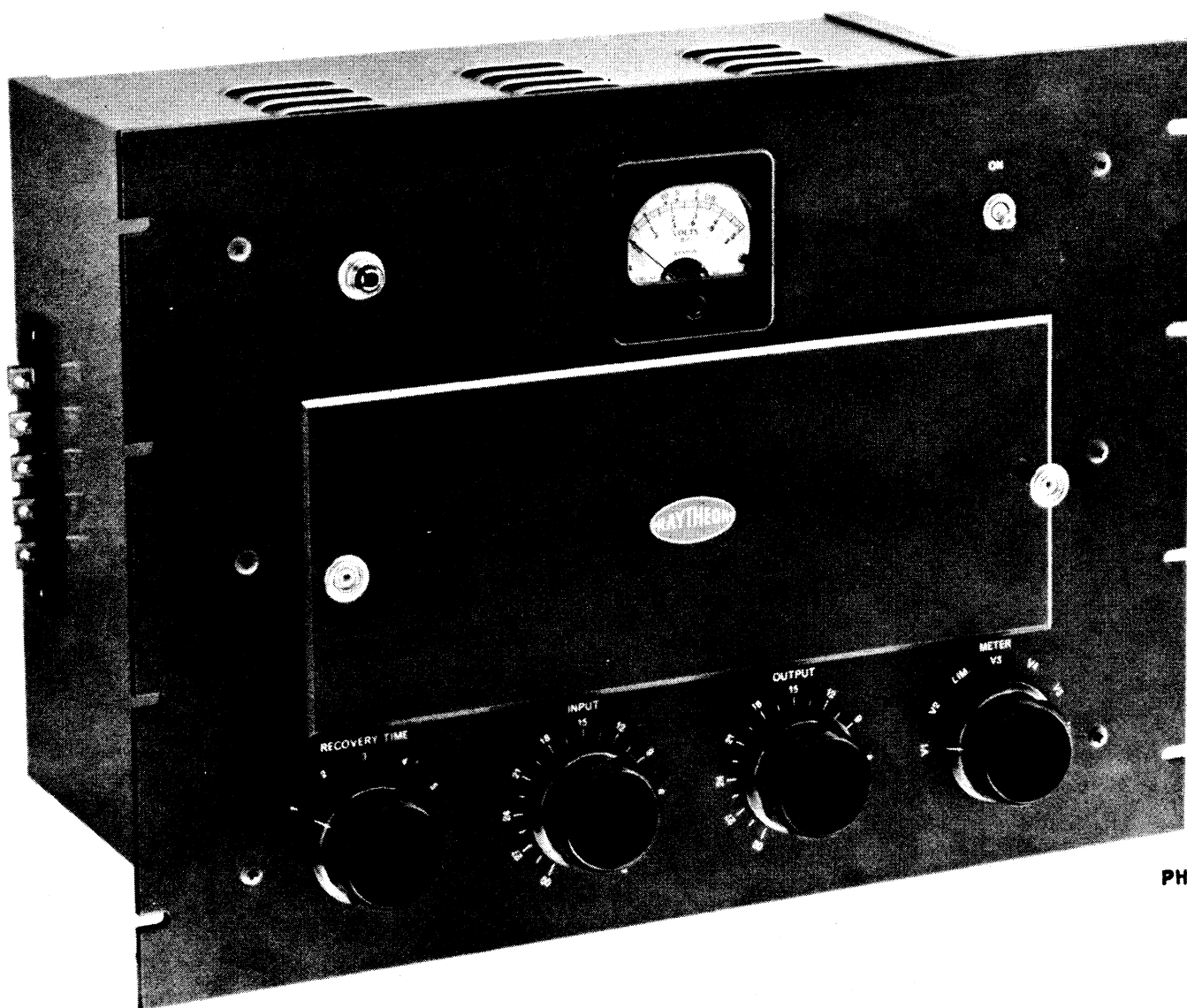


LINE AUDIO
VOLT. MEAS.
AT. 1+2 ON
LIMITER.
AV. .02 V.
WENT
BUT AFTER

**LIMITING AMPLIFIER
MODEL RL - 10**



PH-75

FRONTISPIECE

RL-10 LIMITER

ii

**LIMITING AMPLIFIER
MODEL RL - 10**

RAYTHEON MANUFACTURING COMPANY
BROADCAST EQUIPMENT DIVISION
7475 NORTH ROGERS AVENUE + CHICAGO 26, ILLINOIS

S.O. 8614

IB1-4

Table of Contents

<u>Title</u>	<u>Page</u>
Technical Summary	1
Description	2
Installation	3
Operation	4
Maintenance	5
Tube Voltages	5
Over-All Performance Checks	7
Replacements Parts List	9

List of Illustrations

Frontispiece -- RL-10 Limiter	ii
Figure 1. -- Test Set Up for RL-10 Measurements.	12
Figure 2. -- RL-10 (Top View)	13
Figure 3. -- RL-10 (Underside View)	14
Figure 4. -- Frequency Response of Amplifier ...	15
Figure 5. -- Schematic Diagram	16

TECHNICAL SUMMARY

Electrical Characteristics

Input Impedance 600 Ohms
Output Impedance 600 Ohms
Gain 43 db (with 600 ohm input and output impedances and with both adjustable attenuators set to zero)
Power Output 423 db*, approximately, (at single frequency input with adjustable output attenuator set at zero at point of limiting and fixed output pad omitted)
Output Noise 60 db below output level of 423 db (when input is at the limiting point, both adjustable attenuators set at zero and fixed output pad omitted)
Output Distortion:
 (1) For Program Less than 1% under all conditions up to 5 db of compression
 (2) For Single Frequency (a) Below compression; less than 1%
 Tone Input (b) For 5 db compression; less than 1% for frequencies above 200 cycles and less than 1.5 % for frequencies of 50-200 cycles
Frequency Response Within 1 db of the 1000 cycle value from 30-15,000 cycles
Power Supply 110 to 125 volts, 50-60 cycles a-c
Compression Ratio 10:1 (A 10 db increase in input level above the compression point produces a 1 db increase in output)
Recovery Time Variable in steps of 0.2 second from 0.2 to 1 second
Power Consumption 115 Watts

Tube Complement

2 1612 or 6L7 Metal Tubes
2 6SJ7 Metal Tubes
2 6F6 Tubes
1 6H6 Tube
1 5U4G
* Zero db Reference level 1 Milliwatt - 600 Ohms.

Mechanical Specifications

Panel 19"x14" (for standard relay rack or cabinet mounting)
Finish Raytheon Woodland Brown (other finishes on special order)
Weight Approximately 42 pounds

DESCRIPTION

The Model RL-10 Audio Amplifier is designed to control the operating level in high quality AM or FM program circuits. It is of the peak limiting type and contains circuits which automatically reduce the gain when the input level reaches a certain pre-determined amount. The equipment comprises three push-pull audio stages, a special audio rectifier circuit, and an associated power supply.

FUNCTION AND LAYOUT OF CONTROLS

Front Panel Controls. The function and layout of the front panel controls from left to right on the panel are as follows:

A. "RECOVERY TIME" Switch;

<u>Position</u>	<u>Recovery Time</u>
1	0.2 Sec
2	0.4 Sec
3	0.6 Sec
4	0.8 Sec
5	1.0 Sec

B. "INPUT" Control;

Zero to 30 db in steps of 1.5 db, linear.

C. "OUTPUT" Control;

Zero to 30 db in steps of 1.5 db, linear.

D. "METER" Switch;

Position No. 1 Tube V-1 plate current
Position No. 2 Tube V-2 plate current
(0-1 ma Scale)

Position No. 3 Normal position for
limiting action
(0-30 db Scale)

Position No. 4 Tube V-3 cathode voltage
Position No. 5 Tube V-4 cathode voltage
(0-5 volt Scale)

Position No. 6 Tube V-5 cathode voltage
Position No. 7 Tube V-6 cathode voltage
(0-50 volt Scale)

The pilot light, meter, and power switch are located from left to right in order, above the controls. The front panel itself is arranged with a pull-out door in the center so that all tubes are accessible and all adjustments may be made from the front.

Input Fixed Attenuator. The input fixed attenuator pad consists of resistors R-35, R-36 and R-37 as shown on the circuit diagram. It is located on the lower right hand side of the chassis and is normally a 5 db unit. It is used in conjunction with the variable "INPUT" attenuator R-45 to set the program level. This fixed input attenuator may be changed if desired in accordance with the table below. Table 5 gives the value of resistors to use for various fixed pads.

TABLE 1

<u>Input Level db</u>	<u>Fixed Input Attenuator</u>
-5 to 0	10 db
-30 to -10	5 db

Output Fixed Attenuator. The output fixed attenuator pad consists of resistors R-38, R-39 and R-40 as shown on the circuit diagram. It is located on the lower left hand side of the chassis and is normally a 10 db unit. It is used in conjunction with the variable "OUTPUT" attenuator R-46 to set the output level. Where still greater output is desired it may be removed entirely. The following table indicates the range of output available.

TABLE 2

<u>Output Level db</u>	<u>Fixed Output Attenuator</u>
+12 to -15 to +23	10 db None

INSTALLATION

Mounting. The equipment requires 14 inches of panel space in a standard relay rack or cabinet and screws are provided for mounting.

External Connections. External connections to this unit are simple to make. The power receptacle is located on the left side of the chassis and a connecting plug is provided. A terminal board on the right side of the chassis has audio terminal connections as follows:

No. 1	Input
No. 2	Input
No. 3	Ground
No. 4	Output
No. 5	Output

A permanent ground connection should be made to No. 3 terminal. In addition all input and output connections should be made with shielded twisted pair wire with shields preferable insulated and grounded at end points only. If uninsulated shielded pair is used it must be carefully grounded to prevent hum and noise pick-up.

Alignment. To make adjustments on the RL-10 Amplifier the audio input terminals 1 and 2 should be connected to an audio oscillator set at 1000 cycles, but with the oscillator turned off. The audio output terminals 4 and 5 on the RL-10 Amplifier should be connected to a Raytheon RV-10 or equivalent Volume Indicator with a 500 ohm resistor shunting terminals 4 and 5.

The controls on the RL-10 Amplifier should be set as follows:

"RECOVERY TIME" Switch on Position No. 3
"INPUT" Attenuator on 15 db
"OUTPUT" Attenuator on 0 db
"METER" Switch on Position No. 3 (limiting)

With no input, turn the power on and allow 5 minutes to warm up. Now adjust control "R-1" on the chassis, which is accessible through the door on the front panel, until the meter reads 0 db. Next check the plate currents of tubes V-1 and V-2 by turning the "METER" switch to position 1 and 2. This should indicate approximately 0.58 ma on the 0-1 ma scale. Turn the "METER" switch to positions 4 and 5 to read the cathode voltages on V-3 and V-4. This should show approximately 3 volts on the 5 volt scale. Set the switch at positions 6 and 7 to show the cathode voltages on V-5 and V-6 which should read approximately 22 volts on the 50 volt scale. Potentiometer "R-29" is sealed at the factory and will normally require no adjustment. To obtain minimum distortion at low frequencies it may be necessary in some cases to readjust this control at the desired frequency while noting the distortion as indicated on a distortion meter connected across the output.

NOTE: Readings taken during operation may vary greatly with compression and do not indicate impaired operation. Do not switch meter during operation.

Apply a 1000 cycle signal to the amplifier. This signal should be at a level which is 10 db higher than the average program level as indicated by a volume indicator at this point in the circuit. This difference makes allowance for the peak factor in program material. Adjust the variable "INPUT" attenuator so that the meter indicates 5 db compression when the "METER" switch is set at the "LIMITER" position No. 3. Now set the adjustable "OUTPUT" attenuator until the output level as shown on the volume indicator connected to the output terminals corresponds to that required for 85 per cent modulation of the transmitter it is to be used in conjunction with.

In order to allow for future adjustments it is desirable that in the initial alignment the "INPUT" and "OUTPUT" attenuators be left as near the mid-position as possible. Such settings may be obtained by using other values of fixed input and output attenuators if necessary.

OPERATION

Use of Compression. The amount of compression to be employed should not exceed 5 db as indicated on the panel meter for any type of transmitter

program material. The meter accuracy is within approximately 1 db at 5 db compression. In the highest quality systems less than 5 db may be desirable. In such cases the amount of allowable compression may best be determined by aural monitoring with a loudspeaker having a wide frequency range. Under these conditions additional attenuation can be obtained by turning the adjustable "INPUT" attenuator counter-clockwise. At the same time it may be necessary to readjust the output level by turning the adjustable "OUTPUT" attenuator. Turning this control counter-clockwise decreases the output and the percentage modulation, while turning it clockwise increases the output as well as the percentage modulation.

"RECOVERY TIME" Settings. Position 3 on the "RECOVERY TIME" switch represents the most satisfactory setting to provide an effective increase in signal strength without causing distortion of high quality program material. However, the "RECOVERY TIME" switch settings may be necessary for certain types of program material. The recovery time for different positions of this switch has already been shown under FUNCTION AND LAYOUT OF CONTROLS. If the recovery time is changed from its initial setting on step 3 it may be necessary to reset control "R-1" as already described under Alignment if the Meter Scale fails to show 0-db with no signal input.

MAINTENANCE

With reasonable care, this unit will provide reliable trouble-free service for long periods of time. When replacements parts are required they may be identified by referring to the photographs, circuit diagram and parts list.

Tubes. Under ordinary usage within the ratings specified for voltage supply, tube life will be consistent with that obtained in other applications. The tubes in this unit may all be checked in a standard tube checker and such checks should be made at frequent intervals so that tube failures will be anticipated and the tube or tubes replaced before an actual failure occurs. It is important that type 6L7 or 1612 metal tubes are used for V-1 and V-2 in this unit.

Voltage Measurements. One means of learning the condition of operation and tracing of circuit faults of the unit is by checking the values of the voltages at the tube sockets. A table of such voltages is shown below. In general, the values indicated are measured from the tube socket contacts to ground; however, the filament voltages are a.c. and appear between the filament contacts.

TABLE 4 TUBE VOLTAGES

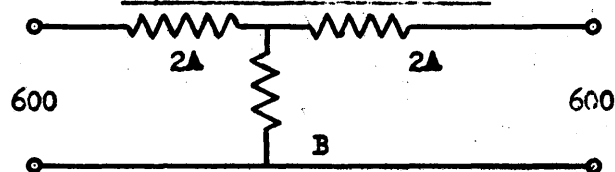
Voltages read with respect to ground (except filament voltages): 20,000 ohms/volt voltmeter. 115 volts applied to primary. No signal input. Voltages may vary $\pm 10\%$ from values shown.

TABLE 4 (con't.)

SYMBOL	TUBE TYPE	FUNCTION	E _f	E _k	E _g	E _{sg}	E _p
V-1	6L7	1st p-p a-f Amplifier	6.3	1.25	27	25	65
V-2	6L7	1st p-p a-f Amplifier	6.3	1.25	27	25	65
V-3	6SJ7	2nd p-p a-f Amplifier	6.3	3.0		60	200
V-4	6SJ7	2nd p-p a-f Amplifier	6.3	3.0		60	200
V-5	6F6	3rd p-p a-f Amplifier	6.3	23		290	290
V-6	6F6	3rd p-p a-f Amplifier	6.5	23		290	290
V-7	5U4G	Rectifier	5.				
V-8	6H6	Audio Rectifier	6.3	50			0

B_f Voltage at Filter Output..... 300 volts

TABLE 5

TABLE OF PADS BASED ON CALCULATED AND
10% RMA RESISTOR VALUES

DB Loss	2A	RMA	B	RMA
1.0	34.50	33	5199.60	*5100
2.0	68.76	68	2582.40	2700
3.0	102.6	100	1704.00	1800
4.0	135.78	*130	1258.80	1200
5.0	168.06	*160	986.88	1000
6.0	199.2	*200	803.28	820
7.0	209.56	220	669.60	680
8.0	238.48	*240	567.72	560
9.0	285.84	270	487.08	470
10.0	311.76	*300	421.56	*430
15.0	418.8	*430	220.32	220
20.0	490.8	470	121.20	120
25.0	536.4	560 (2x270)	67.68	68
30.0	563.28	560	37.98	39
35.0	579.12	560	21.34	22
40.0	588.24	560	12.0	12

*5% RMA Value

OVER-ALL PERFORMANCE CHECKS

It may be necessary or desirable in some instances to run a complete over-all test on the instrument as in the case where components have been replaced or the unit is suspected of being out of adjustment. Special tests for this purpose are outlined below:

Preliminary Adjustment. Arrange the equipment according to the test set-up shown in Fig. 1 with the dust cover on the RL-10 Limiter.

With no audio input and the "Meter" switch set on position "3" turn the power on and allow a few minutes to warm up. Now adjust control "R-1" until the meter reads "0 db".

Set "Meter" switch on position "6" and "7" and note the cathode voltages on the output tubes V-5 and V-6 which should read approximately 22 volts. Adjust R-29 if necessary for a balanced reading.

Compression Check. Put the snap-on door on the unit. The Audio Oscillator should be off; the VTVM, Distortion Meter, and Scope should be turned on. First check the Limiter on the Scope to see if there is any tendency to oscillate when full on. If it is stable, proceed with the test.

Turn on the A-F Oscillator and set the output as shown on the VTVM to "0 db". Set the "Meter" switch on RL-10 to "Lim." position and the "Input" and "Output" controls full-on. The input level to RL-10 is now -30 db. Note the meter on RL-10 and reduce the audio input signal until the RL-10 meter reading starts to change. Note the input required to produce a change. This establishes the point of compression which is normally -32 db \pm 2 db. Note: it may be necessary to start with more input in some cases in order to find the compression point.

Frequency Response Check. Reduce the a-f input on RL-10 to -35 db and check the frequency response using 1000 cycles as a reference. The response should be \pm 1 db from 30-15000 cycles.

Gain. Check the system gain from a 500 ohm source to a 500 ohm load with both adjustable attenuators set at zero. The gain should be approximately 40 db.

Noise. Check the output noise. This is measured below the level obtainable when both attenuators are set at zero and the input to RL-10 is at the compression point. The noise level shall not be less than 65 db below the output level obtained above.

(-64 dB) 6/9/61 R.P.

Distortion. Set the controls on RL-10 as follows:

"Input" at "0"

"Output" at "0"

"Recovery Time" at "3"

Establish the input necessary for compression to start then increase the input signal by 1db. Check the meter on RL-10 for evidence of oscillation. Now increase the input signal 10 db above the point at which compression starts. This gives 10 db compression. Measure distortion in accordance with the table below. If distortion is excessive, adjust R-29 at 50 cycles for minimum distortion. Seal R-29 when test is complete.

DISTORTION TABLE

6V6
OUT PUT
TUBES
1/7/64 R.P.

<u>C.P.S.</u>	<u>Max. Allowable % Distortion</u>
50	1.5
100	1.0
400	0.6 - - - 0.65%
1000	0.6 - - - 0.5%
5000	0.6
7500	0.6 - - - 0.4%
10000	0.6 - - - 0.4%
15000	0.6 - - - 0.3%

REPLACEMENT PARTS LIST

SYMBOL NUMBER	NO. REQ	DESCRIPTION	SUPPLIER	RAYTHEON PART NO.
C-1,2,4,6, 7,8,9,12,13	9	Condenser: 0.1 Mfd. 600 V. DCW, paper tubular #TP418	Mallory	50-L-10A
C-3,5	2	Condenser: 15 Mfd. $-10 \pm 50\%$ V. DCW, electrolytic condenser #FP143	Mallory	50-L-21B
C-10,11	2	Condenser: 0.01 Mfd. $\pm 10\%$ 300 V. DCW, Type 339	Micamold	50-L-22A
C-14,15,16	3	Condenser: 4 Mfd. 600 V. DCW. oil filled type TLA 6040	Cornell-Dub.	50-L-19A
	4	Knob	John Mack & Sons	166-V-21A
F-1	1	Fuse: 3 AMP Type 3AG	Bussman	
I-1	1	Pilot Bulb: 6-8V. Type R-44	Raytheon	177-L-2A
J-1	1	Plug: #6LM10	Amphenol	219-L-1A
L-1,2	2	Choke: 10 H. 100 Ma. #M10584	Raytheon	65-L-15A
M-1	1	Meter: 0-1 Ma. DC Model 301 rectangular flush bakelite case 3 1/8" x 3" calib. for 3/16" Al panel	Weston	187-U-40
R-1,29	2	Potentiometer: 500 ohm, 4 watt No. M500 P	Mallory	244-L-8A
R-2	1	Resistor: 180 ohm $\pm 10\%$ 1W. insulated carbon, Type GB	Allen Bradley	237-L-200
R-3,4	2	Resistor: 470,000 ohm $\pm 10\%$ $\frac{1}{2}$ W. insulated carbon, Type EB	Allen Bradley	237-L-168
R-5,13,14	3	Resistor: 100,000 ohm $\pm 10\%$ 1 W. insulated carbon, Type GB	Allen Bradley	237-L-233
R-6	1	Resistor: 22,000 ohm $\pm 10\%$ 1 W. insulated carbon, Type GB	Allen Bradley	237-L-550
R-7,8,9, 10,11	5	Resistor: 2.2 Megohm $\pm 10\%$ $\frac{1}{2}$ W. insulated carbon, Type EB	Allen Bradley	237-L-176
R-15,16	2	Resistor: 560 ohm $\pm 10\%$ 1 W. insulated carbon, Type GB	Allen Bradley	237-L-206

REPLACEMENT PARTS LIST

SYMBOL NUMBER	NO. REQ	DESCRIPTION	SUPPLIER	RAYTHEON PART NO.
R-17,18	2	Resistor: 56,000 ohm $\pm 10\%$ 1 W. insulated carbon, Type GH	Allen Bradley	237-L-230
R-19,20	2	Resistor: 2400 ohm $\pm 5\%$ 1 W. insulated carbon, Type GB	Allen Bradley	237-L-533
R-21,22, 27,28	4	Resistor: 220,000 ohm $\pm 10\%$ $\frac{1}{2}$ W. insulated carbon, Type EB	Allen Bradley	237-L-164
R-23,24	2	Resistor: 82,000 ohm $\pm 10\%$ 1 W. insulated carbon, Type GB	Allen Bradley	237-L-232
R-25	1	Resistor: 390,000 ohm $\pm 10\%$ 1 W. insulated carbon, Type GB	Allen Bradley	237-L-240
R-26	1	Resistor: 390 ohm $\pm 10\%$ 1 W. insulated carbon, Type GB	Allen Bradley	237-L-204
R-30,31	2	Resistor: 270,000 ohm $\pm 10\%$ $\frac{1}{2}$ W. insulated carbon, Type EB	Allen Bradley	237-L-165
R-32,33	2	Resistor: 10,000 ohm $\pm 10\%$ 1 W. insulated carbon, Type GB	Allen Bradley	237-L-221
R-34	1	Resistor: 30,000 ohm 10 W. Brown Devil	Ohmite	237-L-766B
R-35,36	2	Resistor: 150 ohm $\pm 10\%$ $\frac{1}{2}$ W. insulated carbon, Type EB	Allen Bradley	237-L-126
R-38,39	2	Resistor: 270 ohm $\pm 10\%$ $\frac{1}{2}$ W. insulated carbon, Type EB	Allen Bradley	237-L-129
R-37	1	Resistor: 820 ohm $\pm 10\%$ $\frac{1}{2}$ W. insulated carbon, Type EB	Allen Bradley	237-L-135
R-40	1	Resistor: 360 ohm $\pm 5\%$ $\frac{1}{2}$ W. insulated carbon, Type EB	Allen Bradley	237-L-368
R-41,42	2	Resistor: 470 ohm $\pm 10\%$ 2 W. insulated carbon, Type EB	Allen Bradley	237-L-278
R-43	1	Resistor: 4900 ohm (select from 4700 ohm $\frac{1}{2}$ W. $\pm 5\%$ stock resistors)	Allen Bradley	237-L-395
R-44	1	Resistor: 52,405 ohm (select from 51,000 $\frac{1}{2}$ W. $\pm 5\%$ stock resistors)	Allen Bradley	237-L-420

REPLACEMENT PARTS LIST

SYMBOL NUMBER	NO. REQ	DESCRIPTION	SUPPLIER	RAYTHEON PART NO.
R-45	1	Attenuator: 500/500 ohm #LA351-F	Daven	244-L-7A
R-46	1	Attenuator: 500/500 ohm #LA 351-F with Detent.	Daven	244-LA-7A
S-1	1	Switch: S.P.S.T. No. 81015	Arrow H & H	263-L-8A
S-2	1	Switch: 1 pole, 5 pos. 1 gang, shorting type	Oak Mfg. Co.	263-U-9C
S-3	1	Switch: 2 pole, 7 pos. 2 gang	Oak Mfg. Co.	263-U-7B
T-1	1	Transformer: 500 ohm line to PP grid #94191 RC-75 case	U.T.C.	291-L-52A
T-2	1	Transformer: PP 6F6 Triode to 500 ohm line #94193 RC-87 case	U.T.C.	291-L-54A
T-3	1	Transformer: Power supply type #DU74-1675 (Pl. & Fil.)	Raytheon	291-U-48B
V-1,2	2	Tube: 1612 or 6L7 metal	R.C.A.	
V-3,4	2	Tube: 6SJ7GT	Raytheon	
V-5,6	2	Tube: 6F6	Raytheon	
V-7	1	Tube: 5U4-G	Raytheon	
V-8	1	Tube: 6H6	Raytheon	
	1	Pilot assembly: Miniature Bayonet Type 50, Red Jewel	Drake	177-L-1A
	1	Receptacle: #61F11 with Clamp	Amphenol	219-L-2A
	8	Socket: Octal, Black Bakelite MIP-8	Amphenol	256-L-2B

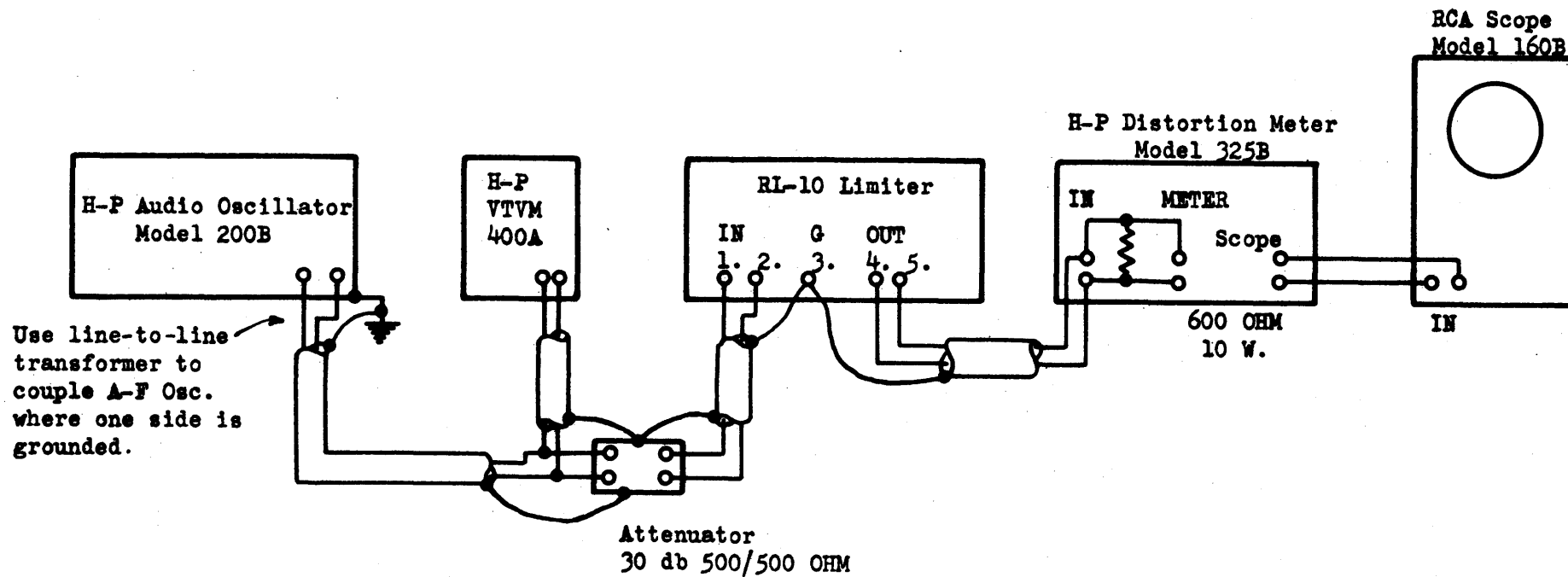


Fig. 1. Test Set Up for RL-10 Measurements.

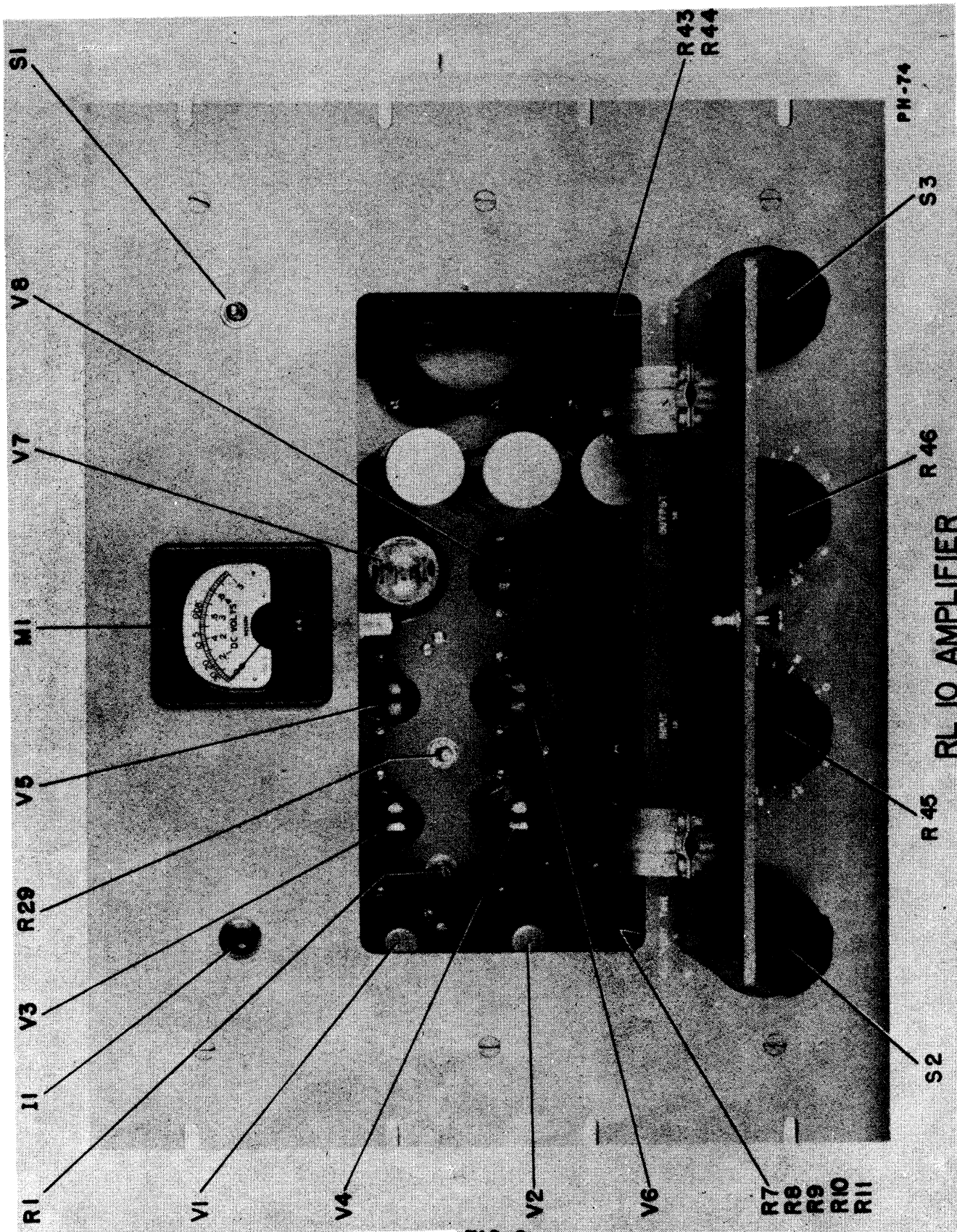


FIG. 2
PAGE 13

270K
 32K 390K
 82K
 90K

5652

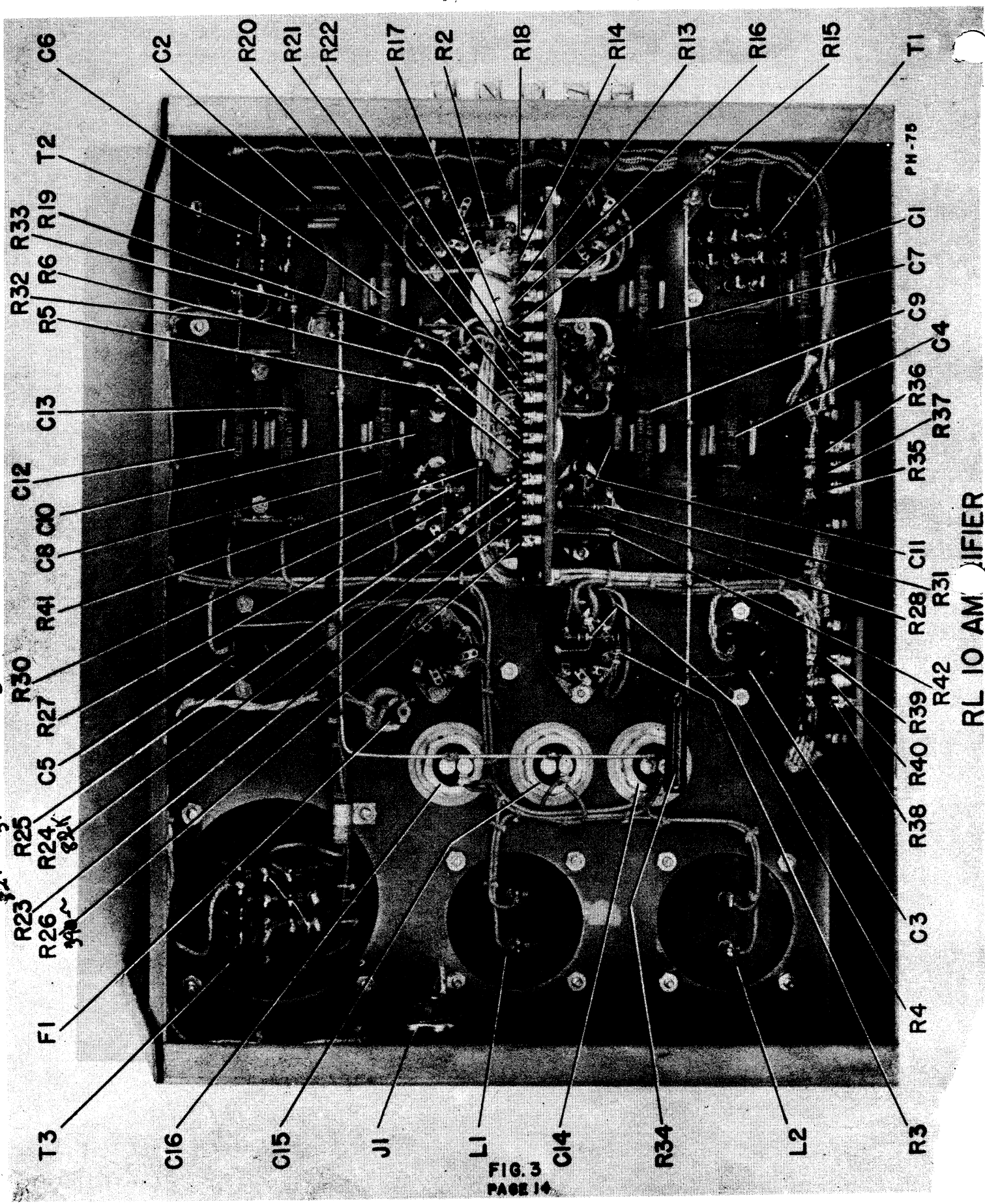
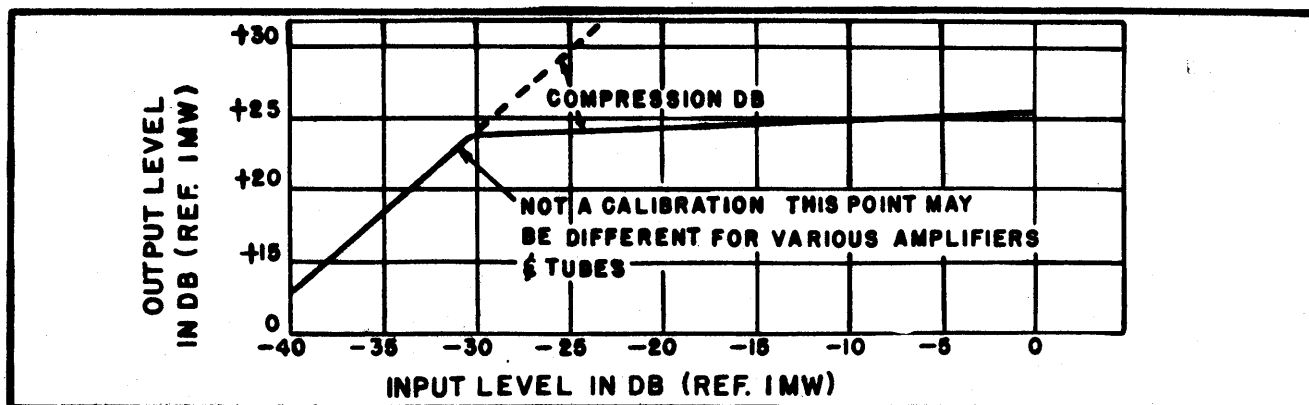
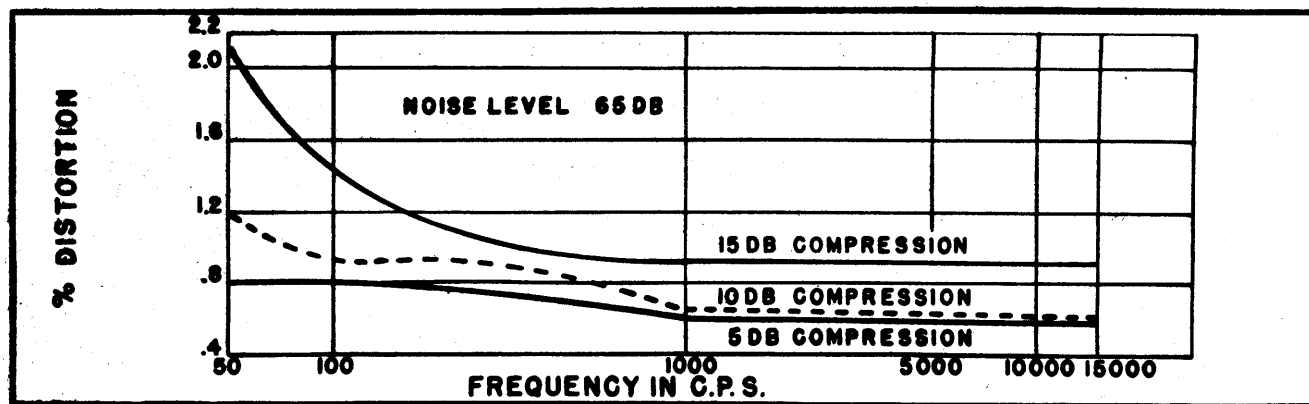


FIG. 3
PAGE 14

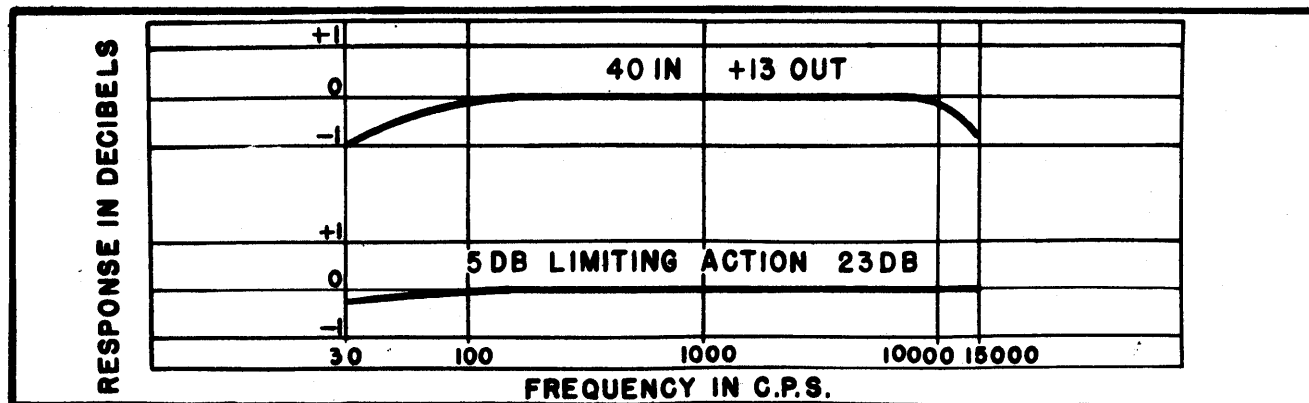
RL IO AM JIFIER



LIMITING ACTION CHARACTERISTIC.

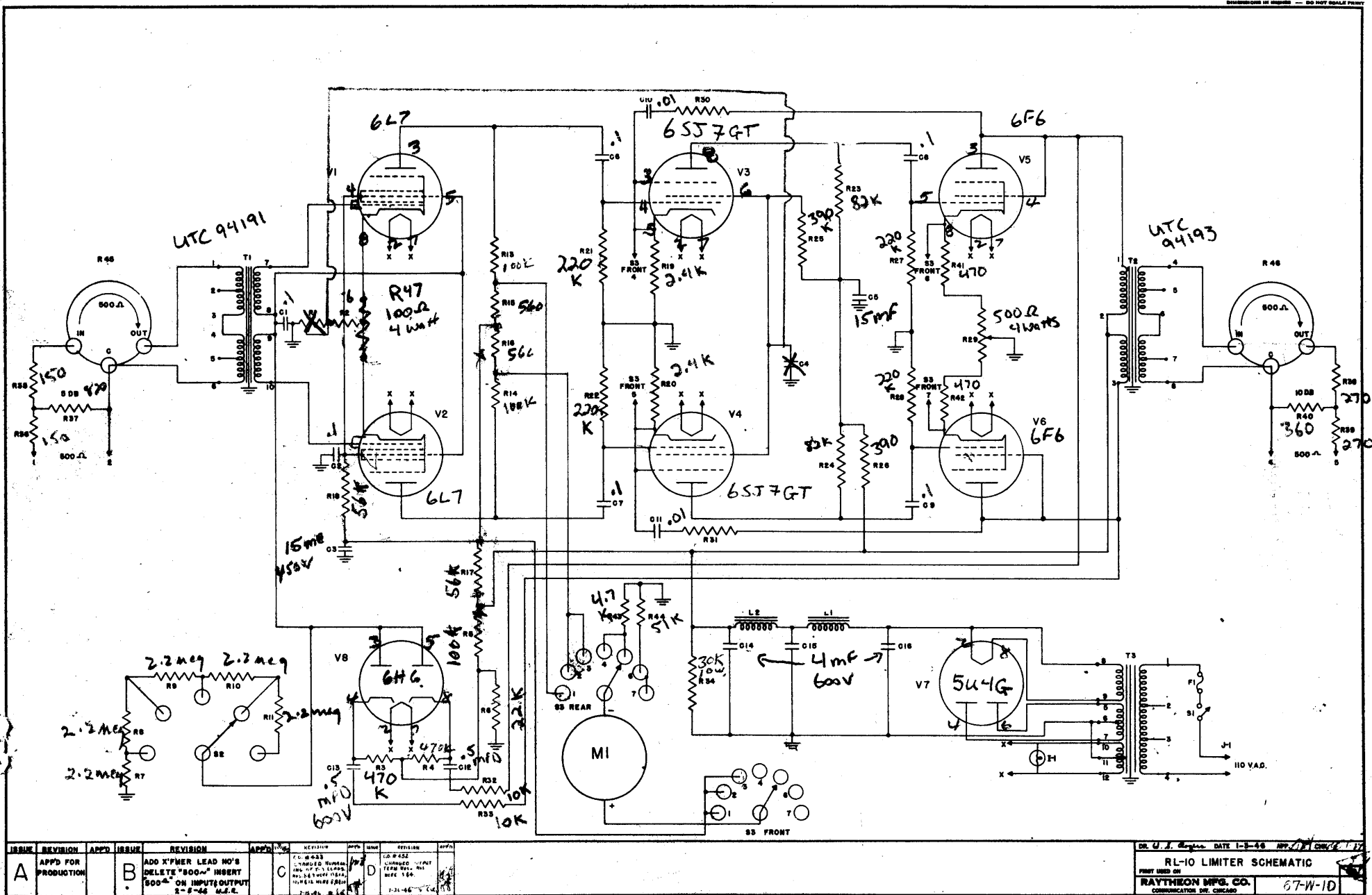


PERCENTAGE DISTORTION WITH 5, 10 AND 15 DB LIMITING ACTION.



FREQUENCY RESPONSE OF AMPLIFIER, MEASURED BOTH WITH AND WITHOUT COMPRESSION.

SEE ATTACHED SHEETS FOR
MODIFICATION MADE 9/6/50 *RCG*



ISSUE	REVISION	APPD	ISSUE	REVISION	APPD	ISSUE	REVISION	APPD	ISSUE	REVISION	APPD
A	APPD FOR PRODUCTION		B	ADD K'FMR LEAD NO'S DELETE "800" INSERT "800" ON INPUT/OUTPUT 2-5-48 G.S.G.		C	REVISION		D	REVISION	

DE U.S. Patent DATE 1-5-48 REF. 101 CH. 117
RL-10 LIMITER SCHEMATIC
PRINT USED ON
RAYTHEON MFG. CO.
COMMUNICATIONS DIV. CINCINNATI
67-W-10

RAYTHEON*Excellence in Electronics**Mr. Amundsen*FIELD SERVICE BULLETIN
BROADCAST #108

July 26, 1950

TO: All Users of the Model RL-10 Limiting Amplifier

SUBJECT: Circuit improvements.

The model RL-10 Limiting Amplifier circuit has recently been modified to improve its operation under sudden transient peak and low frequency shock disturbance conditions. The changes and their effect on their associated circuits are:

Attack time reduction

The "attack time" is the time required for limiting action to take place and is determined by the time constant of capacitor C1 and the source impedance of the audio rectifier charging circuit. The source impedance consists of--audio rectifier V8, coupling condensers C12-13, isolating resistors R32-R33, and the plate impedances of V5-V6. A decrease in source impedance with a consequent reduction of the attack time to approximately one half of its former value is accomplished by the replacement of coupling condensers C12-C13 (.1 mfd 600 V.) with .5 mfd 600 V. units.

Addition of input stage balancing potentiometer

Dynamic balancing of input tubes V1 and V2 may be readily accomplished by the addition of a 100 ohm potentiometer to their cathode circuit as shown on the attached schematic.

Service Department

RAYTHEON MANUFACTURING COMPANY — WALTHAM 54, MASS.

The resultant improvement in operation that can be expected from both circuit changes are:

1. Speed up of limiting action on steep wave front signals such as line switching or mishandling of mikes and pickups.
2. Reduction of distortion and noise due to more accurate balancing of the input stage.

The circuit modifications may be accomplished with a minimum of time and effort if the following procedure is used.

Components Required

<u>Symbol</u>	<u>Description</u>
R2	Resistor, 56 ohm \pm 10% 1 watt carbon
R47	Potentiometer, 100 ohm 4 watt. Mallory type M100 PX or equivalent.
C12, 13	Condenser, .5 mfd 600 V. Paper Aerovox type 684 or equivalent.
<ol style="list-style-type: none">1. Remove potentiometer R1 (500 ohm) from its mounting adjacent to V1 and V2 and install in its place the new 100 ohm balancing potentiometer which will carry the new symbol R47.2. Remove condenser C4 (V3, V4 screen bypass) and its mounting clip and relocate to the side of the chassis in back of input transformer T1. Transpose the connections of C1 and C4 by removing the hot lead of C1 from terminals 9 and 10 of T1, placing it on the screens of V3 and V4; and connecting the former C4 in place of C1.	

July 26, 1950

3. Enlarge the hole exposed by the removal of C4 mounting clip to 3/8" and install R1 in this new position. Connect one outside terminal of R1 to the adjacent ground bus and the center arm to pin 6 of V1 (pin 6 is used as a tie point). Connect the new R2 (56 ohm) from this same pin 6 to the center arm of R47.
4. Cut at its midpoint the jumper connecting the V1, V2 cathodes (pin 8) and connect each of these wires to the nearest outside terminal of R47.
5. Remove the two .1 mfd condensers (C12 and C13) from the audio rectifier cathodes (Pins 4 and 8) and replace with .5 mfd units.

Tests and adjustments

With power on but no input signal applied, adjust R47 balance potentiometer until the meter readings of V1 and V2 are equal. Switch meter to "LIM" position and adjust R1 (if necessary) to obtain a 0 DB reading.

All circuit voltages, meter readings, and adjustments should be as described in the RL-10 instruction manual. R47 should be used in conjunction with R29 for the minimum distortion adjustment if distortion meter is available.