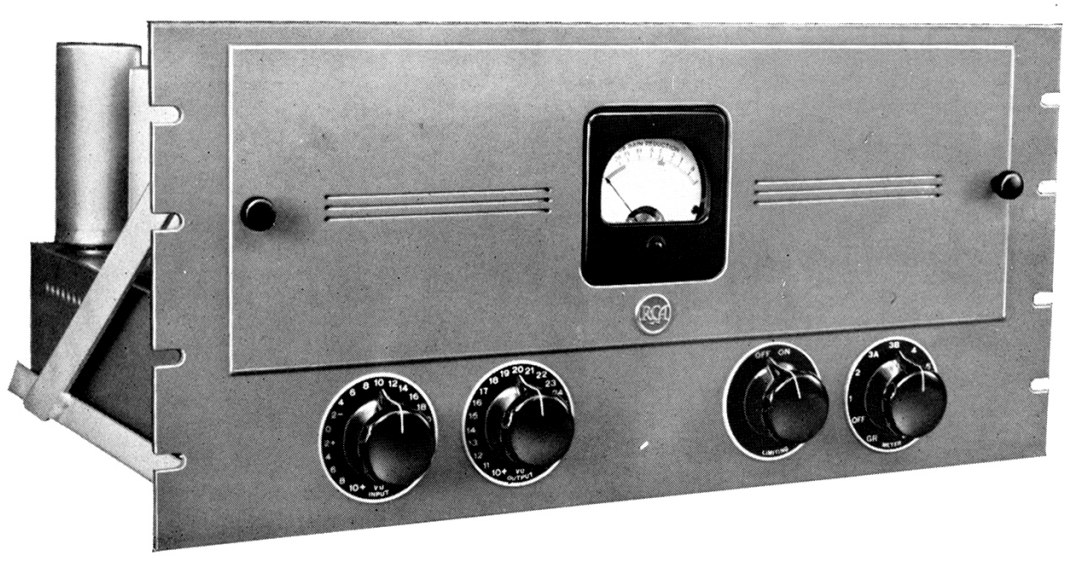
Limiting Amplifier - Type 86-B



86-B Mounted on 36-B Shelf

Features

- Excellent frequency response—suitable for FM.
- High compression with low distortion.
- Low noise level.
- Prevents distortion and adjacent channel interference caused by overmodulation of transmitters.
- Provides for a more effective use of transmitter power by raising the average modulation percentage.
- Meter with rotary selector switch shows gain reduction, checks plate current of all tubes, and checks overall voltage supply.
- Economical in price.
- Improved tube balance.

Uses

The 86-B Limiting Amplifier has been designed for use in the speech input channels of FM and AM broadcast transmitters. It serves to limit the audio signal peaks to a certain pre-determined level thereby preventing over modulation with its consequent distortion and adjacent channel interference. This amplifier also provides for a more effective use of transmitter power by raising the average percentage modulation level several db without appreciably increasing the harmonic distortion. The limiting characteristics of the 86-B also readily adapt it for use in recording applications. For this use, it prevents overcutting of the recording disc on heavy passages of music or speech and permits a marked improvement in the signal to noise ratio.

Description

The 86-B Limiting Amplifier uses push-pull vacuum tubes (RCA 6K7) in the variable-gain stage. The design is such that a uniform frequency response and a remarkably low distortion is maintained with large compression ratios as much as 18 db. Moreover, low distortion is maintained at all modulating frequencies in the normal audio band.

An improved tube balancing circuit has been included in this amplifier which allows any pair of standard RCA 6K7 tubes to be used in the limiter circuit. Balance can be easily maintained through the normal life of the tube.

There are no audible "thumps" even though a large compression is suddenly applied. Compression timing constants have been chosen which have proved most desirable in actual broadcast service. The fast pick-up time of one millisecond restricts over-modulation surges which might cause transmitter outages. The return time is slow enough to prevent distorting low frequency times, but fast enough to prevent noticeable level reduction after loud volume peaks.

The circuit of the 86-B is straight forward and push-pull stages are used throughout. The a-c power supply is self contained and utilizes one RCA 5T4 rectifier tube. New plug-in type electrolytic capacitors are used to simplify servicing the equipment. The hum and noise level is maintained to a low value through special transformer shielding. When used in conjunction with a two stage pre-amplifier, the 86-B has sufficient maximum gain (60 db) for making local announcements. The push-pull output stage and efficient circuit design provide a maximum power output of 1 watt (+30 VU) with less than 0.75% total rms distortion measured at 400 cycles with a compression of 18 db. The distortion is less than 1.8% rms when measured at any frequency between 50 and 7500 cycles.

All the components are mounted on a single metal chassis. A meter is provided for (1) indicating gain reduction directly in

db, (2) dynamic match indicator for input tubes, (3) measurement of all tube plate currents, and (4) measurement of plate voltage. A switch on the front of the chassis selects the desired meter function.

Step-by-step input and output volume controls are provided. These controls are equipped with "vu" scales to indicate input and output levels at the verge of compression. Auxiliary adjustable controls are (1) hum balance, (2) zero adjustment of gain reduction meter scale, (3) vernier control for close adjustment of level at which limiting action takes place, and (4) switch (on front) which makes limiter function inoperative. A power switch and fuse are provided. For rack mounting the Type 36-B Shelf should be used. A special umber-grey 36-B door panel with meter cut-out is supplied with the 86-B Amplifier.

Specifications

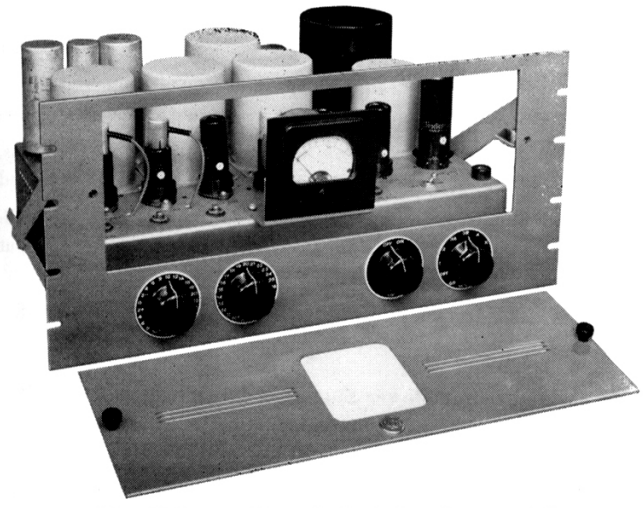
Input Source Impedance ..... 600 or 250 ohms

Output Load Impedance ..... 600 or 250 ohms

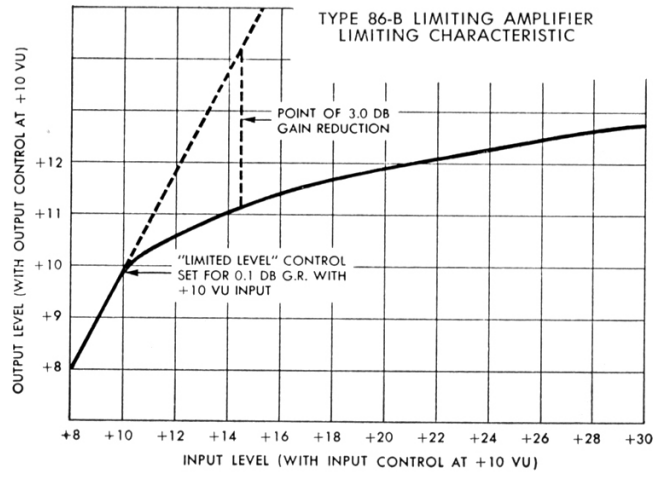
Frequency Response ..... ±2db 30-15,000 cycles
(At any setting of gain controls—with or without compression)

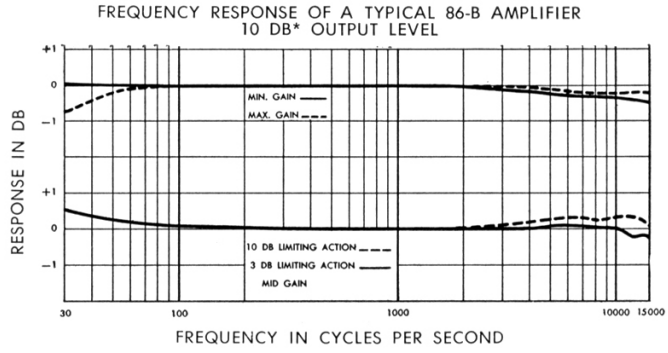
Input Level
- Maximum (at limiting verge) ..... +10 dbm
- Maximum (with 18 db gain reduction) ..... +30 dbm
- Minimum (at limiting verge) ..... —30 dbm

Output Level:
- Less than 1.8% rms distortion with 18 db compression at any frequency between 50 and 7500 cycles ..... +30 dbm
- Less than 0.75% rms distortion at 400 cycles with 18 db gain reduction ..... +30 dbm
- Less than 0.4% rms distortion at 400 cycles with no gain reduction ..... +10 dbm



The 86-B, as shipped, includes the special door panel shown above





Gain (with maximum volume control setting and signal below limiting level) ..... 60 db

Noise Level: below +30 dbm output ..... —85 db
below +10 dbm output ..... —77 db

Output Range (at verge of limiting) ..... +10 dbm to +30 dbm

Time Constants
- Seconds for complete action of gain reduction 0.001
- Seconds for 90% recovery of gain after signal drops below limiting level (when connected as furnished) 2.0
  Note: may be varied from .26 sec. to 5.2 sec. by changing one resistor.

Power Input (105-125 volts, 50-60 cycles) ..... 70 watts

Dimensions ..... Width 16″, depth 13″, height 7½″

Weight (unpacked) ..... 30 lbs.

Stock Identification: Umber Gray MI-11216-D
Complete with one set of tubes and panel and shelf

Accessories

Tube Kit (complete tube complement) MI-11286-B
2 RCA-6K7, 1 RCA-6N7, 2 RCA-1621, 1 RCA-6R7, 1 RCA-5R4GY

* Reference level one milliwatt.

INSTRUCTIONS FOR

Limiting Amplifier

TYPE 86-B

(MI-11216-D, -E)

DESCRIPTION

Application

The Type 86-B Limiting Amplifier is intended for use in the speech input channel of a radio transmitter to prevent overmodulation by limiting the high audio signal peaks which occasionally occur in program material. This limitation permits a substantial increase in the average level of modulation, and hence an increase in the effective range of the transmitter without any increase in carrier power. The amplifier may also be used advantageously in recording.

Action of Limiter

The action of the limiter is similar to that of delayed automatic volume control in a radio receiver. For signal levels below a specified value, the gain in the amplifier is not affected. Above this level, however, the gain is sharply reduced, and the

TECHNICAL DATA

Power Required

105-125 volts, 50-60 cycles, 70 watts

Radiotrons

2 RCA-6K7 (Push-pull)
1 RCA-6N7 or 6N7GT (Push-pull)
1 RCA-6R7
2 RCA-1621 (Push-pull)
1 RCA-5T4 or 5R4GY

Impedances

Source, 500-600 ohms or 250 ohms
Input, 600 or 250 ohms, approx
Output, 520 or 260 ohms
Load, 500-600 ohms or 250 ohms

Input Level

Maximum: +10 db* at limiting verge
+30 db* with 18 db gain reduction
Minimum: −30 db* at limiting verge

Gain

60 db, with maximum volume control setting and signal below limiting level

Gain Controls

Input, 40 db in 2 db steps
Output, 20 db in 1 db steps

Gain Reduction Characteristic

See figure 4

Time Constants (Approx)

0.001 second for complete action of gain reduction
2 seconds for 90% recovery of gain after signal has dropped below limiting level

Frequency Response

±1.0 db from 30 to 10,000 cycles
±2.0 db at 15,000 cycles (500-600 ohms source and load)

Hum and Noise Level

(With input terminated and hum potentiometer adjusted for minimum)
(a) −55 db* (85 db below signal with output control at +30)
(b) −67 db* (77 db below signal with output control at +10)

Power Output

+30 db* with 18 db gain reduction and 1% total rms harmonic distortion at 1000 cycles

Output Range

(At verge of limiting)
+10 db* to +30 db*

Dimensions and Weight

Width, 19 inches
Depth, 14 inches
Height, 10½ inches
Weight, 44½ pounds (unpacked)

*0 db = 0.001 watt

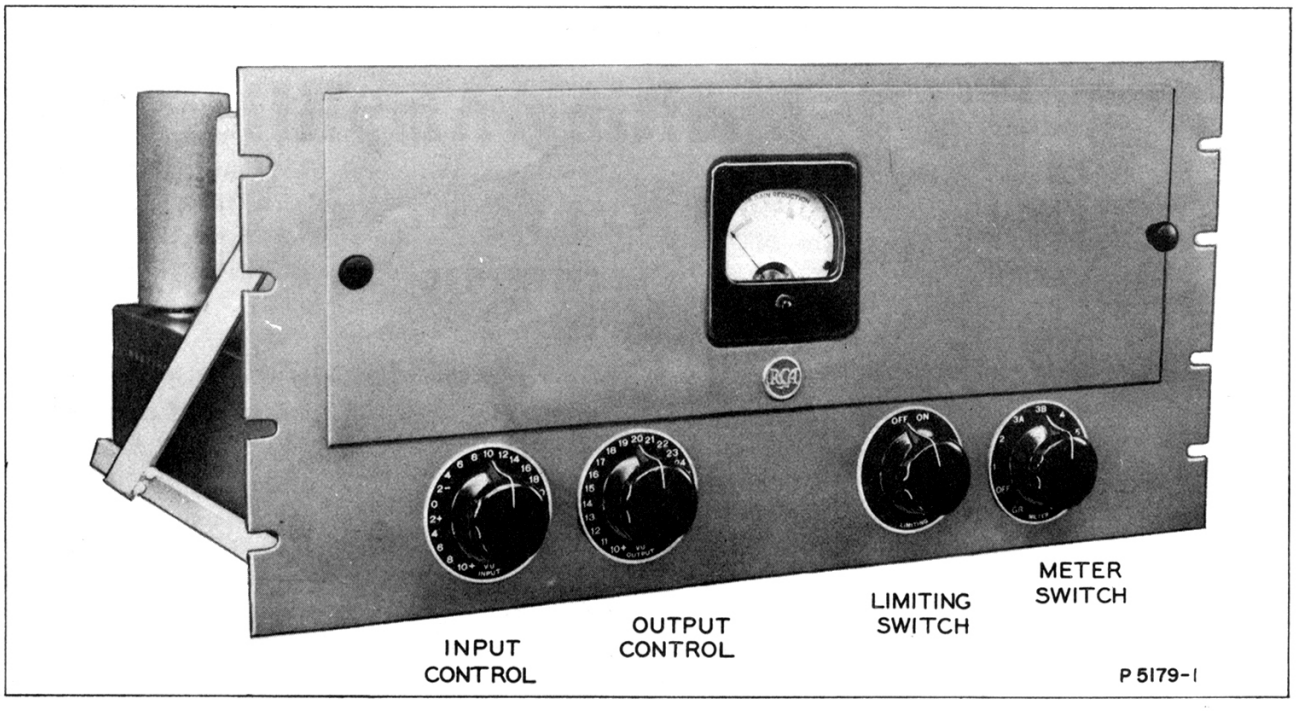


Figure 1—Front view of 86-B Amplifier (door closed)

amount of reduction increases with the strength of the signal. As a result, above the predetermined level the output of the amplifier changes relatively little for large changes in the input level. The electrical action of the limiter is shown in the circuit diagram of the amplifier (fig. 3). A portion of the signal voltage across the secondary of T-2 is impressed on the grid of the triode section of 6R7, and the resulting output of this triode is then rectified by the two diodes of the same tube. The diode plates are polarized negatively by a fixed amount so that the diodes do not conduct until the signal voltage exceeds the polarizing voltage. When the signal is strong enough to make the diodes conduct, condenser C-8 charges up to a voltage which depends on the amount by which the signal voltage exceeds the polarization voltage. The voltage across the condenser is then applied as bias on the control grids of the two 6K7 tubes. The higher this bias, the less these tubes amplify. Thus an automatic check on the gain in the amplifier is established as soon as the signal voltage exceeds a predetermined value. The effectiveness of the limiting, for one particular setting of the controls, is shown in figure 4.

Time Constants

If overmodulation of the transmitter is to be prevented when sudden intense peaks of signal occur, the limiter circuit must respond almost instantaneously. This requires that condenser C-8 be charged through a low resistance and that its capacity be not excessively large. The specified capacity of C-8 is 0.25 mfd. and the resistance of the charge circuit is virtually only that of the diodes. This combination is such that the circuit responds in about 0.001 second, which is generally considered fast enough.

After the gain has been depressed by a sudden strong peak, the circuit must recover its normal amplification if signals of weak and moderate levels are to reach the modulator with desired amplitudes. This limiter recovers by the discharge of C-8 through resistor R-41. For the specified values of C-8 and R-41 it requires about 2 seconds for the circuit to recover 90% of its normal gain. A longer recovery time would cause noticeable loss of volume after each gain reduction, and a much shorter recovery time might have an unfavorable effect on the quality.

Controls

There are four main controls on the panel (fig. 1). They are discussed in detail below.

a. *Input Control.* The knob at the extreme left of the panel controls a dual potentiometer R-2 which is connected in the control grid circuit of the 6K7 tubes. The resistance of each side of this potentiometer is 25,000 ohms and the control is

calibrated in steps of 2 db. Its function is to compensate for differences in input signal levels. This calibrated control should be set for the average program level at input.

b. *Output Control.* The second knob from the left controls a dual potentiometer R-14 which is connected in the grid circuits of the 6N7 tube. The resistance of each side of this potentiometer is 13,000 ohms and the control is calibrated in steps of 1 db. This control determines the limited output of the amplifier. Therefore the calibrated dial should be set for the desired output program level.

c. *Limiting Switch.* The third control on the panel is an ON-OFF switch (S-3) which determines whether or not the limiting action of the amplifier will be used. In the OFF position the 6R7 tube is not functioning and the gain of the amplifier is independent of the strength of the signal. The maximum gain is then about 60 db. In the ON position of the switch the output of the amplifier is limited on predetermined peaks.

d. *Meter Switch.* The fourth control on the panel is a six-deck, 11-step gang switch (S-1) for connecting the meter to various points in the circuit for testing purposes. The table given in Maintenance shows the various connections made and the quantity tested in each switch position.

Adjustment Controls

Several minor controls are provided in the amplifier for facilitating restoration of balance in the circuit after tubes and other parts have been replaced. These controls are taken up below.

a. *Limited Level.* The control marked LIMITED LEVEL on the chassis and R-16 in the circuit diagram permits variation of the input voltage to the control tube 6R7 when the limiting switch S-3 is in the ON position, and in this manner allows variation in the degree of limiting. The

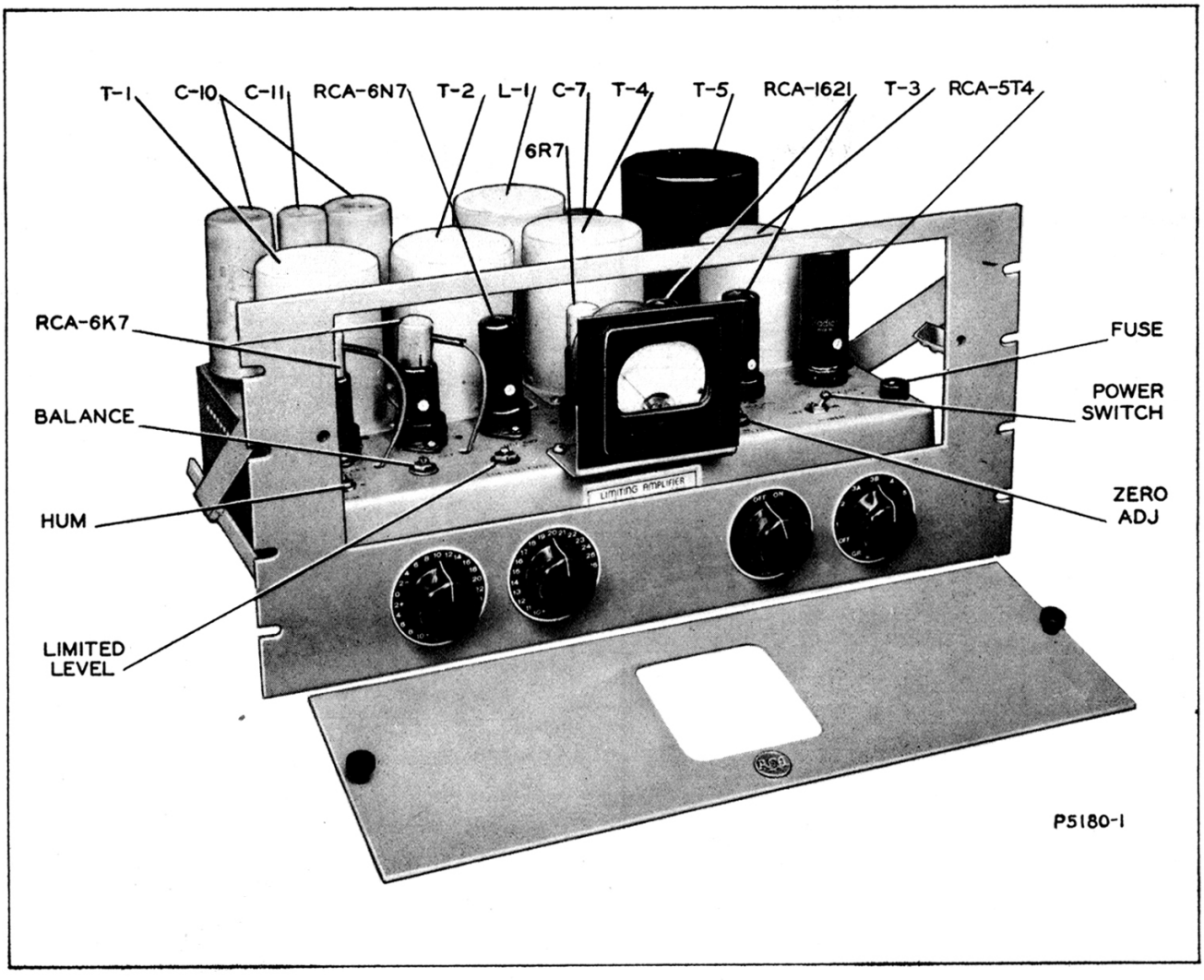


Figure 2—Front view of 86-B Amplifier (door open)

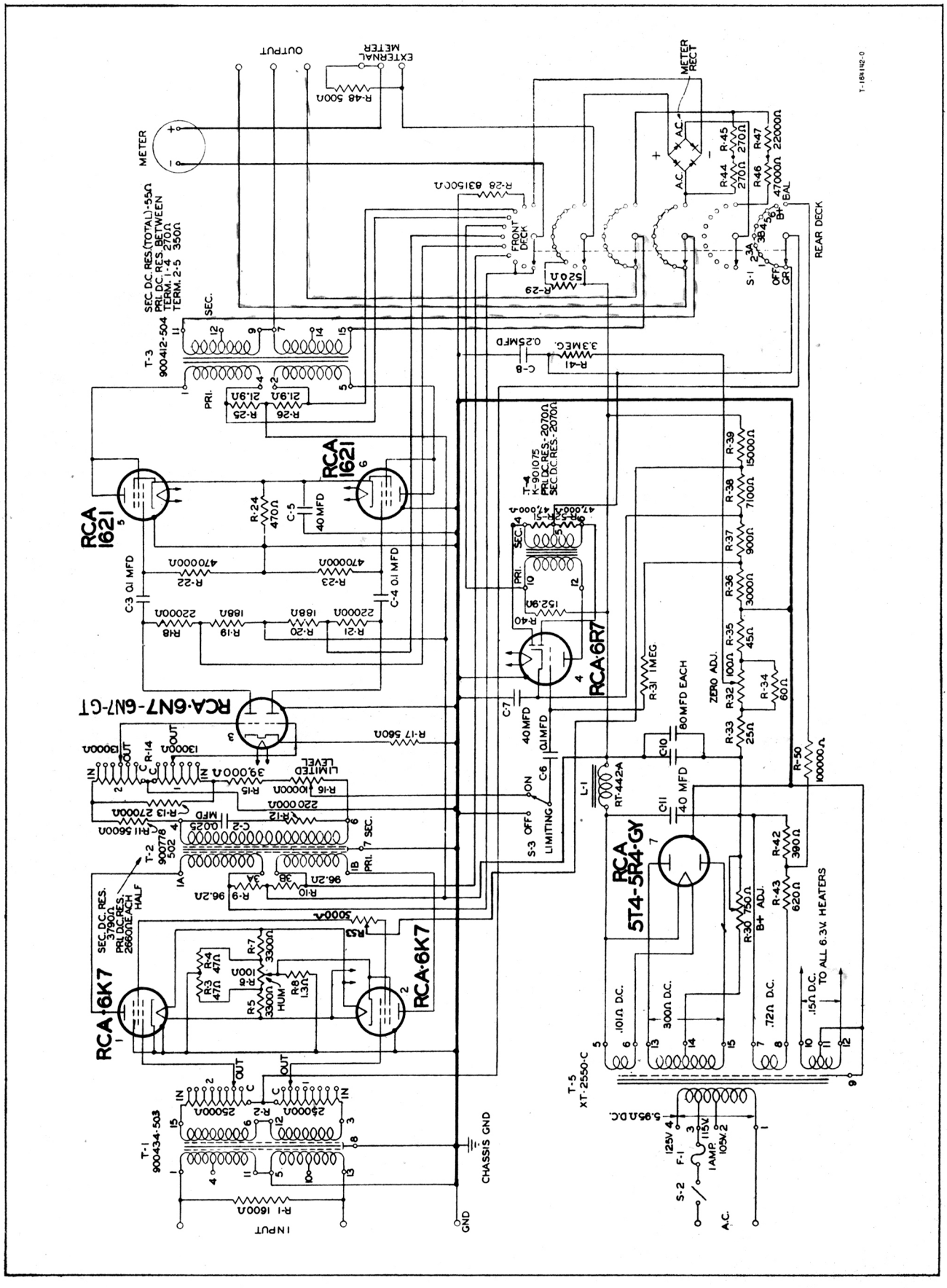


Figure 3—Circuit diagram of 86-B Amplifier

range of variation is from about 73% to 90% of the total signal voltage across the secondary of transformer T-2. The adjustment is effected with a screwdriver through the door in the panel. The use of this control is discussed under Maintenance.

b. *Zero Adjustment.* The control marked ZERO ADJ. is a 100-ohm potentiometer R-32 in the low potential side of the voltage divider of the power supply. This is also adjusted with a screwdriver and is reached through the door in the panel. It serves to adjust the reading of the gain reduction meter to 0 db when the amplifier is not limiting. Its adjustment is discussed under Maintenance.

c. *Hum Adjustment.* This control is a 100-ohm potentiometer R-6 in the cathode-heater circuit of the 6K7 tubes which serves to reduce the hum to a minimum. It is reached through the door in the panel and is adjusted with a screwdriver. For further details refer to *Hum Reduction* in Maintenance.

d. *Balance Adjustment.* The control marked BALANCE, a 5000-ohm potentiometer in the screen circuit of the push-pull 6K7 stage, permits balancing the 6K7 tubes to cancel even harmonic distortion. It is a screwdriver adjustment which is reached through the panel door. The use of this control is explained in the Maintenance section under *Dynamic Balance of 6K7's.*

e. *Power Switch and Fuse.* The power switch S-2 and the fuse F-1 are located at the right end of the chassis just inside the door in the panel.

INSTALLATION

Mounting

Mount the amplifier in a rack 19 inches wide such as any of the Type BR-84 Series of Cabinet Racks. Four slots are provided on each side of the panel for the mounting screws supplied with the rack.

Tubes and Capacitors

Insert the tubes and the three electrolytic capacitors in the correct sockets as indicated by the stencilling on the chassis.

Amplifier Connections

Make all permanent connections of the amplifier to the terminal board located at the rear of the amplifier. Figure 6 shows the arrangement of the terminals.

a. *Input Connections.* The incoming signal line should be connected to the terminals marked INPUT on the rear terminal board. These terminals connect to terminals 1 and 13 on transformer T-1. With this connection the input impedance is 500-600 ohms and therefore the source impedance should have this value. If the source impedance is 250 ohms, the input leads should be moved from terminals 1 and 13 to terminals 4 and 10, respectively, leaving the connection of R-1 undisturbed. The input leads should consist of shielded and twisted pair insulated for 200 volts. They should be kept away from all other leads as much as practicable. In making connections to the source of signal it should be remembered that the center of the input transformer T-1 is connected to chassis ground.

b. *Output Connections.* The load on the amplifier is connected to the three terminals marked OUTPUT. When the load impedance is 500-600 ohms, the two output leads (brown and black-brown) should be left connected to the secondary of the output transformer T-3. But if the load impedance is 250-300 ohms, the two outside leads should be moved, respectively, from terminals 11 and 15 to terminals 12 and 14 on the output transformer. The middle of the three OUTPUT terminals is connected to the mid-point on the secondary of the transformer. When this impedance change is made, the two resistors R-45 and R-47 in the meter rectifier circuit should be short-circuited.

The output leads, like the input leads, should be shielded and twisted pair insulated for 200 volts, and they need not be larger than No. 19 A.W.G. They should preferably go directly to the transmitter.

c. *External Meter.* Provision has been made for the use of an external gain reduction meter. In installing this meter, the shunt on the terminals marked METER should be removed and the meter should be connected to the terminals directly above the marking. The center terminal is negative.

Setting Up

After the input, output, and power connections have been made to the amplifier, set the input and output controls to the approximate levels to be used. Turn the meter switch to GR and impress a 200- to 2000-cycle sine wave signal of constant amplitude on the amplifier. Use the LIMITED LEVEL control as a vernier on the OUTPUT

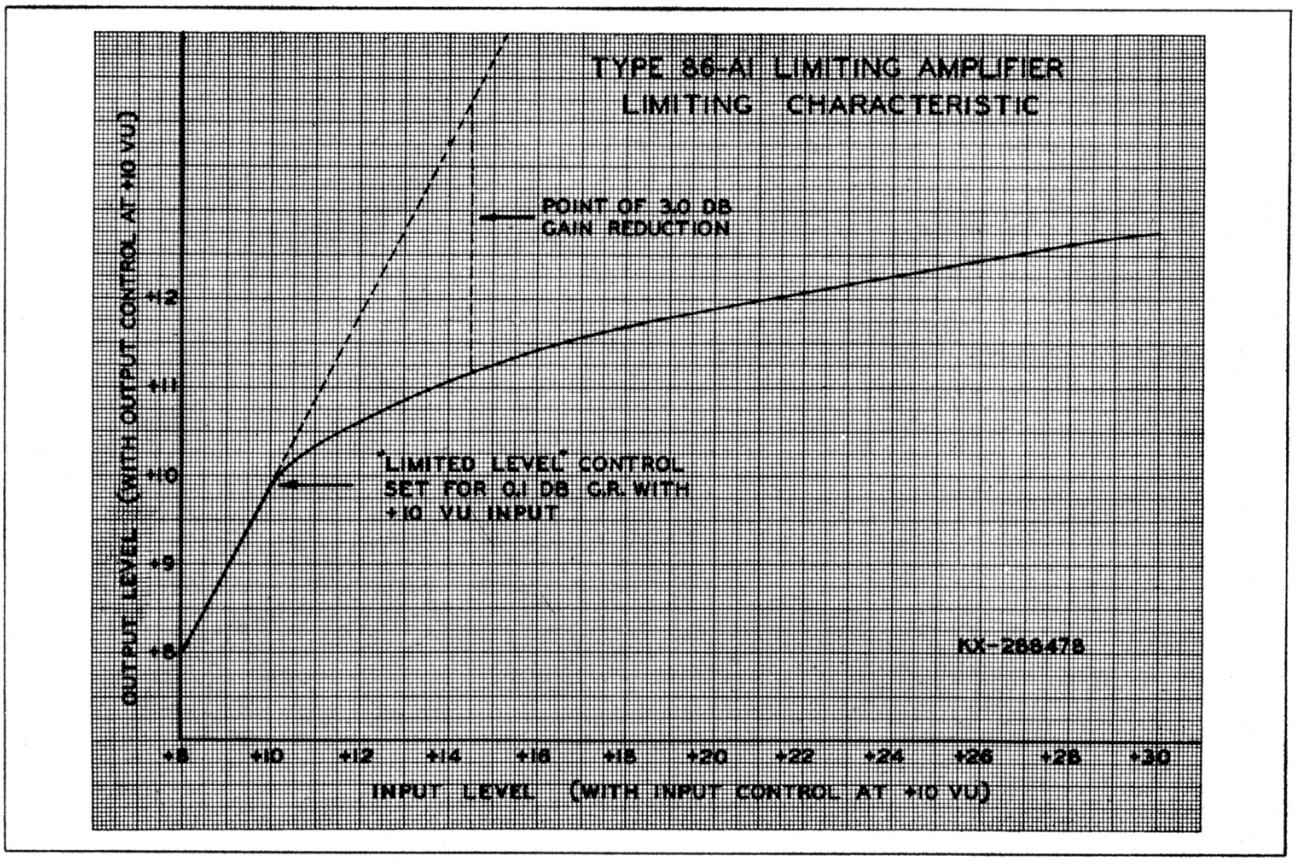


Figure 4—Gain reduction characteristics of Type 86-B Amplifier

CONTROL to obtain the exact maximum modulator input level when the meter shows a gain reduction of approximately 3 db. If the **LIMITED LEVEL** control does not have sufficient range to bring this about, readjust the input by the required amount. When this adjustment has been effected, the gain reduction in the amplifier is determined by the input signal level and by the setting of the **INPUT** control, as well as by the dynamic range and character of the signal material. The **INPUT** control provides for changes in 2 db steps. If the program limiting requires closer adjustment, it should be done with a continuous control in the channel preceding the Type 86-B amplifier.

The average reduction should not exceed about 3 db. This corresponds to a condition in which the meter needle normally stands at or near 0 db gain reduction and only intermittently kicks to 3 db gain reduction. In estimating the momentary gain reduction it should be remembered that the meter needle tends to overshoot slightly. When the system has been adjusted in this manner, momentary overmodulation may occur on strong signal peaks. However, the periods of overmodulation will be exceedingly short and will not give rise to noticeable distortion or interference with other channels. They will occur during the initial period of a gain reduction and during periods of rapid change in the signal level.

Adjustment for Line Voltage

The Type 86-B amplifier has been wired at the factory for a power line voltage of 115 volts. If the line voltage regularly deviates from this value by more than 5% in either direction, an appropriate wiring change should be made in the primary of the power transformer T-5 (fig. 3). The lead containing the fuse should be moved to tap 4 if the line voltage is high and to tap 2 if it is low.

MAINTENANCE

If the Type 86-B amplifier is to give top performance at all times, it must be maintained in good operating condition. It should be tested frequently and be subjected to such corrective measures as the tests indicate. In order to facilitate these tests, the meter switch has been provided. With it the indicating meter can be connected into eleven different points in the circuit. The quan-

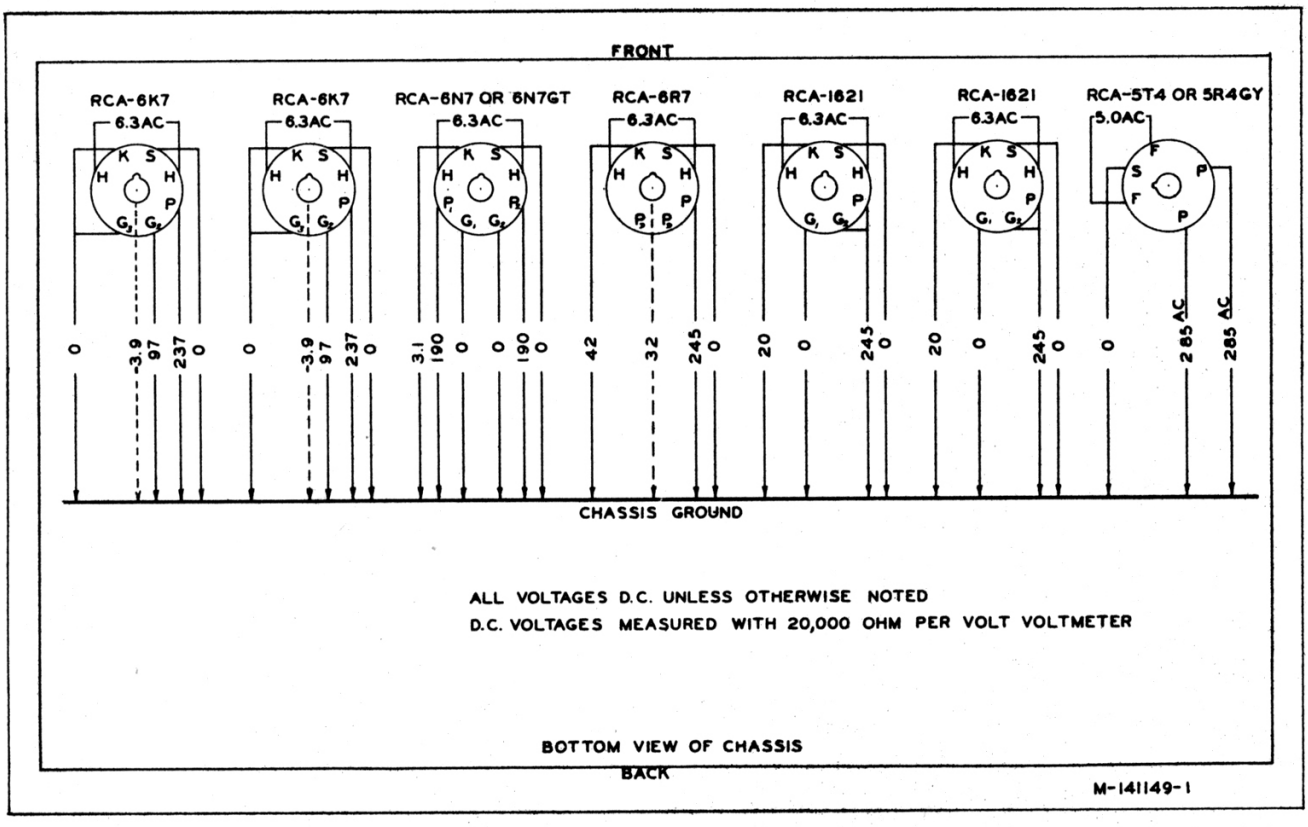


Figure 5—Socket voltage diagram of 86-B Amplifier

tity measured in each position and the result expected are shown in the table below.

Dial	*Indication*	*Meter Range*
GR	Gain reduction	DB Scale
OFF	Meter disconnected	
1	Ip of RCA-6K7 No. 1	Check
2	Ip of RCA-6K7 No. 2	Check
3A	Ip of RCA-6N7 No. 3	Check*
3B	Ip of RCA-6N7 No. 3	Check*
4	Ip of RCA-6R7 No. 4	Check
5	Ip of RCA-1621 No. 5	Check*
6	Ip of RCA-1621 No. 6	Check*
BAL	RCA-6K7 balance	6K7 Match
B+	Rectified output voltage	Check

*NOTE: Readings on 3A and 3B should be in the check range, but they may be between 1 and 4 on the meter scale provided that the two readings do not differ from each other by more than the width of the check range mark. The same applies to the readings on steps 5 and 6 for the two RCA-1621 tubes.

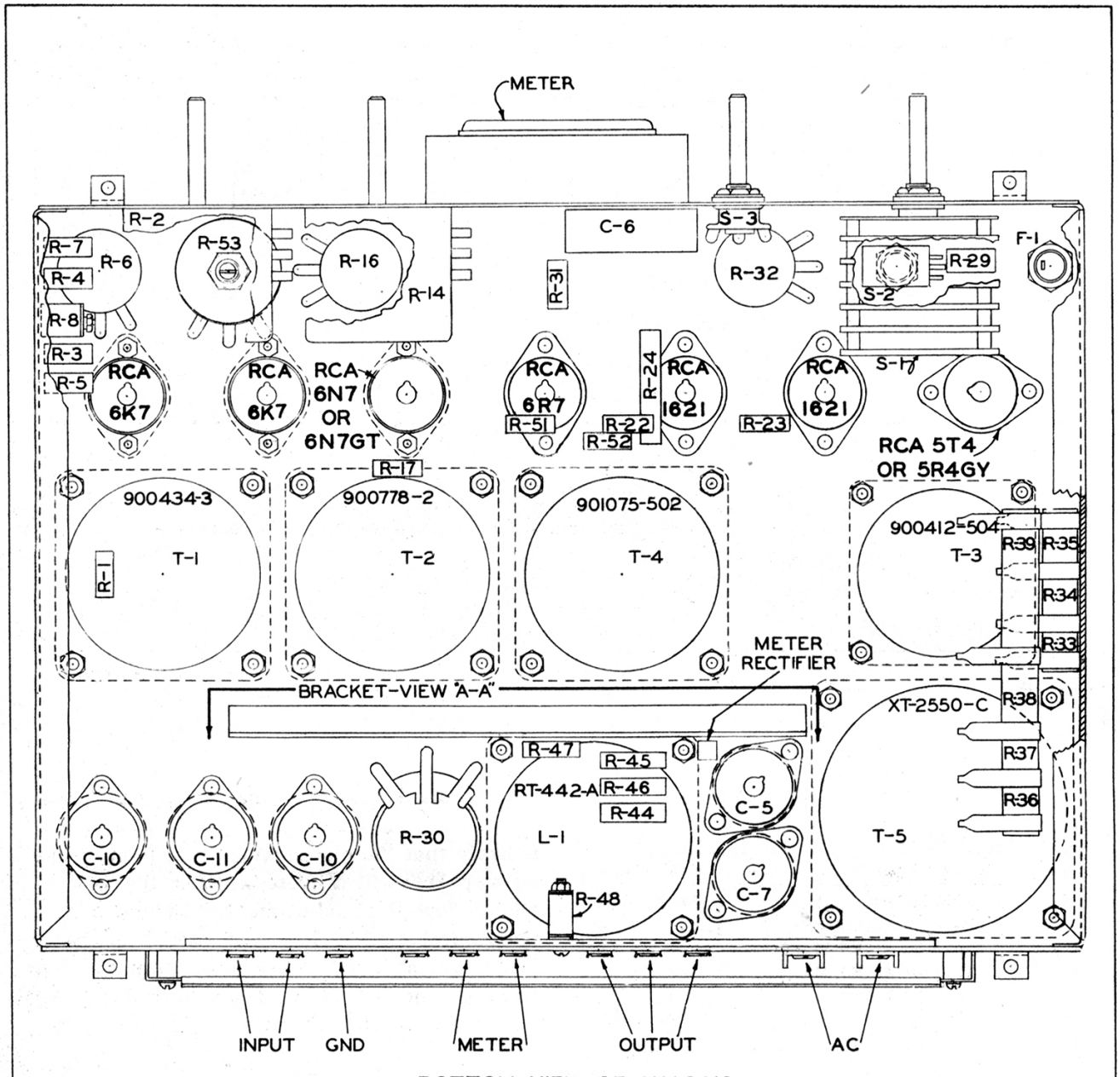
Adjustments

If the indications are not as expected, adjustments must be made to bring the circuit in balance. These adjustments may be required because tubes have been replaced, because the old tubes have deteriorated unequally, or because of some other change in the circuit.

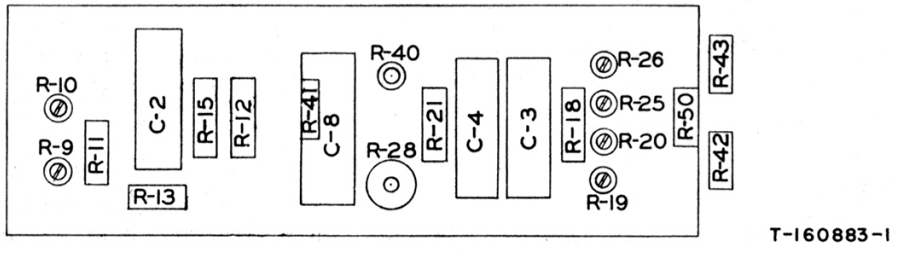
a. *Plate Voltage.* If the readings are consistently either above or below the **CHECK** mark, it is likely that the plate voltage is at fault. A check on step B+ will disclose whether the voltage is high or low. If an adjustment must be made, turn the control marked B+ ADJ., which is the 750-ohm rheostat R-30 in the lead from the center point on the secondary of transformer T-5, until the voltage reading checks.

b. *Zero Adjustment.* Turn the meter to **GR.** Do not impress an input signal on the amplifier. Adjust the **ZERO ADJ.** control R-32 until the meter indicates 0 db gain reduction. Make the adjustment slowly so that the meter will have time to come to rest after a change in the adjustment has been made. This precaution is necessary because of the long time constant of the reduction circuit on recovery.

c. *Hum Reduction.* Connect a 600-ohm resistor across the input terminals in place of the signal source and connect the output terminals of the amplifier to the input terminals of a Type 69-B Noise Level Meter. Set the input and output controls to the positions used in normal operation and adjust potentiometer R-6, marked **HUM** on the chassis, until the hum is minimum.



BOTTOM VIEW OF CHASSIS



BRACKET-VIEW "A-A"

Figure 6—Bottom view of chassis of 86-B Amplifier

d. *Dynamic Balance of 6K7's.* Turn the tubes on and let them warm up for about 10 minutes. Set the meter switch on BAL. This injects a 60-cycle voltage into the control grids of the 6K7's, with the grids in parallel, and it also connects the 60-cycle output of the amplifier, through the rectifier, to the indicator meter. Set the OUTPUT control to +30 db, that is, to the point of greatest output. This output will be due to unbalance in the amplifier. The meter indication should fall within the 6K7 MATCH range of the scale. If it falls outside, turn the BALANCE control until the match is close enough to bring the needle within the match range.

e. *Limited Level.* A change of tubes may result in a slight change of gain in the amplifier, or a change in the level at which gain reduction starts, or a change in the level to which the output is limited. Therefore the LIMITED LEVEL control should be readjusted whenever tubes have been changed. When this control is in mid-position, the INPUT control calibration shows the approximate level at which limiting action starts, and the OUTPUT control calibration shows the approximate level at verge of limiting. The LIMITED LEVEL control changes both these calibrations over a range of about 1.5 db. In setting this control, the limiting switch should be set to ON and the meter switch to GR.

Operating Voltages

The normal operating voltages, a.c. as well as d.c., are shown in figure 5. These voltages should be obtained when the a-c line voltage is 115 volts and the d-c voltages are measured with a 20,000 ohms per volt meter. Measured values should not differ by more than 5% from the listed values. If the d-c voltages are measured with a voltmeter having a lower resistance, all readings will be less than those listed by an amount depending on the resistance through which the meter current has to flow. The voltage across condenser C-11 should be about 280 volts.

Time Constant Changes

Occasionally after the amplifier has limited a strong peak in the program or a sharp transient in the input line, a blank in the output may be observed. That is, a note of music or a word of speech may be missing. This lapse is due to the slow recovery rate of the gain in the amplifier. While such lapses are normal, their observance is rare. If, however, they should be observed so frequently as to become annoying, it may be desirable to change the time constant of the recovery circuit. This is done simply by changing the value of resistance R-41. The table below gives the time constants for five different values of R-41 and the resulting time of gain recovery.

R-41	*Time Constant*	*Time for 50% Recovery*	*Time for 90% Recovery*
10 meg.	2.5	1.4 sec.	5.2 sec.
5 meg.	1.25	.7 sec.	2.6 sec.
2.5 meg.	.625	.35 sec.	1.3 sec.
1.25 meg.	.313	.18 sec.	.65 sec.
.5 meg.	.125	.07 sec.	.26 sec.

As an aid in the selection of time constant for gain recovery the following facts are presented:

a. *Fast Recovery Rate*

(1) Smaller loss of low-amplitude passages which follow soon after passages which are higher than the critical level. This is not serious if high values of compression are avoided, as they should be.

(2) More readily obtainable in design.

b. *Slow Recovery Rate*

(1) More thorough filtering of the control voltage is obtained. That is, the control voltage has less tendency to swing with individual audio cycles and thus less distortion is introduced.

(2) Any background noise returns more slowly after removal of a signal higher than the critical value, and thus is less noticeable.

(3) Other factors and adjustments being the same, on average programs there is less loss of dynamic range.

LIST OF REPLACEMENT PARTS

The following parts list is inclosed to provide identification when ordering replacement parts. Order from RCA Replacement Parts Department, Camden, N. J., giving the *stock number* and *description* of parts wanted. Replacement parts supplied may be slightly different in form or size from the original parts but will be completely interchangeable with them.

Circuit Symbol	*Description*	*Stock No.*
C-2	Capacitor, 0.025 mfd ±10%, 1000 v	70654
C-3	Capacitor, 0.1 mfd ±10%, 600 v	70638
C-4	Same as C-3	
C-5	Capacitor, 40 mfd, 150 v	39459

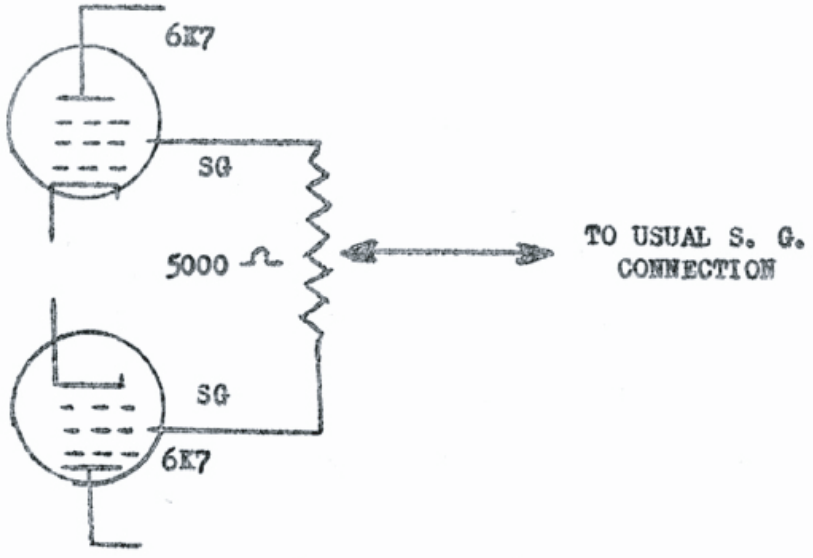
Circuit Symbol	Description	Stock No.
C-6	Same as C-3	
C-7	Same as C-5	
C-8	Capacitor, 0.25 mfd ±10%, 400 v	70618
C-10	Capacitor, 80 mfd, 450 v	39458
C-11	Capacitor, 40 mfd, 450 v	39457
F-1	Fuse, 1 ampere, 3AG	14133
L-1	Reactor, filter reactor	17568
M-1	Meter, gain reduction meter	43504
R-1	Resistor, 1600 ohms, ½ w, ±5%	
R-2	Control, dual input, carbon 50,000 ohms total	43496
R-3	Resistor, 47 ohms, ½ w, ±10%	
R-4	Same as R-3	
R-5	Resistor, 3300 ohms, ½ w, ±10%	
R-6	Control, 100-ohm, hum adjust	43498
R-7	Same as R-5	
R-8	Resistor, 1.3 ohms ±2%, wire-wound	17617
R-9	Resistor, 96.2 ohms ±1%	17589
R-10	Same as R-9	
R-11	Resistor, 5600 ohms, ½ w, ±5%	
R-12	Resistor, 220,000 ohms, ½ w, ±10%	
R-13	Resistor, 27,000 ohms, ½ w, ±5%	
R-14	Control, dual output, carbon 13000-13000 ohms	43497
R-15	Resistor, 39,000 ohms, ½ w, ±5%	
R-16	Control, 10,000 ohms, limited level	43499
R-17	Resistor, 560 ohms, ½ w, ±5%	
R-18	Resistor, 22,000 ohms, 1 w, ±5%	
R-19	Resistor, 188 ohms, ±1%, wire-wound	17590
R-20	Same as R-19	
R-21	Same as R-18	
R-22	Resistor, 470,000 ohms, ½ w, ±10%	
R-23	Same as R-22	
R-24	Resistor, 470 ohms, 2 w, ±5%	
R-25	Resistor, 21.9 ohms ±1%, wire-wound	20473
R-26	Same as R-25	
R-28	Resistor, wire-wound, 831,500 ohms, ±1%	17967
R-29	Resistor, 520 ohms ±1%, wire-wound	17591
R-30	Rheostat, 750 ohms, plate voltage	43500

Circuit Symbol	Description	Stock No.
R-31	Resistor, 1 meg, ½ w, ±10%	
R-32	Same as R-6, zero adjust	
R-33	Resistor, tapped 25-60-45 ohms This stock item includes R-34 and R-35	17631
R-36	Resistor, tapped 3000-900-7100-15000 ohms This stock item includes R-37, R-38, and R-39	17632
R-40	Resistor, 152.9 ohms, ±1%	20449
R-41	Resistor, 3.3 megohms, 1 w, ±10%	
R-42	Resistor, 390 ohms, ½ w, ±5%	
R-43	Resistor, 620 ohms, ½ w, ±5%	
R-44	Resistor, 270 ohms, 1 w, ±10%	
R-45	Same as R-44	
R-46	Resistor, 47,000 ohms, 1 w, ±5%	
R-47	Same as R-18	
R-48	Resistor, 500 ohms, ±2%, wire-wound	43507
R-50	Resistor, 100,000 ohms, ½ w, ±10%	
R-51	Resistor, 47,000 ohms, ±10%	
R-52	Same as R-51	
R-53	Resistor, variable, wire-wound, 5000 ohms, ±10%, 4 w	57134
S-1	Switch, meter control	43501
S-2	Switch, power, S.P.S.T., toggle	43503
S-3	Switch, limiting OFF-ON, S.P.D.T.	43502
T-1	Transformer, input	48115
T-2	Transformer, interstage	43579
T-3	Transformer, output	43577
T-4	Transformer, interstage	43580
T-5	Transformer, power	44683
. . .	Catch, female latch	21446
. . .	Holder, fuse, for F-1	32059
. . .	Knob, control	17268
. . .	Knob, door	43308
. . .	Rectifier, copper oxide, full wave for M-1	43505
. . .	Socket, 8 contact tube	28413
. . .	Socket, 8 contact tube	31319
. . .	Socket, condenser socket	45368

January 7, 1949

86 - A1 LIMITER AMPLIFIER MODIFICATIONS

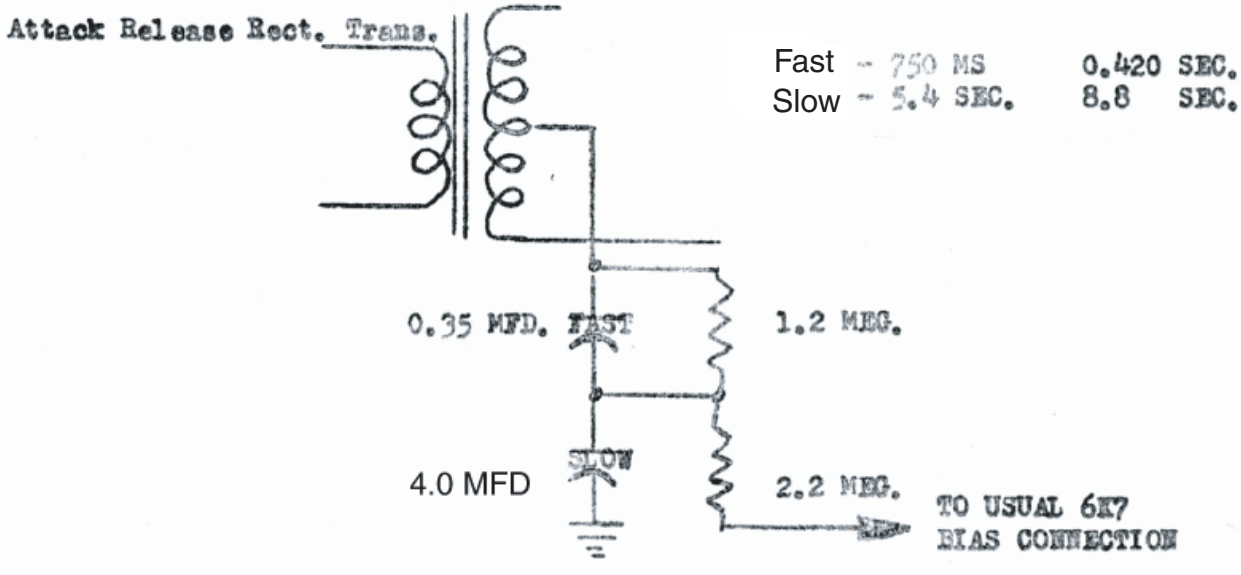
Indicated below are the various desirable changes that can be made in an 86 - A1 to improve operational results.



F I G U R E #1

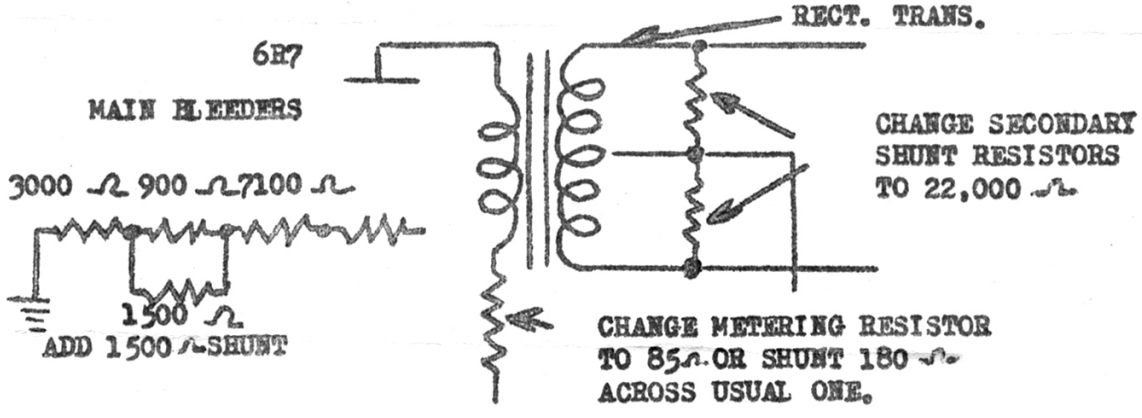
This change is already incorporated in the 86 - B.

A potentiometer is added to the screen grid circuit of the controlled stage as shown in Figure #1. This is for the purpose of improving tube balance. Normally, good tubes can be definitely improved in balance, and it is possible to achieve excellent results using tubes which would be completely unbalanced without the control.



F I G U R E #2

A double time constant system is installed in place of the single system in order to provide the same overall action as N B C has employed over a period of years in certain automatic audio gain controls. By installing a double time constant circuit in the 96A or the 86A, the same overall action can be achieved, and with great simplicity of equipment. The circuit constants permit quick limiting through the rapid charging of the smaller condenser. When high peak levels persist, the general overall gain is reduced so that less limiting action is required. This general level reduction is timed by the larger condenser. Thus for occasional high level peaks, the limiter only is effective. However, for prolonged high levels, the slow circuit takes over most of the control.



F I G U R E #3

The changes in figures #2 and #3 may also be incorporated in the 86 - B.

Gain reduction time is materially reduced from the normal level. This is partially because the series condenser combination is only about half the normal capacity value. Furthermore, the charging circuit impedance is cut by reducing the driver tube plate impedance. This is accomplished by reduced grid bias as shown in Figure #3. Normal plate current is only 3.3 m.a., and after modification it is approximately 6.3 m.a. Also, reduced rectifier transformer terminations help in this respect, while slightly reducing control by extremely narrow peaks--that is, 10 kc control is diminished by 2 db.

With an RCA 86-A so modified, we find it possible to reduce gain by as much as 25 db without audible plops or distortion. Pumping, due to rapid gain rise during pauses, is minimized by the slow action circuit. Yet, at the same time, limiting action is always available. Gain reduction time, measured on a single-sweep CRO, is only about 750 microseconds for 90% reduction.

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