a W.E. 124 or equivalent type amplifier. The use of this winding has little appreciable effect on the main output of the amplifier.

2.14 The amplifier is capable of supplying a maximum output of +28 dbm (600 milliwatts) with less than 1 per cent distortion into a 600-ohm load.

(G) Feed-back Circuit

2.15 Feed-back is applied over both stages of amplification. The plate circuit of the output tube V2 is coupled back to the cathode of the input tube V1 through the resistor R8 and capacitor C1. This feed-back coupling results in a lower output impedance over the audio frequency range as seen looking back into the output terminals of the amplifier, as well as stabilized and improved amplifier characteristics.

(H) Power Supply Circuit

2.16 The power supply of the 106A amplifier operates from any 105 to 125-volt, 50 or 60-cycle a-c power source. This a-c power is connected to terminals 24 and 25 of the amplifier.

2.17 The power transformer of the amplifier has a tapped primary winding. The selection of the correct tap depends upon the voltage range of a particular a-c supply.

2.18 The secondary windings of T3 consist of a 5-volt winding, a 10-volt center-tapped winding and a 550-volt center-tapped winding. The 5-volt winding, terminals 7 and 8, supplies filament power to the rectifier tube V3. The 10-volt winding, terminals 4 and 6, supplies power tc the heaters of the amplifying tubes V1 and V2 and is also available on amplifier terminals 22 and 23 for use with external amplifiers which may be operated sometimes with the 106A amplifier. The center tap of the 10-volt winding, terminal 5, is connected to the junction of resistors R10 and R15 which are in the cathode circuit of V2. This places the heaters of the amplifying tubes approximately 8 volts above ground, and reduces noise. The 550-volt winding, terminals 9 and 11, is connected to the plates of the rectifier tube V3. The center tap of this winding, terminal 10, is connected to the negative side of the plate supply (terminal 19) which should normally be connected to ground terminal 15, except when the amplifier furnishes plate supply to external amplifiers.

2.19 The output d-c voltage is approximately 240 volts after being filtered by the inductors L1 and L2, and the capacitors C6.1, C6.2 and C7.1.

2.20 The 106A amplifier consumes 41 watts at 115 volts, 44.5 watts at 120 volts and 48 watts at 125 volts a-c supply line voltage. The amplifier contains a 0.5 ampere Fustat which is connected in series with the a-c supply line and the primary winding of the power transformer T3. Maximum protection is supplied by a thermal cutout type of fuse, such as the Fustat, and it is inadvisable to employ any other type with this amplifier unless Fustats are not available. The switch D1 is used to disconnect the amplifier from the a-c supply.

(I) Power Supply Arrangements for External Amplifiers

2.21 Power supply arrangements are provided on the 106A amplifier for supplying partially filtered plate voltage as well as filament voltage to external amplifiers. The power transformer and rectifier have sufficient capacity to supply filament and plate powers to other external amplifiers of the "preamplifier" type normally used in connection with studio pickup equipment. Terminals are provided on the 106A amplifier for this purpose.

2.22 The available plate supply for external use (terminals 19 and 20) is 4 milliamperes at approximately 275 volts, but is not adequately filtered for program purposes. When this is employed to energize other amplifiers, an external filter section consisting of a Western Electric 221A retardation coil or equivalent and an 8 microfarad capacitor may be required.

2.23 The available filament supply for external use (terminals 22 and 23) is 2 amperes at 10 volts a-c.

(J) Electron Tube Arrangements

2.24 The electron tubes used in the 106A amplifier are of the 10-volt heater type for the amplifying section and 5.0-volt filament type for the rectifier. The heaters of the 10-volt tubes V1 and V2 are connected in parallel and wired to terminals 4 and 6 of the power transformer T3. The filament of the 5.0-volt rectifier tube V3 is connected to terminals 7 and 8 of T3.

2.25 Only Western Electric electron tubes may be employed in the amplifier with the exception of the rectifier tube V3 which may be of the commercial type if a Western Electric type can not be obtained.

2.26 The code number, quantity and designation for the amplifier and rectifier tubes are as follows:

Tube Type	Quantity	Designation
W.E. 310B	1	V1
W.E. 336A	1	V2
W.E. 274A*	1	V3

* A commercial type 5Z3 electron tube may be used in place of the W.E. 274A tube if the latter is not available.

(K) Monitoring Arrangement

2.27 As described in Paragraph 2.13, the 106A amplifier is provided with an additional winding on the output transformer for monitoring purposes. While this winding is designed to operate with a W.E. 124-type amplifier, it may be used with any amplifier having sufficient gain and output power, and which will operate satisfactorily from the low impedance presented by this winding.

(L) Amplifier Gain

2.28 The maximum gain of the 106A amplifier is dependent on the input arrangement employed and is shown as follows:

Input Arrangement	Input Terminals	Approximate Maximum Gain in db
600-ohm	1-2	45
Bridging	7-8	20

2.29 The gain control potentiometer P1 has nineteen 2 db steps of attenuation and an "off" position.

(M) Cathode Current Measurements

2.30 Two push-type keys are provided on the front panel of the 106A amplifier for use in conjunction with an external meter for measuring the cathode currents of tubes V1 and V2. The cathode currents are obtained by depressing each key, one at a time, and reading the voltage drop across resistors R5 and R11, using an external meter which must be connected to amplifier terminals 9 and 10.

2.31 While cathode current tests may be made, a more complete test may be obtained by making standard tube tests with the KS-15560-L1 Tube Tester or equivalent. An external meter such as the KS-10003 or KS-7328 meter must be used for the cathode current tests. An equivalent meter would be one with a 200-microampere scale, and with a multiplier of proper value. The total resistance of the multiplier and the meter should be 1000 ohms. Use of a standard type milliammeter when bridging R5 and R11 will cause the readings to be incorrect due to its low internal resistance.

(N) Grounding Arrangements

2.32 Terminals 15 and 21 of the amplifier are connected to the chassis. Terminal 19 connects to the negative side of the amplifier plate supply. The chassis normally should be connected to the negative side of the d-c power supply by strapping terminals 15 and 19.

2.33 When external amplifiers obtain their plate supply from the 106A amplifier, it may be found desirable to omit the strap connecting terminals 15 to 19 and make this grounding connection at the terminal strip of one of the external amplifiers in order to obtain the lowest noise level.

2.34 A good external ground should be connected to terminal 15 or 21 of the amplifier.

(O) Noise

2.35 With the 106A amplifier adjusted for maximum gain and the input and output terminated with 600 ohms, the normal output noise level should not be greater than 43 dba with flat weighting (LINE input, dummy plugs in SOUND jacks, K3 to FLAT and K4 to 144) as measured with a 2B noise measuring set.

3. INSTALLATION

(A) Mounting 106A Amplifier

3.01 The amplifier is designed to be mounted vertically on a standard 19-inch relay rack or in an apparatus cabinet.

3.02 The amplifier has a height of 7 inches, length of 19 inches, depth of 7-1/4 inches, and weighs approximately 22 pounds.

3.03 Care should be taken when installing the amplifier to guard against exposure to strong magnetic fields. Although special shielding precautions have been taken in the design of the amplifier, and noise from electromagnetic coupling has been practically eliminated in the amplifier itself, objectionable hum from other sources may be experienced if this precaution is not taken.

3.04 The 106A amplifier produces an appreciable external stray field from its power transformer which requires attention in installation to avoid noise induction in other nearby program amplifiers and telephone repeaters. Therefore, it is desirable, when installing 106A amplifiers, to locate them with at least 12 inches separation between them and also to maintain at least 12-inch separation from all other repeaters or amplifying devices.

(B) Noise Pickup

3.05 The noise pickup should be negligible if the amplifier is installed properly. Some noise, feed-back or amplifier instability may be encountered if the tube shield is not placed over the 310B electron tube.

(C) Ventilation

3.06 When a 106A amplifier is mounted on a partially closed shelf or in a perforated cabinet, sufficient ventilation must be provided for cooling. The temperature of the air one inch above the power transformer T3 should never be more than 30 degrees F. above room temperature and under maximum room temperature conditions should not exceed 130 degrees F. after the amplifier has been operating four hours. If sufficient ventilation is not provided, the Fustat may blow as it is quite sensitive to external heat.

3.07 The 106A amplifier should never be installed in a cabinet in which there are no perforations or other means of ventilation.

(D) Wiring

3.08 Two terminal strips, stenciled TS1 and TS2, are provided on the amplifier. Fig. 3 shows the location of the strips. TS1 contains the terminals numbered from 1 to 20. These terminals are for the audio frequency circuits, cathode current meter, and plate supply for the external amplifiers. TS2 contains the terminals numbered 21 to 25 for the primary a-c power circuits. The normal connections for the terminals are as follows:

Terminal Numbers	External Connections
1 and 2	Input (600 ohms).
3 and 4	Center tap of primary winding of input transformer (strapped).
5	Center tap of input terminating resistor.
6	Spare.
7 and 8	Bridging input (10,000 ohms).
9 and 10	Cathode current meter (10 positive).
11 and 12	Output (600 ohms).
13 and 14	Monitor output.
*15	Ground.
16, 17 and 18	Spare.
*19 and 20	Plate supply for external amplifiers (20 positive).
+21	Ground.
+22 and 23	Filament supply for external amplifiers.
24 and 25	105-125-volt, 50-60-cycle, a-c power source.

* Terminals 15 and 19 should normally be strapped unless the amplifier furnishes plate supply for external amplifiers.

\+ Connections made to terminals 22 and 23 with shielded twisted pair copper wire not smaller than No. 16 gauge. Terminal 21 is provided for grounding the shields of the a-c leads.

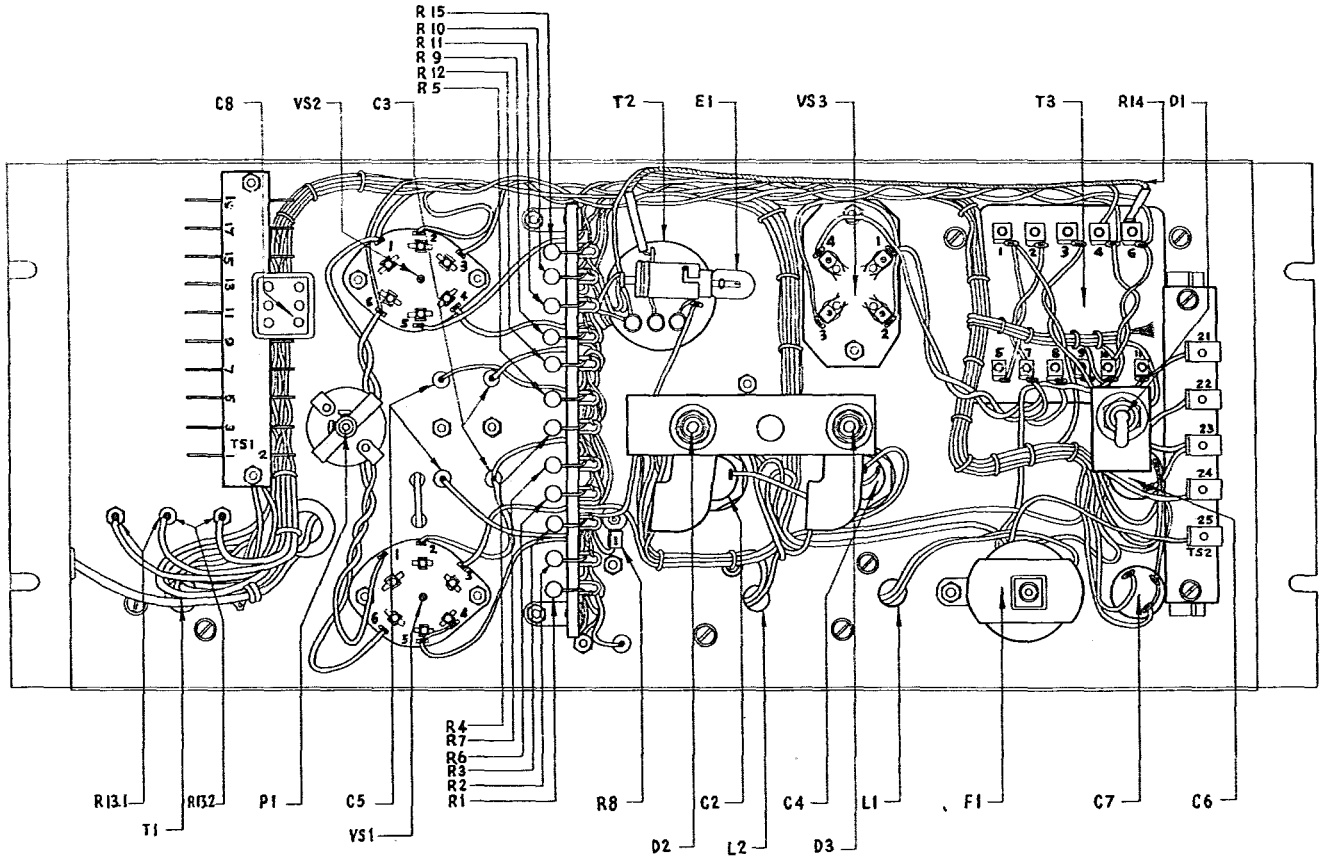


Fig. 3 - 106A Amplifier - Bottom View

4. AMPLIFIER OPERATING ADJUSTMENTS

(A) Primary Line Voltage Connections

4.01 The amplifier, as delivered, is wired normally for line voltages between 115 and 125 volts, and the a-c power must be connected to terminals 24 and 25. If the line voltage is between 105 and 115 volts, the connection on terminal 3 of the power transformer T3 should be transferred to terminal 2.

(B) Electron Tubes

4.02 With the a-c supply properly connected to the amplifier as explained in Part 4(A), the heater currents for the amplifier and rectifier tubes should be satisfactory. With the heater currents operating within correct limits, the grid potentials and plate currents should, in general, be correct. Therefore, no other power supply adjustments are provided.

(C) Input Arrangements

600-ohm Input

4.03 When it is desired to have the amplifier present a 600-ohm impedance to a line connected to its input, the line should be connected to terminals 1 and 2 of the amplifier.

Bridging Input

4.04 The amplifier will present a 10,000-ohm input impedance for bridging purposes when the circuit to be bridged is connected to input terminals 7 and 8. With this arrangement the maximum gain is reduced approximately 25 db from that obtained when the 600-ohm arrangement is used.

(D) Output Arrangement

4.05 The output of the amplifier is designed to work into a 600-ohm load. No other output arrangement is provided, except for monitoring purposes.

(E) Frequency Characteristics

4.06 When operating into a 600-ohm output load, the amplifier has a frequency characteristic that is flat within approximately ± 1 db from 30 to 15,000 cycles. The following table shows the frequency characteristic of a typical 106A amplifier:

Frequency in Cycles	Deviation from 1000-Cycle Value in db
30	+0.1
50-12,000	0.0
14,000	+0.1
16,000	+0.2

(F) Input and Output Levels

4.07 Care must be taken not to overload the 106A amplifier by using too high a level. Input levels are limited by the permissible maximum output level, and may be of such values that the output levels will not be exceeded by approximately +18 vu.

5. ASSOCIATED DRAWINGS - NOT ATTACHED

Title	Drawing No.
106A Amplifier Schematic	ESO-611771
106A Amplifier Wiring Diagram	ESX-611772
106A Amplifier-Apparatus List	ESL-611825

6. PARTS LIST

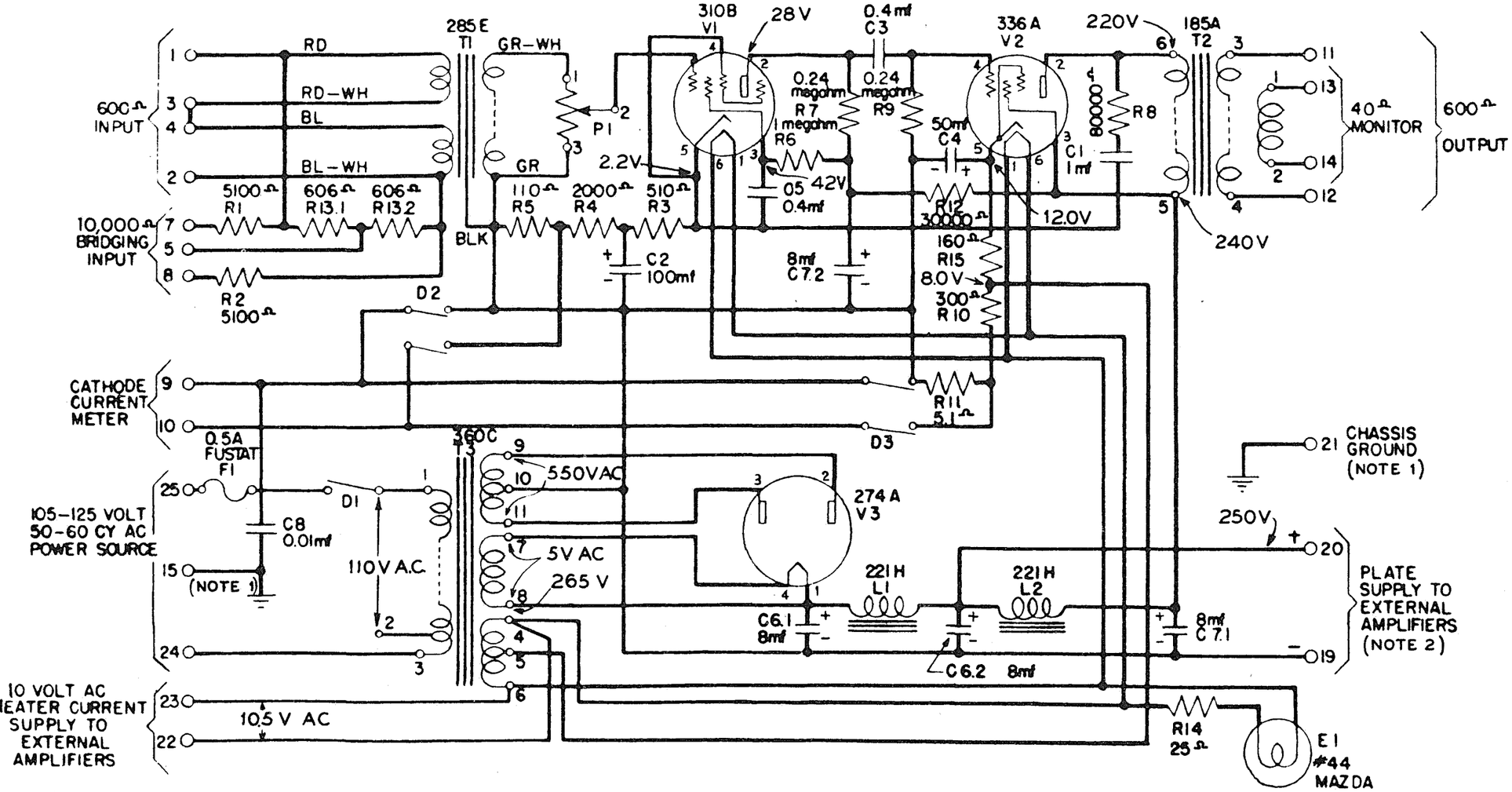
6.01 The item designations shown below are those indicated on the schematic drawing, Fig. 2.

Item	Description
T1	285E Input Transformer
T2	185A Output Transformer
T3	360C Transformer
L1, L2	221H Retardation Coils
C1	229C Condenser, 1.0 Microfarad
C3, C5	230A Condensers, 0.4 Microfarad
C2	Sprague Electric Co. Type DEW, or Aerovox Corp. Type GEP Capacitor, 100 Microfarads, 25 Volts
C4	Sprague Electric Co. Type DEW, or Aerovox Corp. Type GEP 50-Microfarad, 50-volt Capacitor
C6.1, C6.2 C7.1, C7.2	Sprague Electric Co. Type DEW, or Aerovox Corp. Type GEP, 8-8 Microfarad, 450-volt Capacitor
C8	Cornell Dubilier Corp. Type 1W Capacitor .01 Microfarad
R13.1, R13.2	19NG Resistance, 606-606 ohms

Item	Description
	International Resistor Company Type BT-1 Resistors
R1, R2	5100 Ohms ± 5%
R6	1.0 Megohm ± 5%
R7, R9	0.24 Megohm ± 5%
R12	30,000 Ohms ± 5%
	International Resistor Company Type BW-1 Resistors
R3	510 Ohms ± 5%
R4	2000 Ohms ± 5%
R5	110 Ohms ± 5%
R10	300 Ohms ± 5%
R11	511 Ohms ± 5%
R15	160 Ohms ± 5%
R8	International Resistor Company, Type WW-3 Resistor, 80,000 Ohms, provided with terminal lugs
R14	Clarostat Series FX Flexible Resistor 25 Ohms, Length 9 inches not incl. leads

Item	Description
P1	Daven Type CR-51 Potentiometer, 50,000 Ohms, per ESA-612056, "Pot. No. 2."
D1	Hart and Hegeman Type 20994-DQ Switch with 1/2" Mounting Sleeve, provided with 2 hexagonal nuts.
D2, D3	Yaxley Manufacturing Co. No. 2004 Pushbutton Switches
E1	Mazda No. 44 Pilot Light Lamp, 6-8 Volts
ES1	Mallory Socket Type B303AR
VS1, VS2	Eby 33-1-C Electron Tube Sockets per KS-7741
VS3	Hammarlund Mfg. Co., Inc. Type BS-4 Electron Tube Socket & Type BSC Cover
FM1 & F1	Bussman Mfg. Co. SRD1 Fuse Receptacle and .5 Ampere Fustat
Shield for V1	Electron Tube Cover per ESO-677879-5

All apparatus is Western Electric unless otherwise specified.



Note 1: Terminals 15 and 21 are connected to the chassis. A good external ground should be connected to either terminal 15 or 21.

Note 2: Terminals 15 and 19 should normally be strapped. If the 106A amplifier furnishes plate supply for external amplifiers, it may be found desirable to make the ground connection at the terminal strip of one of the external amplifiers, instead of strapping terminals 15 and 21, in order to obtain the lowest noise level.

Note 3: All voltage values shown are typical of those measurements which may be expected within + 10% when employing a 20,000-ohm-per-volt voltmeter and an a-c line voltage of 120 volts.

106A Amplifier - Schematic Circuit Diagram

Fig. 2