TM 11-2256

WAR DEPARTMENT TECHNICAL MANUAL

LIMITER AMPLIFIER, TYPE 3BLH, AND SPEAKER, TYPE 6AL

WAR DEPARTMENT *22 NOVEMBER 1944*

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WASHINGTON 25, D. C., 22 November 1944.

TM 11-2256, Limiter Amplifier, Type 3BLH, and Speaker, Type 6AL, is published for the information and guidance of all concerned.

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(For explanation of symbols see FM 21-6.)

WARNING

HIGH VOLTAGE

IS USED IN THE OPERATION OF

THIS EQUIPMENT.

DEATH ON CONTACT

MAY RESULT IF OPERATING PERSONNEL

FAIL TO OBSERVE SAFETY PRECAUTIONS.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

DESTRUCTION NOTICE

WHY — To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN — When ordered by your commander.

HOW — 1. Smash — Use sledges, axes, handaxes, pickaxes. hammers, crowbars, heavy tools.
2. Cut — Use axes, handaxes, machetes.
3. Burn — Use gasoline, kerosene, oil. flame throwers, incendiary grenades.
4. Explosives — Use firearms, grenades, TNT.
5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT — 1. Smash — All tubes, transformers, speaker, and amplifier chassis.
2. Cut — All cables, wires, coil windings.
3. Burn — All parts of the equipment that can not be demolished by other means.
4. Bend — Chassis, dust cover.
5. Bury or scatter — All parts of the equipment after destroying their usefulness.

DESTROY EVERYTHING

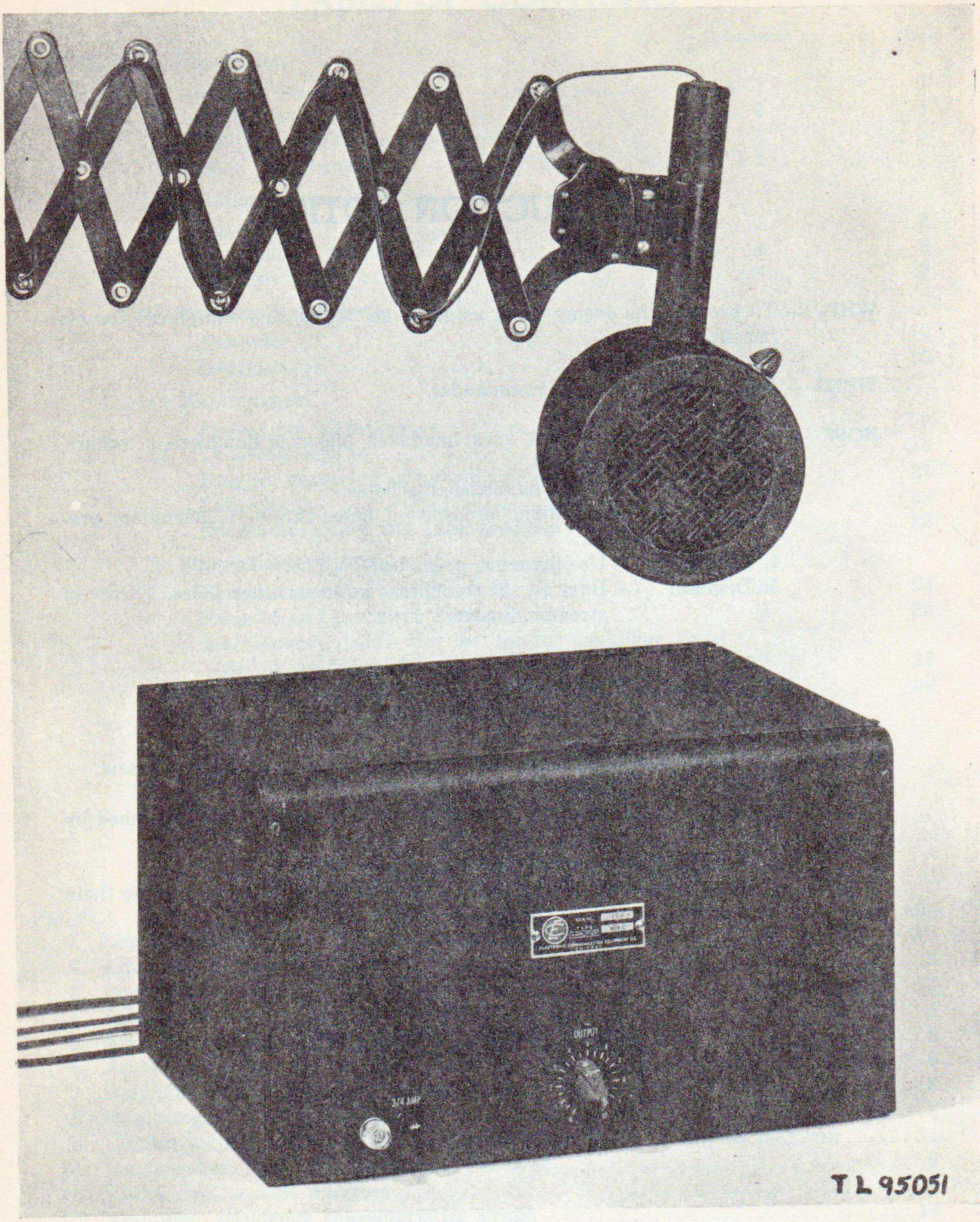

Figure 1. Limiter amplifier, type 3BLH, and speaker, type 6AL.

SECTION I

DESCRIPTION

1. GENERAL.

Limiter amplifier, type 3BLH, and speaker, type 6AL, is designed for use in railroad train dispatching and other centralized traffic control systems. The equipment consists of an amplifier and a separately housed loudspeaker (fig. 1).

a. Amplifier. The amplifier unit amplifies incoming and outgoing conversation over the telephone line. As a very necessary feature of the equipment incoming calls can be heard in the loudspeaker at the same time that the dispatcher or operator is sending a message over the line. Further, incoming and outgoing limiter features of the amplifier serve to reduce unwanted line noise and to provide a stable output level despite variations in incoming signal strength.

b. Power Source. The equipment operates at 115-volt, 60-cycle alternating current (ac). The power consumed at 115 volts is 50 watts.

2. COMPONENTS.

Quantity	Name	Dimensions (in.)	Weight (lb)
1	Amplifier, type 3BLH	9 x 15¼ x 11	36
1	Speaker, type 6AL	5-9/16 x 3⅝ (6" handle)	3¼

3. ADDITIONAL EQUIPMENT REQUIRED.

The following additional equipment is required to operate a dispatcher's sending station in a railway train dispatching telephone system.

1 Western Electric Co No. 98B protector, or equivalent.
1 Western Electric Co No. 502-A or No. 501B subset, or equivalent.
1 Western Electric Co modified No. 345-B jack box, or equivalent.
1 Western Electric Co No. 3B or No. 3D foot switch, or equivalent.
1 Western Electric Co type 47 extension bracket, or equivalent.
1 Kellogg Switchboard and Supply Co No. 177-L dispatcher's breast transmitter, or equivalent.

4. TUBE COMPLEMENT.

Quantity	Reference symbol (fig. 9)	Name and description	Function
1	7B8	JAN 7B8 converter	Preamplifier and limiter
2	7N7(1) 7N7(2)	JAN 7N7 double triode	Interstage amplifier; limiter rectifier; transmitter amplifier
2	7C5(1) 7C5(2)	JAN 7C5 beam-power amplifier	Push-pull audio output
1	(80)	JAN 80 full-wave rectifier	B + power supply

SECTION II

INSTALLATION AND OPERATION

5. INSTALLATION.

a. Mounting. To remove the equipment from its shipping case, open the case and remove the cartons containing running spare tubes and the carton containing the loudspeaker. Before removing the amplifier, remove the four corner cushioning pads, since they might damage the neon indicator on the front panel in the removal of the set. Lift the amplifier straight up from the carton, using caution to avoid damaging anything on the front panel. Figure 2 illustrates the dimensions of the amplifier so that space may be estimated for its installation. The amplifier need not be anchored in place. The speaker may be mounted in place in the Western Electric type 47 extension bracket.

b. Ventilation. Place the amplifier so as to allow maximum ventilation. Allow at least 2 inches clearance on each side and sufficient space at the top of the case for good air circulation and for opening of the hinged dust cover.

c. Wiring. Figures 3 and 4 are wiring diagrams for connecting the amplifier and speaker with the associated equipment. Follow either figure 3 or figure 4, according to the types of associated equipment furnished. Both diagrams show jacks to be used for connections to the subset or amplifier, but installation of keys in place of the jacks will make for greater convenience. All connections should be made with insulated wire in twisted pairs. The wires should be buzzed out and identified, then tagged.

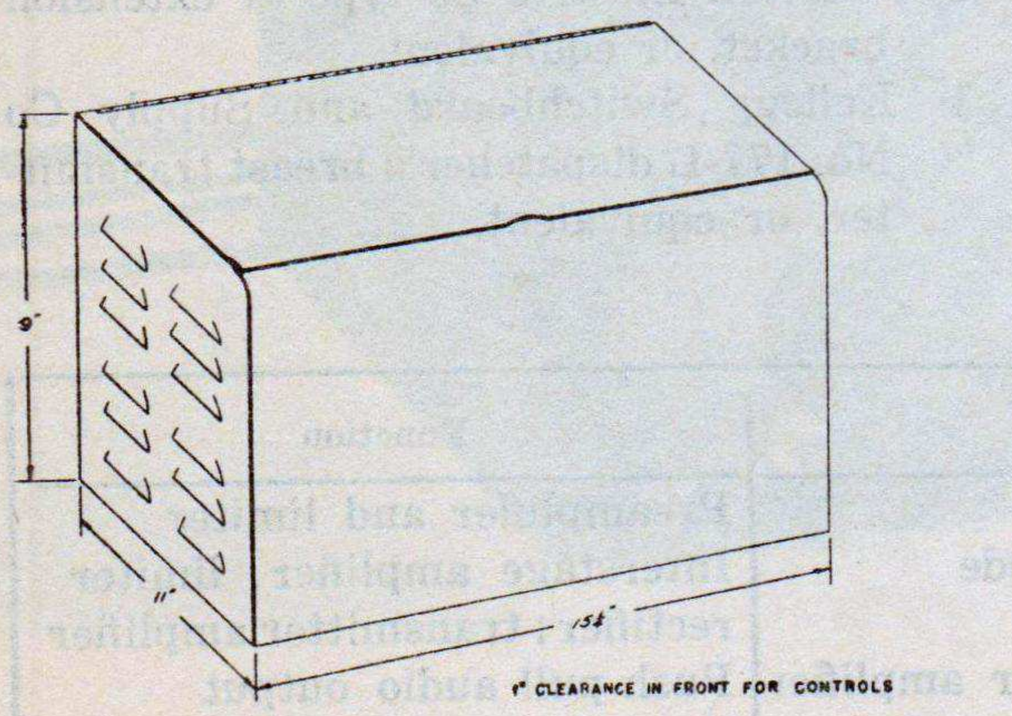

Figure 2. Amplifier, dimensional drawing.

d. Foot Switch. The contacts on the foot switch should be inspected and adjusted so as to conform to instructions in figure 3 or figure 4. Close the two contacts which are connected to terminals 7 and 8 of the amplifier, in figures 3 and 4, before those that energize the telephone microphone. This eliminates the momentary "sing" of the amplifier caused by feedback from speaker to microphone.

6. PREPARATION FOR USE.

a. Adjustment of the Line Amplifier. (1) Set the OUTPUT control on the front panel at 10 (fig. 1). Always leave this control at 10 for most efficient operation of the amplifier. If line noise is at such a high level that the LINE CONTROL will not reduce it sufficiently, the OUTPUT control may be set at a value slightly below 10, *but should never be used below* 5.

(2) Set the controls on top of the chassis, inside the dust cover (fig. 5), as indicated below.

(*a*) Set the LIMITER control between 6 and 8. The exact setting of the LIMITER control for 2-watt output is stencilled on one of the transformer cases *and should not be varied from, since it is predetermined for optimum performance* of the limiter action of the amplifier.

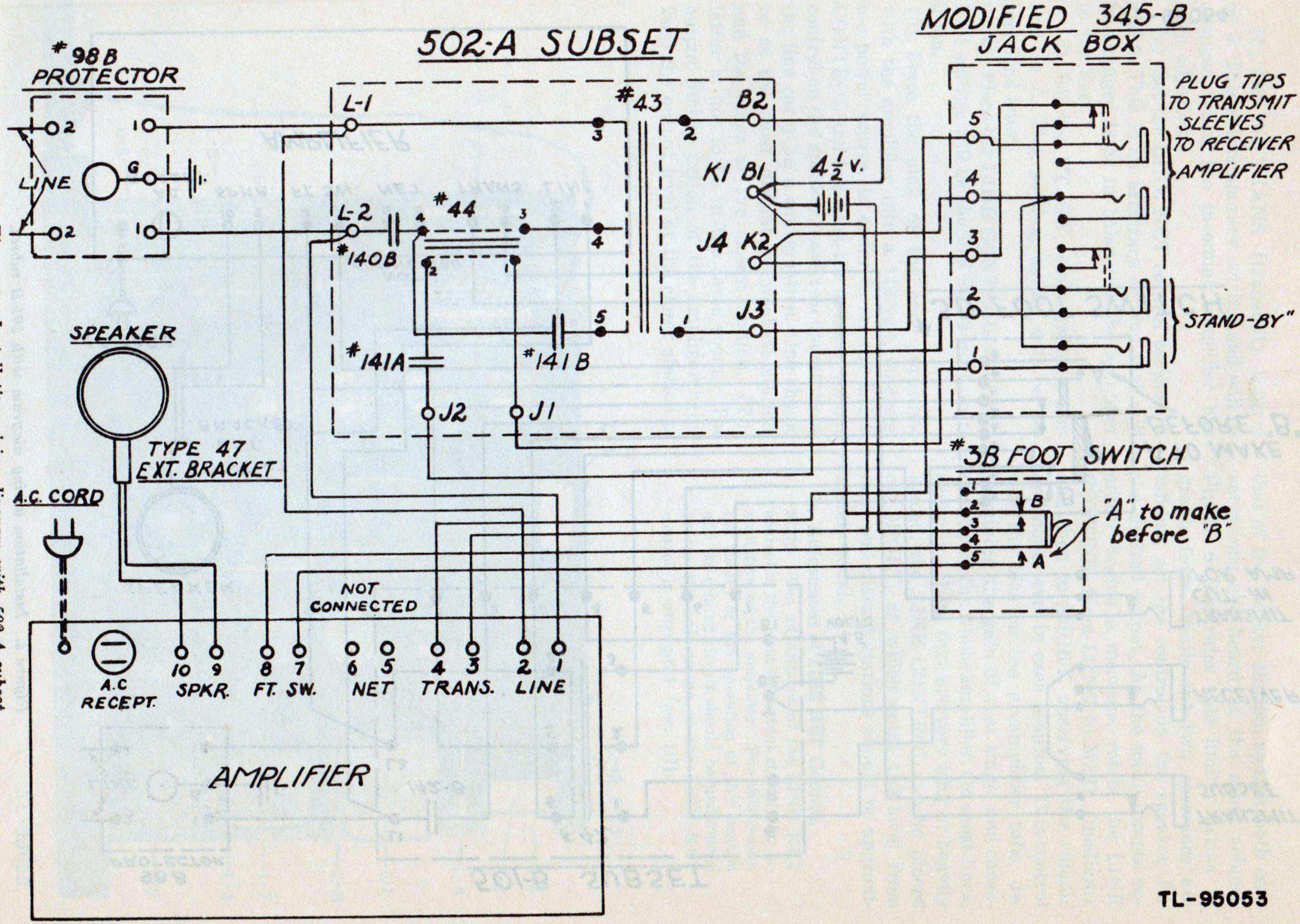

Figure 8. Installation wiring diagram with 502-A subset.

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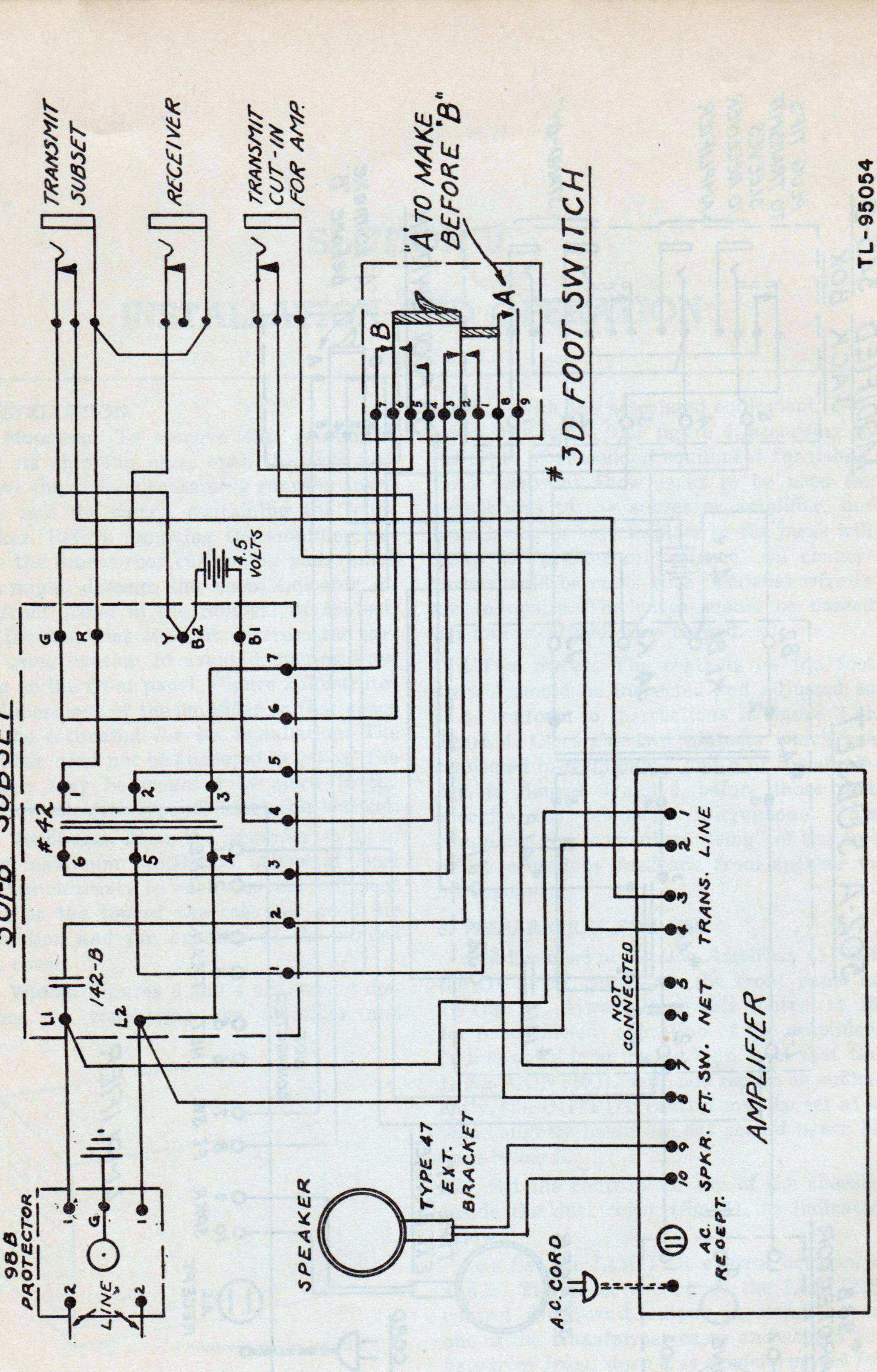


Figure 4. Installation wiring diagram with 501-B subset.

(*b*) Set the TRANS (transmit) control on 0. This is a temporary setting and will be changed when the incoming amplifier has been adjusted.

(*c*) Set the LINE NET control between 5 and 6. This is an arbitrary setting that will be changed later in balancing the amplifier to the line.

(*d*) Set the FT. SW. (foot switch) control on 0. This setting, again, will be determined later.

(*e*) Place the LINE CONTROL on LONG. This setting will be checked in the next operation.

(3) Place the plug of the cord furnished with the amplifier into a 115-volt, 60-cycle, a-c power source. In order to set the LINE CONTROL and to adjust the speaker volume control on the speaker, have two operators on the line carry on a conversation. One should be at the most distant or weakest station, and the other at the closest station. (The latter is not to be in the same room.) The output limiter action of the amplifier helps keep the output level of the closer station to that of the weaker station, so that both conversations are heard at the same volume. Figure 6 illustrates this limiter action in graph form. While the two operators are talking, set the control on the speaker for the desired output. As the more remote operator begins a message, rotate the LINE CONTROL from LONG to MED. (medium) and then to SHORT, observing the volume and noise level in each position. This control sets the bias on the preamplifier tube, determining the gain of that stage, and consequently of the whole amplifier. On most lines, excepting those that are very long or heavily loaded, the LINE CONTROL can be placed on SHORT, at which point the level from near and distant stations should be approximately equal.

b. Adjustment of LINE NET Control.

NOTE: The adjustment of the LINE NET control is the most important step in the installation of the amplifier. For this reason the theory of the operation of this control and its related circuit should be understood before the adjustment of the LINE NET control is attempted (sec. III).

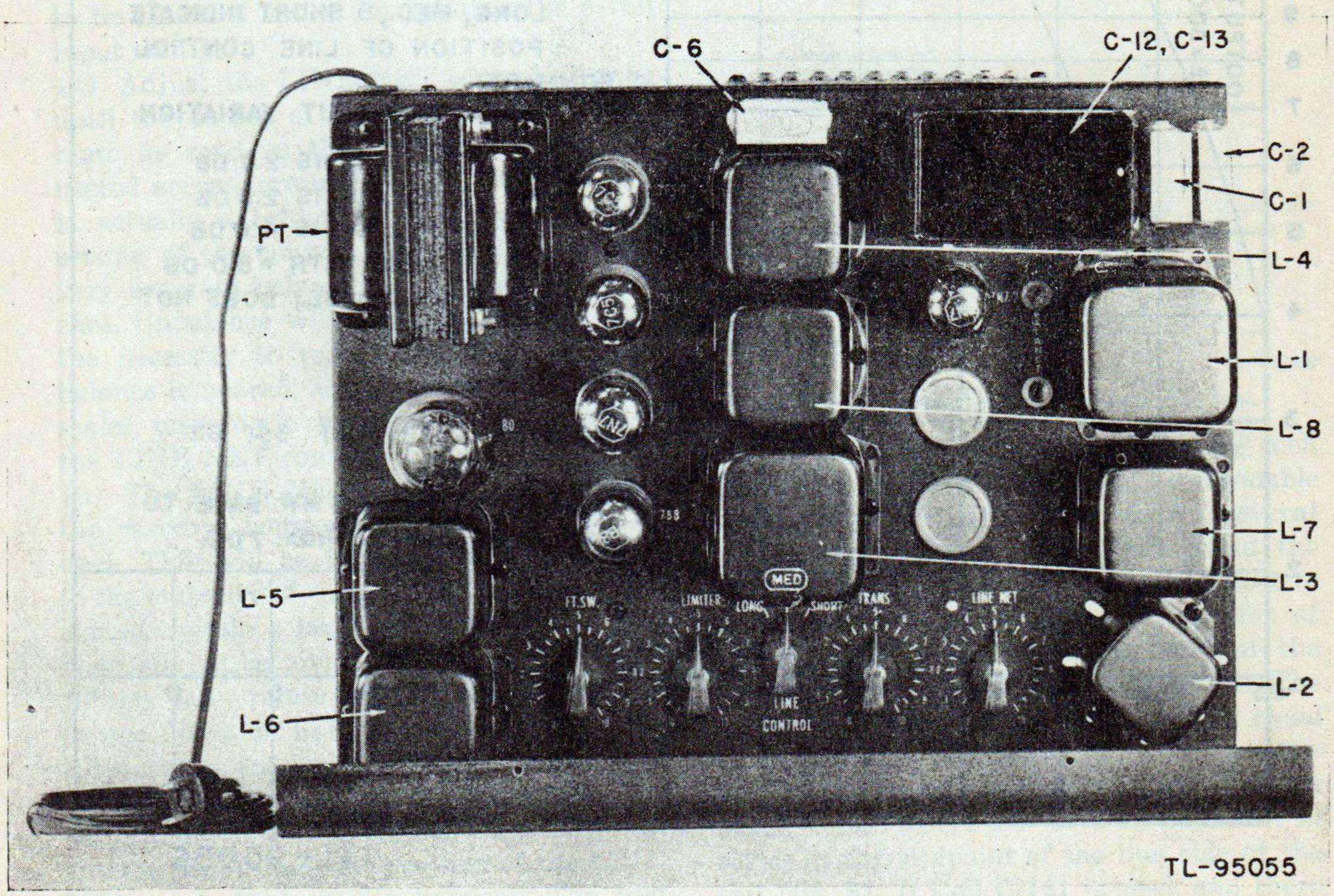


Figure 5. Amplifier chassis, top view.

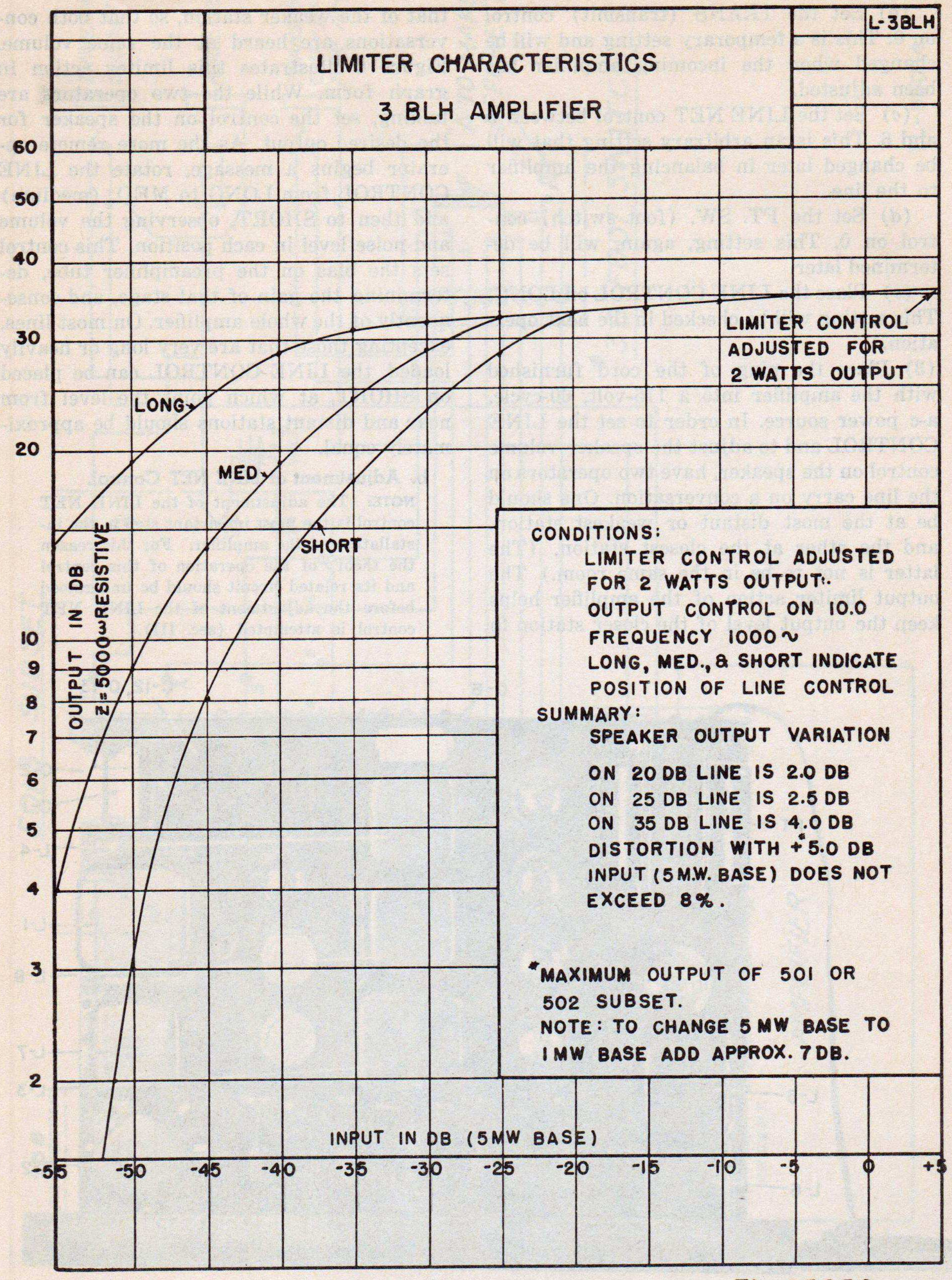


Figure 6. Amplifier, audio input vs audio output graph.

An audio oscillator and a 1,000-ohm-per-volt a-c voltmeter or decibel meter are necessary for the adjustment of the LINE NET control. Proper balancing of the hybrid coil is very important; thus the use of instruments rather than audible indications of balance is required. During the procedure outlined below, a 1,000-cycle note will be present on the telephone line; thus it is well to have the various steps well in mind in advance so as to make the adjustments in the shortest possible time.

(1) Adjust the TRANS control to 7 (fig. 5).

(2) Connect an a-c voltmeter or decibel meter to the SPKR (speaker) terminals, 9 and 10, at the rear of the amplifier (fig. 7). The speaker or a 5,000-ohm resistor should also be connected to SPKR terminals 9 and 10 during this time in order to provide the necessary load to the amplifier. Set the meter on the 50- or 100-volt scale.

(3) Connect an audio oscillator, tuned to 1,000 cycles, to TRANS terminals 3 and 4 at the back of the set (fig. 7). Adjust the output of the oscillator for +10 db or 5 volts. An a-c meter can be momentarily connected to terminals 3 and 4 for reading the 5-volt input voltage.

(4) Adjust the LINE NET control (fig. 5) until the output of the amplifier is a minimum as read on the voltmeter when connected across terminals 9 and 10. Since this is actually a bridge balancing adjustment, setting of the control must be delicate, and very accurate balance can be obtained with care. Unbalance will result in feedback and the necessity to reduce amplifier gain. As balance is neared, set the voltmeter to lower scales, insuring more accurate adjustment of the LINE NET control.

(5) The LINE NET control balances only the resistive component of the line impedance. This will be found to be satisfactory in the majority of cases. If the telephone line should contain a large amount of cable, balance will not be precise as read on the meter. In this case, rotate the LINE NET control in one direction until the meter takes a decided jump upward. Note this point, then turn the control in the other direction. The output meter will decrease, then show an upward trend. Note the position of the LINE NET control when this happens. The best obtainable balance point under these conditions will be reached when the control is set exactly midway between these two points. To find this center point, subtract the noted lower setting of the LINE NET control from the higher setting, divide the result in two, add the result to the lower reading, and set the LINE NET control at this point.

Example:

Meter jumps upward when LINE NET control is turned to	8
Meter swings up again when LINE NET control is turned to.....	3
Difference.....	5
Divide result by 2	2.5
Add quotient to lower setting	5.5

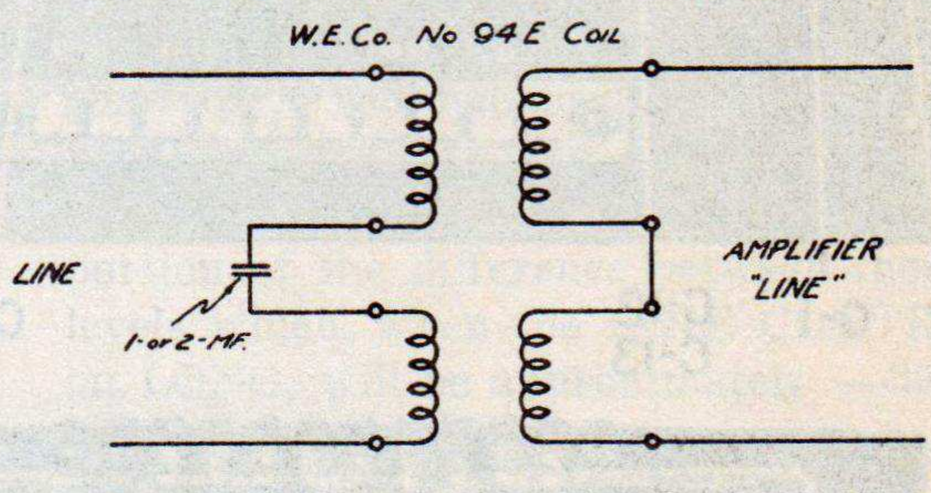


Figure 8. Repeating coil, circuit diagram.

(6) If the irregularities of the line are such that it is impossible to obtain a reasonable balance with the LINE NET control, several means can be taken which will avoid the need for a precision net. The most effective means has been found to be the insertion of one or more repeating coils between the transmission line and the equipment. The Western Electric Co No. 94-E Coil or equal or Coil C-161 will prove to be quite satisfactory. To permit ringing with the Western Electric coil, insert a 1- or 2-mf capacitor in series at the midpoint of the line side of the coil (fig. 8). If Coil C-161 is used, and there

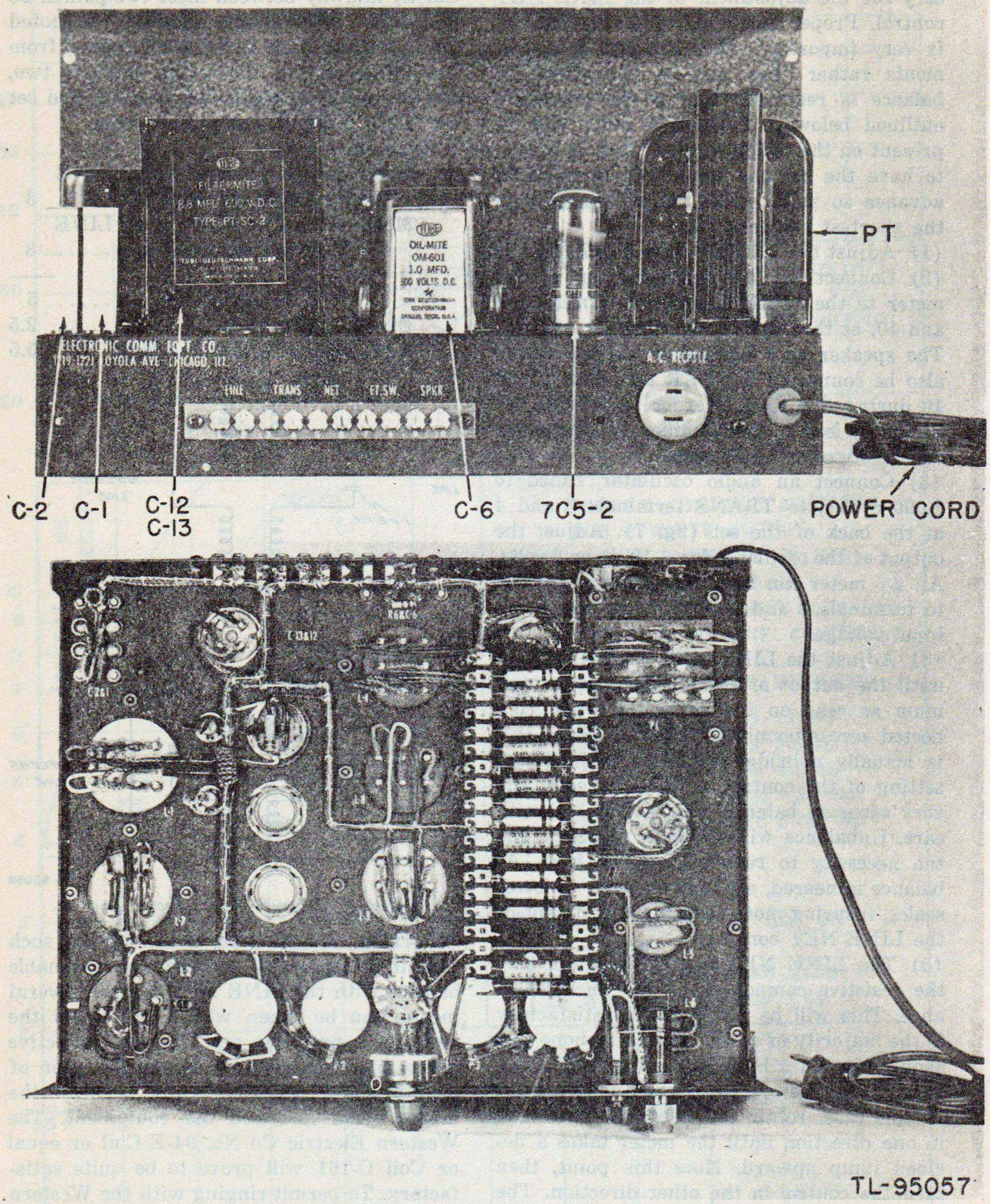


Figure 7. Amplifier chassis, rear and bottom views.

is selective ringing on the line, the coil can be rewired to insert a 1- or 2-mf capacitor in series at the midpoint of the line side of the coil. In either case, the addition of the capacitor adds to the impedance of the line side of the coil at ringing frequencies.

(7) If a 1,000-ohm-per-volt voltmeter is not available for balancing, the output terminals of the hybrid coil (fig. 9, 2 and 5 on L-1) are brought to pin jacks on the top of the chassis. These are marked BALANCE (fig. 5) and a 600-ohm db meter may be inserted here.

c. Transmitter Gain Adjustment. Advance the TRANS control (fig. 5) to a point just below overload at the nearest station, or to a point where there is a suitable level at the most distant station on the line. For most efficient operation, the dispatcher should put out a signal of higher level than the other stations. The hybrid coil in the amplifier, when properly balanced, allows any station to cut in on the dispatcher and be heard even though the dispatcher's signal is higher in level than the station breaking in.

d. Adjustment of FT. SW. Control. The FT. SW. control provides a shunt across the input to the loudspeaker during the time that the dispatcher is speaking on the line, reducing the output of the speaker at this time, and eliminating feedback from the loudspeaker to the microphone, which would cause "singing" in the amplifier. As the FT. SW. control is moved toward 9, the dispatcher's transmitted signal is progressively decreased at the speaker. This also reduces the level of any signal that might "break-in" while the dispatcher is using the line. Thus the FT. SW. control should be carried as near 0 as possible without causing feedback to the microphone. In the event of a suddenly unbalanced line, rotation of the FT. SW. control to its highest point will permit operation of the equipment without "singing", but will reduce or eliminate cutting in by other stations while the dispatcher is talking on the line.

7. OPERATION.

a. Use of Foot Switch. Operation of the limiter amplifier involves only the use of the foot switch connected to the equipment. The foot switch is depressed when the microphone is used to talk over the telephone line. While the switch is depressed, as noted above, the output of the loudspeaker is reduced, but at the same time calls can break in on the dispatcher. When the foot switch is not depressed, all calls on the line are heard at normal volume in the loud speaker. The level of all calls, whether from near or distant stations, is held to approximately the same level by the limiter action of the amplifier.

b. Purpose of the FT. SW. Control. If the equipment tends to develop feedback easily, check the hybrid coil balance with the LINE NET control rather than simply adjusting the FT. SW. control. The FT. SW. control is not intended to make balancing of the hybrid coil easy, but to dissipate the difference between the gain of the amplifier and the feedback point of the equipment. Since the gain of the amplifier is 75 db and the "singing" point of a well-balanced hybrid coil is approximately 45 db, the primary purpose of the FT. SW. control is to dissipate the major portion of the difference between these two levels which, when the LINE CONTROL is on LONG, will be approximately —30 dbm.

c. Speaker Control. A control on the speaker, type 6AL, (fig. 10) controls the level of the sound when calls on the line are coming in through the amplifier. This control on the speaker should be used freely as it is the only volume control in the normal operation of the equipment.

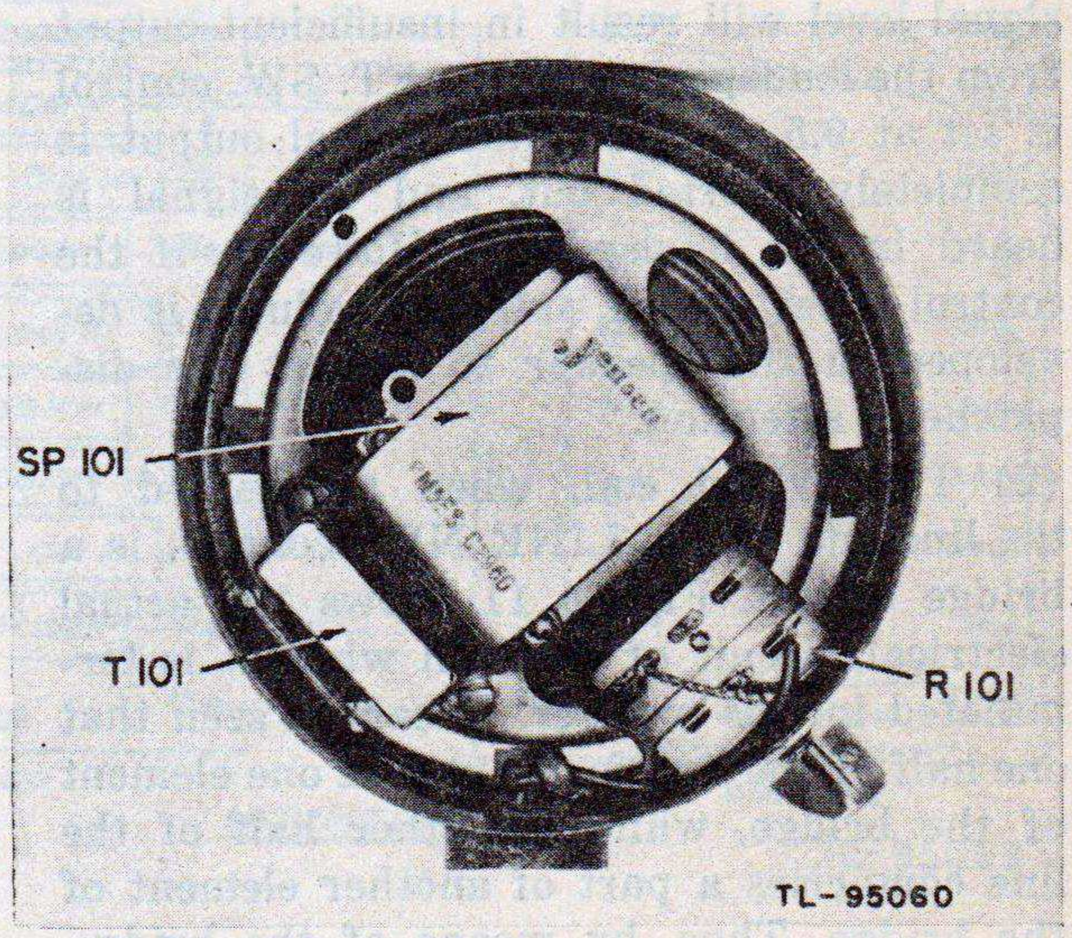


Figure 10. Loudspeaker, rear view, back cover removed.

SECTION III

FUNCTIONING OF PARTS

8. AMPLIFIER (fig. 9).

a. Line Hybrid Coil. It is imperative that the dispatcher have complete control at all times, and that in case of emergency anyone on the line can contact him, even though he may be making a call on the line.

(1) This is made possible by the use of a hybrid coil input which electrically separates the incoming telephone line signal from the outgoing amplifier signal. This permits simultaneous two-way communication without the use of relays or other mechanical devices. By balancing the hybrid coil to the particular telephone line being used, it is possible for the dispatcher to be transmitting at a signal level + 10 db, 50 milliwatts, and simultaneously have a —30 db, 0.005 milliwatt, signal level input received and amplified to a satisfactory volume. The volume is maintained to a satisfactory level by proper adjustment of the FT. SW. control. The FT. SW. control places an adjustable resistor in shunt with the speaker. A proper setting for the FT. SW. control must be selected inasmuch as a too great attenuation of output signal level will result in insufficient output from the loudspeaker. If the FT. SW. control is set at 9.5, the amplifier signal output is completely shorted out, and no signal is heard in the loudspeaker. However, if the control is set near 5, sufficient volume is developed in the speaker to attract the dispatcher's attention.

(2) The hybrid coil, when terminated to the line and to the LINE NET control, is a bridge circuit. Figure 11 shows the actual electrical circuit of this coil when it is terminated in this manner. It can be seen that one half of the line forms part of one element of the bridge, while the other half of the line comprises a part of another element of the bridge. Thus, by means of the bridge, actual measurement to the electrical center point of the line can be made. Thus, if the line itself is unbalanced, the bridge circuit will be unbalanced.

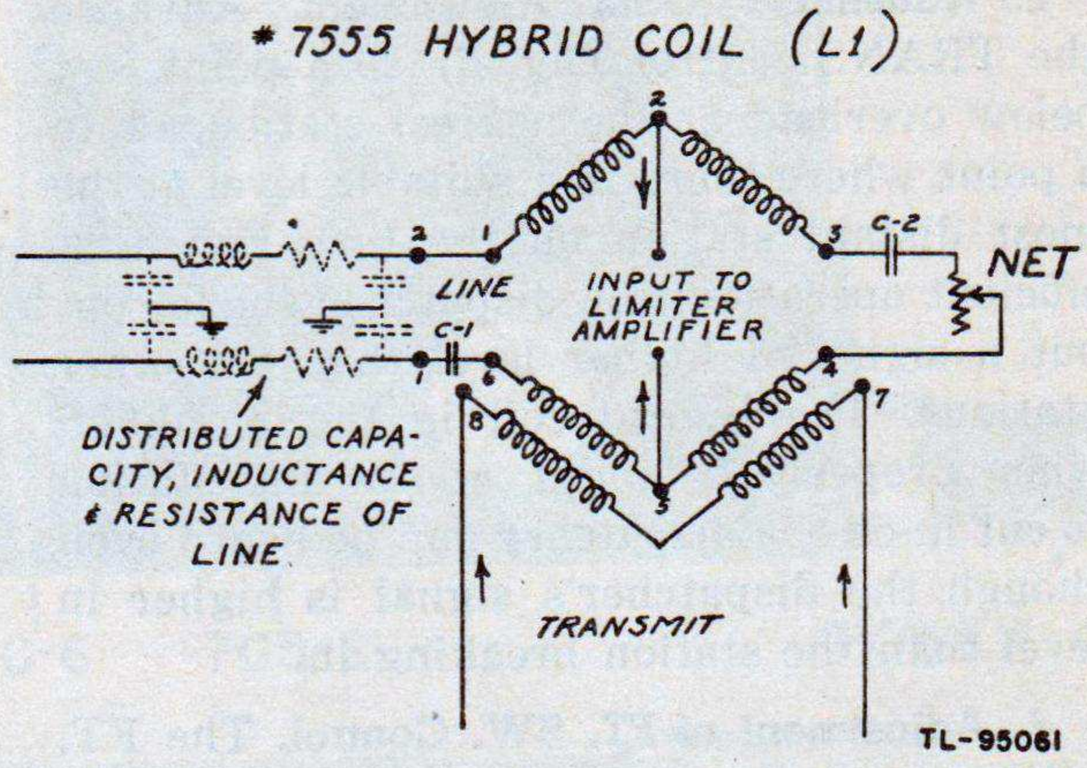


Figure 11. Hybrid coil, circuit diagram.

(3) Theoretically, it is necessary to reproduce exactly the characteristics of the line in the LINE NET to obtain perfect balance of the bridge. However, it has been found that for the average installation, satisfactory balance can be obtained with the use of a purely resistive balancing network. In the amplifier, a 1,000-ohm variable resistor provides this resistive network. This will provide good balance in a majority of cases.

(4) There are two cases in which it is important to know the voltage distribution in this bridge network.

(*a*) The first case is when a signal from the line appears across terminals 1 and 6 of the hybrid coil (fig. 11). Assuming that the LINE NET control is adjusted to balance the line, half of the incoming signal will be dissipated in the LINE NET control. The remainder of the signal will be equally divided, half of the voltage appearing across terminals 1 and 3, and half of it appearing across terminals 4 and 6. A voltage also will appear across terminals 2 and 5. This voltage is fed to the input of the incoming amplifier.

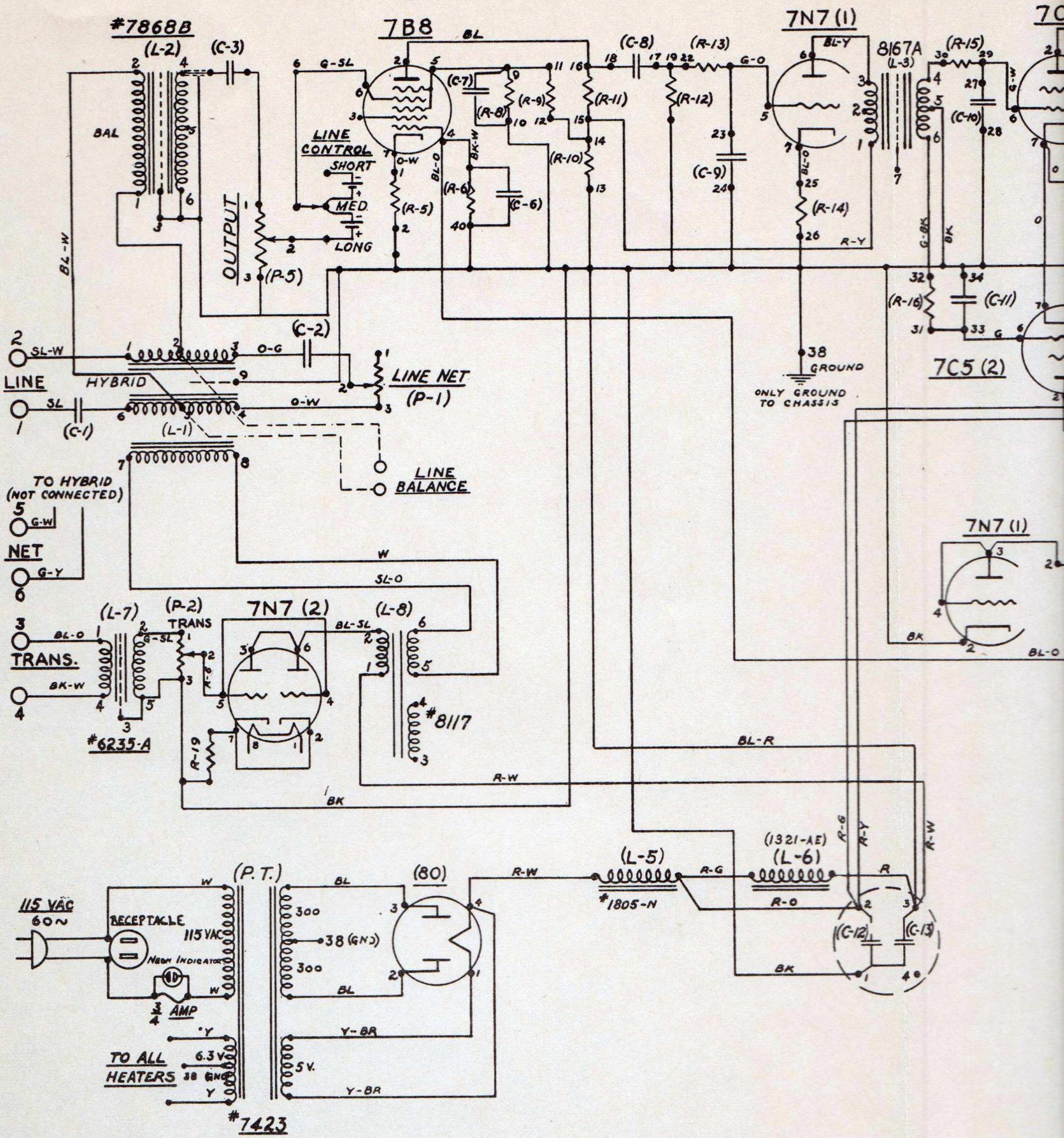
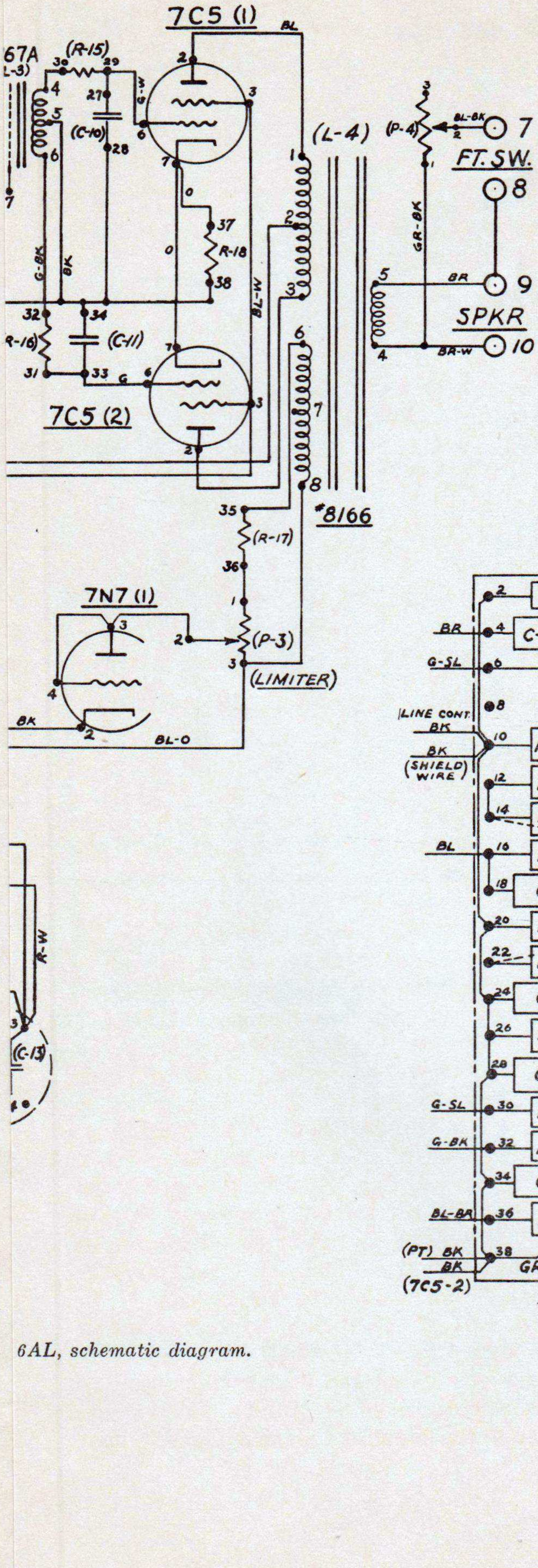
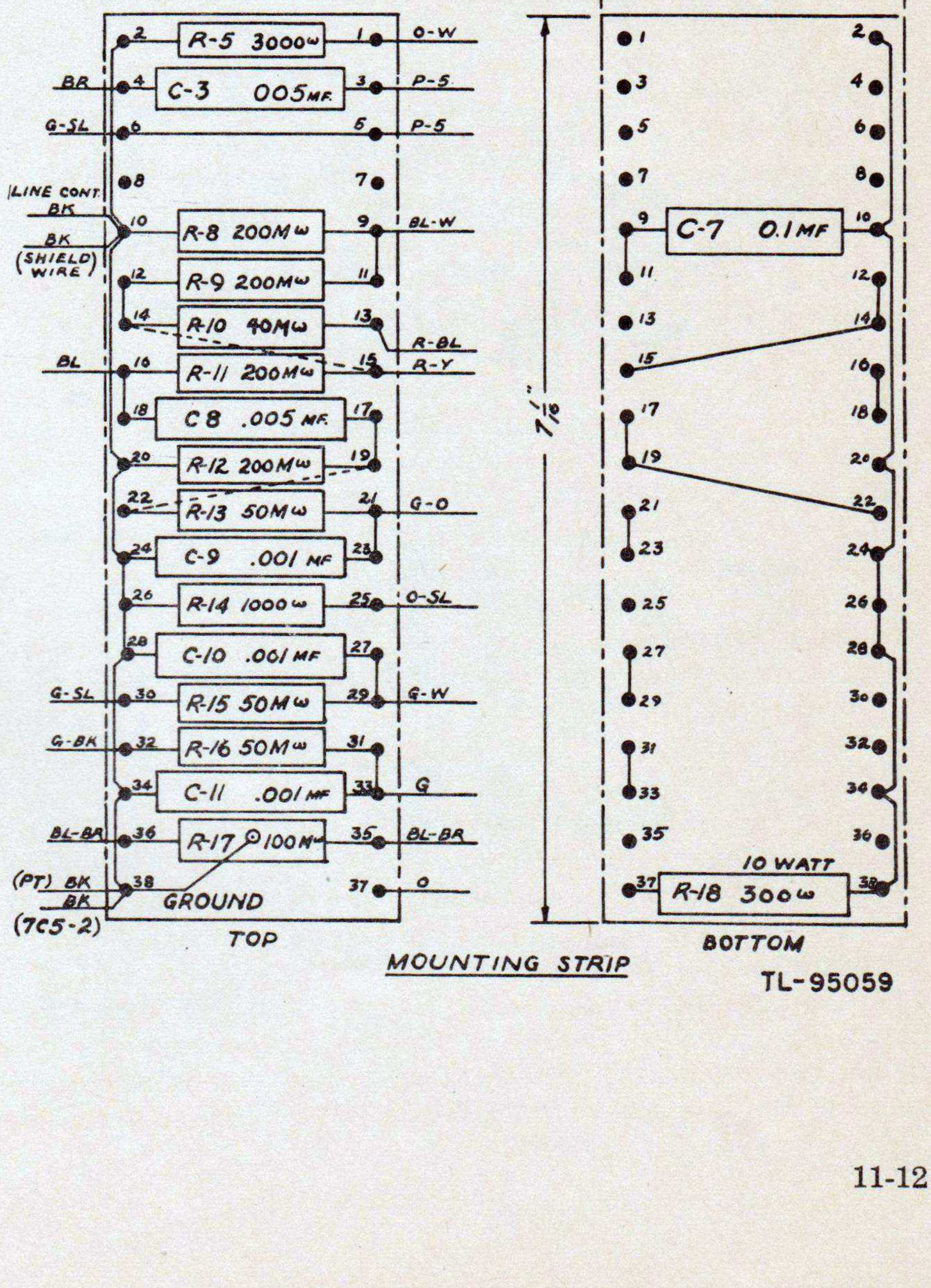


Figure 9. Limiter amplifier, type 3BLH, and speaker, type 6AL, schematic dia

RESISTORS			CAPACITORS		
NO.	OHMS	WATTS	NO	MF	V.D.C.
P-1	1 MΩ POT.	3	C-1	1.0	400
P-2	50 MΩ POT.	1	C-2	1.0	400
P-3	25 MΩ POT.	1	C-3	.005	600
P-4	1 MΩ POT.	4			
P-5	50 MΩ POT.	1			
R-5	3 MΩ		C-6	1.0	400
R-6	1 MEG.	½	C-7	0.10	400
R-8	200 MΩ	1	C-8	.005	600
R-9	200 MΩ	1	C-9	.001	600
R-10	40 MΩ	1	C-10	.001	600
R-11	200 MΩ	1	C-11	005	600
R-12	200 MΩ	1	C-12	DUAL 8+8	600
R-13	50 MΩ	1	C-13	PT. SC-2	
R-14	1 MΩ	1			
R-15	50 MΩ	1			
R-16	50 MΩ	1	COILS		
R-17	100 MΩ	1	L-1	7555	
R-18	300Ω	10	L-2	7668-B	
R-19	1 MΩ	1	L-3	8167-A	
			L-4	8166	
			L-5	1805-N	
			L-6	1321-AE	
			L-7	6235 A	
			L-8	8117	
			PT	7424	





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6AL, schematic diagram.

(*b*) The second case is when the transmitting amplifier is being used to send a signal to the line. The signal voltage introduced at terminals 7 and 8 (fig. 11) orients the bridge 90°. This signal induces voltages in the winding between terminals 4 and 6 and also in the winding between terminals 1 and 3. If the LINE NET control is adjusted to balance the line, half of the power will again be dissipated in this control, while the remaining half will appear across terminals 1 and 6 and thus be introduced to the telephone line. Since the bridge is balanced, none of this signal voltage will appear across terminals 2 and 5, and none of it will be fed to the incoming amplifier. If the LINE NET control is not adjusted to balance the line, the unbalance will cause a voltage to appear across terminals 2 and 5. This voltage will be amplified in the incoming amplifier, and will cause feedback from the loudspeaker to the microphone, seriously interfering with the operation of the equipment. A further effect of unbalance in the hybrid circuit will be distortion in the output to the speaker and in the output to the transmission line. This means that the equipment is "singing".

(5) Capacitors C-1 and C-2 (fig. 9) are line blocking capacitors inserted to permit ringing on the line without undue loss. These capacitors must be balanced to each other in order not to disturb the balance of the hybrid coil.

b. Incoming Amplifier. Incoming signals appearing at terminals 2 and 5 of the hybrid coil (fig. 9 [L-1]) are fed to the input transformer (L-2). The input transformer is coupled by means of capacitor C-3 through the OUTPUT control to the grid of the preamplifier tube (7B8). The OUTPUT control (P-5) controls the amount of the signal to reach the grid of the preamplifier tube (7B8). Under ordinary circumstances, this control should be set so that the full signal voltage will be put on the grid of the tube, and full limiting action can be obtained.

(1) An incoming limiter feature is incorporated in the grid circuit of the first stage. By means of the LINE CONTROL, the gain of the amplifier is adjusted to the losses encountered on the telephone line. The LONG position of the control should provide ample gain for 35 db of line loss, the MED. position for 25 db of line loss, and the SHORT position for 20 db of line loss. Figures 6 and 12 illustrate the operation of the amplifier in these various conditions. Note that the output of the amplifier is relatively the same in any case. When the LINE CONTROL is in the LONG position (fig. 9) the preamplifier tube (7B8) is operating at full gain with normal cathode bias obtained through resistor R-5 and the OUTPUT control (P-5). The cathode resistor R-5 is unbypassed, which introduces degeneration to reduce weak signal noise. When the switch is in the MED. position, a 1-volt bias cell (in reality a 1-volt dry battery) is introduced into the circuit, making the grid bias more negative, and reducing the gain of the stage. When the LINE CONTROL switch is in the SHORT position, a second 1-volt bias cell is added to the grid circuit, reducing the gain further to compensate for a line of relatively little loss.

(2) An output limiting action is also incorporated in the first stage. The gain of the JAN 7B8 tube in operation is controlled by varying the bias on the inner grid. This bias is obtained in the following manner: The voltage in the output transformer (L-4) induces a voltage in an additional winding. A part of this induced voltage, controlled by the LIMITER control (P-3), is rectified by one section of a double triode tube (7N7[1]) in which the grid is connected to the plate so that it acts as a diode. This rectified voltage, smoothed by the time constant circuit consisting of resistor R-6 and capacitor C-6, is applied as bias on the inner grid. The amount of bias will depend on the magnitude of the output voltage. Thus a higher output voltage will generate more bias to reduce the gain of the preamplifier. Thus, a type of automatic volume control is secured, and the output of the amplifier to the speaker will remain fairly constant despite the strength of the signal coming from the transmission line. The optimum setting of the LIMITER control for 2-watt output depends on circuit constants, and is determined during production testing of the amplifier. This setting is stenciiled on one of the transformer cans in the set.

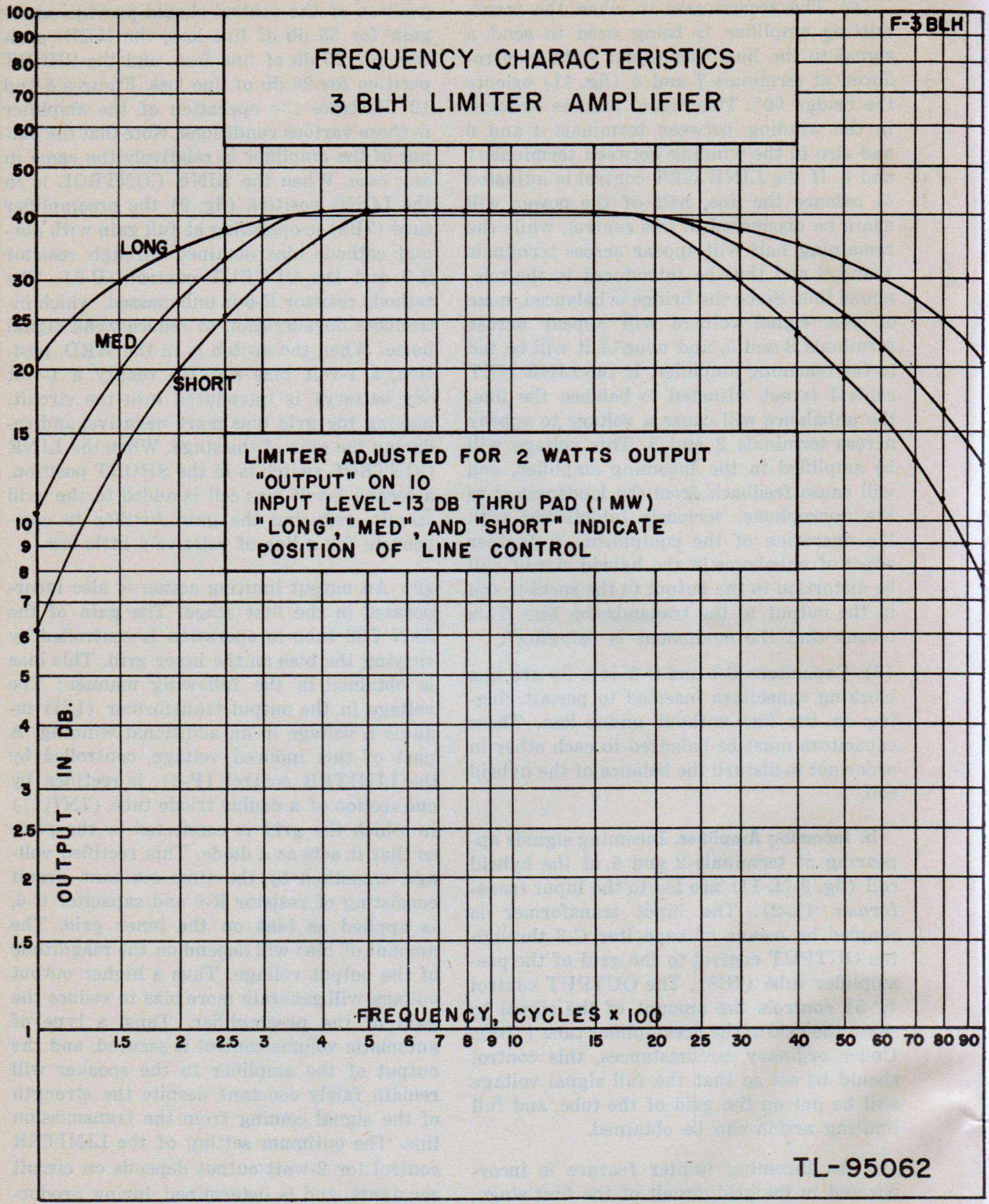


Figure 12. Amplifier, frequency characteristics graph.

(3) The output of the preamplifier stage is coupled by means of capacitor C-8 to the grid of one half of the double triode (7N7 [1]). This is a voltage-amplifier stage, which, since the cathode resistor (R-14) is unbypassed, incorporates degeneration which reduces distortion. Resistor R-13 and capacitor C-9 serve to limit high-frequency gain. The output of this stage is fed to the push-pull input transformer (L-3). This transformer drives the grids of the power tetrodes (7C5) arranged in push-pull. Again, resistors R-15 and R-16 and capacitors C-10 and C-11 limit high-frequency gain. It is to be noted that high-frequency gain is undesirable in the equipment, because much of the line noise tends to be of a higher frequency than that of the normal speaking voice. This stage, because of the unbypassed cathode resistor, again incorporates negative feedback, to further eliminate distortion. The push-pull output transformer (L-4) drives the loudspeaker, and provides voltage for the output limiter action.

c. Transmitter Amplifier. Signals from the microphone are fed through the input transformer (L-7) to a double triode (7N7[2]) in which the cathodes, grids, and plates are tied together. This method of operation provides for large plate dissipation as well as fulfilling the desired characteristics for the set. The TRANS control (P-2) regulates the signal voltage introduced to the grids of the tube, thus regulating the output of the stage The output of the tube goes to the hybrid coil through the output transformer (L-8).

d. Power Supply. The power supply is conventional, the type 80 tube providing full-wave rectification. The filter is a two-section choke input type, consisting of chokes L-5 and L-6 and capacitors C-12 and C-13. A neon indicator parallels the ¾ AMP fuse in the primary circuit of the transformer. The neon indicator glows when the fuse opens or is removed.

9. THE LOUD SPEAKER (fig. 13).

A dual variable resistor (R101) and a matching transformer (T101) are contained in the speaker case. The variable resistors regulate the output of the speaker while presenting a constant impedance to the output transformer of the amplifier. The matching transformer matches the impedance of the input circuit to that of the voice coil of the loudspeaker.

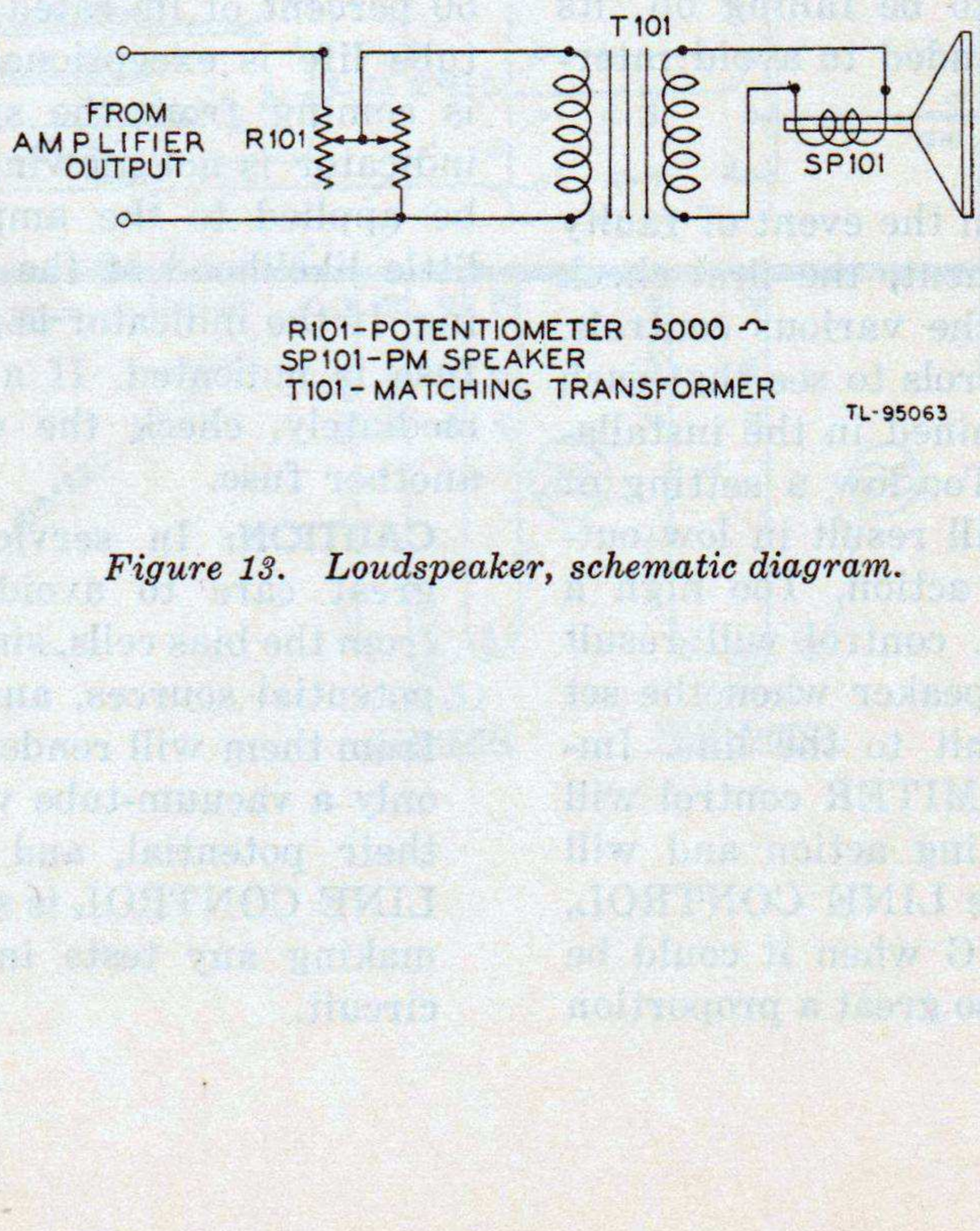


Figure 13. Loudspeaker, schematic diagram.

SECTION IV

MAINTENANCE

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report). If Form No. 468 is not available, see TM 38-250. Failure or unsatisfactory performance of equipment used by Army Air Forces will be reported on Army Air Forces Form No. 54 (unsatisfactory report).

CAUTION: High voltages dangerous to life are present in the amplifier. Use great caution when working with live circuits.

10. PREVENTIVE MAINTENANCE.

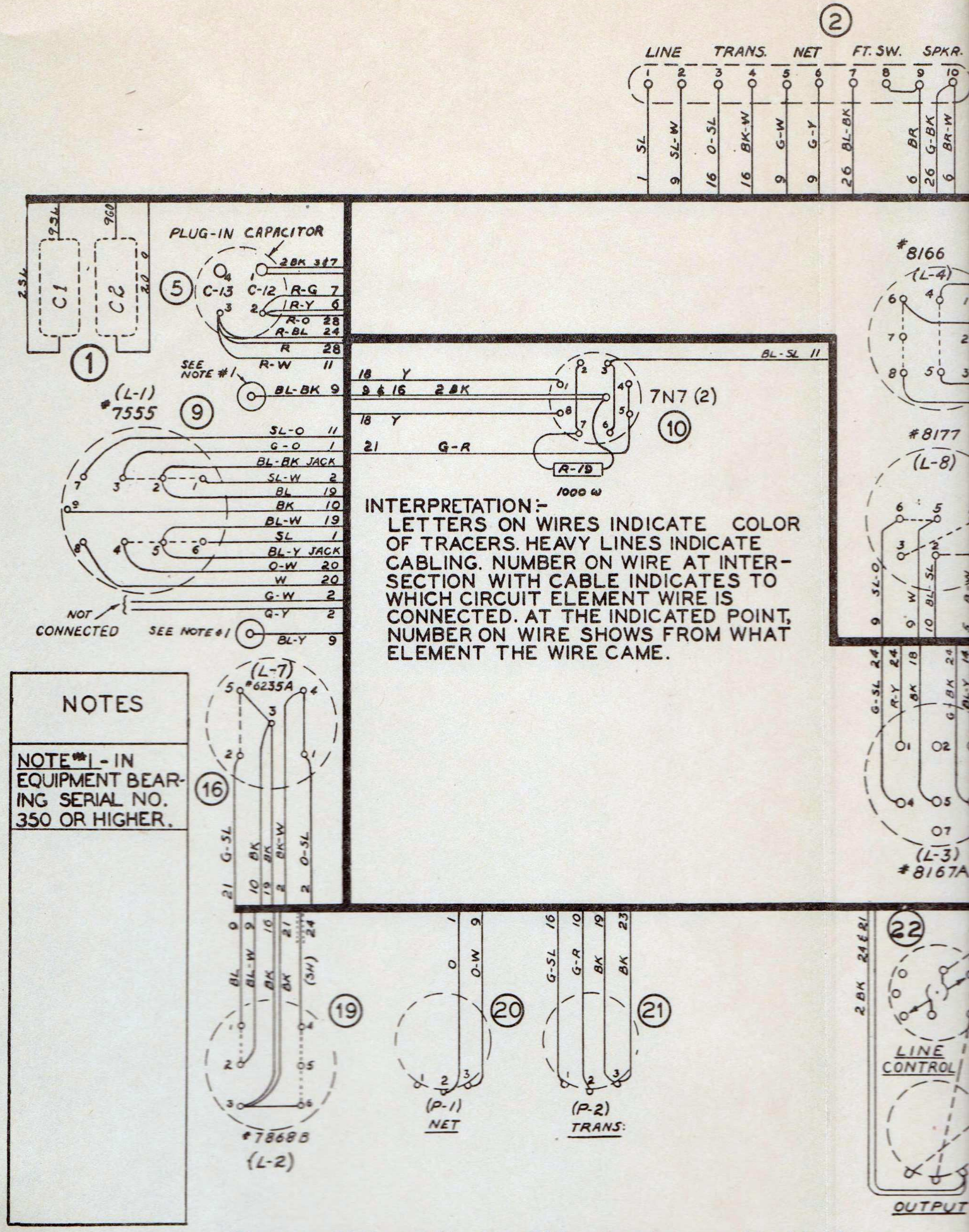
Preventive maintenance of the equipment consists of a periodic inspection of circuit elements (fig. 14), including testing of the tubes. It is recommended that a log be kept of tube readings. This will aid in an intelligent forecast of tube life so that replacements can be anticipated and interruptions in service avoided. At each inspection, the chassis should be cleaned carefully and a check made to see that contacts are clean and connections tight. When a test of the tubes shows any tube to be falling off, its replacement is recommended to avoid interruption of service.

11. TROUBLE ANALYSIS.

a. Check of Controls. In the event of faulty operation of the equipment, the first check to be made is that of the various controls. Inspect the various controls to see that each is in the position determined in the installation of the equipment. Too low a setting of the OUTPUT control will result in low output and poor limiting action. Too high a setting of the FT. SW. control will result in poor volume at the speaker when the set is being used to transmit to the line. Improper setting of the LIMITER control will interfere with the limiting action and will introduce distortion. The LINE CONTROL, if set on MED. or LONG when it could be set on SHORT, will let too great a proportion of line noise to be amplified. Lack of balance at the hybrid coil with the LINE NET control will cause distortion and feedback when the amplifier is being used to talk over the line (par. 12).

b. Preliminary Check. If the controls have been found to be in order, a check of all tubes should precede further investigation. Experience with this equipment has shown that over 90 percent of the trouble encountered is in tube failures. Note in this connection that no tube is operated at more than 50 percent of its rated cathode current, thus tube life is exceptionally long. If no sound is coming from the speaker and the neon indicator is not glowing, the power may not be applied to the amplifier, since there is little likelihood of the neon indicator's failing. If the indicator is glowing, a burned-out fuse is indicated. If a new fuse blows immediately, check the circuit before trying another fuse.

CAUTION: In servicing the set, take great care to avoid drawing current from the bias cells, since they are strictly potential sources, and drawing current from them will render them useless. Use only a vacuum-tube voltmeter in testing their potential, and be sure that the LINE CONTROL is set on LONG before making any tests in that part of the circuit.



NOTES

NOTE #1 - IN EQUIPMENT BEARING SERIAL NO. 350 OR HIGHER.

INTERPRETATION:-
LETTERS ON WIRES INDICATE COLOR OF TRACERS. HEAVY LINES INDICATE CABLING. NUMBER ON WIRE AT INTERSECTION WITH CABLE INDICATES TO WHICH CIRCUIT ELEMENT WIRE IS CONNECTED. AT THE INDICATED POINT, NUMBER ON WIRE SHOWS FROM WHAT ELEMENT THE WIRE CAME.

Figure 14. Limiter amplifier, type 3BLH, and speaker, type 6AL, wiring diagram.

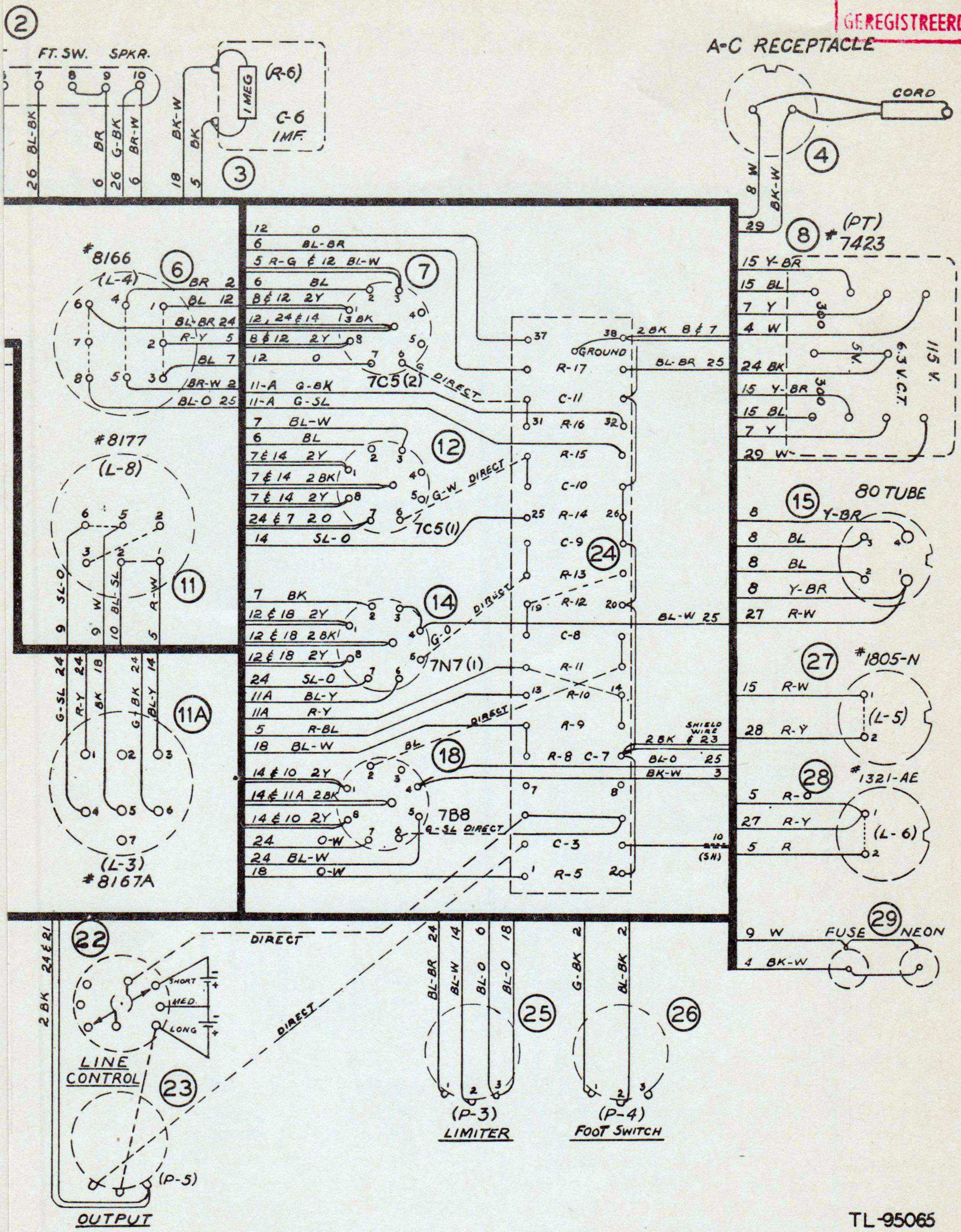


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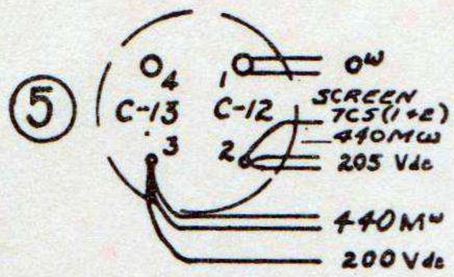
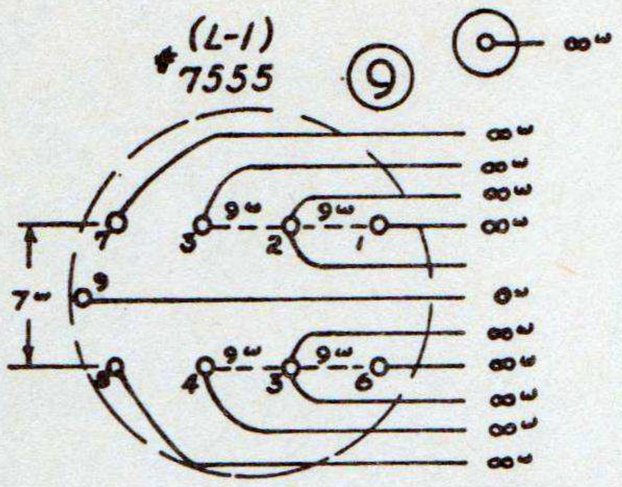
diagram.

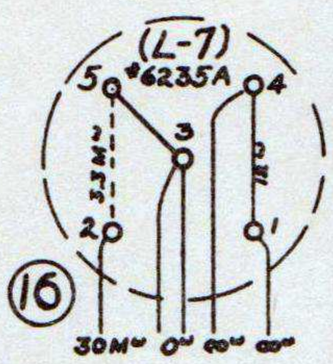
SIGNAL TRACING

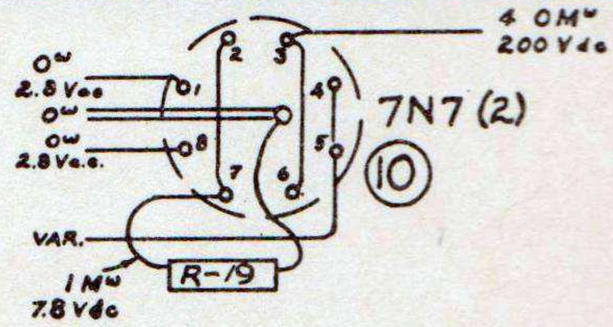
CONDITIONS: "LIMITER" ADJUSTED FOR 2 WATTS OUTPUT (SEE MARKING INSIDE CASE). "OUTPUT" ON 10.0. "LINE NET" SET TO 6.0 ON DIAL. FREQUENCY 1000 CYCLES. LEVEL 5 VOLTS TO LINE TERMINALS 1 & 2. RECTIFIER TYPE VOLTMETER 1000 Ω/VOLT. 10 VOLT SCALE UNLESS OTHERWISE NOTED. USE FIGURE 9 AND 14.

1. (NO POWER APPLIED TO EQUIPMENT).
   ON L-1 (#7555 HYBRID COIL):
   (a) TERMINAL 1 TO 6, 5 VOLTS
   (b) TERMINAL 2 TO 5, 2.5 VOLTS
   (c) TERMINAL 3 TO 4, 0.5 VOLTS
   (d) TERMINAL 7 TO 8, 2.5 VOLTS
2. ON L-2 (7868B INPUT TRANSFORMER)
   (a) TERMINAL 1 TO 2, 2.5 VOLTS
   (b) TERMINAL 4 TO 6, 7.75 VOLTS
3. ON TERMINAL BOARD 24:
   (a) TERMINAL 4 TO GROUND, 7.75 V.
   (b) TERMINAL 3 TO GROUND, 3.75 V. (± 10% DUE TO C-3)
   (c) TERMINAL 5 TO GROUND, 3.75 V ("LINE CONTROL" MUST BE ON "LONG": ANY OTHER POSITION WILL DAMAGE BIAS CELLS WHEN MEASUREMENT IS MADE)
   ARM OF P-5 TO GROUND, 3.75 V.
4. (a) APPLY 117 Va.c. TO EQUIPMENT, LEAVING CONTROLS AS THEY ARE.
   (b) TERMINATE "SPKR" TERMINALS 9 & 10 WITH SPEAKER OR 5000 Ω RESISTOR.
   (c) VOLTAGE ACROSS R-6 AND C-6, 15 V ON 50 V.D.C. SCALE.
   (d) ON L-3 (8167A):
   1. TERMINAL 4 TO 5, 4 VOLTS.
   2. TERMINAL 5 TO 6, 4 VOLTS.



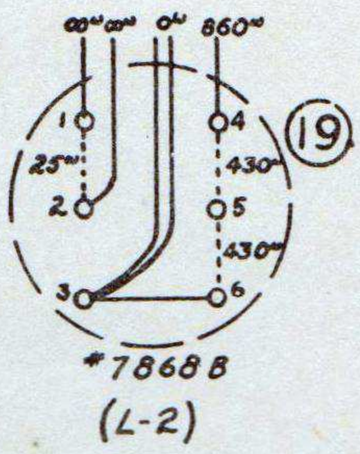


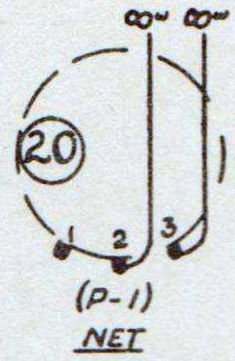




NOTES

1. ALL MEASUREMENTS ARE TO GROUND (CHASSIS) UNLESS MEASUREMENT BETWEEN TWO TERMINALS IS INDICATED
2. VOLTAGE DATA WAS TAKEN WITH A 1000 OHM PER VOLT METER.
3. RESISTOR TOLERANCES ARE ± 10%
4. MAKE MEASUREMENTS WITH LINE CONTROL ON 'LONG'. OTHER POSITIONS MAY RESULT IN DAMAGE TO BIAS CELLS.
5. FILAMENT VOLTAGES CAN BE MEASURED AT TUBE SOCKETS. ALL OTHER VOLTAGES CAN BE MEASURED ON CAPACITOR-RESISTOR MOUNTING STRIP EXCEPT IN CASE OF 7C5(1&2), PLATE VOLTAGE CAN BE MEASURED ON TERMINALS 1&3 OF L-4.
6. RESISTANCES IN OHMS UNLESS OTHERWISE NOTED.





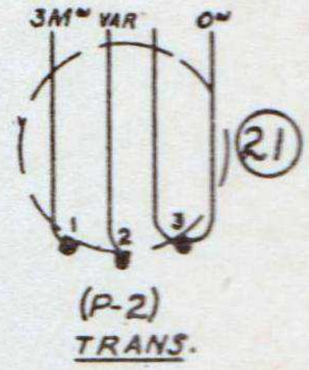


Figure 15. Resistance and voltage measurements.

V.
V. (± 10% DUE TO C-3)
(LINE CONTROL
POSITION WILL
SUREMENT IS MADE)

AVING CONTROLS

.S 9 & 10 WITH

N 50 V.D.C. SCALE.

3

1 MEG R-6

C-6

#8166 (6) (L-4)

∞ω
440MΩ 200 Vdc — PLATE 7C5-2
1 MEG
440MΩ 205 V.dc
440MΩ 200 Vdc — PLATE 7C5-1
∞ω
1 MEG

#8177 (L-8)

7ω 220ω 190ω 1.3 Vdc
∞ω ∞ω 440MΩ 200 Vdc 440MΩ 200 Vdc
(11)

R.

1.5MΩ 400MΩ 130 Vdc 0ω 1.5MΩ 400MΩ 130 Vdc
615ω 615ω 2.0 Vdc
1.5M 1.5M
(11A)
07
(L-3).
8167A

CATHODE 7C5 1&2 — 300ω 14 Vdc — 37 — 38 — 0ω GROUND
PLATE 7C5-1 — 1 MEG. — R-17 — 1 MEG 0 Vdc.
GRID 7C5-2 — 50MΩ 0v. — C-11 — 1 MEG 0v.
50MΩ 0v. — 31 — R 16 — 32 — 45MΩ 0v.
GRID 7C5-1 — 50MΩ 0v. — R-15 — 45MΩ 0v.
50MΩ 0v. — C-10 — 0ω 0v.
3MΩ 45 Vdc — 25 — R-14 — 26 — 0ω 0v.
250MΩ 0v. — C-9 — 0ω 0v.
(24)
GRID 7N7-1 — 250MΩ 0v. — R-13 — 200MΩ 0v.
200MΩ 0v. — 19 — R-12 — 20 — 0ω 0v.
200MΩ 0v. — C-8 — 600MΩ 50 Vdc.
PLATE 788
PLATE 7N7-1 — 400MΩ 113 Vdc — R-11 — 600MΩ 50 Vdc.
B+ — 440MΩ 200 Vdc — 13 — R-10 — 14 — 400MΩ 113 Vdc
SCREEN 788 — 200MΩ 12 Vdc — R-9 — 400MΩ 113 Vdc
200MΩ 12 Vdc — R-8 — C-7 — 0ω 0ω
0v. — 7 — 8 — 0v.
GRID 788
0-50MΩ 0v.
50MΩ 0v. — C-5 — 860ω 0v.
CATHODE 788 — 3MΩ 1.3 Vdc — 1 — R-5 — 2 — 0ω 0v.

#8 (PT) #7423

440MΩ 230 Vdc
100ω 300 Vac
0ω 3.1 Vac
80ω 0v
0ω
440MΩ 230 Vdc
100ω 300 Vac
0ω 3.1 Vac
∞ω 0v
100ω 190ω 0ω 0ω 0ω 6ω

(15) 80 TUBE

440MΩ 230 Vdc
100ω 300 Vac
100ω 300 Vac
440MΩ 230 Vdc

#1805-N (27) (L-5)

440MΩ 230 Vdc
420ω
440MΩ 205 Vdc

#1321-AE (28) (L-6)

440MΩ 205 Vdc
560ω
440MΩ 200 Vdc

(29)

80ω 0v
80ω 0v
FUSE NEON

(22)

SHORT
MED
LONG
LINE CONTROL

NOTE
MEASURE BIAS CELL VOLTAGE ONLY WITH ELECTRONIC VOLTMETER

(23)
(P-5)
OUTPUT

1 MEG 1 MEG 1 MEG
(25)
(P-3)
LIMITER

∞ω ∞ω
(26)
(P-4)
FOOT SWITCH

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c. Voltages and Resistances. If the tubes have been found to be good, check voltages and resistances (fig. 15). If this check fails to indicate the trouble, signal tracing procedure, as outlined on figure 15, may be of help. Follow the listed steps closely and in the order given on this chart. Instruments needed for this testing are an audio oscillator, a 1,000-ohm-per-volt a-c voltmeter or vacuum-tube voltmeter, a d-c voltmeter, and an ohmeter.

d. A-c Receptacle. The A.C. RECEPTACLE (fig. 7) at the rear of the amplifier will provide a convenient source of a-c power for instruments or a soldering iron. To use this receptacle when power is not desired in the set, remove the ¾ AMP fuse in the front panel. A voltage will exist across the primary side of the power transformer, but it is slight and is easily avoided.

e. Neon Indicator Removal. If it is necessary to remove the neon indicator, a piece of friction tape wrapped around its tip will make removal of the tube easy. The equipment should not be used without the neon indicator in its socket.

12. FURTHER BALANCING OF HYBRID COIL.

a. Hybrid Coil Balance Test. If, in the use of the equipment, it becomes apparent that the hybrid coil has not been properly balanced, repeat the procedure outlined in paragraph 6*b*. An observation of the balance of the hybrid coil may be made by inserting a resistor of between 200 and 1,000 ohms in place of the line at LINE terminals 1 and 2 at the rear of the chassis (fig. 7). Since the LINE NET control is a linear 1,000-ohm variable resistor, its setting, when the procedure set forth in paragraph 6*b* has been followed, using the "dummy" line, will correspond very closely to the value of the resistor inserted in place of the line. Thus it can be seen that the position of the LINE NET control, when balanced properly, indicates the resistive component of the impedance of the telephone line to which the equipment is connected.

b. Capacitors C-1 and C-2. When the equipment is built, capacitors C-1 and C-2 are very closely matched to each other, since the balance of the hybrid coil will be disturbed by a mismatch of these capacitors. In use, a lightning surge or aging over a long period of time may affect the characteristics of these capacitors, and difficulty in obtaining balance of the hybrid coil may be traced to this fact. To test the capacitors, use a "dummy" line as outlined in subparagraph *a* above, carefully short out both capacitors, and balance the hybrid coil as outlined in paragraph 6*b*. When balance has been obtained, remove the shunts from the capacitors. If the balance has been affected, capacitors C-1 and C-2 are no longer identical. Replacement for these parts must be matched to each other, using the same method as a check.

c. Additional Balancing Procedure. If balance is still difficult to obtain after the check in subparagraph *a* above has shown that the hybrid coil can be balanced, and the procedure outlined in subparagraph *b* above has indicated that capacitors C-1 and C-2 are matched, the insertion of a repeater coil may enable more critical balancing. There are many means of adjusting the elements in the bridge circuit of the equipment so that it will match the line. Transmission line characteristics vary so widely that it is difficult to outline every procedure to be followed. The following example illustrates what can be done as a result of experimentation. On a railroad installation, the dispatcher may be required to dial switch from one to nine lines on his amplifier. These lines may range from a 2-mile stub to a 137-mile line. No precise nets are installed, though provisions are made for them. A repeater coil is inserted in the line, with a 2-mf capacitor and a 1,000-ohm resistor in series connected across the amplifier side of the repeater coil (fig. 8). The equipment will function in a perfectly satisfactory manner, despite the extreme difference in line lengths and the widely varying line conditions.

13. LUBRICATION.

Lubrication is not required for this equipment.

14. MOISTUREPROOFING AND FUNGIPROOFING.

a. General. The operation of Signal Corps equipment in tropical areas, where temperature and relative humidity are extremely high, requires special attention. The follow-

ing items represent problems which may be encountered in operation:
(1) Resistors, capacitors, coils, chokes, transformer windings, etc., fail.
(2) Electrolytic action takes place in resistors, coils, chokes, transformer windings, etc., causing eventual break-down.
(3) Hook-up wire and cable insulation breakdown. Fungus growth accelerates deterioration.
(4) Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs and crosstalk.

b. Treatment. A moistureproofing and fungiproofing treatment has been devised, which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of moisture- and fungi-resistant varnish applied with a spray gun or brush. Refer to TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish-spray method of moistureproofing and fungiproofing, which includes the description and use of equipment and materials required.

CAUTION: Varnish spray may have toxic effect if inhaled. To avoid inhaling spray, use respirator if available; otherwise, fasten cheesecloth or other cloth material over nose and mouth.

c. Step-by-step Instructions for Treating Limiter Amplifier, Type 3 BLH, and Speaker, Type 6AL. (1) PREPARATION. Test the equipment thoroughly and make all repairs, replacements, and adjustments necessary for its proper operation.
(2) DISASSEMBLY. Disassemble the equipment as follows:
(*a*) Remove five mounting screws from edges of amplifier's front panel (fig. 1).
(*b*) Remove two screws from front edge of top cover.
(*c*) Disconnect leads from terminal board on back of chassis (fig. 7).
(*d*) Lift front panel and chassis from cabinet.
(*e*) Remove two screws holding resistor mounting board assembly (fig. 7) in place, and lift the assembly up 1 or 2 inches to facilitate spraying under the mounting board.
(*f*) Remove OUTPUT control knob from front panel.
(*g*) Remove from top of chassis, five knobs marked FT. SW., LIMITER, LINE CONTROL, TRANS, and LINE NET (fig. 5).
(*h*) Remove the two bias cells from holders mounted on the line control switch assembly.
(*i*) Remove back cover plate from loudspeaker by unscrewing four screws from back edge of speaker housing (fig. 10). Take out four Phillips type screws holding speaker to housing, and remove speaker from housing.
(*j*) Clean all dirt, dust, rust, fungus, oil, grease, etc. from the equipment to be treated.
(3) MASKING. (*a*) Mask clear plastic cover of neon indicator holder on lower left side of front panel (fig. 1).
(*b*) Mask A. C. RECEPTACLE on rear of chassis (fig. 7).
(*c*) Mask the ten screw type terminals on terminal board on rear of chassis (fig. 7).
(*d*) Mask the two pin type jacks marked BALANCE (for line balance test) on top of chassis (fig. 5).
(*e*) Mask bottom of socket for plug-in type capacitor (fig. 7, C-13 & 12).
(*f*) Be sure that all tubes are firmly seated in sockets.
(*g*) Mask the glass envelope of rectifier tube JAN 80 (fig. 5). Paper may be molded around this part and held in place by masking tape.
(*h*) Mask the bottom of all tube sockets. Cover the parts with masking tape and press tape firmly around connecting wiring to minimize danger of leaks around edges of masking tape.
(*i*) Completely mask the line control switch assembly (fig. 7, P-5) including the wafer type switch and two bias cell holders. Paper may be molded around this part and held in place with masking tape.

CAUTION: Great care must be taken in masking the wafer type switch to completely protect it from the varnish spray. Any varnish which might get on the contacts would be very difficult to remove.

(*j*) Mask the contacts of the a-c power plug. Mask 8 or 10 inches of the a-c power cord adjacent to the chassis. Mask rubber grommet. Rubber is *not* to be varnished as the varnish is injurious to this type of material.

NOTE: It is important that the masking be done carefully and thoroughly so that all points where varnish would affect operation are protected from the spray. Lack of proper masking will render the equipment inoperative and require complete overhaul to repair.

(4) DRYING. Place the equipment to be treated in a drying oven and bake for six hours at 140° F.

CAUTION: Do not exceed 140° F. If wax in any of the components should begin to melt, decrease the temperature and increase the drying time 1 hour for each 10° F decrease in temperature.

(5) VARNISHING. (*a*) As you spray, inspect all masking to make sure it has not loosened during the moisture removal process. Do not allow too much time between removal from oven and spraying.

(*b*) Spray one coat of moistureproofing and fungiproofing varnish on components. Spray both inside and outside of steel cabinet.

(*c*) Using a brush apply varnish to any portions not reached by the spray gun. Take care that all wiring, with the exception of the a-c line cord, is adequately covered with varnish.

(*d*) Using a brush apply one coat of varnish to both inside and outside of loudspeaker housing parts; i.e. the transformer, potentiometer, cone, and supporting frame.

CAUTION: Do not get any varnish on center portion of speaker cone.

(*e*) Allow 15 to 20 minutes drying time, and then repeat spraying, brushing, and drying operations two more times.

(*f*) When varnish is completely dry remove all masking. Where there is more than one inch of varnished wire, apply one coat of varnish with brush.

NOTE: Do not reassemble equipment until varnish is thoroughly dry.

(6) REASSEMBLY. (*a*) Reassemble equipment by following instructions for disassembly in reverse order.

(*b*) Make a complete operational check of the amplifier to insure that it is in good operating condition.

(7) MARKING. Mark the equipment with "MFP" and the date of treatment.
Example: MFP - 10 June 1944.

SECTION V

SUPPLEMENTARY DATA

15. PERFORMANCE AND SPECIFICATIONS.

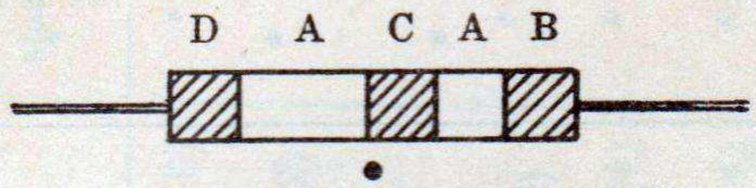
Following is a chart showing the technical characteristics and performance capabilities of limiter amplifier, type 3BLH, and speaker, type 6AL:

Maximum power output (with limiting action)		2 watts
Maximum amplifier gain (no limiting action)		75 db
Output impedance		5,000 ohms
Distortion (at 1,000 cps)	Input +5 db	8%
	Input —15 db	6%
	Input —30 db	2%
Frequency response		500 to 2,500 cps
Hum level (OUTPUT control at maximum, LINE terminated in 600 ohms, LIMITER set for 2-watt output.)		60 db below Full output
Maximum transmitter output to line (microphone with 4½-v battery, no subset) (5 MW base)		10 db
Transmitter input impedance		50 ohms
Power source		115 volts 60 cps
Power drain		50 watts
Class of service		Continuous

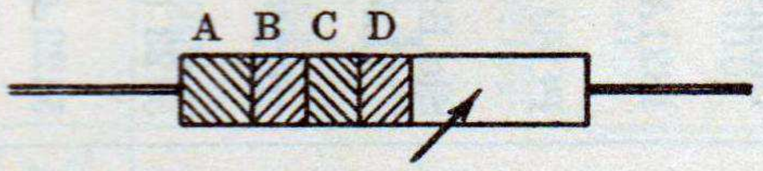
16. RESISTOR AND CAPACITOR COLOR CODES.

The chart on the following page describes the color codes for resistors and capacitors, as compiled by the Radio Manufacturers Association of America. These color codes are applicable to the equipment described in this manual.

RMA COLOR CODES FOR RESISTORS (OHMS)



BAND OR DOT
OLD COLOR ARRANGEMENT



BODY COLOR
NEW COLOR ARRANGEMENT

Body color (new color arrangement only) indicates type of resistor, as follows:

Black—Composition, non-insulated.

Tan, Olive or White—Composition, insulated.

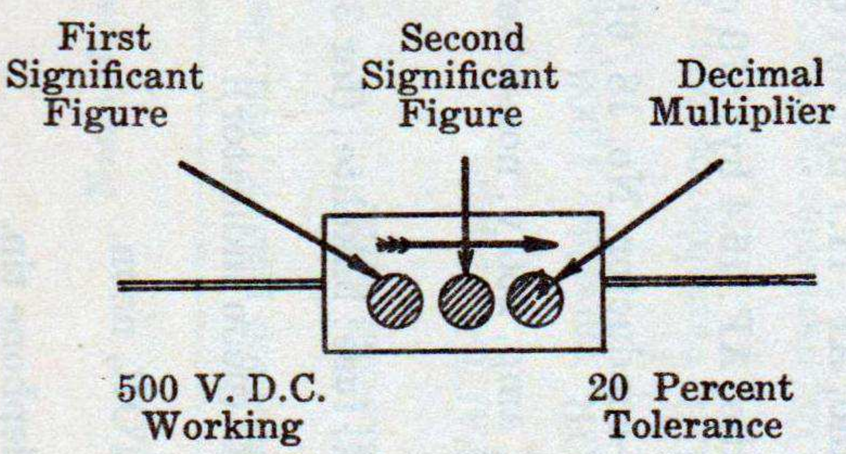
Dark Brown—Wire-wound, insulated.

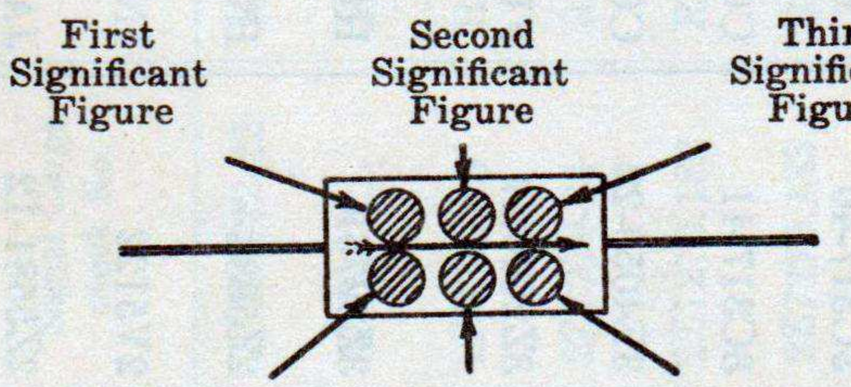
COLOR	A 1st Digit	B 2nd Digit	C Multiplier
Silver			0.01
Gold			0.1
Black		0	1.0
Brown	1	1	10
Red	2	2	100
Orange	3	3	1,000
Yellow	4	4	10,000
Green	5	5	100,000
Blue	6	6	1,000,000
Purple	7	7	10,000,000
Gray	8	8	100,000,000
White	9	9	

D—Tolerance Code:

Gold—5% Silver—10% No Color—20%

RMA COLOR CODES FOR CAPACITORS (MMF)





Color	Numeral	Volts	Multiplier	Total
Black	0		1	
Brown	1	100	10	1%
Red	2	200	100	2%
Orange	3	300	1,000	3%
Yellow	4	400	10,000	4%
Green	5	500	100,000	5%
Blue	6	600	1,000,000	6%
Violet	7	700	10,000,000	7%
Grey	8	800	100,000,000	8%
White	9	900	1,000,000,000	9%
Gold		1,000	0.1	5%
Silver		2,000	0.01	10%
No Color		500		20%

TL-95066

17. MAINTENANCE PARTS LIST FOR LIMITER AMPLIFIER, TYPE 3BLH, AND SPEAKER, TYPE 6AL.

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Mfrs part and code No.	†Station stock	†Region stock
C-1, C-2, C-6	3DB1.601-2	CAPACITOR, fixed: paper; oil; 1 mf +20%, −10%; 600 vdcw.	3	OM-601 (T22)	*	*
C-3, C-8	3DA5-167	CAPACITOR, fixed: paper; 0.005 mf +20%, −10%; 600 vdcw.	2	A7135 (F24)	*	*
C-7	3DA100-280.1	CAPACITOR, fixed: paper; 0.1 mf +20%, −10%; 400 vdcw.	1	3664 (F24)	*	*
C-9, C-10, C-11	3DA1-165	CAPACITOR, fixed: paper; 0.001 mf +20%, −10%; 600 vdcw.	3	A7136 (F24)	*	*
C-12, C-13	3DB8-10	CAPACITOR: wax-filled; 2-section, 8 x 8 mf +20%, −10%; 600 vdcw.	1	PT-SC-2 (T22)	*	*
E-6	3A9046	CELL, bias: 1 v.	2	Bias Cell (M1)		
L-5	3C317-40	COIL, radio, AF: 11.7 hy; 461 ohms, 65 ma.	1	1805N (C8)		*
L-6	3C317-41	COIL, radio, AF: 16.4 hy; 570 ohms, 50 ma.	1	1321AE (C8)		*
	3E4059-22	CORD: 2-conductor; No. 18; 6½′ lg.	1	POSJ-64 (B2)		*
¾ AMP	3Z2600A7	FUSE: ¾ amp, 250 v; non-renewable.	1	Slo Blo 1047 (L3)	*	*
	3Z3275F	HOLDER, fuse: bakelite; (for 3 AG fuses).	1	1075F (L3)	*	*
	2Z5984	HOLDER: (neon indicator).	1	5123 (L3)		*
	2V5122	INDICATOR, neon.	1	5122 (L3)	*	*
	2Z5581-12	JACK, telephone tip.	2	78-IP (A13)		*

† Parts not stocked in station or region stock are carried in depot stock.

* Indicates stock available.

17. MAINTENANCE PARTS LIST FOR LIMITER AMPLIFIER, TYPE 3BLH, AND SPEAKER, TYPE 6AL (contd).

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Mfrs part and code No.	†Station stock	†Region stock
	2ZK5822-22	KNOB: molded plastic; red; bar type.	6	S-292-3L (K6)	*	*
	6Z759-7.1	PLUG: AC line cord.	1	POSJ-64 (B2)		*
	2Z3063-15	RECEPTACLE: 2-pole.	1	61F (A13)		*
P-4	2Z7279-84	RESISTOR, variable: 1,000 ohms ±10%; 4 w; WW.	1	M1MP (M1)	*	*
P-3	2Z7270.182	RESISTOR, variable: carbon; 25,000 ohms; 1 w.	1	10101690 (C4)	*	*
P-2, P-5	2Z7270.183	RESISTOR, variable: carbon; 50,000 ohms; 1 w.	2	10101329 (C4)	*	*
P-1	2Z7279-83	RESISTOR, variable: 1,000 ohms; 3 w; WW.	1	21010111 (C4)	*	*
R-5, R-14	2Z6300-169	RESISTOR: carbon; 3,000 ohms ±10%; 1 w.	2	CM1 (S24)	*	*
R-6	3RC20AE105K	RESISTOR: carbon; 1 meg ±10%; ½ w.	1	CM½ (S24)	*	*
R-8, R-9, R-11, R-12	3Z6720-46	RESISTOR: carbon; 200,000 ohms ±10%; 1 w.	4	CM1 (S24)	*	*
R-10	3Z6640-73	RESISTOR: carbon; 40,000 ohms ±10%; 1 w.	1	CM1 (S24)	*	*
R-13, R-15, R-16	3Z6650-147	RESISTOR: carbon; 50,000 ohms ±10%; 1 w.	3	CM1 (S24)	*	*
R-17	3RC30AE104K	RESISTOR: carbon; 100,000 ohms ±10%; 1 w.	1	CM1 (S24)	*	*
R-18	3Z6030-101	RESISTOR: fixed; 300 ohms ±5%; 10 w; WW.	1	10K (S8)	*	*
R-19	3RC30AE102K	RESISTOR: carbon; 1,000 ohms ±10%; 1 w.	1	CM1 (S24)	*	*

† Parts not stocked in station or region stock are carried in depot stock.

* Indicates stock available.

17. MAINTENANCE PARTS LIST FOR LIMITER AMPLIFIER, TYPE 3BLH, AND SPEAKER, TYPE 6AL (contd).

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Mfrs part and code No.	†Station stock	†Region stock
	2Z8674.8	SOCKET, tube: 4-prong; molded plastic.	2	S4 (A13)		
	2Z8678.21	SOCKET, tube: 8-prong; molded plastic.	5	78-8L (A13)		*
	3Z9693-4	CONTACT, switch: 3-position, 3-contact.	1	3223J (M1)		*
	2Z9438-5	TERMINAL BOARD ASSEMBLY: 38 terminals; laminated phenolic, linen base.	1	(E43)		
	2Z9410.86	TERMINAL BOARD ASSEMBLY: 10-screw type terminals.	1	1799 (C6)		
L-1	2Z9637.41	TRANSFORMER: hybrid coil; 500 ohms line to 500 ohms line; primary, 500 ohms line balanced to ground; secondary 1, 500 ohms line CT; secondary 2, 500 ohms line CT.	1	7555 (C8)		*
L-2	2Z9631.199	TRANSFORMER, audio input: pi-wound; balanced; audio range, 300-3,000 cps; 1:5 ratio; primary 600 ohms; secondary 15,000 ohms; electrostatic shield.	1	7868-B (C8)		*
L-3	2Z9636.67	TRANSFORMER, audio interstage pi-wound; balanced; audio range, 300-3,000 cps.; 1:2 ratio; primary 10,000 ohms, secondary 40,000 ohms; electrostatic shield.	1	8167-B (C8)		*
L-4	2Z9632.266	TRANSFORMER, audio output: audio range, 300-3,000 cps; 1:2 ratio; primary 10,000 ohms CT; secondary 1 and 2, 12,000 ohms CT to limiter; 5000 ohms output.	1	8166A (C8)		*
L-7	2Z9631.198	TRANSFORMER, microphone input: audio range 300-3,000 cps; 1:28 ratio; primary 50 ohms; secondary 39,000 ohms; electrostatic shield.	1	6235A (C8)		*

† Parts not stocked in station or region stock are carried in depot stock.

* Indicates stock available.

17. MAINTENANCE PARTS LIST FOR LIMITER AMPLIFIER, TYPE 3BLH, AND SPEAKER, TYPE 6AL (contd).

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Mfrs part and code No.	†Station stock	†Region stock
L-8	2Z9632.267	TRANSFORMER, audio output: audio range 300-3,000 cps; primary 5,000 ohms; secondary 600 ohms.	1	8117 (C8)		*
PT	2Z9613.321	TRANSFORMER, power: 100 w at 115 v; secondary 1, 6.3 v CT; secondary 2, 300 each side, CT; secondary 3, 5 v.	1	7423 (C8)		*
7B8	2J7B8	TUBE JAN 7B8.	1	7B8 (S19)	*	*
7N7(1) 7N7 (2)	2J7N7	TUBE JAN 7N7.	2	7N7 (S19)	*	*
7C5 (1) 7C5 (2)	2J7C5	TUBE JAN 7C5.	2	7C5 (S19)	*	*
80	2J80	TUBE JAN 80.	1	80 (S19)	*	*
	1B3018-2.15	CORD: 2-conductor, No. 18 stranded; black neoprene insulation; 7½′ lg; (for loud speaker).	1	POSJ-64 (B2)		*
	2ZK5822-22	KNOB: molded plastic; red; bar type; (for loudspeaker).	1	S-202-3L (K6)		*
LS101	6C35-22	LOUDSPEAKER: permanent magnet field; includes T101.	1	PM5ES		*
T101	2Z9632.271	TRANSFORMER: matching; voice coil to line; 5,000 ohms input; (for speaker).	1	T-C2960-2		*
R101	2Z7284-70	RESISTOR, variable: 2-section; 5,000 ohms each section; 4 w; WW; (for speaker).	1	MM5MP (M1)		*

† Parts not stocked in station or region stock are carried in depot stock.

* Indicates stock available.

18. LIST OF MANUFACTURERS.

Code	*Manufacturer's Name*
A 13	American Phenolic Corp.
B 2	Belden Mfg. Co.
C 4	Centralab.
C 6	Cinch Mfg. Corp.
C 8	Chicago Transformer Corp.
E 43	Electronic Communications Equipment Co.
F 24	Fast, John E.
K 6	Kurz-Kasch Co.
L 3	Littlefuse Lab.
M 1	Mallory, P. R. & Co.
S 19	Sylvania Electric Products Co.
S 8	Sprague Products Co.
S 24	Stackpole Carbon Co.
T 22	Tobe Deutschmann Mfg. Corp.

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