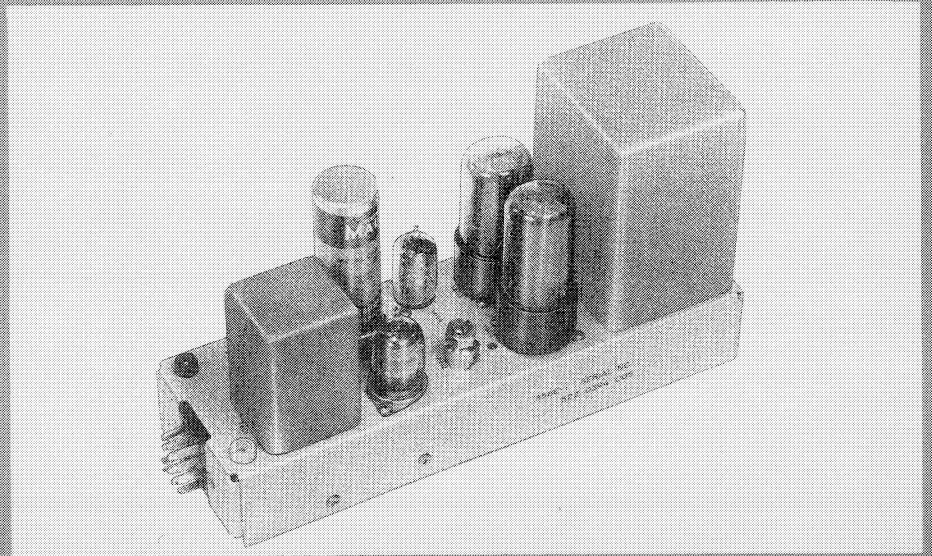


Collins



356E-1

LIMITER AMPLIFIER

I N S T R U C T I O N B O O K

**Instruction Book
for**

356E-1 LIMITER AMPLIFIER

**COLLINS RADIO COMPANY
Cedar Rapids, Iowa**

**520 5448 00
15 MAY 1956**

GUARANTEE

The equipment described herein is sold under the following guarantee:

Collins agrees to repair or replace, without charge, any equipment, parts, or accessories which are defective as to design, workmanship or material, and which are returned to Collins at its factory, transportation prepaid, provided

- (a) Notice of the claimed defect is given Collins within one (1) year from date of delivery and goods are returned in accordance with Collins' instructions.
- (b) Equipment, accessories, tubes, and batteries not manufactured by Collins or from Collins' designs are subject to only such adjustments as Collins may obtain from the supplier thereof.
- (c) No equipment or accessory shall be deemed to be defective if, due to exposure or excessive moisture in the atmosphere or otherwise after delivery, it shall fail to operate in a normal or proper manner.

Collins further guarantees that any radio transmitter described herein will deliver full radio frequency power output at the antenna lead when connected to a suitable load, but such guarantee shall not be construed as a guarantee of any definite coverage or range of said apparatus.

The guarantee of these paragraphs is void if equipment is altered or repaired by others than Collins or its authorized service center.

No other warranties, expressed or implied, shall be applicable to any equipment sold hereunder, and the foregoing shall constitute the Buyer's sole right and remedy under the agreements in this paragraph contained. In no event shall Collins have any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any other cause.

HOW TO RETURN MATERIAL OR EQUIPMENT. If, for any reason, you should wish to return material or equipment, whether under the guarantee or otherwise, you should notify us, giving full particulars including the details listed below, insofar as applicable. If the item is thought to be defective, such notice must give full information as to nature of defect and identification (including part number if possible) of part considered defective. (With respect to tubes we suggest that your adjustments can be speeded up if you give notice of defect directly to the tube manufacturer.) Upon receipt of such notice, Collins will promptly advise you respecting the return. Failure to secure our advice prior to the forwarding of the goods or failure to provide full particulars may cause unnecessary delay in handling of your returned merchandise.

ADDRESS:

Collins Radio Company
Sales Service Department
Cedar Rapids, Iowa

INFORMATION NEEDED:

- (A) Type number, name, and serial number of equipment
- (B) Date of delivery of equipment
- (C) Date placed in service
- (D) Number of hours of service
- (E) Nature of trouble
- (F) Cause of trouble if known
- (G) Part number (9 or 10 digit number) and name of part thought to be causing trouble
- (H) Item or symbol number of same obtained from parts list or schematic
- (I) Collins' number (and name) of unit sub-assemblies involved in trouble
- (J) Remarks

HOW TO ORDER REPLACEMENT PARTS. When ordering replacement parts, you should direct your order as indicated below and furnish the following information insofar as applicable. To enable us to give you better replacement service, please be sure to give us complete information.

ADDRESS:

Collins Radio Company
Sales Service Department
Cedar Rapids, Iowa

INFORMATION NEEDED:

- (A) Quantity required
- (B) Collins' part number (9 or 10 digit number) and description
- (C) Item or symbol number obtained from parts list or schematic
- (D) Collins' type number, name, and serial number of principal equipment
- (E) Unit sub-assembly number (where applicable)

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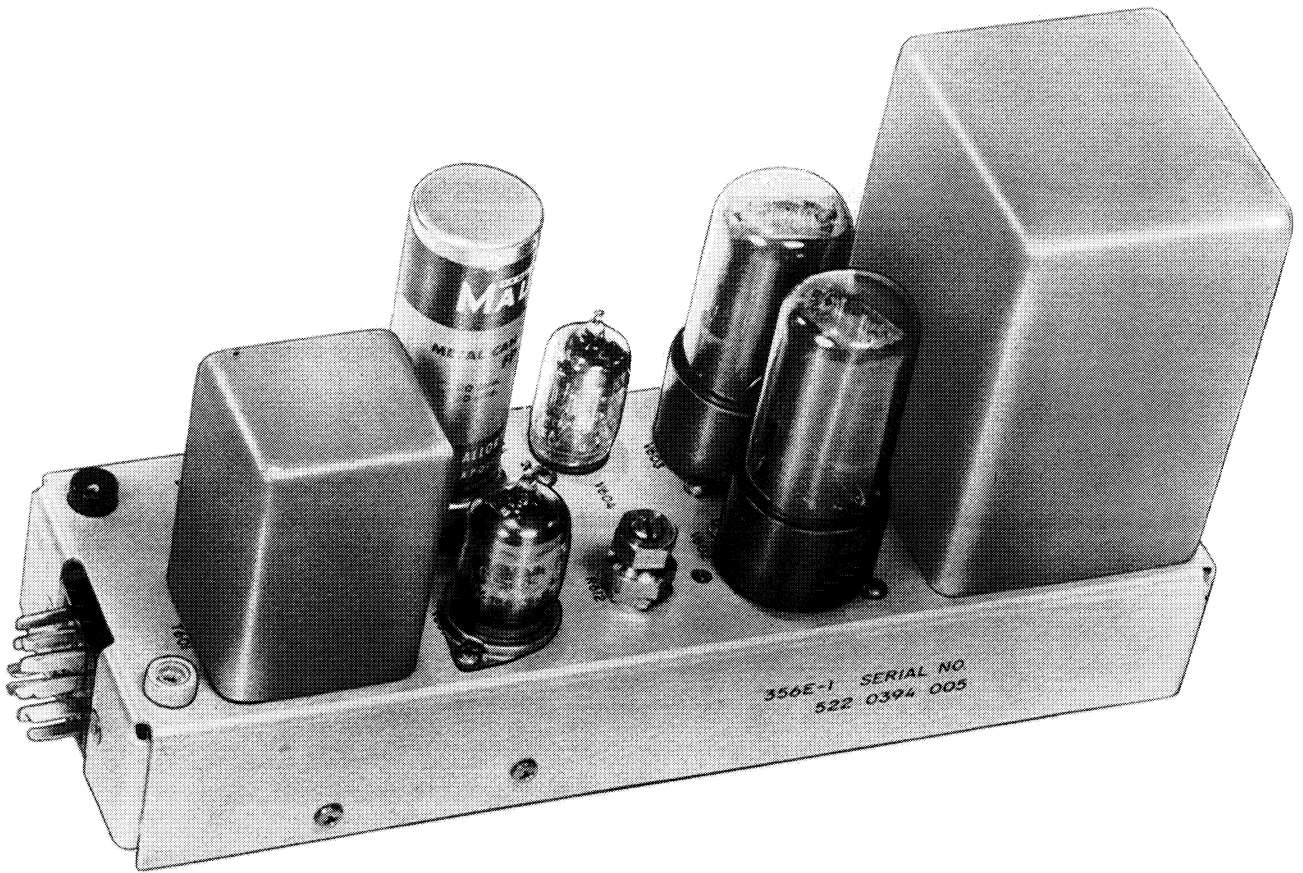
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Figure 1. Collins Type 356E-1 Limiter Amplifier,
Equipment Supplied

TYPE 356E-1 LIMITER AMPLIFIER

1. PURPOSE OF EQUIPMENT.

The 356E-1 Limiter Amplifier is an automatic average level or peak limiting amplifier for broadcast, TV, and microwave audio systems.

2. PHYSICAL DESCRIPTION.

The 356A-1 Limiter Amplifier (figure 1) is a plug-in module containing two stages of amplification with a bias rectifier. It is 5-5/16 inches high, 3 inches wide, and 9-1/2 inches long and weighs 4.75 pounds.

3. TUBE COMPLEMENT.

<u>Function</u>	<u>Symbol</u>	<u>Tube Type</u>
Input Amplifier	V601	GL6386
Output Amplifier	V602	6V6
Output Amplifier	V603	6V6
Bias Rectifier	V604	6AL5

4. ELECTRICAL CHARACTERISTICS.

a. CONNECTORS. - One 12-pin connector, P601, is located at the front end of the chassis. All connections for input, output, and power are made at this connector. Two jacks, J601 and J602, are provided at the front corners of the chassis top for measurement of threshold voltage.

b. POWER REQUIREMENTS. - Power requirements for the 356E-1 Limiter Amplifier are as follows: 300 volts d-c at 77 milliamperes and 6.3 volts a-c at 1.55 amperes.

c. FREQUENCY RANGE. - The frequency range of the 356E-1 Limiter Amplifier is 50 to 15,000 cycles per second.

d. INPUT IMPEDANCE. - The 356E-1 Limiter Amplifier is factory wired for 600 ohms unloaded transformer input impedance. It may be rewired for 150 ohms input impedance if desired. See figure 11.

e. GAIN. - The gain of the 356E-1 Limiter Amplifier is 54 db.

f. OUTPUT IMPEDANCE. - The 356E-1 Limiter Amplifier is factory wired for 600 ohms output impedance. It may be rewired for 150 ohms output impedance if desired. See figure 11.

g. FREQUENCY RESPONSE. - The frequency response of the 356E-1 Limiter Amplifier is ± 1 db from 50 to 15,000 cps.

h. DISTORTION. - The distortion of the 356E-1 Limiter Amplifier is as follows: 1.5% maximum distortion from 50 to 15,000 cps with no compression and 2% maximum distortion from 50 to 15,000 cps at any level up to 30 db gain reduction (with threshold set at +20 dbm output).

i. NOISE LEVEL. - The noise level in the output of the 356E-1 Limiter Amplifier is -50 dbm with threshold control set for +20 dbm output.

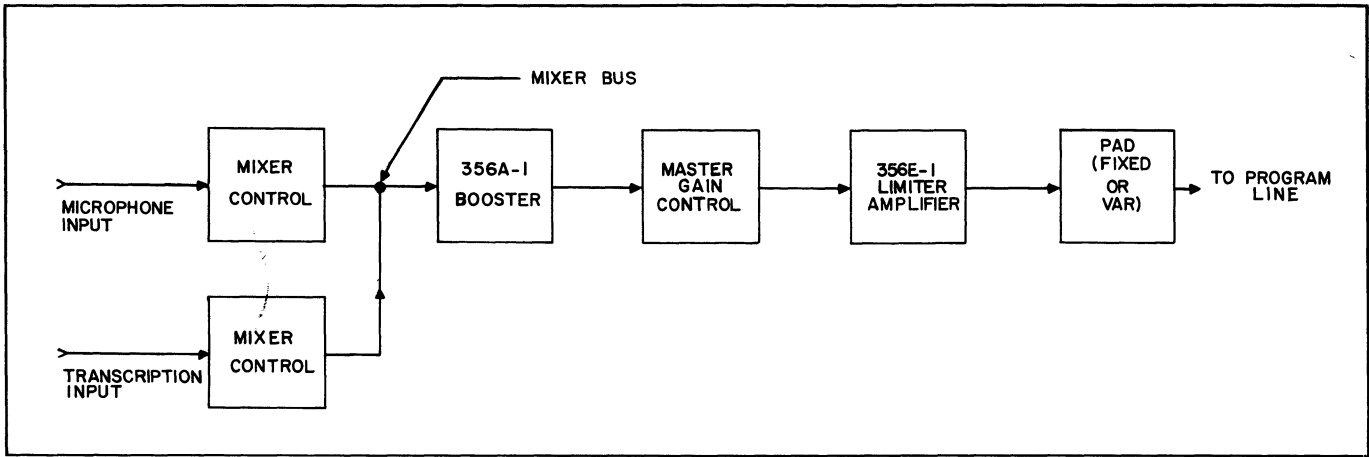
j. COMPRESSION RATIO. - The compression ratio of the 356E-1 Limiter Amplifier is adjustable from a ratio of 1.6/1 to a ratio of 5/1. A ratio of 3/1 is optimum over a 30-db range of input levels.

k. ATTACK TIME. - The attack time of the 356E-1 Limiter Amplifier is 11 milliseconds with the switch set in DUAL position or 62 milliseconds with the switch set in AVERAGE position.

l. RELEASE TIME. - The release time of the 356E-1 Limiter Amplifier is 0.9 seconds for 63% recovery with the switch set in the DUAL position, or 5.2 seconds for 63% recovery with the switch set in the AVERAGE position.

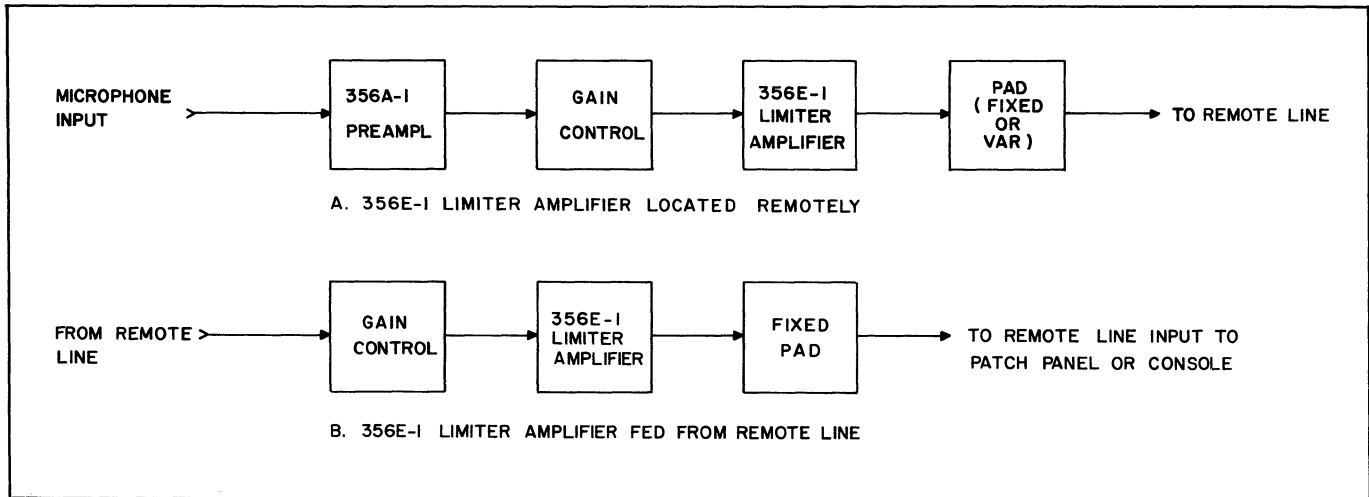
5. CIRCUIT DESCRIPTION.

Figure 11 is a schematic diagram of the 356E-1 Limiter Amplifier. Transformer T601 couples input signal to the grids of the push-pull input stage V601. Output from V601 is coupled to the grids of the push-pull output stage by C602 and C603. The output stage is transformer coupled to the load by T602. The threshold voltage control (R612) adjusts the positive bias applied to the cathodes of the bias rectifier V604. A sample of the output signal from the plates of V602 and V603 is coupled to the bias rectifier cathodes by C605 and C606. When the audio voltage at the plates of the output stage is high enough to overcome the threshold voltage, the bias rectifier V604 conducts. Plate current for V604 develops a negative voltage across R616. This negative voltage is the control voltage for the automatic gain circuit. It is applied to the grid return of the input amplifier V601. An increase in level of the input signal does not produce any limiting action until the threshold voltage is exceeded. When this happens, the gain of the input stage is reduced and the output level remains comparatively constant. When the signal level at the input is again reduced below the threshold voltage, the bias rectifier V604 stops conducting and the bias of the input stage falls back to normal. Attack and



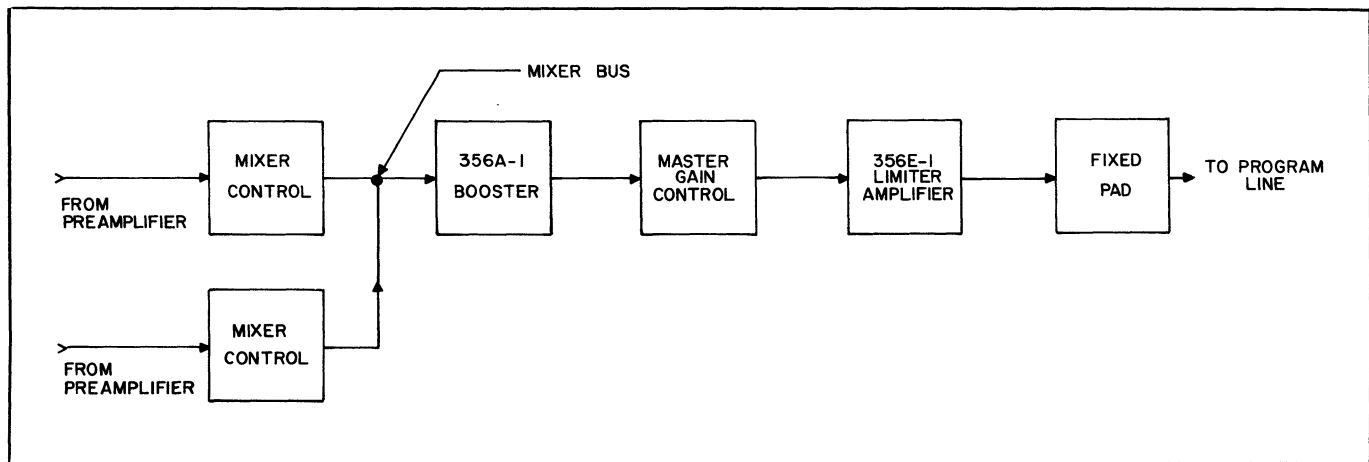
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Figure 2. Collins Type 356E-1 Limiter Amplifier as Automatic Fader Control, Suggested Arrangement



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Figure 3. Collins Type 356E-1 Limiter Amplifier as Automatic Level Control, Suggested Arrangement



C99-12-3

Figure 4. Collins Type 356E-1 Limiter Amplifier as Automatic Mixer, Suggested Arrangement

release times of the amplifier are determined by the RC time constants in the plate circuit of V604. When S601 is in DUAL position, C607 is charged by the voltage across R616 and the attack time of the amplifier is determined by the time constant of R615 and C607. When the switch S601 is in the same position and V604 stops conducting, the release time of the circuit is the time necessary for C607 to discharge through R616. When S601 is in AVERAGE position, R617 is shorted out. This connects C608 in parallel with C607 and the attack time is determined by the RC time constant of R615 and the sum of the capacities of C607 and C608. When V604 stops conducting, the release time of the circuit is the time necessary for C607 and C608 to discharge through R616.

6. APPLICATION.

a. GENERAL. - The 356E-1 Limiter Amplifier may be used as an automatic fader control, as an automatic level control in unattended remote operation, as an automatic mixer, or as a level control in microwave relay systems. Arrangements and adjustments for these uses are described in the following paragraphs.

b. THE 356E-1 LIMITER AMPLIFIER USED AS AUTOMATIC FADER CONTROL. - Refer to figure 2. The 356E-1 Limiter Amplifier is plugged into J108 of the 212F-1 Broadcast Console. Operate the switch on the 356E-1 Limiter Amplifier to DUAL position. Adjust the mixer in the transcription channel until the GR meter indicates a 2 to 5 db gain reduction. Adjust the mixer in the microphone channel until the microphone signal at the mixer bus is 20 db higher than the transcription signal at the same point. The use of the microphone channel automatically causes the transcription signal to drop 20 db below the microphone signal with an over-all output increase of less than 7 db. This 7-db increase may be handled by the peak-limiting amplifier usually employed at the transmitter.

With this type of operation, announcements may be made over the transcription signal without adjustment of the mixers in the microphone or transcription channels. When an announcement is over, the transcription signal automatically returns to its original level.

c. THE 356E-1 LIMITER AMPLIFIER USED AS AUTOMATIC LEVEL CONTROL IN UNATTENDED REMOTE OPERATION. - Figure 3A shows a suggested arrangement for using the 356E-1 Limiter Amplifier at a remote location. Figure 3B shows a suggested arrangement for using 356E-1 Limiter Amplifier at a studio with input from a remote line.

With an average input signal, adjust the input to the 356E-1 Limiter Amplifier to produce approximately 15-db gain reduction.

d. THE 356E-1 LIMITER AMPLIFIER USED AS AUTOMATIC MIXER. - Figure 4 shows a suggested arrangement for using the 356E-1 Limiter Amplifier as an automatic mixer. When two signals are present at the mixer bus, the amplifier acts as a master gain control, expander-compressor, or as a straight program amplifier.

e. THE 356E-1 LIMITER AMPLIFIER USED IN MICROWAVE RELAY SYSTEM. Figure 5 shows a suggested arrangement for using the 356E-1 Limiter Amplifier to minimize audio level variations in a microwave relay system.

7. ADJUSTMENTS OR MODIFICATIONS.

a. GENERAL. - The following paragraphs describe adjustments of threshold voltage for various input and output levels, modification of resistor values for various release times, and modification of meter and switching circuits to provide for monitoring the amount of gain reduction.

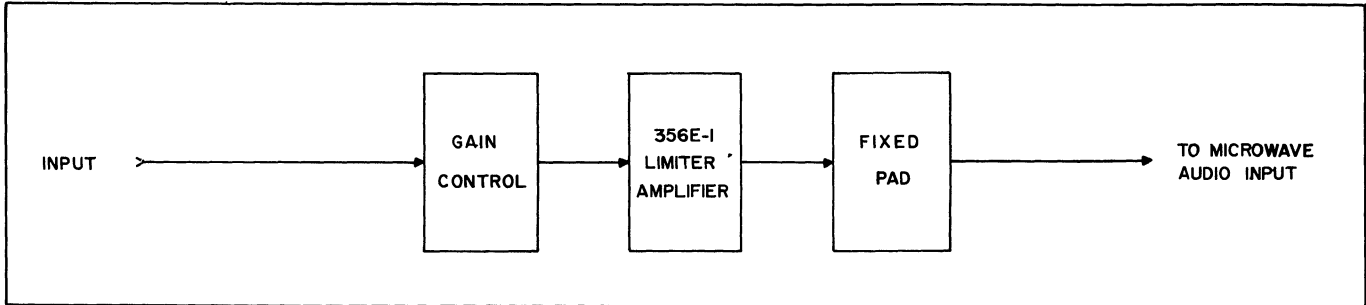
b. THRESHOLD VOLTAGE SETTINGS. - Table 1 gives threshold voltage settings for various input and output levels. Optimum operation results when the threshold voltage is set at 23.5 volts for an output level of +20 dbm. If this level is too high, a fixed pad may be inserted in the output line. For selection of resistor values for selected values of attenuation, refer to figure 6.

TABLE 1. THRESHOLD VOLTAGE SETTINGS

Input DBM	Output DBM	Threshold Voltage
-44	+10	7.5
-40	+14	12.0
-36	+18	19.5
-34*	+20*	23.5*
-32	+22	29.0
-28	+26	45.0
-24	+30	69.0

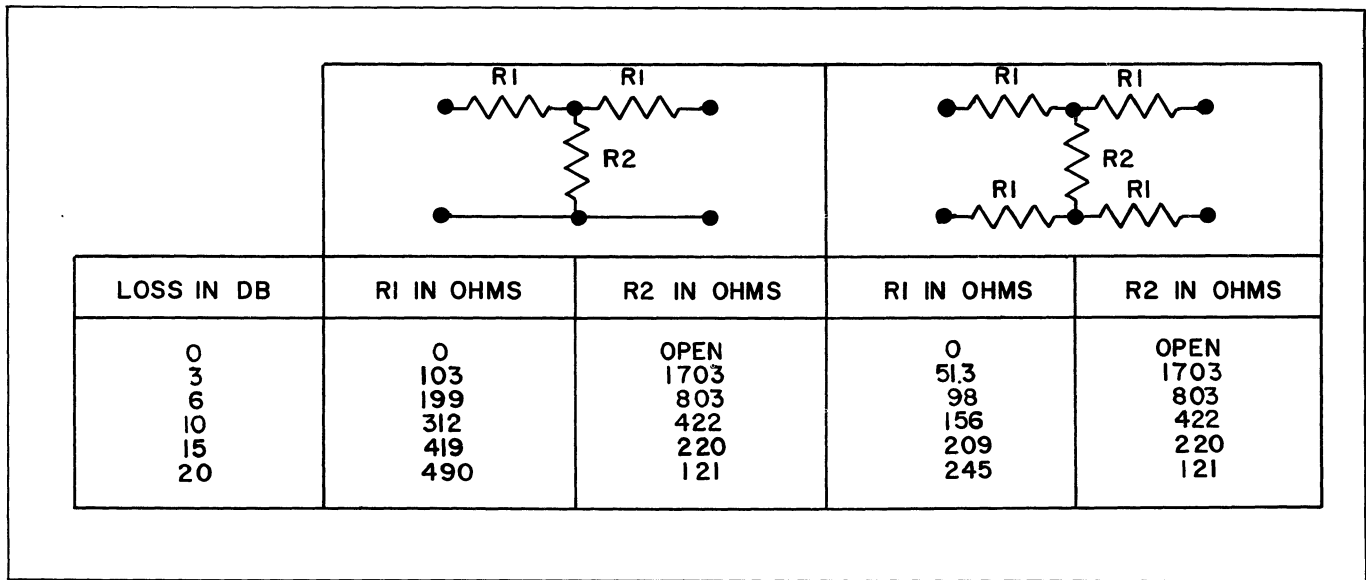
*Optimum

c. RELEASE TIME. - The release time of the 356E-1 Limiter Amplifier is satisfactory for most applications. If some other value of release time is desired, change the values of R616 and R617. Table 2 gives other values of resistance for R616 and R617 with corresponding release times.



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Figure 5. Collins Type 356E-1 Limiter Amplifier as Automatic Level Control In Microwave Relay Systems, Suggested Arrangement



C99-18-3

Figure 6. Resistor Values for 600 Ohm Fixed Pads

TABLE 2. VALUES OF R161 AND R617 AND CORRESPONDING RELEASE TIMES

Megohms		DUAL Position Seconds		AVERAGE Position Seconds
R616	R617	FAST	SLOW	
2.2	10	0.48	12.2	2.7
3.3	3.3	0.73	6.6	4.0
3.3	10	0.73	13.3	4.0
4.3	4.3	0.95	8.6	5.3
4.3	10	0.95	14.3	5.3
5.1	10	1.1	15.1	6.2
6.2	10	1.4	18.2	7.6

d. MODIFICATION OF VU METER AND SWITCHING CIRCUITS TO READ GAIN REDUCTION. - Procedures for application of the GR-scale decal (supplied with the 356E-1 Limiter Amplifier) and for modification of switching circuits are outlined in the following steps:

- (1) Remove the front of the VU meter.

- (2) Prepare the decal for application according to printed instructions on the decal.

- (3) Apply the decal to the VU meter scale with the plain black line of the decal directly over the black line on the meter scale and with the zero of the decal aligned with the zero of the meter scale. See figure 7.

- (4) Replace the front of the VU meter.

- (5) If VU-GR switching is desired, refer to figure 8 for wiring connections.

8. MAINTENANCE.

Normal maintenance will consist of tube replacement. If excessive distortion occurs, replace V303 and V304. Table 1 gives voltage and resistance measurements for the 356E-1 Limiter Amplifier.

9. TABLE OF REPLACEABLE PARTS.

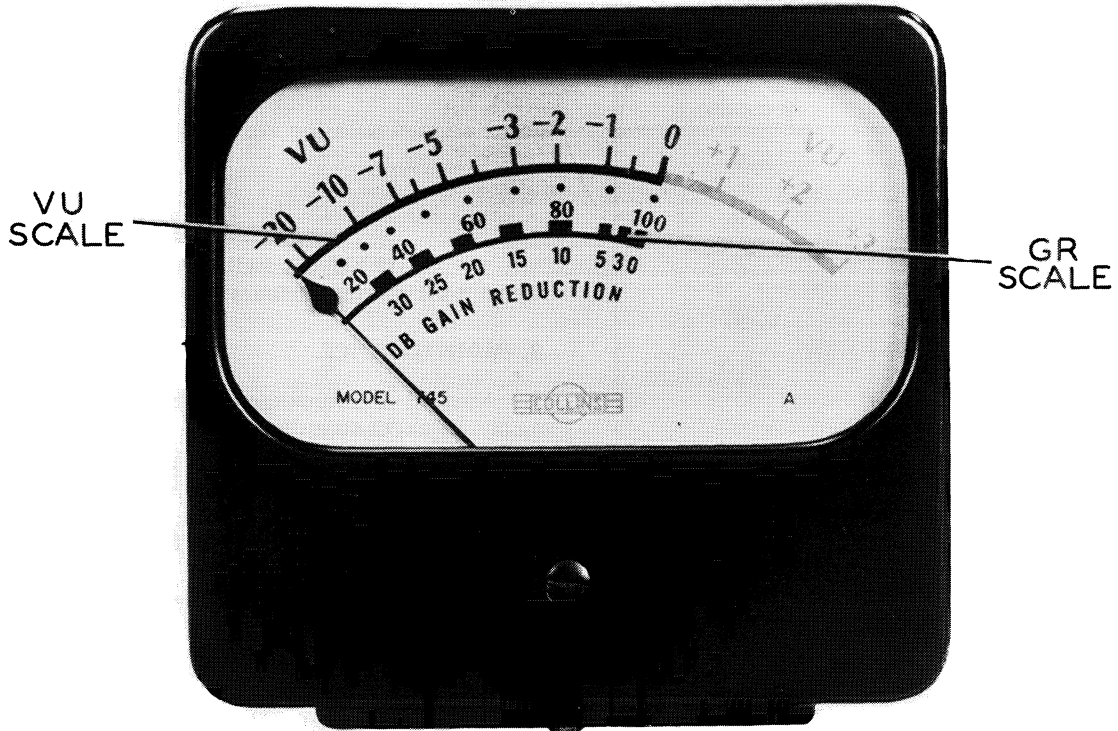
Table 2 gives the description, circuit function, and Collins part number for all replaceable parts in the 356E-1 Limiter Amplifier. When replacement of parts is necessary, only parts identical or equivalent to those listed should be used. All parts on top of the chassis are identified in figure 9. All parts mounted beneath the chassis are identified in figure 10.

TABLE 3. VOLTAGE AND RESISTANCE MEASUREMENTS FOR THE 356E-1 LIMITER AMPLIFIER

Conditions of measurements:

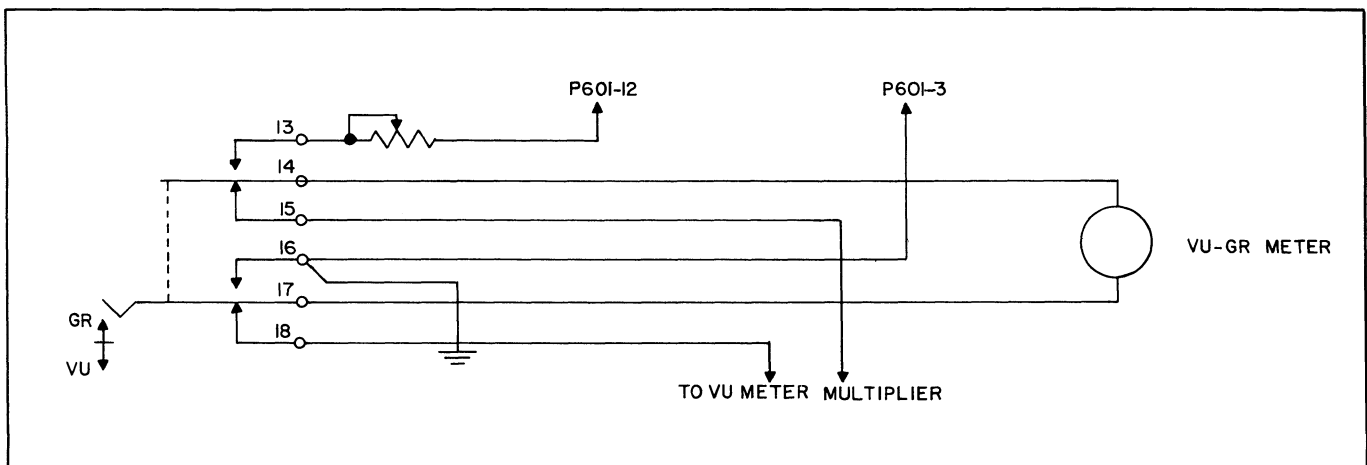
- a. Voltage readings are taken with a 20,000 ohms-per-volt meter.
- b. Line voltage 115 vac. Plate voltage adjusted to +300 volts d-c.
- c. Resistance readings taken with no power applied.
- d. All measurements from terminal to ground.

Tube		Pin Number								
		1	2	3	4	5	6	7	8	9
V601 (6386)	DC V.	20-50	1.2	-0.2	67	0	67	-0.2	1.2	20-50
	AC V.	3.0	0	0	0	0	0	0	0	3.0
	Ohms	2800	200	3.8 meg	55K	Inf	55K	3.8 meg	200	2800
V602 (6V6)	DC V.	0	20-50	290	300	0	0	20-50	18	
	AC V.	0	3.0	0	0	0	0	3.0	0	
	Ohms	Inf	2800	27K	27K	510K	Inf	2800	220	
V603 (6V6)	DC V.	0	20-50	290	300	0	0	20-50	18	
	AC V.	0	3.0	0	0	0	0	3.0	0	
	Ohms	Inf	2800	27K	27K	510K	Inf	2800	220	
V604 (6AL5)	DC V.	0	0	20-50	20-50	0	0	0		
	AC V.	0	0	3.0	3.0	0	0	0		
	Ohms	510K	3.8 meg	2800	2800	510K	Inf.	3.8 meg		



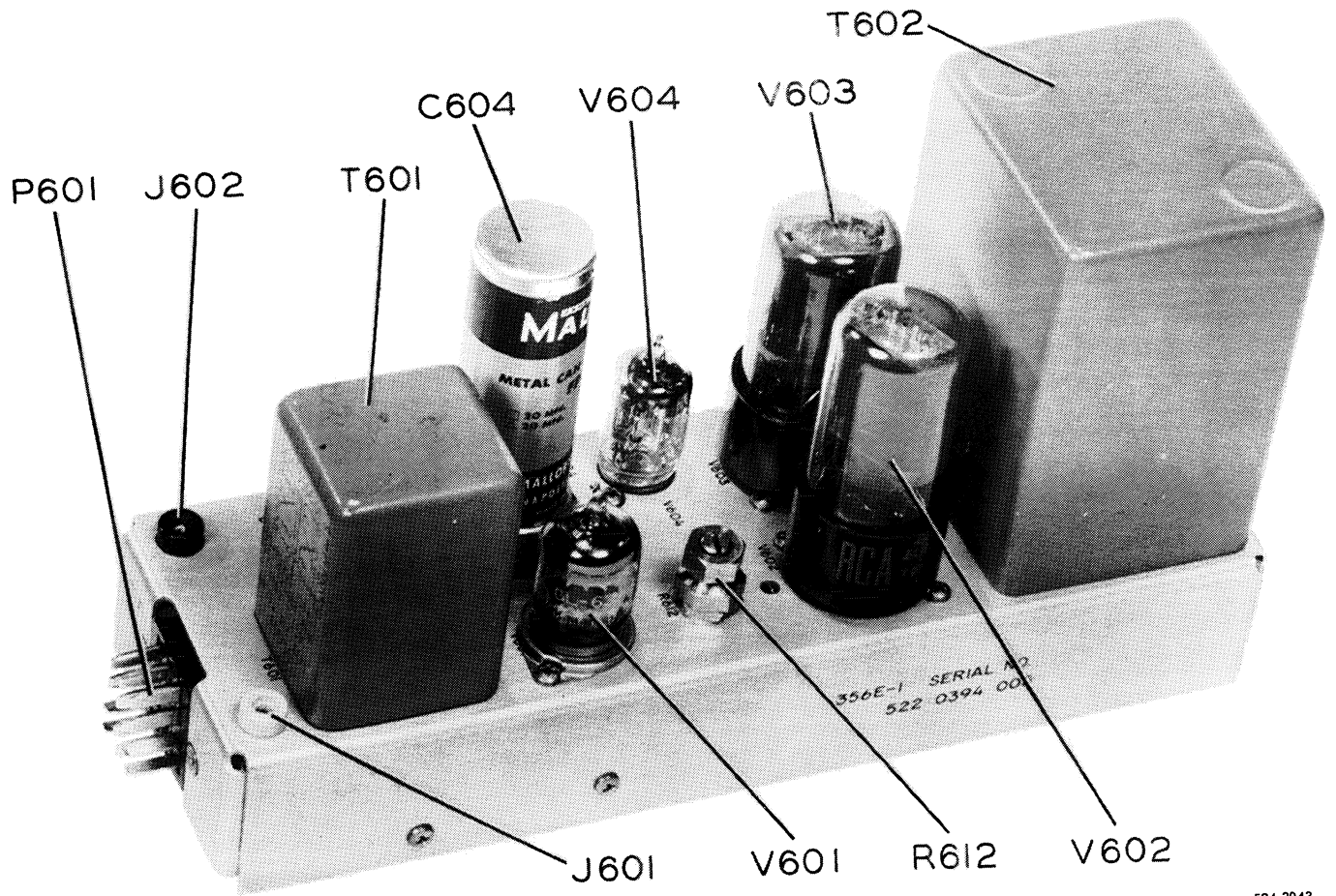
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Figure 7. VU Meter With GR Scale Decal Applied



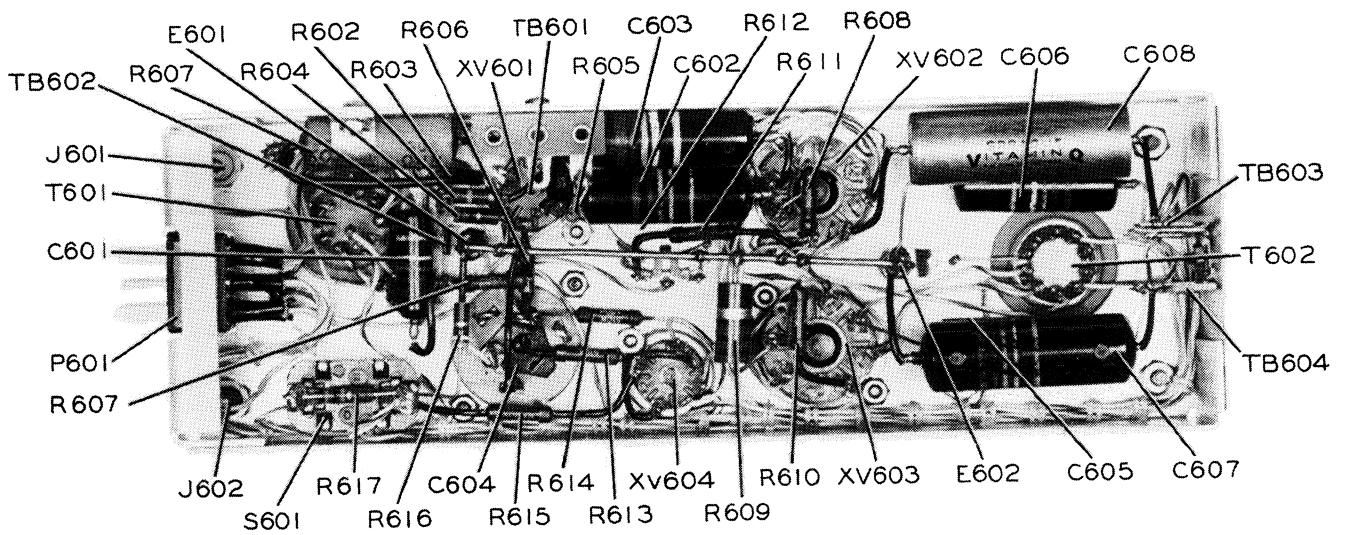
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Figure 8. VU Meter and GR Switch Connections, Schematic Diagram



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Figure 9. Collins Type 356E-1 Limiter Amplifier, Top View



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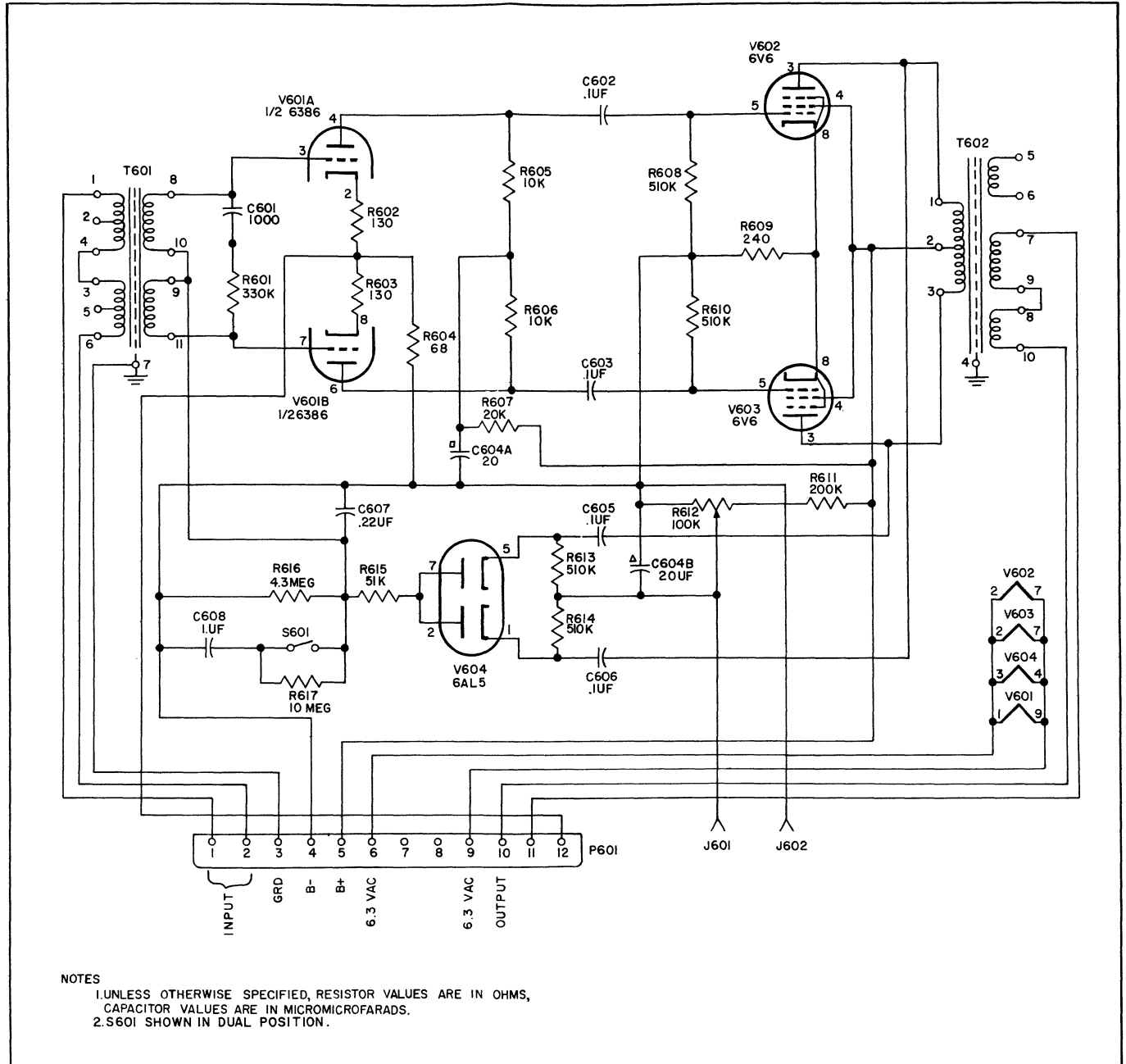
Figure 10. Collins Type 356E-1 Limiter Amplifier, Bottom View

TABLE 4. TABLE OF REPLACEABLE PARTS FOR THE 356E-1 LIMITER AMPLIFIER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C601	Frequency compensation	CAPACITOR: paper, 0.001 uf $\pm 10\%$, 400 vdcw	931 0277 00
C602	Coupling	CAPACITOR: paper, 0.1 uf $\pm 10\%$, 400 vdcw	931 0299 00
C603	Coupling	SAME as C-602	931 0299 00
C604	Decoupling	CAPACITOR: electrolytic; dual section; 20 uf -10% +50%, 450 vdcw each section	183 1262 00
C605	Coupling	SAME as C602	931 0299 00
C606	Coupling	SAME as C602	931 0299 00
C607	Part of attack-and-release time circuit	CAPACITOR: paper, 0.22 uf $\pm 10\%$, 400 vdcw	931 0303 00
C608	Part of attack-and-release time circuit	CAPACITOR: paper, 1.00 uf $\pm 20\%$, 200 vdcw	931 0908 00
E601	Tie point	TERMINAL, stud: melamine body, terminal, brass hot tin tipped, base brass, cadmium plated; hex	306 0234 00
E602	Tie point	SAME as E601	306 0234 00
J601	Pin jack	JACK, TIP: small phone tip, insulated w/ yellow low-loss nylon; nonprecious contact w/ precious metal finish; solder wire attachment	360 0066 00
J602	Pin jack	CONNECTOR, receptacle: 1 round female contact; straight type	360 0063 00
P601	Connector	CONNECTOR, plug: 12 rectangular male contacts	365 2120 00
R601	Frequency compensation	RESISTOR: comp, 0.33 megohm $\pm 5\%$, 1/2 w	745 1456 00
R602	Cathode bias for V601A	RESISTOR: comp, 130 ohms $\pm 5\%$, 1/2 w	745 1315 00
R603	Cathode bias for V601B	SAME as R602	745 1315 00
R604	Cathode bias for V601	RESISTOR: comp, 68 ohm $\pm 5\%$, 1/2 w	745 1302 00
R605	Plate load for V601A	RESISTOR: comp, 10,000 ohms $\pm 5\%$, 1/2 w	745 1393 00
R606	Plate load for V601B	SAME as R605	745 1393 00
R607	Decoupling	RESISTOR: wire wound, 20,000 ohms $\pm 5\%$, 5 w	747 9796 00
R608	Grid load for V602	RESISTOR: comp, 0.51 megohm $\pm 5\%$, 1/2 w	745 1466 00
R609	Cathode bias	RESISTOR: comp, 240 ohm $\pm 5\%$, 2 w	745 5626 00
R610	Grid load for V603	SAME as R608	745 1466 00
R611	Voltage-dropping	RESISTOR: comp, 0.20 megohm $\pm 5\%$, 1/2 w	745 1448 00
R612	Threshold voltage adjust	RESISTOR: variable; comp, 100,000 ohms $\pm 20\%$, 1/2 w at 40°C	380 0234 00
R613	Diode bias	SAME as R608	745 1466 00

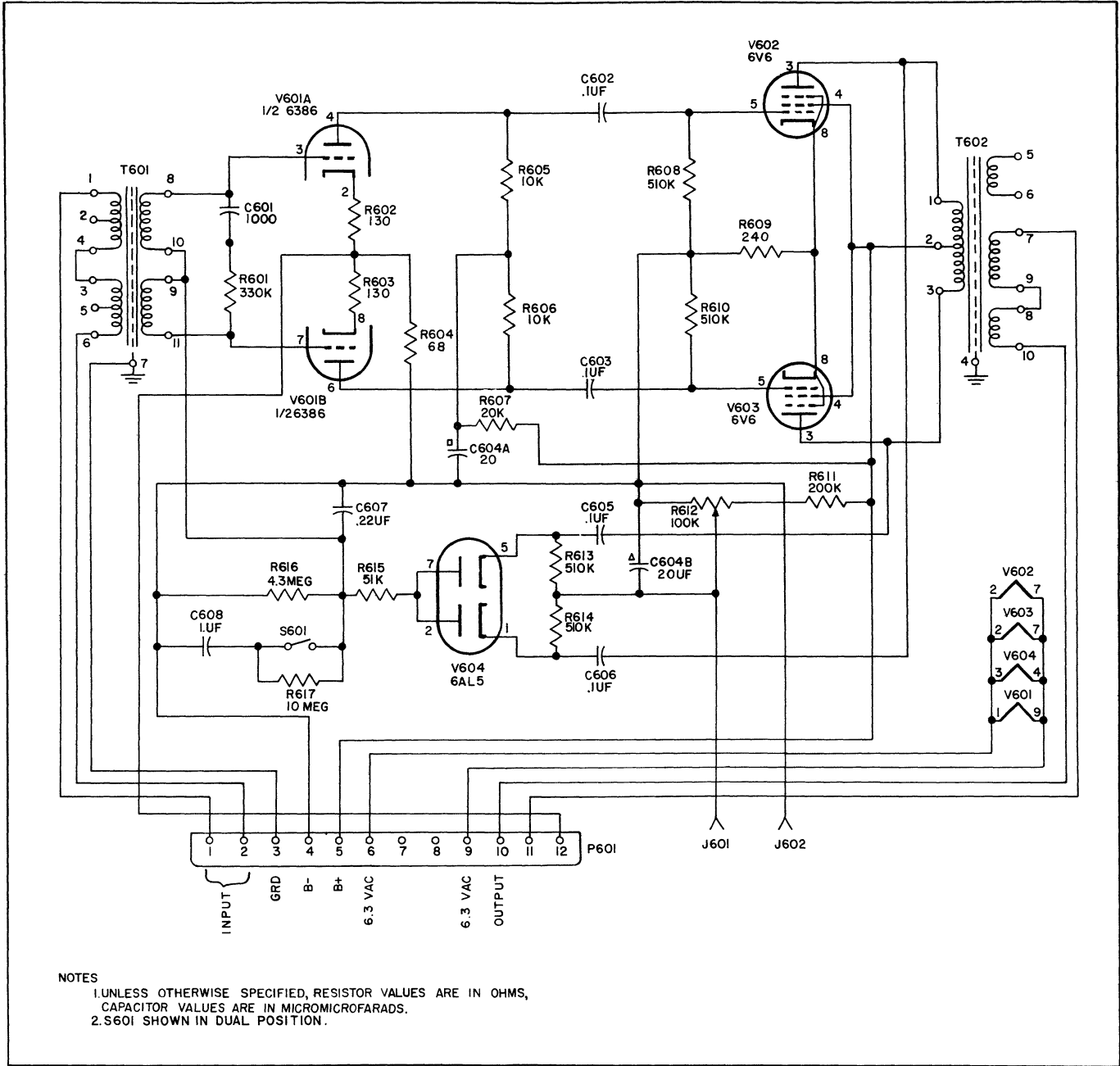
TABLE 4. TABLE OF REPLACEABLE PARTS FOR THE 356E-1 LIMITER AMPLIFIER (Cont)

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R614	Diode bias	SAME as R608	745 1466 00
R615	Part of attack-and-release time circuit	RESISTOR: comp, 51,000 ohms $\pm 5\%$, 1/2 w	745 1424 00
R616	Part of attack-and-release time circuit	RESISTOR: comp, 4.3 megohm $\pm 5\%$, 1/2 w	745 1504 00
R617	Part of attack-and-release time circuit	RESISTOR: 10 megohm $\pm 5\%$, 1/2 w	745 1519 00
S601	Selects DUAL or AVERAGE limiting	SWITCH, toggle: spst, 30 V dc, 20 amps in locking position, phenolic body	266 3072 00
T601	Input transformer	TRANSFORMER, AF: input type; 1000 cps, 1 milliwatt; primary 600 ohm, tap No. 1, 150 ohms, connected CT, tap No. 2, 150 ohms, 500 rms; secondary 60,000 ohms connected CT, 500 rms	667 0211 00
T602	Output transformer	TRANSFORMER, AF: output type; primary 9000 ohms, secondary impedance 600 ohms when series connected; 150 ohm when parallel connected; transformer contains a feedback winding shielded between primary and secondary grounded	667 0222 00
TB601		BOARD, TERMINAL: phenolic, 3 solid lug terminals, brass terminals	306 9033 00
TB602		SAME as TB601	306 9033 00
TB603		SAME as TB601	306 9033 00
TB604		SAME as TB601	306 9033 00
V601	Input amplifier	TUBE, electron: vacuum tube, 6386	253 0015 00
V602	Output amplifier	TUBE, electron: receiving tube beam, 6V6 GT	255 0021 00
V603	Output amplifier	SAME as V602	255 0021 00
V604	Diode limiter	TUBE, electron: twin diode rectifier 6AL5	257 0018 00
XV601		SOCKET, tube: 9 contact miniature	220 1274 00
XV602		SOCKET, tube: 8 prong octal	220 1005 00
XV603		SAME as XV602	220 1005 00
XV604		SOCKET TUBE: 7 contact miniature	220 1152 00



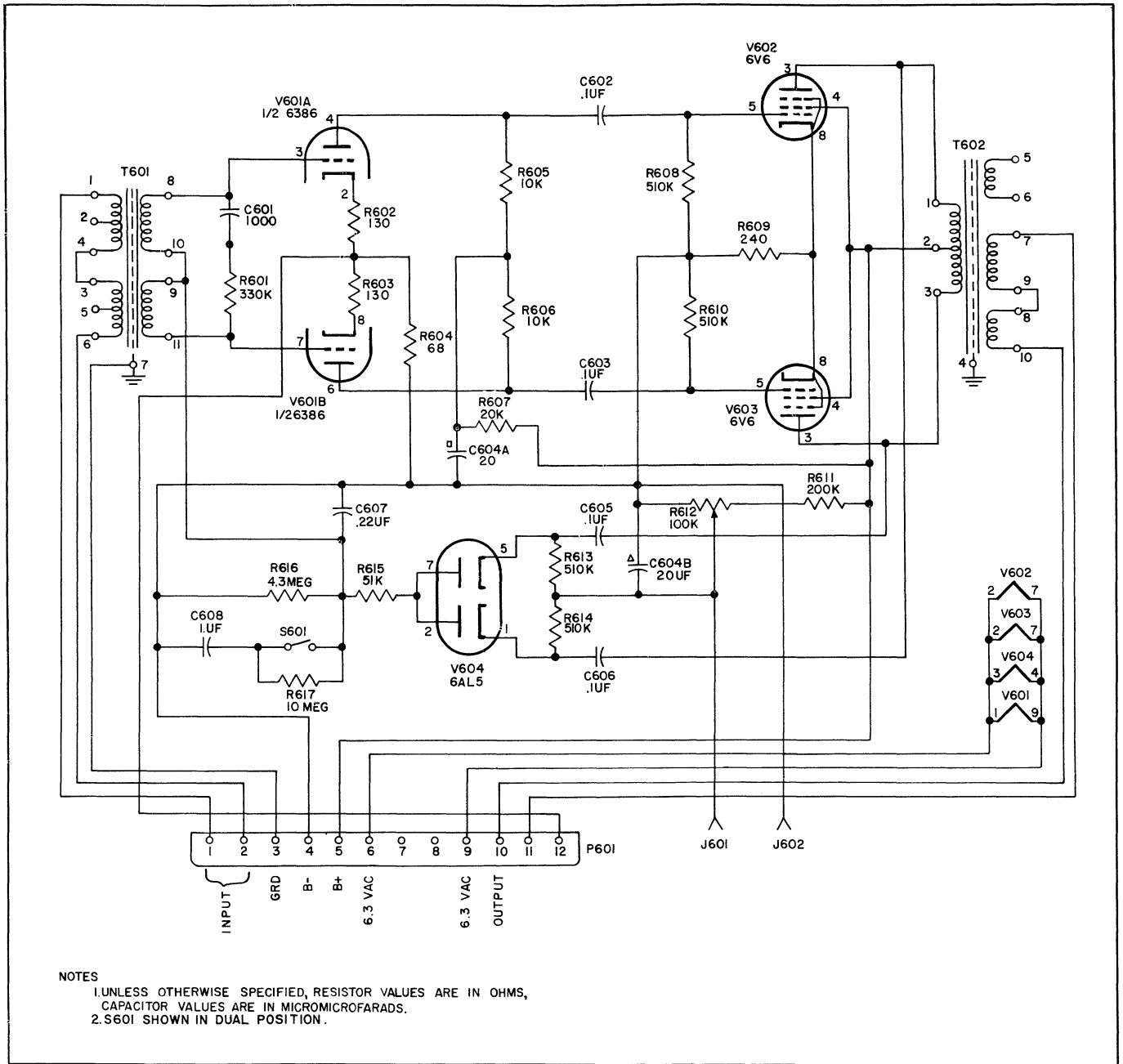
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Figure 11. Collins Type 356E-1 Limiter Amplifier, Schematic Diagram



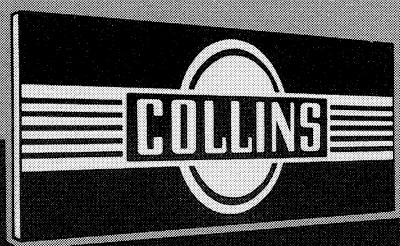
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Figure 11. Collins Type 35E-1 Limiter Amplifier, Schematic Diagram



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Figure 11. Collins Type 356E-1 Limiter Amplifier, Schematic Diagram



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