118A AMPLIFIER — DESCRIPTION

CONTENTS

1. GENERAL

1.01 This section describes the 118A amplifier. The important electrical and mechanical features of the amplifier are discussed in detail. Installation information is also included.

1.02 The 118A amplifier is a medium gain, audio frequency, power amplifier provided with a high impedance bridging type input connection to facilitate its use in all types of sound systems and with all circuit impedances normally encountered in the telephone plant. When the amplifier is used in connection with the low level sources such as microphones or phonograph pickups, it will be necessary to employ a suitable preamplifier (117A or equivalent) between this source and the input of the 118A amplifier.

2. TRANSMISSION AND CIRCUIT FEATURES

(A) Basic Amplifier Circuit

2.01 The amplifying part of the circuit is basically a two stage amplifier employing a push-pull arrangement in the input stage and push-pull parallel arrangement in the output stage (see Schematic Drawing, Fig. 1). A top view picture and a bottom view picture of the 118A amplifier with composite parts of the amplifier designated are shown in Figs. 2 and 3, respectively.

2.02 Referring to Fig. 1, the audio frequency is fed into the primary of the input transformer T1. The secondary of this transformer supplies the audio frequency to the grids of the push-pull first stage amplifying tubes V1 and V2. The plate circuits of V1 and V2 are resistance coupled to the grid circuits of the push-pull parallel second stage tubes V3, V4, V5, and V6. The plate circuits of V3, V4, V5, and V6 are transformer coupled through T2 to a loud-speaker or to more than one loud-speaker if desired.

2.03 The 118A amplifier operates directly from any 110 to 125-volt, 60-cycle, a-c supply. This voltage is stepped up to the proper value, rectified and filtered by means of a power supply incorporated in the amplifier. Amplifiers suitable for operation from 50 cycles a-c voltages are available and are marked "50 - 60 cycles" on the chassis name-plate.

(B) Input Circuit

2.04 The input circuit of the 118A amplifier consists of T1, R1, R2, and P1. This circuit provides the amplifier with a high impedance bridging input and a lower impedance high gain input.

2.05 The high impedance input appears between terminals 2 and 3 of the amplifier. The impedance looking into this pair of terminals is approximately 25,000 ohms. Thus, the amplifier may be bridged across a 600-ohm circuit without materially affecting the program level on that circuit. When the driving amplifier or circuit connected to the input requires a specific terminating impedance (such as 600 ohms to properly terminate a 600-ohm circuit), this impedance is bridged directly across the 118A amplifier input. The source impedance as it affects the amplifier may be regarded as the combined parallel impedance of the source and its termination. If the source impedance (such as a preamplifier) is unbalanced to ground, the low or grounded side is connected to input terminal 3 in order to reduce longitudinal transmission. When a balanced input source (such as a line) is employed, terminal 3 may be left ungrounded.

2.06 The high gain connection (impedance looking into amplifier = 1500 ohms) when bridged across a 600-ohm circuit causes a slight level change on the circuit. This connection provides an increase of 10 db in amplifier gain as compared with the bridged arrangement described above. The high gain input is obtained by connecting the source to terminals 1 and 3 on the amplifier.

> Note: The gain control must be left in its maximum gain position when the high gain input is used. An external gain control pad is required if gain adjustments are to be made when using this input connection. (See Fig. 7.)

2.07 The 25,000-ohm gain control is intended as a means of infrequent gain adjustment rather than for continuous control of program level. The range of gain adjustment is approximately 40 decibels and the rotation is clockwise for an increase in amplifier gain.

(C) First Stage Tube Connections

2.08 Bias for the control grids (top connection) of the tubes is obtained from the voltage drop across the resistors R3 and R4 in the tube cathode circuits. The audio input is impressed on the grid of V1 180 degrees out of phase with that on the grid of V2. This is accomplished by the center tapped secondary of the input transformer T1.

2.09 The screen grids of V1 and V2 are connected together and supplied a positive voltage from one end of R18.

2.10 The suppressor grid of each tube is connected to its cathode.

(D) Interstage Circuit

2.11 The interstage circuit consists essentially of resistance coupling through the plate resistances R5 and R6 (which supply plate battery to V1 and V2), the coupling condensers C1 and C2, and the grid resistances R7 and R8.

(E) Second Stage Tube Connections

2.12 This stage uses a push-pull parallel circuit which will deliver up to 50 watts of audio power output.

2.13 The voltage drop across one half of R15 is used as control grid bias for V3 and V4 while the voltage drop across the other half of R15 is used as control grid bias for V5 and V6. The midpoint of R15 is grounded. The control grid of V5 is connected to the control grid of V3 through R9. The control grid of V6 is connected to the control grid of V4 through R10.

2.14 The screen grid of each tube is kept at a potential of about 318 volts above ground by its connection to a tap on R17 which is part of the voltage divider consisting of R16 and R17.

2.15 The plate of V3 and plate of V5 are connected to terminal 4 of T2 and one side of R13. The plate of V4 and plate of V6 are connected to terminal 1 of T2 and one side of R14. Resistors R13 and R14 are part of the feedback circuit. The feedback circuit is described in Part G of this section.

2.16 Each of the deflector plates of V3, V4, V5, and V6 is connected to its cathode within each tube.

(F) Output Circuit

2.17 The plate voltage to the second stage tubes is supplied through the midpoint of the primary of the output transformer T2. Condenser C7 guards against high frequency surges with an attendant possible breakdown of the final stage tubes. The plate voltage of the tubes in the second stage is normally about 425 volts.

2.18 There are four secondary windings on the output transformer T2 which may be connected in a number of ways so that operation into a considerable number of load impedances between 1 and 1000 ohms may be arranged. For matching load impedances see Table 3, Page 9.

(G) Feedback Circuit

2.19 There are two feedback paths in the 118A amplifier. One path is from the plates of V3 and V5 through the resistance R13 and the resistance R3. The other path is from the plates of V4 and V6 through the resistance R14 and the resistance R4. The first feedback path connects to the cathode of V1 and the second feedback path connects to the cathode of V2. The feedback 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.

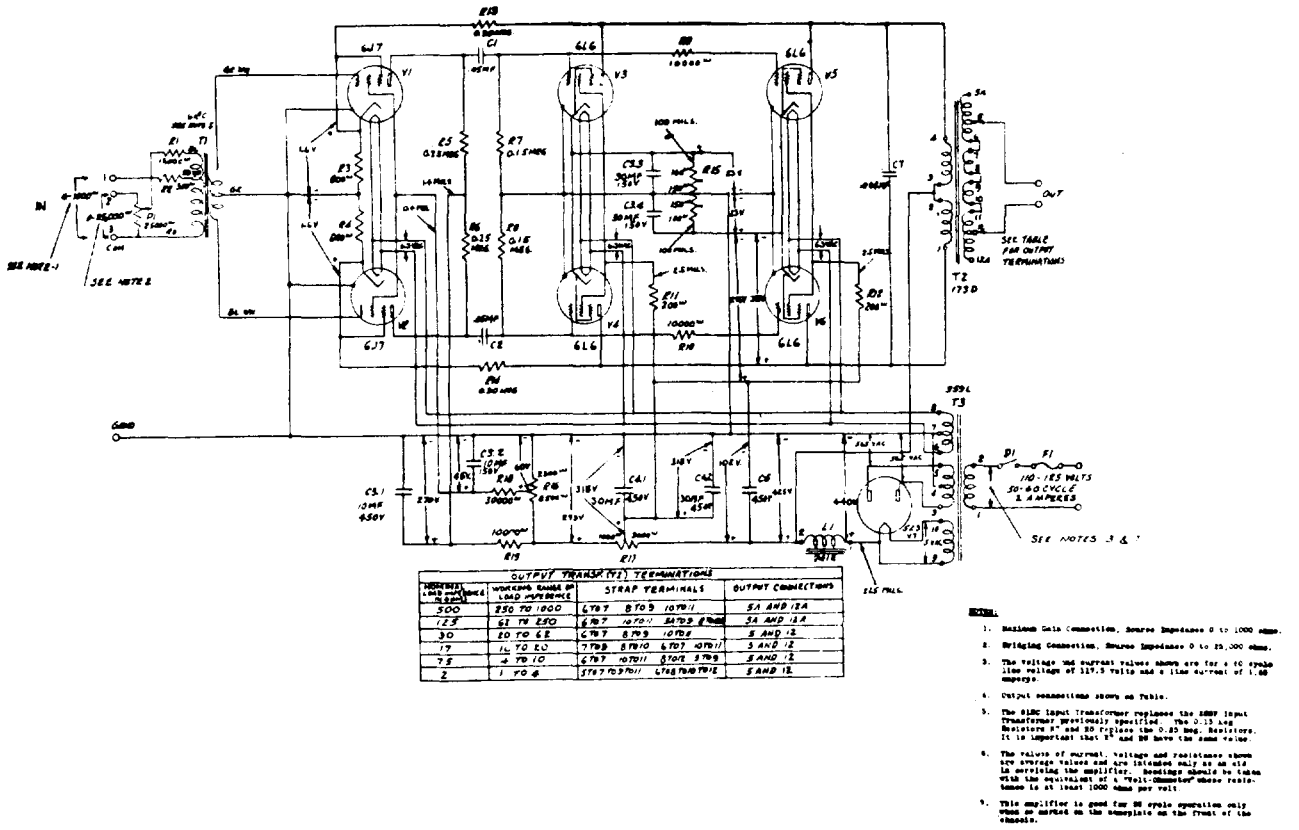


Fig. 1 - Schematic Drawing of 118A Amplifier

(H) Power Supply Circuit

2.20 The d-c power supply operates from 110 to 125-volt, 60-cycle, a-c power supply source. This a-c voltage is connected to terminals 1 and 2 of the power supply transformer T3. The secondary of T3 has one 6.3-volt center tapped winding, one 5-volt winding and one 1130-volt center tapped winding. The 6.3-volt winding, terminals 6 and 8, supplies filament power to V1, V2, V3, V4, V5, and V6; the center tap of this winding, terminal 7, is connected to ground. The 5-volt winding, terminals 9 and 10, supplies filament power to V7; terminal 9 is also the positive high voltage terminal. The 1130-volt winding, terminals 3 and 5, is connected to the plates of the rectifying tube V7; the center tap of this winding, terminal 4, is connected to ground.

2.21 The d-c voltage made available after being filtered by the retard coil (L1) and the filter condenser (C5) is approximately 425 volts.

2.22 The amplifier requires a primary a-c line current of approximately 1.75 amperes and the power supply is fused with a 2-1/2 ampere fustron or fustat. The 118A amplifier as delivered by the Western Electric Company contains a fuse as a part of the amplifier. However, those manufactured prior to about June 1941 do not contain this fuse requiring one to be installed either on or external to the amplifier. For this purpose, a model A0205 fustat adapter which fits a standard electrical outlet may be used. Fustrons or fustats are used in place of other types of fuses because they will operate at lower current values if subjected to temperatures higher than normal. Thus, a measure of protection against overheating, due to insufficient ventilation, is provided. The fuse is connected in series with the primary winding (terminals 1 and 2) of the power transformer (T3).

(I) Vacuum Tube Arrangements

2.23 The tubes used in the amplifying circuits of the 118A amplifier are of the 6.3-volt heater type. The heaters of the six amplifier tubes are wired in parallel and are connected to the 6.3-volt winding, terminals 6 and 8, of the power transformer T3. The tubes may be used in either the glass or metal variety with the exception of the 5Z3 rectifier tube which

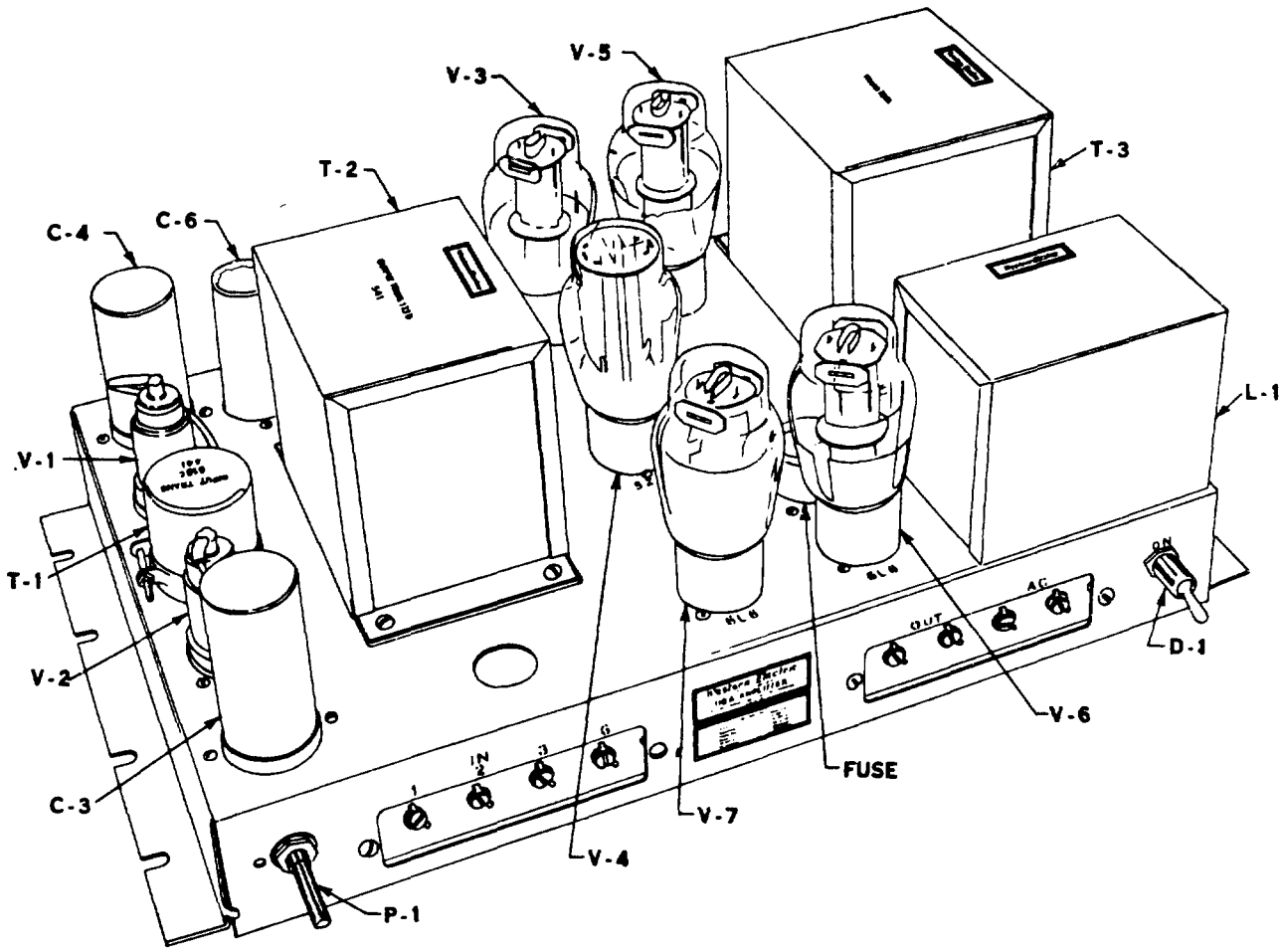


Fig. 2 - Top View of 118A Amplifier

is available as a glass tube only. The tube code number with the letter "G" following indicates a glass type tube, i.e., the 6J7 and 6L6 are metal tubes while the 6J7G and 6L6G are glass tubes.

2.24 It is preferable that tubes V1 and V2 be of the metal type (6J7) while tubes V3, V4, V5, and V6 be of the glass type (6L6G). When tubes V1 and V2 are of the metal variety there is less chance of singing due to feedback as the metal tubes provide better shielding.

2.25 The code number, quantity and designation for the amplifier and rectifier tubes required are given in Table 1.

TABLE 1

Type	Quantity	Designation
6J7 or 6J7G	2	V1, V2
6L6 or 6L6G	4	V3, V4, V5, V6
5Z3	1	V7

CAUTION: The operating personnel should be warned against handling the vacuum tubes while the amplifier is in operation, due to the danger of burns, particularly in the case of the rectifier and final stage amplifier tubes. While the glass tubes do not become as hot as the metal tubes either type may become a hazard if touched after the amplifier has been operating for some time.

2.26 The arrangement of terminals and connections of the vacuum tubes used in the 118A amplifier, as viewed from the bottom, are given in Fig. 4. A wiring diagram of the amplifier is given in Fig. 5.

(J) Grounding Arrangements

2.27 The following points of the amplifier are connected to the terminal marked "G" for external grounding; the midpoint of the secondary winding of the input transformer T1; the midpoint of the 6.3-volt filament winding on the power transformer T3; the metal shell of the amplifying tubes when metal type tubes are used; and the chassis of the amplifier. A good building ground should be connected to the terminal marked "G."

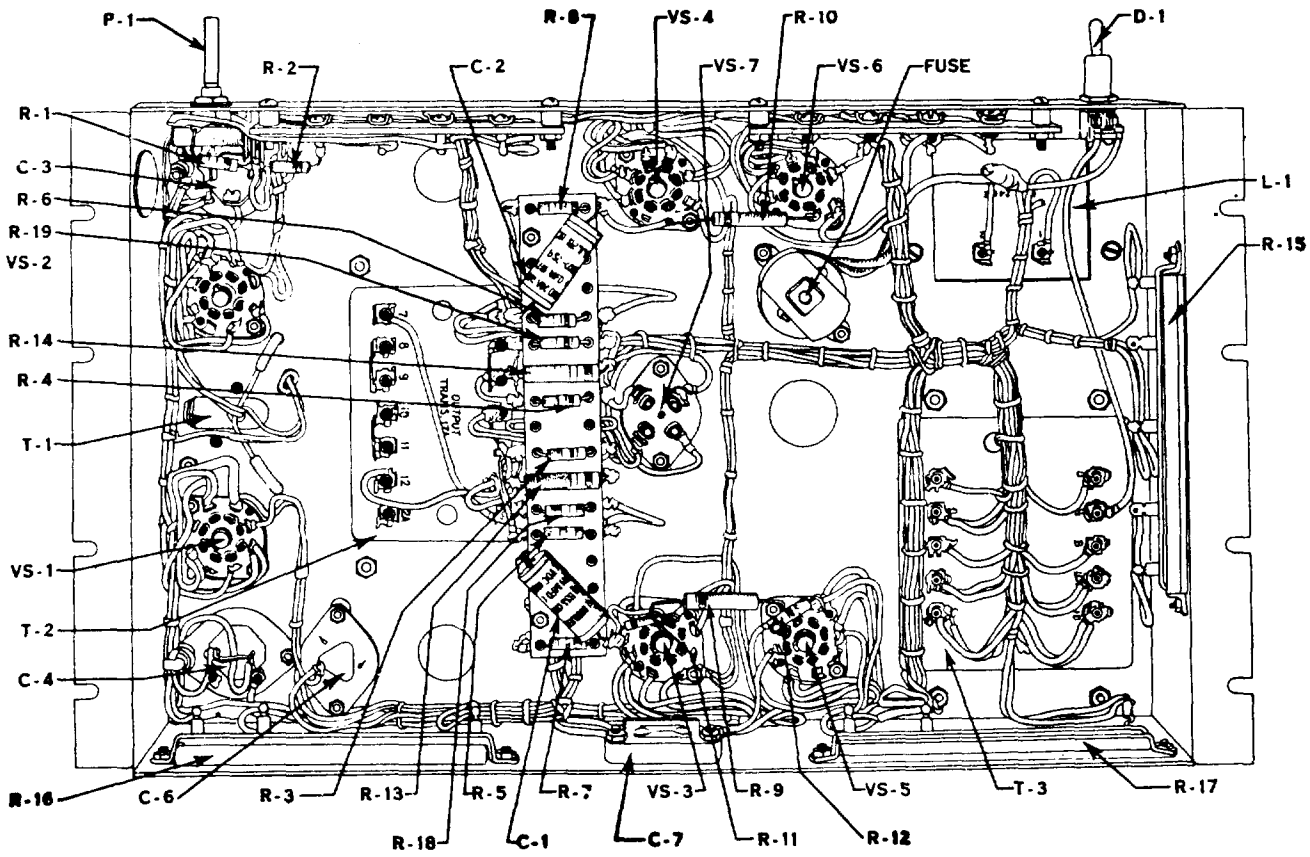


Fig. 3 - Bottom View of 118A Amplifier

2.28 Terminal 3 of the input transformer T1 is sometimes connected to terminal "G" if desirable from a noise standpoint. Information on grounding terminal 3 and the input connection is explained in Paragraph 2.05 of this section.

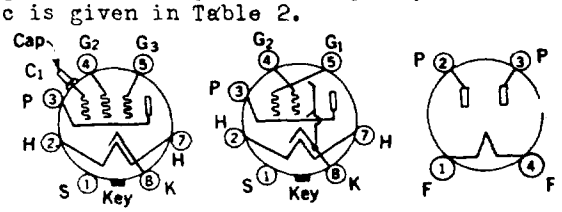
(K) Noise

2.29 With the 118A amplifier adjusted for maximum gain, the input terminated in an impedance of 600 ohms, and the output terminals connected to the load impedance for which the output transformer is strapped, the normal output noise level (program weighting) will not be higher than 50 db above reference noise level using a 2B Noise Measuring Set.

(L) Amplifiers in Parallel

(1) Separate Load Impedances

2.30 Two or more 118A amplifiers (using the Bridging Connection - terminals 2-3) may be connected to a single input source to supply audio power to several isolated load impedances. For such lications, similarly numbered input terminals of each of the amplifiers are connected together (see Fig. 6). When the amplifiers are connected in this manner the gain controls of all the amplifiers are available to adjust the output level to the desired value for each individual load. When a number of 118A amplifiers are connected to a single source the maximum source impedance from which they may be operated without appreciably changing the normal amplifier frequency characteristic is given in Table 2.



G_1 - Control Grid
G_2 - Screen Grid
G_3 - Suppressor Grid
P - Plate
K - Cathode
H - Heater
F - Filament
S - Metal shell of tube if metal tube

Fig. 4 - Arrangement of Terminals and Connections of Vacuum Tubes Used in the 118A Amplifier Viewed from the Bottom

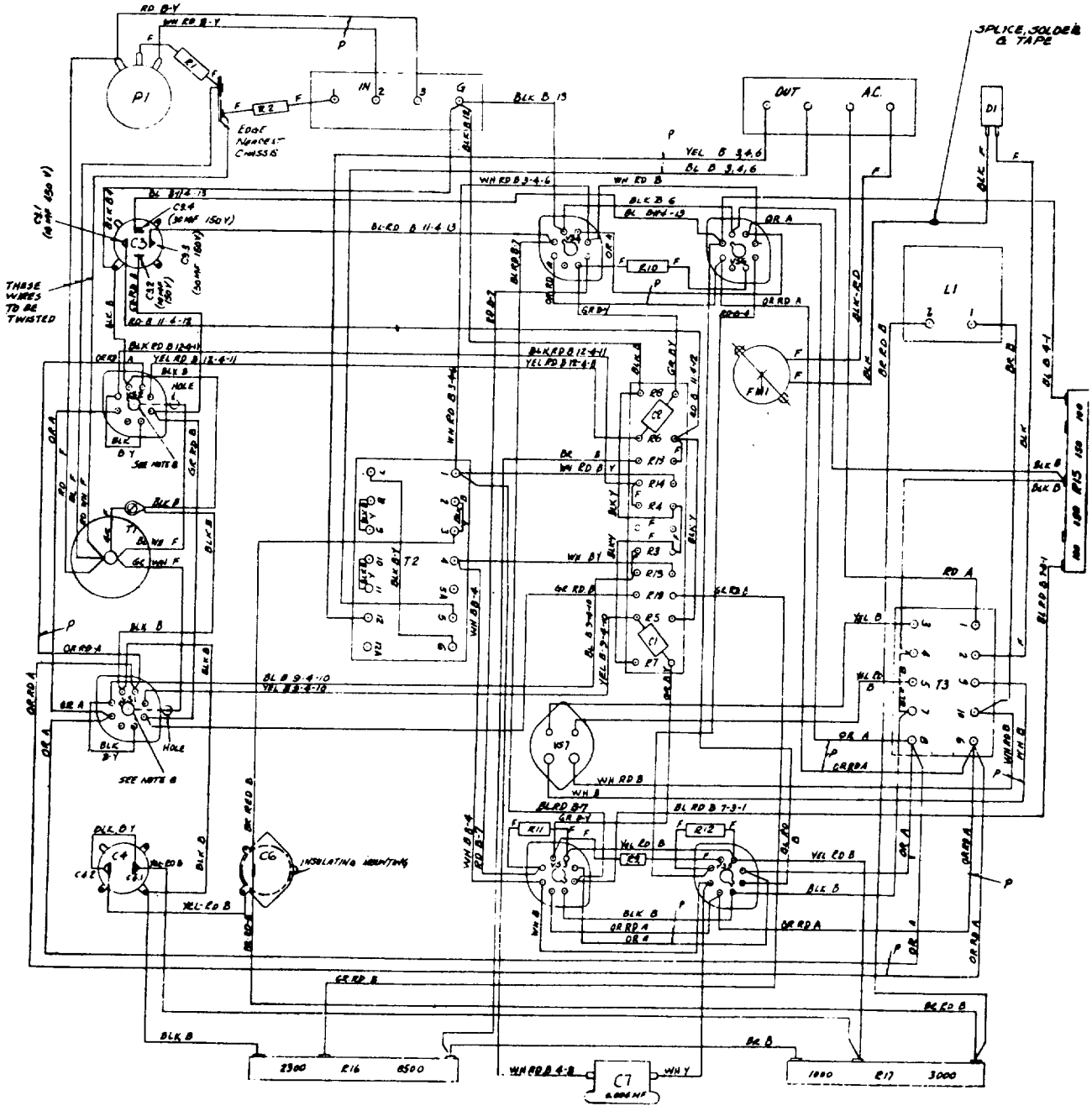


Fig. 5 - Wiring Diagram

TABLE 2

Number of 118A Amplifiers	Maximum Source Impedance
1	25,000 ohms
2	12,500 ohms
3	8,325 ohms
4	6,250 ohms
5	5,000 ohms

2.31 The high gain input connection is not usually employed for operating a number of amplifiers from a single input source because of its low internal impedance.

(2) Common Load Impedance

2.32 When more output into a single load impedance is required than can be supplied by one amplifier, two or more amplifiers may be operated with their inputs and outputs in parallel.

2.33 When the 118A amplifiers are operated in this manner, only a single gain control is used in order that the input to each amplifier will be at the same level. To accomplish this, an external gain control can be used, removing the gain control (P1) of each amplifier from the circuit by disconnecting it from terminal 2 of its amplifier and connecting that

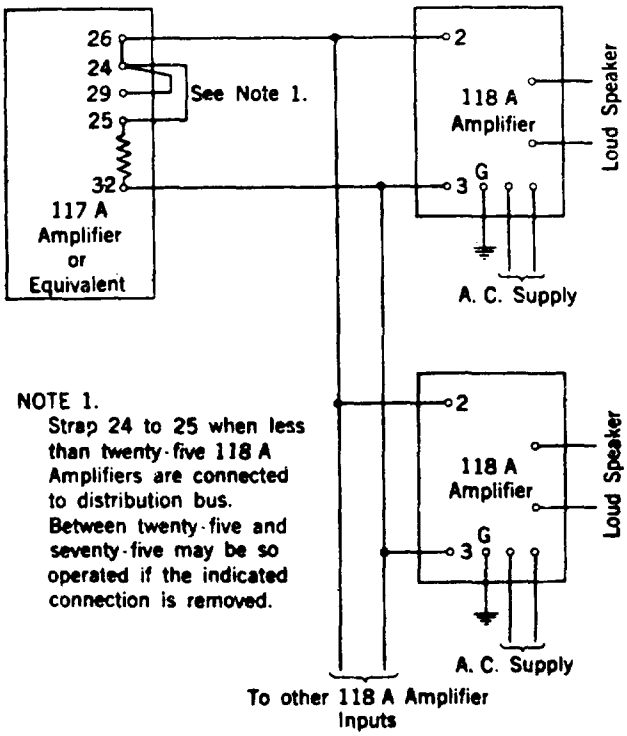


Fig. 6 - Connections for Typical System Employing Bus Program Distribution to a Number of 118A Amplifiers

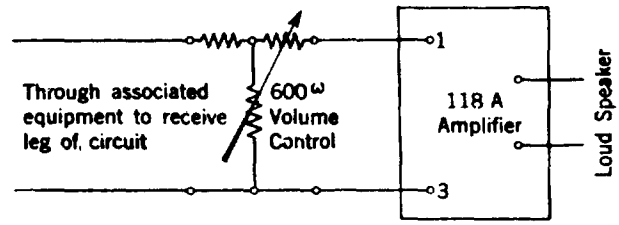


Fig. 7 - Station Circuits with Loud-speaker Signaling

terminal directly to the lead of the 12,000-ohm resistor (R1) which formerly went to the gain control (see schematic Fig. 1).

2.34 To connect two or more 118A amplifiers (less gain controls) in parallel (Bridging Amplifier Input Connection - terminals 2-3) strap correspondingly numbered input terminals together. The same output transformer strap connections should be used for each amplifier in the parallel group and correspondingly numbered output transformer terminals (connected on each amplifier through the terminals marked OUT) of the amplifiers are connected together. The terminals on the output transformer (T2) of each amplifier should be strapped in accordance with Table 2 to match an impedance that is equal to the load impedance times the number of amplifiers used in parallel.

Example: If three 118A amplifiers are to be used with the outputs connected in parallel and are to supply power into a load which has an impedance of 10 ohms, each of the output transformers of the three amplifiers is strapped to match an impedance of 30 ohms (10-ohm load x 3 amplifiers = 30 ohms output impedance of each amplifier).

2.35 When two or more 118A amplifiers with both inputs and outputs in parallel are connected to a single source of input the maximum source impedance from which they should be operated is outlined in Paragraph 2.31.

2.36 In the event that the polarity of one of the amplifiers is reversed with respect to the other amplifiers, the output of this amplifier when connected in parallel with another will be practically zero with a normal signal applied to the input terminals. This fact provides an easy check on the polarity of the output leads. The amplifiers will not be damaged by operation for short periods with the output of one reversed in polarity with respect to the other.

2.37 The frequency characteristics of the 118A amplifier are but slightly affected by parallel operation. The available power output

of two amplifiers connected in parallel is two times that of a single amplifier.

3. INSTALLATION

(A) Mounting

3.01 The 118A amplifier may be mounted either vertically or horizontally in a relay rack or on a shelf or in an apparatus cabinet. When the amplifier is not mounted in a metal cabinet or when it is mounted on a relay rack adjacent to other equipment a metal bottom plate should be used to provide adequate electrical shielding. The mounting holes are spaced for standard 19-inch vertical relay rack mounting and when so mounted a standard 12-1/2-inch cover plate should be used.

(B) Noise Pickup

3.02 The input transformer (T1) is not magnetically shielded. When operating the amplifier adjacent to other electrical equipment it may be necessary to equip the input transformer with an external magnetic shield (No. 42-A) to reduce disturbing magnetic coupling which may increase the noise level of the amplifier. The No. 42-A shield will reduce the normal output noise level of the amplifier approximately 10 db and its use is recommended where extremely quiet operation of the amplifier is a requirement.

3.03 A reduction in noise due to magnetic pickup by the input transformer may be obtained by loosening the input transformer mounting ring clamping screw and rotating the transformer to a position of minimum pickup.

(C) Ventilation

3.04 Care should be taken when mounting the 118A type amplifier on a partially closed shelf or in a perforated cabinet to provide sufficient ventilation for adequate cooling. The temperature of the air 1 inch above the output transformer (T2) should never be more than 30 degrees Fahrenheit above room temperature and under maximum room temperature condition should not exceed 130 degrees Fahrenheit after the amplifier has been operated four hours.

3.05 This condition may usually be realized for a single 118A amplifier when approximately 60 square inches of opening to free air at room temperature is provided in the housing near the bottom of the amplifier and a similar area in the top. At least 4 inches of space should be provided between the top of the housing and the nearest part of the amplifier.

3.06 When additional 118A type amplifiers or other equipment of similar wattage dissipation is mounted within the same cabinet, a proportionally larger area of opening must be provided in the cabinet to meet the recommended temperature requirements. A space of at least seven inches should be provided between 118A amplifiers or between a 118A amplifier or other equipment of similar heat dissipation.

3.07 If sufficient ventilation is not provided for the 118A amplifier the fustat may blow as it is quite sensitive to external heat.

(D) Wiring

3.08 In order to avoid noise pickup in the input leads, shielded pair such as "Specification AT-6474 Shielded Inside Wire" or equivalent may be employed for the input wiring of the 118A amplifier. The metal shield should be connected to the amplifier ground terminal G.

3.09 When wiring the output of a 117A, 119A or other type high gain amplifier to the input of 118A amplifier, it may be necessary to use shielded wire if there is a possibility of coupling between this wiring and that in the output of the 118A amplifier.

3.10 Shielded wire may also be employed for the output wiring of the 118A amplifier to prevent crosstalk into adjacent low level circuits. The insulation and size of the wire used for the output wiring should be sufficient to carry the audio power developed by the 118A amplifier.

(E) Safety Precautions

3.11 No terminals or wiring involving the a-c supply or secondary power should be exposed to accidental contact. When the amplifier is mounted on a relay rack or an open type cabinet or shelf, the (out - a-c) terminal strip should be covered with an insulating plate and the wiring side of the amplifier should be covered with a metal bottom plate at least 1/16" thick attached to the chassis flanges. With this form of mounting, connections should be made to the rear of the covered terminal strip through the 3/4-inch pipe knock-out hole provided in the wall of the chassis. A similar knock-out hole is provided at the other end of the chassis for connection to the input terminal strip.

4. AMPLIFIER OPERATING FEATURES

(A) Primary Line Voltage Connection

4.01 An a-c power supply of between 110 and 125 volts and capable of delivering approximately 2 amperes is required to operate the 118A type amplifier. This a-c power is connected to the two terminals marked a-c on the amplifier. There are no taps provided on the power transformer (T3) to make adjustments for different voltages in this range. A switch (D1) is provided as part of the amplifier and by operating this switch the amplifier may be turned on or off.

(B) Vacuum Tubes

4.02 With the a-c supply connected to the proper terminals of the amplifier as explained in Paragraph 4.01, the heater currents for the amplifier and rectifying tubes should be satisfactory and with those currents within the correct operating limits the grid potentials and plate currents should in general be correct. Therefore, no other power supply adjustments are provided.

(C) Gain and Frequency Range

4.03 The 118A type amplifier has a gain of 53 db when operating from a 600-ohm source and using the bridging input connection (terminals 2 and 3). When the non-bridging maximum gain input connection (terminals 1 and 3) is employed the amplifier has a gain of 63 db. Input circuit arrangements are explained in Part 4(E) of this section and include information on gain control adjustments.

4.04 If the 118A amplifier is operated under the condition where two of the four output tubes are removed, as explained in Paragraph 4.07, the gain of the amplifier is reduced by 3 db.

4.05 The useful frequency range of the 118A type amplifier is from 35 to 15,000 cycles. The frequency characteristic of the average 118A amplifier is flat within ± 2.0 db from 50 to 8000 cycles and within ± 5.5 db from 35 to 15,000 cycles with respect to a reference frequency of 1000 cycles when operating from a 600-ohm source (either the high gain or bridging connection) and into a nominal load impedance.

(D) Audio Power Output

4.06 The 118A amplifier when using four 6L6 or 6L6G type tubes in the output stage will deliver approximately 50 watts of audio power with less than 5 per cent. total harmonic distortion to a nominal load impedance.

4.07 In cases where a power output of 50 watts is not required and the a-c line voltage is less than 120 volts, satisfactory operation with a maximum output power of 25 watts may be obtained by removing two of the 6L6G type output tubes V5 and V6 (see schematic). These are the tubes located nearest the power transformer and the retard coil both of which are toward one end of the chassis. Equally satisfactory operation of the amplifier will result if tubes V3 and V4 are removed in place of V5 and V6. See Fig. 2 for tube locations.

Note: When removing tubes for reduced power output, remove them only in the paired combinations as stated above. If the tubes are removed in a combination of V3 and V5 or V4 and V6 the push-pull output stage will be disrupted and distortion will result.

4.08 When only two output tubes are employed all the nominal and working range load impedances given in Table 3 should be multiplied by a factor of 2. The gain of the amplifier under this condition is reduced by 3 db and the power consumption is also reduced.

(E) Input Arrangements

4.09 Fig. 6 shows the proper method of connecting the output of a 117A or 119A type amplifier to the input of one or more 118A type amplifiers. When connected in this manner, the gain of the 118A amplifier is adjusted so that its overload point will be reached slightly earlier than that of the voltage amplifier. The gain control of the 117A or 119A amplifier can then be used for frequent gain adjustment.

4.10 Fig. 7 shows a typical application of the 118A amplifier to a circuit employing loud-speaker signaling.

TABLE 3

Nominal Load Impedance In Ohms	Working Range of Load Impedance (Ohms)	Strap Terminals of Output Transformer as follows:				Output Connections to following Terminals of Output Transformer
500	250 to 1000	6 to 7	8 to 9	10 to 11		5A to 12A
125	62 to 250	6 to 7	10 to 11	5A to 9	8 to 12A	5A and 12A
30	20 to 62	6 to 7	8 to 9	10 to 11		5 and 12
17	10 to 20	7 to 9	8 to 10	6 to 7	10 to 11	5 and 12
7.5	4 to 10	6 to 7	10 to 11	8 to 12	5 to 9	5 and 12
2	1 to 4	(5 to 7	to 9	to 11)	(6 to 8 to 10 to 12)	5 and 12

Note: When only two output power tubes are employed all the nominal and working range load impedances given in this table should be multiplied by a factor of 2.

4.11 When the low impedance high gain input connection (terminals 1 and 3) is used the gain control is not connected in the circuit and must be left in its maximum gain position. This connection is used when increased gain (approximately 10 db) is required of the 118A amplifier. This input arrangement when bridged across a 600-ohm circuit will cause a slight level change in the circuit.

(F) Output Arrangements

4.12 Output load impedances between 1 and 1000 ohms may be connected to the terminals marked "out." As delivered the amplifier is suitable for connection to load impedances between 20 and 62 ohms. For other load impedances the strapping of the terminals of the output transformer (T2) must be changed in accordance with Table 3.

5. PARTS LIST

5.01 The item designations shown on Table 4 are those indicated on the schematic drawing Fig. 1.

TABLE 4

Item	Description
C1, C2	Cornell Dubilier Cond. Type TVC 605CD-3, .05 mf 600 V D.C.W.V. less mounting strap.
C3	Mallory No. 101425-0 Type FP Cond. 10 mf 450 V, 30 mf 150 V, 30 mf 150 V, 10 mf 150 V, plain. Can size 1-3/8" dia., 3" high, with metal mtg. plate.
C4	Mallory No. 101209-0 Type FP Cond. 30 mf 450 V, 30 mf 450 V. Can size 1-3/8" dia., 3" high, with metal mtg. plate.
C6	Mallory No. 93727-0 Type FP Cond. 30 mf 450 V with aluminum finished wax impregnated cardboard insulating cover glued on can and bakelite mtg. plate. Can size 1" dia., 3" high.
C7	Aerovox Mica Cond. No. 1456, .004 mf ± 20% molded in XM262 bakelite (yellow).
VS1 to VS6, Inc.	39-1-E Eby Vacuum Tube Socket per KS-7862
VS7	33-1-A Eby Vacuum Tube Socket per KS-7741
T1	288F Input Transformer
T2	173D Output Transformer
T3	359L Power Transformer
P1	IRC Type "C," Curve "C," 25,000-ohm Pot. with spiral wiper connector, one lockwasher, one hex. nut, std. 280 degree flat; dim. A - 1-1/2", B - 3/16", C - 1".
D1	H & H 20510 SPST Tumbler Switch, 7/8" lg. mtg. sleeve, bakelite laminations, 2 hex. nuts and 8" long leads. Long pear-shaped lever, and lockwasher.
L1	241E Retard Coil
	IRC Resistances
R1	Type BT-1/2 - 12,500 ohms
R2	Type BT-1/2 - 300 ohms
R3, R4	Type BT-1/2 - 800 ohms
R5, R6, R7, R8	Type BT-1/2 - 0.25 meg.
R9, R10	Type BT-1/2 - 10,000 ohms
R11, R12	Type BT-1/2 - 200 ohms
R13, R14	Type BT-1 - 0.3 meg.
R15	MW5, 4 Section, 500 ohms total, Tapped 100 ohms 2 watts, 150 ohms 4 watts, 150 ohms 4 watts, 100 ohms 2 watts, ± 10%, No. 2 terms.
R16	MW5, 2 Section, 10,800 ohms total, wattage evenly distributed. Tapped 8500 ohms, 2300 ohms, ± 10%, No. 2 terms.
R17	MW5, 2 Section, 4000 ohms total, wattage evenly distributed. Tapped 3000 ohms, 1000 ohms, ± 10%, No. 2 terms.
R18	Type BT-1/2 - 30,000 ohms
R19	Type BT-1/2 - 10,000 ohms